Factors Delaying Hospital Admission After Stroke in Leicestershire

G.D. Harper, MRCP; R.A. Haigh, MRCP; J.F. Potter, DM; and C.M. Castleden, MD

**Background and Purpose:** Use of thrombolysis and acute treatments for cerebral infarction may require that acute stroke be treated as a medical emergency. To assess the factors influencing the time to admission in acute stroke, we conducted a prospective study of all such patients admitted to the hospitals in Leicester, UK, over a 12-month period.

**Methods:** Factors assessed were age, sex, time of stroke onset, stroke severity, home circumstances, and routes of admission. Initial between-group comparisons were made with the Mann-Whitney U test. The individual contribution of each of these variables was assessed with multiple linear regression analysis.

**Results:** An accurate time of stroke onset was identified in 374 (70%) of 535 registered patients (median age 77 [range, 29–98] years; 332 men, 203 women). Median time from onset to admission was 6 hours, with 25% of the patients arriving in less than 2.5 hours and 75% in less than 11.5 hours. Multiple regression confirmed that only admission through the bed allocation bureau (p < 0.001), living alone (p < 0.001), and nocturnal onset (p = 0.003) prolonged delay time. Despite patients over 70 years of age taking a median of 7 hours from onset to admission compared with 4 hours for those under age 70 (p < 0.001), the effect of age appeared to be dependent on these three factors. Age, sex, level of consciousness, rural domicile, and place of admission did not influence the delay time independently.

**Conclusions:** We have identified some of the factors affecting the hospital admission delay time for stroke. With the possible advent of effective early treatments for stroke, these factors will need to be addressed. (Stroke 1992;23:835–838)

**KEY WORDS** • cerebrovascular disorders • hospitalization • Great Britain

The manner in which a patient is referred and admitted to a hospital is closely related to the nature of the underlying diagnosis. Knowledge of the natural history of myocardial infarction and the value of coronary care units has prompted professional awareness of the urgency of hospital admission in cases of severe chest pain. The advent of thrombolytic therapy has reinforced this sense of urgency. A recent study has shown that despite the undeniable benefit of thrombolytic therapy, approximately 50% of patients with acute myocardial infarction, particularly those over 65 years of age, still take over 3.5 hours to be admitted.

Advances in the treatment of ischemic stroke are presently being evaluated and, if effective, appear to require a similar urgency of initiation. The time taken by patients with stroke to reach the hospital in the United Kingdom, and the factors affecting this, are not yet known.

In the present study, we assessed admission times for all stroke patients admitted to the Leicester hospitals over a 12-month period and examined the important influencing factors. We discuss our findings in relation to admissions to a coronary care unit in the same area and experience from the United States.

From the University Department of Medicine for the Elderly, Leicester General Hospital, Leicester, UK.

Address for correspondence: Dr. Glen Harper, University Department of Medicine for the Elderly, Leicester General Hospital, Gwendolen Road, Leicester, UK LE5 4PW.

Received March 14, 1991; accepted February 21, 1992.

**Subjects and Methods**

Leicester is typical of many large English cities, with a population of over 800,000 (including Leicestershire) served by four acute general hospitals at the time of the survey. Referrals to the hospitals were made through the accident and emergency department and general practitioner referrals to one of two bed allocation bureaus. Only a small minority of patients are admitted directly to the wards. All stroke patients are admitted to the acute medical and geriatric wards, with no acute contribution from the neurologists and no selective admissions policy. During most of the study period we had only one operational computed tomographic head scanner, and thus only selected cases of stroke were referred for a scan.

The Leicester Hospitals Stroke Register was established in July 1989. All patients admitted to the Leicester District General Hospitals with acute stroke syndrome were seen within 48 hours by one investigator, and an extensive questionnaire was completed. Admission details, demographic data, past medical history, and full physical examination findings were recorded, and patients were reviewed at regular intervals. The register comprised all cases conforming to the World Health Organization definition of stroke, with the exclusion of subarachnoid hemorrhage, transient ischemic attacks, subdural hematoma, and intracerebral malignancy. Cases of acute confusion, possible fits, or "extension of stroke" with no clear, new neurological deficit were also omitted. The study group thus comprised only...
The aim of the study was to determine, using current referral patterns, the number of patients suitable for treatment and the admission delays in this group. The study population therefore included all cases in which a clear recall of onset was possible and cases in which the event could be reliably judged to have occurred within a period of no more than 6 hours or in which weakness was present on waking. For these cases, the time of stroke was recorded as being the midpoint of that period, e.g., halfway between going to bed and waking up. These cases formed the "accurately timed" group.

If the onset could be isolated to a 12-hour period, the delay time was noted as the "best estimate" of the likely delay to compare the overall distribution with the more accurately timed strokes. The time of onset of the stroke in this group was again taken as the midpoint, as above. These patients were not included in the analysis of the contributing factors. Patients registered as having a stroke with an onset not attributable to a 12-hour period or who were later revealed to have a diagnosis other than stroke were omitted altogether.

The time of hospital admission was defined as the time at which a hospital doctor was able to see and assess the patient. For admissions through the bed allocation bureau, this was the time of arrival on the ward; casualty referrals are seen within 10 minutes of the time of arrival, and this was therefore used as a pragmatic indicator of the time of admission.

Age, sex, full address, postal code, presence, and relation of caregiver and the source and route of admission were recorded in all cases. The nature and severity of the stroke (in particular, the level of consciousness and degree of motor loss) was noted using a simple scoring system (after that of Mathew).

Prospective data were collected by one of the authors and entered into a database (DBASE IV) on a desktop personal computer. Statistical analysis was performed using MINITAB software.

Analysis was performed on the accurately timed cases admitted within 48 hours of stroke onset. The proportions of patients taking over 48 hours to admission were compared using the \( \chi^2 \) test. Mann-Whitney \( U \) tests were used for the initial between-group comparisons. Multiple linear regression analysis was used to detect the influence on delay time by the following independent variables: level of consciousness (unconscious versus conscious), age, time of stroke (overnight versus day), caregiver (alone versus caregiver), route of admission (accident and emergency versus bed allocation bureau), distance from hospital (city versus rural [defined below]), place of admission, and sex. The distribution of the residuals from the regression equation was normalized with log transformation of the delay time. The analysis was performed in a "step-up" manner; subjects with missing values were excluded from the regression analysis. A univariate association between age as a continuous variable and the log-transformed delay time was assessed with Pearson's correlation. Results were considered significant at the 5% level, 95% confidence intervals are given as indicated.

Approval for the project was granted by the local ethical committee.

Results

The time of stroke onset could be accurately identified in 374 of the 535 patients (70%) registered in the first year. The study population (374) matched the total registered population well. The mean age for the former was 74.5 (median, 77; range, 29–98) years, and 203 (54%) were female. In the latter, mean age was 74.6 (median, 77; range, 29–98) years, and 53% were female. In all, 16 of the 374 patients (4.3%) were admitted more than 48 hours after onset. For those admitted within 48 hours, the median admission time was 6 hours, with 25% under 2.5 hours and 75% under 11.5 hours (Figure 1).

The effect of the studied variables on the time to admission are summarized in Table 1. The time taken for patients arriving through the accident and emergency department was significantly shorter than that of patients admitted through the bed allocation bureau. The onset of stroke between midnight and 6 AM resulted in a significantly greater delay than onset during the day.
Patients living alone \((n=106)\) took significantly longer to get to a hospital than those living with spouses, relatives, or friends \((n=199)\). Those living in institutions \((n=10)\) appeared to have a similar delay to those with caregivers \((\text{median, 6.7 hours})\), and those in sheltered housing \((n=10)\) were similar to those living alone \((\text{median, 9.8 hours})\). The small numbers for these latter groups do not allow a statistical comparison to be made. (Home circumstances were not noted in the remainder.)

Patients 70 years of age and older took longer to get to a hospital than patients less than 70 years of age \((\text{Figure 1, Table 1})\). The difference in the time taken is dramatically shown in Figure 1, with an early peak in the younger admissions that is delayed by up to 6 hours in the older group. In 5.3\% of the older group compared with 2.8\% of the younger group, admission delay was more than 48 hours \((\text{not significant})\). Similarly, admissions to the geriatric wards had a greater delay than those to the medical wards.

Three major independent contributors to delay time were revealed using multiple linear regression analysis as described above. These were, admission through bed allocation bureau as opposed to the accident and emergency department \((p<0.001)\), onset during the night \((p=0.003)\), and living alone \((p<0.001)\). The final step-up regression analysis is shown in Table 2; adjusted \(R^2\) was 27.3\%, and thus these factors only account for about a quarter of the observed delay time. Univariate analysis of age versus log-transformed delay time demonstrated a weak but significant association \((r=0.175, p=0.001)\). However, age, sex, and distance from a hospital did not independently influence the delay time in the multivariate analysis. Adjusting for other factors in the model, delay time and level of consciousness were not associated.

The greater delays seen in admission of older patients can be accounted for by the age distribution of patients within the subgroups of the three significant contributor variables identified above. Patients admitted through the bed allocation bureau were older than those using the accident and emergency department \((\text{median age, 78 versus 74 years; } p<0.001)\). Patients with nocturnal onset of stroke were older than those with daytime or evening onset \((\text{median age, 78 versus 75 years; } p<0.006)\). Those living alone were older than those living with a spouse, friend, or relative \((80 \text{ versus 73 years; } p<0.0001)\).

There was no appreciable difference in the delay pattern between men and women or between rural patients \((\text{living over 10 miles from the city center})\) and city patients \((\text{Table 1})\). Despite a tendency for unconscious patients to arrive within 24 hours, no difference could be established statistically between conscious and unconscious patients \((\text{Table 1})\). Patients in the unconscious group were much older \((\text{median age, 81 versus 76 years; } p<0.006)\).

Those patients not included in the main analysis on grounds of poor recall of onset showed a tendency to longer delay times \((\text{Figure 1})\). In all, 106 cases \((20\%)\) could be included in the best estimate group; the remaining 55 \((10\%)\) were unclassifiable. Reasons for inaccurate recall in this study included gradual onset, coma, dysphasia, lack of caregiver, infrequent visits by caregivers and relatives, confusion, and poor memory.

### Discussion

In the present study, the time to admission after stroke was significantly prolonged by living alone, nocturnal onset, and admission through the bed allocation bureau as opposed to the accident and emergency unit. Each of these independent factors was more common with increasing age and probably contribute entirely to the greater delay seen in the older age group. Nevertheless, in this study approximately half of the patients with stroke arrived within 6 hours of onset. This endorses the view that a more rapid admission and trauma-style approach\(^4\) would be needed to enable early treatment, particularly when as much as 5 hours' time is required for basic investigations.\(^5\)

There is good evidence of the need for early treatment in ischemic stroke. Animal studies and clinical pilot studies of early \((\text{under 7 hours})\) reperfusion have shown dramatic benefit.\(^4\) Late reperfusion may lead to intracerebral hemorrhage.\(^6,\) The "ischemic penumbra," a ring of nonfunctioning but viable tissue around a central infarct core that slowly diminishes with the

---

**Table 1. Effect and Significance of Variables Influencing Time to Admission**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subgroup (n)</th>
<th>Time</th>
<th>Subgroup (n)</th>
<th>Time</th>
<th>(p)</th>
<th>(95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route of admission</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A&amp;E</td>
<td>229</td>
<td>2.8</td>
<td>B/B</td>
<td>108</td>
<td>8.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Time of stroke</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day</td>
<td>263</td>
<td>5.0</td>
<td>Night</td>
<td>94</td>
<td>9.4</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Caregiver status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caregiver</td>
<td>199</td>
<td>5.0</td>
<td>Alone</td>
<td>106</td>
<td>8.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Admitting unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>184</td>
<td>4.4</td>
<td>Geriatric</td>
<td>164</td>
<td>8.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>70-73</td>
<td>4.0</td>
<td>70-250</td>
<td>7.0</td>
<td>0.001</td>
<td>(0.7-3.0)</td>
</tr>
<tr>
<td>Stroke severity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>193</td>
<td>5.5</td>
<td>Mild</td>
<td>129</td>
<td>7.5</td>
<td>0.06</td>
</tr>
<tr>
<td>Level of consciousness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unconscious</td>
<td>45</td>
<td>5.5</td>
<td>Conscious</td>
<td>281</td>
<td>6.3</td>
<td>NS</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>162</td>
<td>5.6</td>
<td>Female</td>
<td>194</td>
<td>6.0</td>
<td>NS</td>
</tr>
<tr>
<td>Domicile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>57</td>
<td>6.0</td>
<td>City</td>
<td>218</td>
<td>6.1</td>
<td>NS</td>
</tr>
</tbody>
</table>

\(n\), Number of patients. A&E, accident and emergency unit; B/B, bed allocation bureau. Shortfall in subgroup totals results from patients admitted over 48 hours after onset and from missing data.

---

**Table 2. Multiple Regression of Variables Against Log-Transformed Delay Time**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coefficient</th>
<th>(t) ratio</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.16</td>
<td>19.35</td>
<td>0.000</td>
</tr>
<tr>
<td>Route</td>
<td>1.03</td>
<td>9.40</td>
<td>0.000</td>
</tr>
<tr>
<td>Living alone</td>
<td>0.41</td>
<td>3.90</td>
<td>0.000</td>
</tr>
<tr>
<td>Nocturnal onset</td>
<td>0.35</td>
<td>3.00</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Adjusted \(R^2\)=27.3\%.
duration of occlusion,9 may persist for up to 24 hours. However, treatment after 12 hours is unlikely to be very beneficial; thus, therapy to ameliorate ischemic damage is likely to be most effective in the first few hours. Oral nimodipine, a calcium channel antagonist, has shown a clear benefit when used within 12 hours of ischemic stroke.10,11 Aspirin, nafidrofuryl, and NMDA (N-methyl-D-aspartate) receptor antagonists can also inhibit the mechanisms of ischemic injury but still require evaluation as acute stroke therapies.

Patients unable to pinpoint the onset of ictus or presenting for admission late would not be eligible for the proposed newer treatments. The high level of poor recall that we found (30%) may be reduced if the timing of stroke onset should become more important, but by its very nature stroke onset can be very difficult to define. In the present study, inclusion of the best estimate group did not add significantly to the numbers presenting within 6 hours, and the data as analyzed should give a good idea of the actual number of patients eligible for treatment with present admission patterns. In the United Kingdom, as in the United States, many minor strokes are presently treated at home. In Leicester only small numbers of patients are referred but not admitted to a hospital, and these would tend to have near complete resolution of signs. The greater “risk versus benefit” of treatment in minor stroke may preclude treatment in this group anyway.

The accurate timing of stroke occurring during the night is very difficult. It is understood that some ongoing clinical trials have designated such strokes as having a midnight onset, primarily for safety reasons. However, in practice, therapies other than thrombolysis are unlikely to be dangerous when given a few hours late. Using the midpoint between sleeping and waking, as in this study, would allow a significant number of patients access to potentially useful treatment. A recent study from North Carolina reported that only 42% of patients were admitted within 24 hours of stroke onset.12 This study was conducted in neurological centers on a relatively young population and defined nocturnal stroke onset as the time of awakening. The greater delays found in North Carolina compared with Leicester are difficult to explain. Reasons may include a tertiary versus an immediate referral pattern, a privately based versus a free service, levels of community care and investigation prior to admission. The older study population and use of the midpoint for nocturnal strokes in our study make the differences even more startling. The methodologies of the two studies were otherwise very similar.

The greater admission delay seen in older patients has also been demonstrated in patients with myocardial infarction in Aberdeen and Leicester.2,13 The ISIS-II study has shown that the lowering of mortality with early thrombolysis was proportionally greater in the elderly.3 Similar results may also apply to stroke, in which mortality and morbidity both increase with age,4,5 and effective treatments may well have a more significant impact in this group. The increased delay in the elderly is predictable to some extent, owing to the greater social isolation, stroke severity, immobility, and use of general practitioners found in this age group. The higher incidence of nocturnal stroke in the older group is, however, less easy to explain. Studies of diurnal variation in stroke onset have not demonstrated an age difference.5,16

The factors that we have identified account for only 27% of the admission delay. One study of patients with myocardial infarction3 suggests that the major part of the delay may be the time taken to contact the medical services, which is probably closely related to the patients’ level of distress. Measures taken to reduce the delay for stroke admissions would thus require careful education among the profession and the public of the importance of prompt treatment, particularly in those who are single and elderly. Even if this approach is successful,1,7 benefit may still be limited by the reasons for delay operating at a more instinctive level.13

Acknowledgments

The authors would like to thank the physicians and geriatricians of Leicester for their cooperation with this study; particularly, we thank Dr. Carol Jagger and Dr. John Thompson, Department of Community Medicine, University of Leicester, for their expert perusal of this paper. We are also most grateful to Bayer (UK) Limited for their generous support.

References

Factors delaying hospital admission after stroke in Leicestershire.
G D Harper, R A Haigh, J F Potter and C M Castleden

*Stroke*. 1992;23:835-838
doi: 10.1161/01.STR.23.6.835

*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1992 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/23/6/835

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in *Stroke* can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to *Stroke* is online at:
http://stroke.ahajournals.org//subscriptions/