Factors Associated With Delayed Admission to Hospital and In-Hospital Delays in Acute Stroke and TIA
A Prospective, Multicenter Study

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Background and Purpose—Early admission to hospital followed by correct diagnosis with minimum delay is a prerequisite for successful intervention in acute stroke. This study aimed at clarifying in detail the factors related to these delays.

Methods—This was a prospective, multicenter, consecutive study that explored factors influencing the time from stroke or transient ischemic attack (TIA) onset until patient arrival at the emergency department, stroke unit, and CT laboratory. Within 3 days of hospital admission, the patients and/or their relatives were interviewed by use of a standardized structured protocol, and the patients’ neurological deficits were assessed. No information about this study was given to the public or to the staff.

Results—Patients (n = 329) were studied at 15 Swedish academic or community-based hospitals: 252 subjects with brain infarct, 18 with intracerebral hemorrhage, and 59 with TIA. Among stroke and TIA patients, the median times from onset to hospital admission, stroke unit, and CT scan laboratory were 4.8 and 4.0 hours, 8.8 and 7.5 hours, and 22.0 and 17.5 hours, respectively. From multivariate ANOVA with logarithmically transformed time for increasing delay to hospital admission as the dependent variable, a profile of significant risk factors was obtained. This included patients with a brain infarct, gradual onset, mild neurological symptoms, patients who were alone and did not contact anybody when symptoms occurred, patients who lived in a large catchment area, those who did not use ambulance transportation, and those who visited a primary care site. These factors explained 45.3% of the variance in delayed hospital admission. The median time from arrival at the emergency department to arrival at the stroke unit or CT scan laboratory (whichever occurred first) was 2.6 and 2.7 hours in the stroke and TIA groups, respectively. A large catchment area, moderate to mild neurological deficit, and waiting for the physician at the emergency department were all significantly related to in-hospital delay.

Conclusions—Increased public awareness of the need to seek medical or other attention promptly after stroke onset, to use an ambulance with direct transportation to the acute-care hospital, and to have more effective in-hospital organization will be required for effective acute treatment options to be available to stroke patients. (Stroke. 1999;30:40-48.)

Key Words: cerebrovascular disorders ■ hospitalization ■ stroke management ■ stroke onset ■ emergency service, hospital

In stroke, the extent of cell damage is determined by the degree and duration of ischemia as well as by various degrees of susceptibility to ischemia among different cell types in the brain. Stroke should be considered an emergency condition with a similar acute-phase status as, for example, myocardial infarction. A 6-hour time window has arbitrarily been used in many clinical stroke intervention trials, although both shorter and in some cases longer therapeutic intervals are likely to exist. Today, there is no approved established short-term medical treatment in Europe for stroke victims, although >30 different potentially effective substances have recently been or are currently being clinically tested, some with promising results. It is thus likely that acute intervention will be available for the general population within the near future. However, a prerequisite for successful acute stroke intervention with thrombolytics, neuroprotectors or other strategies, including the structured management of patients in stroke units, is that the time from stroke onset to initiation of treatment is kept to a minimum. This means that promptly after symptom onset, stroke victims must turn to the emergency department at hospitals where such treatment is provided, that these patients must be investigated by stroke physicians, and that a CT scan must be done with minimum delay.

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In recent years, there have been several studies of time from stroke ictus to arrival at hospital, with somewhat limited and conflicting results. This may be due to different study designs: most studied only patients at a single hospital and explored only a few variables. Some studies were retrospective, some did not consider patients with a hospital arrival beyond 24 or 48 hours after symptom onset, and some only considered patients transported to the hospital by ambulance. There were also differences in interpreting nocturnal onset of stroke.

Prospective, multicenter studies on referral patterns in stroke victims based on both academic and community-based hospitals with differences in geographic and catchment-area sizes have not been reported previously. In addition, there are no such reports on patients with transient ischemic attacks (TIAs), who during the first few hours of onset of focal neurological deficits may be impossible to differentiate from stroke patients. The aim of the present study was to assess the time between stroke/TIA onset and clinical and radiological diagnoses and to explore in detail the factors associated with any related delays.

Subjects and Methods
This study was designed as a prospective, multicenter, consecutive characterization of time from stroke or TIA onset until the patient arrived at the emergency department, stroke unit (or equivalent), and CT scan laboratory. The participating stroke centers were selected to represent different geographical locations and different catchment-area sizes and had to have primary responsibility for all acute stroke and TIA patients in their catchment areas. The ethics committees at the centers involved approved the study protocol. The inclusion criteria were focal neurological symptoms of presumed vascular origin in patients who sought medical help at the emergency department within 7 days of onset of symptoms and who were referred to a stroke unit or its equivalent. Exclusion criteria were diagnosis of subarachnoid hemorrhage, a CT scan or other investigation that revealed a primary cause of the symptoms other than stroke or TIA, lack of informed consent, or lack of specification of time of symptom onset. Patients with in-hospital stroke or TIA were not considered unless they were first transferred to the emergency department, which is not the routine procedure in Sweden. The study was performed from April 11 to May 31, 1996, at 15 stroke centers representing both academic and community-based hospitals. All hospitals had previously in the study had experience with acute intervention studies. However, no public campaigns or other educational efforts to recruit patients were performed at this time. Information about the study was not given in advance or during the study to the hospital staff. It was decided in advance to stop recruiting when each participating center had included ≥20 patients or when the total number of patients included was >300. At each stroke center, all patients arriving at the emergency department, including those with an initial suspicion of stroke or TIA (as judged by the emergency ward nurse, who were not aware of this study) were recorded daily in a logbook by the study nurses. The number of these patients who were hospitalized was also recorded. Within 3 days of hospital admission, the stroke study nurses or doctors contacted in-patients in whom an initial suspicion of stroke or TIA had been raised, and patients who fulfilled the study entry criteria were asked to participate in the study. A structured interview with the patient or relative was made within 3 days of hospital admission. Barthel’s Activities of Daily Living (ADL) function23 before the present illness was estimated, and a European Stroke Scale (ESS) assessment24 was performed as an estimate of stroke severity. The ESS ranges from 0 (worst clinical status) to 100 (without any symptoms), and thus a score of 70 indicates a mild and 30 a severe degree of stroke-related symptoms. The final diagnoses were recorded when the patients were discharged. Time of stroke or TIA onset was defined as the time the patient or an observer first noticed a neurological deficit. Patients who had their first symptoms during the night were divided into 1 group in whom symptoms occurred while awake and another group who noticed the symptoms upon awakening; this latter group was analyzed separately.

For patient characteristics, means (or median), number, and proportions are presented. To test for difference in proportions between the diagnostic groups, the chi-square test was used. Owing to skewed distribution of the time variables, the Mann-Whitney U test and Kruskal-Wallis 1-way ANOVA were used for univariate analysis. For multivariate analysis of time delay, ANOVA with covariates was used, with logarithmically transformed time delay as the dependent variable. The cumulative rates of patients admitted to the emergency departments and stroke unit or CT scan laboratory at various times were examined with log-rank survival analysis to test for differences between diagnostic groups. Because different routines were applied at the participating hospitals regarding whether patients were transported to the stroke unit (or its equivalent) or to the CT scan laboratory after arrival at the emergency department, the time until the first occurrence of these events was calculated as in-hospital delay. Two-tailed significance was used, and a probability value of 0.05 was considered significant in the univariate and multivariate analyses. Analyses were performed with the statistics package SPSS version 6.1.25

Results
Patient Flow
From April 11 to May 31, 1996, a total of 32,922 persons were referred to the emergency departments at the 15 hospitals. Of 966 of these patients, the emergency ward nurse (who was not aware of this study) first taking care of these patients reported an initial suspicion of acute stroke or TIA, and 834 of these subjects were hospitalized. At the time of the interview with the patient or relative within 3 days of hospital admission, 272 patients (33% of those with an initial suspicion of stroke or TIA) were found to have another diagnosis. In 142 of the remaining 562 subjects, a structured interview was not considered possible because the patient had been discharged from the hospital or had died, was too ill, was too confused, or suffered from a severe communicative disorder. Eight patients (1%) did not give informed consent to participate in the study. Thus, 412 patients were interviewed and had an ESS evaluation performed. Thirty-six of these patients were excluded because they were found to have arrived at the emergency department >1 week after symptom onset (n = 15) or they had a final diagnosis inconsistent with acute stroke or TIA (n = 21). These diagnoses were vertigo (n = 6), previous stroke with sequelae without new focal symptoms (n = 6), brain tumor (n = 2), spinal cord ischemia (n = 1), epilepsy (n = 1), subdural hematoma (n = 1), muscle disorder (n = 1), chromosome aberration (n = 1), metabolic disturbance with coma (n = 1), and observation without further specification (n = 1). In 25 patients, the time of ictus of stroke or TIA symptoms was unknown (10 of these patients had been found with symptoms), and these subjects were excluded from further analyses. Of the 42 patients who experienced their first symptoms during the night, 22 noticed symptoms upon awakening; this group was analyzed separately.

Patient Characteristics
The characteristics of the 329 eligible stroke and TIA patients are presented in Table 1. Six percent of the patients had...
intracerebral hemorrhage (ICH), and 18% had TIA. The mean age for the entire group of patients was 73.1 years, with TIA and ICH patients being somewhat younger than infarct patients \( (P<0.05 \text{ by Kruskal-Wallis ANOVA}) \). In the total study group, 21% and 9% had had a previous stroke or TIA, respectively. Thirty-nine percent had a diagnosis of hypertension, 19% angina pectoris, 14% atrial fibrillation, 12% heart failure, and 18% diabetes mellitus. Four percent of patients had been unconscious from symptom onset, whereas 41% and 70% of the patients reported speech disturbance and paresis as initial symptoms, respectively. Most of the patients experienced symptom onset at home, and 51% were transported to the hospital by ambulance. The time, as estimated by the patient or a bystander, for the ambulance to arrive after having been called was 10 to 15 minutes. The majority of patients were independent in ADL before the current disorder according to the Barthel index. The neurological deficit, as measured by the ESS immediately after the interview, differed between diagnostic groups; most TIA patients had no disturbance, brain infarction patients were generally moderately injured (mean ESS value of 78), and the ICH group showed the most severe stroke symptoms (mean ESS of 61). A CT scan had been performed at time of interview in 92% of the study population. Estimates by the patient or bystander at time of interview of the time elapsed from arrival at the emergency department to first examination by a doctor revealed that in 42% of all patients, \( >1 \text{ hour} \) had elapsed (Table 1).

### Duration From Symptom Onset to Arrival at Hospital, Stroke Unit, and CT Scan Laboratory

In the Figure (panels A and B), the time from symptom onset to arrival at an emergency department is shown. There was a significant difference between the diagnostic groups, with the shortest time elapsing in the ICH group (median, 1.7 hours), followed by TIA (median, 4.0 hours) and brain infarction
patients (median, 5.1 hour) (\(P<0.01\) by log-rank survival analysis and \(P<0.01\) by Kruskal-Wallis ANOVA). Much of this delay was due to the time between symptom onset and the patient’s first call for help (panel B), which was to a relative/acquaintance or staff at the emergency 112 call system, a primary care unit, or a hospital. Hence, the median time to call for first help was 0.5, 2.2, and 3.4 hours among ICH, TIA, and infarct patients, respectively (panel B), accounting for 32%, 55%, and 68% of the time from symptom onset to arrival at the emergency department. The median time from symptom onset to arrival at a stroke unit or equivalent was 8.8 hours among stroke patients and 7.5 hours in the TIA group. The median time from symptom onset to arrival at a CT scan laboratory was 22.0 and 17.5 hours among stroke and TIA patients, respectively. The median time from arrival at the emergency department to arrival at the stroke unit or arrival at the CT scan laboratory (whichever occurred first) was 2.7 and 2.3 hours among infarct and hemorrhagic stroke patients, respectively, and 2.7 hours in the TIA group (\(P>0.2\) by log-rank survival analysis).

**Factors Related to Increased Time From Symptom Onset to Hospital Admission: Univariate Analysis**

Age, sex, previous TIA, previous ADL function according to Barthel’s index, marital status (alone or married/cohabiting), way of living (alone in own house, with relative in own house, in service house for the elderly or disabled, or other), level of consciousness, presence of paresis, and time of day that first symptoms appeared had no significant impact on the time from symptom onset to hospital admission (data not shown). Previous stroke, speech disturbance, and sudden onset of initial symptoms were related to decreased time delay among stroke patients (Table 2; \(P<0.01\) to \(P<0.001\) by Mann-Whitney U test). Fluctuating symptoms before arrival at hospital in stroke and TIA patients and mild neurological symptoms according to the ESS score, as well as being alone when symptoms first occurred among stroke patients, were each associated with increased time to hospital admission (\(P<0.05\) to \(P<0.001\) by Kruskal-Wallis ANOVA and \(P<0.01\) by Mann Whitney U test). If the first symptoms were not recognized as stroke related (which was the case among 44% of stroke and 48% of TIA subjects), or despite recognition of symptoms as stroke related, patients actively chose not to seek any help within 1 hour (24% of stroke and 20% of TIA patients), time to hospital admission was increased (\(P<0.001\) by Kruskal-Wallis ANOVA). Stroke and TIA patients who contacted a relative, hospital, or family doctor as a first action after symptom onset had a substantially shorter time to hospital admission than patients who waited (Table 2; \(P<0.001\) by Kruskal-Wallis ANOVA). Among stroke patients not seeking any help within 1 hour, subjects who were not aware of initial symptoms or thought symptoms would disappear, as well as patients who had similar symptoms before that disappeared, had an increased time to hospital admission compared with patients who were unable to call for any help within 1 hour of symptom onset (Table 2; \(P<0.01\)).

In the stroke group, living in a catchment area of \(>200,000\) inhabitants was associated with increased time to hospital admission (\(P<0.01\) by Kruskal-Wallis ANOVA), whereas the distance between the place where the initial symptoms occurred and the hospital did not influence the time to hospital admission (\(P>0.2\)). Stroke patients who were not transported to the hospital by ambulance had a longer delay to
hospital admission (Table 2; P = 0.001), as did stroke and TIA subjects who visited their family doctor before going to a hospital (Table 2; P = 0.01 to 0.001 by Mann-Whitney U test).

Factors Related to Increased Time From Symptom Onset to Hospital Admission:

Multivariate ANOVA

All factors from the univariate nonparametric tests as presented in Table 2 were initially included in a multivariate ANOVA model to explain the variance of the natural logarithmic time value from symptom onset to hospital admission. As presented in Table 3, diagnosis, symptom onset, neurological severity, presence of a bystander, the patient’s initial reaction, catchment-area size, mode of transportation to the emergency department, and visit to a family doctor were all significant factors closely related to increased time to hospital admission. With these factors, 45.3% of the variation in the time from onset of symptoms to hospital admission could be explained.

Patients Who Noticed Symptoms on Awakening

Fifteen patients with brain infarct and 7 with TIA noticed their symptoms upon awakening after a night’s sleep. The median time from onset (set at 3 AM) and arrival at hospital was 10.1 hours among infarct patients and 9.5 hours in the TIA group. Among infarct patients, the initial reaction was significantly associated with increased time to hospital arrival (did nothing, median delay 43.8 hours; contacted relative, median delay 11.8 hours; contacted hospital, median delay 8.0 hours; contacted primary care physician, median delay 5.4 hours; P < 0.05 by Kruskal-Wallis ANOVA). No other significant relationship was observed.

Delay Between Arrival at Emergency Department and Arrival at Stroke Unit or CT Scan Laboratory

Table 4 shows that the degree of neurological deficit and the catchment-area size were associated with increased in-
TABLE 4. Factors Related to Increased Time From Arrival at Emergency Department to Arrival at Stroke Unit or CT Scan Laboratory

<table>
<thead>
<tr>
<th>Factor</th>
<th>Stroke</th>
<th>TIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS score</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>&lt;31</td>
<td>1.7</td>
<td>2.6</td>
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<tr>
<td>31–70</td>
<td>2.6</td>
<td>2.0</td>
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<tr>
<td>&gt;70</td>
<td>2.0</td>
<td></td>
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<tr>
<td>Catchment-area size</td>
<td>*</td>
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<tr>
<td>&gt;200 000</td>
<td>2.9</td>
<td></td>
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<tr>
<td>100 000–200 000</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>&lt;100 000</td>
<td>2.0</td>
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<tr>
<td>Estimated time delay from arrival at emergency department to first examination by physician‡</td>
<td>†</td>
<td>†</td>
</tr>
<tr>
<td>&lt;1 h</td>
<td>2.0</td>
<td>2.0</td>
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<tr>
<td>1–2 h</td>
<td>3.0</td>
<td>3.0</td>
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<tr>
<td>&gt;2 h</td>
<td>4.2</td>
<td>4.6</td>
</tr>
</tbody>
</table>

*P<0.05 and †P<0.001 within the diagnostic groups as measured by Kruskal-Wallis ANOVA. Data are presented as median time in hours. ‡Estimation by patient or bystander at time of interview.

hospital delays among stroke patients. In both stroke and TIA patients, an increased time from arrival at the emergency department to first examination by a physician was associated with an increased time from arrival at the emergency department to arrival at a stroke unit or CT scan laboratory (whichever occurred first; \( P<0.05 \) to 0.001 by Kruskal-Wallis ANOVA). Other factors such as age, sex, time of day of symptom onset, initial symptoms (unconscious, speech, or paresis), and course of symptoms (regress, stationary, progress, or fluctuating) had no significant impact on this delay \(( P>0.2 \) by Kruskal-Wallis ANOVA and Mann-Whitney U test).

Discussion

This prospective, multicenter, consecutive study of stroke and TIA patients explores factors underlying delayed admission to the emergency department of hospitals and further in-hospital delays to the patient’s arrival at a CT scan laboratory or stroke unit or its equivalent. This approach of a detailed characterization of many presumably influencing factors on increased time to hospital admission as well as in-hospital delay in a large population of both stroke and TIA patients is the first of its kind. The 15 participating stroke centers had past experience of acute stroke intervention studies and represent both university and community-based hospitals with differences in geographic location and catchment-area size. The general care of stroke and TIA patients at these sites should be congruent with other hospitals with well-organized acute stroke management. However, it could not be excluded that experience with previous stroke trials had increased the awareness of the primary care and emergency department physicians at these hospitals, resulting in more rapid referral and initial assessments. However, no acute intervention trial was ongoing at any of the participating stroke centers at the time of the present study. Patients with a cerebral infarct or hemorrhage who were included in the study should be representative of a Western stroke population, for which recently published data show a strong trend toward milder stroke severity over time. However, because the present study was based on a detailed structured interview with either the patient (79% of the study population) or the patient and a relative (21%) within 3 days of hospital admission, a significant proportion of patients with severe illness leading to very early death or incapacitation to such a degree that it was impossible to conduct an interview could not be included. This incapacity probably applies to many hemorrhagic stroke patients, who usually present with more severe symptoms in the acute phase, which may explain the relatively small proportion of included patients with cerebral hemorrhage. The proportion of patients with ICH in the present study is similar to a recent report in which stroke patients were interviewed about their general knowledge about stroke. However, provided that a spouse or cohabitant was present at the hospital, some of the very critically ill patients could take part in the present study (see Table 1).

Some of the patients were lost to the study because they had been discharged before the interview was to take place. It is likely that these patients had very mild or transient symptoms. Acute stroke intervention, eg, by thrombolysis or neuroprotectors aiming at reduced evolution of brain damage, is not considered feasible in stroke victims with severe symptoms under most conditions, including substantially impaired consciousness. This may be due to the relatively small size of a potentially treatable region at risk, the so-called penumbra, compared with the large irreversible core of brain damage in these patients. Taken together, we believe that the majority of stroke patients in the present study would have benefited from some kind of acute intervention, provided that they had arrived at the hospital and stroke unit soon after symptom onset.

Because of the use of a log book in this study, the flow of patients referred to the hospitals could be studied in detail. These data show that a remarkably large proportion of hospitalized patients with an initial suspicion of stroke or TIA, as judged by the admitting nurses at the emergency departments, who were not aware that this study was being conducted, were misdiagnosed at the time of interview. This agrees with previously published data. A suspicion of stroke or TIA as judged by the emergency department nurses who see the patient first after admission to hospital may sometimes be raised nonspecifically for symptoms such as dizziness, vertigo, fatigue, and general weakness. In addition, 21 patients who entered the study were found at time of discharge to have diagnoses inconsistent with stroke or TIA. This shows that the diagnosis of stroke and TIA in the very acute and even subacute phase can sometimes be quite difficult to make, and extended investigations may be required to arrive at a final correct diagnosis.

To the best of our knowledge, reports on TIA patients regarding factors influencing time delays from symptom onset until hospital admission, stroke unit admission, and CT scan have not been published previously. The reasons for including TIA patients in this study were as follows. Acute intervention in stroke must probably be initiated within the
first few hours after onset to be effective. A substantial proportion of patients potentially eligible for such treatment strategies will recover spontaneously from their neurological symptoms within 24 hours and thereby be classified as TIA, although the duration of the classic TIA is usually <30 to 60 minutes. Hence, it is practically impossible to differentiate between a stroke and TIA during the first few hours after onset. In public campaigns about increased awareness of stroke-related symptoms and the need to go to the hospital immediately, it will not be possible to single out information about TIA. Furthermore, it is appropriate that patients with TIA are referred to a hospital for a detailed evaluation, including a search for potential differential diagnoses, acute intervention if repeated TIAs occur, and optimum medical or surgical secondary prophylactics. In Sweden, it is believed but not proven that the majority of TIA patients who seek medical help are referred to hospitals and that many of these patients are hospitalized for a few days. However, the hospitalized TIA patients included in the present study probably had a somewhat more severe medical condition than a general TIA population. This could imply that some uncomplicated TIA patients may not have sought medical help at all or were taken care of at a primary care center only, were not hospitalized after arrival at the emergency department, or were discharged before the structured interview took place. However, the demographics of the TIA patients studied here are in good agreement with previously published epidemiological data. A general observation in the present study was that patients with TIA had similar time to hospital admission and similar influencing factors on elapsed time as the ischemic stroke patients. Thus, the course of symptoms, recognition of initial symptoms as stroke related, patient’s initial reaction when first symptoms occurred, and visit to a primary care physician were all factors among TIA patients that had a significant impact on increased time to hospital admission (Table 2).

The median time between symptom onset and hospital admission was 5.1 hours in the infarct group, 1.7 hours among ICH patients, and 4.0 hours in patients with TIA. For stroke patients, this is in the same range as previously published data; median times of 3.5 to 14 hours between stroke onset and hospital admission have been reported. A direct comparison with these studies, however, is difficult because of the different study designs (some were retrospective, some did not consider patients with a hospital arrival beyond 24 or 48 hours after symptom onset, some considered only patients who were transported to the hospital by ambulance, and there were differences in interpreting nocturnal onset of symptoms).

In the present study, results obtained from patients who noticed their first symptoms upon awakening were analyzed separately because the determination of time delays in those patients is very dependent on the coding of ictus. This coding could be either last time seen without symptoms, time of awakening, or a midpoint between those times, or exclusion of these patients. In the present study, the coding of ictus was set at a presumed midpoint during sleep. In both stroke and TIA patients, the time lag from symptom onset to arrival at hospital, as expected, was longer than among patients whose symptom onset came while they were awake. The proportion of patients who had their first symptoms during the night (42 of 351 subjects) is in the range of the wide variation of previously published data.

In general, the results from the univariate and multivariate analyses of factors related to delayed hospital admission were congruent. From the multivariate ANOVA, a profile of risk factors associated with increased time from symptom onset to arrival at the emergency department was obtained. This risk profile included patients with a diagnosis of brain infarct, gradual onset, mild neurological symptoms, patients who were alone and did not contact anybody when symptoms occurred, patients who lived in a large catchment area, patients who did not use ambulance transportation, and patients who visited a primary care site. With these factors, 45.3% of the variation of delayed hospital admission could be explained, a higher value than the 22% to 27% of explained variance reported previously. Related to this observation is the study by Jørgensen and coworkers predicting a hospital admission of more or less than 6 hours using a multiple logistic regression model. They found that marital status, working status, former TIA, and stroke severity could predict 69% of cases in these dichotomized time intervals.

Diagnosis of brain infarct has been reported to be associated with delayed hospital admission compared with ICH in some studies, but not all. In agreement with our data, mild stroke severity has been reported to increase the time to hospital admission, and a sudden onset of a stable deficit was shown to decrease this time. Stroke severity, as assessed in this study by the ESS immediately after the interview, within 3 days after hospital admission, may not always have represented stroke severity shortly after stroke/TIA onset, when the patient and/or bystander decided how to act. This is due to the obvious fact that the course of stroke severity changes individually over time, with most patients improving, some being stable, and others having progression of symptoms during the first days after stroke onset. Patients living alone were shown to have a delayed hospital admission, which agrees in part with our results showing that being alone when symptoms occurred was associated with increased time to hospital admission, although way of living had no significant impact on this time delay.

In the present study, the failure to contact anyone when symptoms occurred was, from a quantitative standpoint, the most important factor in delaying hospital admission. Hence, time from symptom onset to first call for any help accounted for 32% of the total delay in time until hospital admission in the ICH group, 55% among TIA patients, and 68% in the brain infarct group. This may be related to the fact that 44% and 48% of stroke and TIA patients in this study, respectively, did not recognize their first symptoms as stroke related, and an additional 24% and 20% of patients did not seek any help within 1 hour despite accurately recognizing their first symptoms. This is in line with recent reports on the generally poor knowledge about stroke signs, symptoms, and risk factors among stroke patients, their interpretation of stroke symptoms, and how these factors influence the timing of their decision to seek medical attention. Thus, only one
fourth of stroke patients interpreted their symptoms correctly, and this knowledge was not associated with early hospital admission.\textsuperscript{29} One surprising finding in our study was that a large catchment-area size (\textgtr 200,000 persons) was associated with delayed hospital admission. One plausible explanation for this finding may be that the 2 hospitals representing the largest catchment-area size are located in Stockholm, a city known to be overrepresented by old persons living alone. However, irrespective of catchment-area size, there was a similar proportion of patients who were alone when symptoms occurred in our study. Interestingly, the median delay of 11.8 hours from symptom onset to hospital arrival in this category is in good agreement with data from another Scandinavian city of similar size, ie, the Copenhagen study,\textsuperscript{20} in which a median delay of 14 hours was reported. The referral pattern, including transportation of stroke patients, has been shown to be of great importance in delayed hospital admission,\textsuperscript{12,14,17,19,29} which is in agreement with our data showing a substantially prolonged delay in patients first referred to the family doctor and in patients not using an ambulance.

The in-hospital delay, ie, time from arrival at the emergency department to arrival at stroke unit or CT scan laboratory (whichever occurred first), was 2.7 hours in our study. To the best of our knowledge, similar data have not been published previously. This time delay is not acceptable, and it should be possible to reduce this time substantially by changing the within-hospital organization, as has been suggested recently.\textsuperscript{34} Because the emergency departments were not aware of the present study being conducted, only an estimation at the time of interview could be obtained of the time from emergency department admission to first visit by a physician. As predicted, patients with an estimated time to first examination by physician of \textgtr 2 hours and patients with a mild to moderate neurological deficit had a longer time from arrival at the emergency department to arrival at the stroke unit or CT scan laboratory. The implication of this observation is that a stroke physician should examine patients with a presumed stroke or TIA within a few minutes of their arrival at the emergency ward to reduce the in-hospital delay. This would also improve the accuracy of the clinical diagnosis, which can be quite difficult in the acute stage.\textsuperscript{31}

In conclusion, several factors were found to be closely related to delayed hospital admission among stroke and TIA patients. A risk profile of factors was obtained that included patients with a diagnosis of brain infarct, gradual onset, mild neurological symptoms (ESS \textgtr 70), who were alone and initially did not contact anybody when their symptoms occurred. Furthermore, living in a large catchment area (\textgtr 200,000 persons), not using ambulance transportation, and visiting a primary care site were all related to increased time from symptom onset to arrival at the hospital. The additional in-hospital delay, ie, the delay between arrival at emergency department and arrival at the stroke unit or CT scan laboratory, was 2.7 hours, with similar duration in each of the diagnostic groups. Factors that significantly influenced this delay were degree of neurological deficit, living in a large catchment area, and time spent waiting at the emergency department for first examination by a physician. Increased public awareness of the need to seek medical or other attention promptly after stroke onset, to use an ambulance with direct transportation to the hospital, and to provide more effective in-hospital organization is required to ensure that effective acute treatment options will be available for stroke patients.

**Appendix**

The study group consisted of the following investigating doctors and nurses (coordinating doctor at each study site listed first, other investigators in alphabetical order):

- Hospitals with catchment area \textgtr 200,000 persons: B. Leijd, M. Anzén, P. Ring (St Göran’s Hospital, Stockholm); C. Carlström, M. Zetterling (Söder Hospital, Stockholm).
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**References**


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