Factors Influencing Early Admission in a French Stroke Unit
Laurent Derex, MD; Patrice Adeleine, PhD; Norbert Nighoghossian, MD; Jérôme Honnorat, MD; Paul Trouillas, MD, PhD

Background and Purpose—Intravenous tissue plasminogen activator improves outcome after ischemic stroke when given within 3 hours of symptoms onset in carefully selected patients. However, only a small proportion of acute stroke patients are currently eligible for thrombolysis, mainly because of excessive delay to hospital presentation. We sought to determine the factors associated with early admission in a French stroke unit.

Methods—We prospectively studied the admission delay of acute stroke patients in a French stroke unit during a 12-month period ending July 1999. Univariate and multivariate regression analyses were performed to evaluate the factors influencing early stroke unit admission and transport by the Emergency Medical Services (EMS) or Fire Department (FD) ambulances.

Results—One hundred sixty-six patients were primarily admitted to the stroke unit, with a median admission time of 4 hours 5 minutes. Twenty-nine percent presented within 3 hours of symptoms onset and 75% within 6 hours. Univariate analysis showed that early stroke unit arrival was significantly associated with the following factors: female sex, stroke severity assessed by the National Institutes of Health Stroke Scale score, lowered consciousness, sudden onset of stroke, not living alone, recognition of symptoms by bystanders, and transport by EMS or FD ambulances. Age, ethnicity, level of education, employment status, nocturnal onset, distance from place of stroke to the stroke unit, stroke lesion location, presence of brain hemorrhage, and awareness about the symptoms and risk factors of stroke had no measurable effect on early admission. A multivariate regression model demonstrated that the most significant factors associated with early stroke unit arrival were transport by EMS or FD ambulances and sudden onset of stroke. Female sex and not living alone were also significantly associated with early admission in the multivariate model. Multivariate analysis of the mode of transport showed that transport by EMS or FD ambulances was significantly more frequent among female patients, when stroke symptoms were recognized by bystanders, and when the general practitioner was not the first medical contact.

Conclusions—The present study shows that hospital arrival within the first hours of stroke is feasible in a French stroke unit. As many as 75% of the patients are admitted within the first 6 hours of stroke. This is the first study demonstrating that stroke unit admission in France is fastest in patients brought to the hospital by EMS or FD ambulances. However, only 35% of stroke patients activate the emergency telephone system and are currently transported by EMS or FD ambulances. French stroke patients should be encouraged to seek immediate medical attention by using the emergency telephone system, and stroke management should be reprioritized in the French EMS as a time-dependent medical emergency, with the same level of organization and expertise currently applied to myocardial infarction. (Stroke. 2002; 33:153-159.)

Key Words: emergency medical services ■ hospitalization ■ stroke, acute ■ stroke onset ■ stroke units

The positive results of the National Institute of Neurological Disorders and Stroke recombinant tissue plasminogen activator (rtPA) Stroke Study demonstrate the clear need to achieve the earliest possible treatment for stroke.1 Long-term follow-up of this study shows that patients who receive rtPA within the first 3 hours are more likely to have minimal or no disability 3, 6, and 12 months later.2 Similar results may be obtained in everyday practice.3 However, only a small proportion of all patients with acute ischemic stroke are eligible for treatment with intravenous rtPA in recent studies.4 The most common reason for exclusion from this stroke treatment protocol or other urgent therapeutic protocols is delay in presentation.5-12 Since the time from stroke onset to hospital arrival is critical in acute stroke management, we sought to determine the factors influencing early admission of acute stroke patients in a French stroke unit.

Subjects and Methods
This prospective study was performed from July 2, 1998, to July 2, 1999, at the stroke unit of the Neurological Hospital, University Hospital of Lyon, France. The Neurological Hospital serves a large...
urban area of approximately 2 million people. Our stroke team consists of neurologists and nurses who specialize in acute stroke therapy. One neurologist from the stroke team is on call and admission to the stroke unit is possible 24 hours per day, 7 days per week. Brain CT scan and MRI are available around the clock. The stroke unit is located 1 floor above the CT scanner.

Admission time was recorded for every acute stroke patient who was a primary referral to the stroke unit. The time of onset of symptoms was obtained from the patient or any available witness or extracted from the medical record.

A stroke was defined as an acute focal neurological deficit due to a vascular event, lasting for >24 hours, whether it was determined to be ischemic (cerebral infarction) or hemorrhagic (intracerebral hemorrhage or subarachnoid hemorrhage). Patients with transient ischemic attack (TIA) were excluded from the analysis. Any patient with an in-hospital stroke was also excluded. Causes other than stroke were ruled out by brain imaging and other diagnostic studies. The diagnosis of stroke was verified by a neurologist (L.D. or N.N.), and a brain CT scan was performed in all cases.

The study was explained to the patient and/or the legal guardian by a study investigator. A standardized, structured questionnaire was completed for every stroke patient by interviewing the patient or family and by reviewing the medical record. The questionnaire documented the patient’s age, sex, ethnicity, marital status, employment status, highest education level, the mode of stroke onset (sudden, gradual), the course of the deficit before admission (stable, fluctuating), the recognition of stroke (patient, bystanders, physician, other), the specialty of the first physician contacted, and the awareness of the patients regarding stroke warning signs and cerebrovascular risk factors. To minimize in-hospital stroke education, all patients were interviewed within 48 hours after admission.

We documented the exact time of stroke onset, where the stroke occurred, whether the patient lived alone, and the distance from the site of stroke onset to the stroke unit. Distance to the stroke unit was determined with the use of the Lyon and Rhône-Alpes region maps. Stroke severity was assessed on admission with the National Institute of Health Stroke Scale (NIHSS) (range, 0 to 42; normal score =0).

The time of stroke onset was defined as the time when symptoms that may represent a stroke first occurred. When symptoms were first noted on awakening, the time of awakening was recorded as the time of onset because it represents the time when medical help could be sought. Other studies have chosen the same definition of stroke onset for patients whose symptoms were detected on awakening.1,5,6,10

The time of admission was defined as the time the patient presented to the stroke unit in all cases. The exact time of arrival at the stroke unit is routinely marked on the forms of the stroke unit. Patients who presented to their local physician before coming to the stroke unit were still considered to have presented for evaluation of onset because it represents the time when medical help could be sought. Other studies have chosen the same definition of stroke onset for patients whose symptoms were detected on awakening.1,5,6,10

The mode of transport to the stroke unit (ie, ambulance of the Service d’Aide Médicale d’Urgence, which is the French equivalent of the Emergency Medical Services [EMS], private ambulance, Fire Department [FD] ambulance, or private vehicle) was determined in all cases.

**Statistical Analysis**

The distribution of the delay from stroke onset to stroke unit admission was positively skewed. Therefore, the distribution of the admission delay according to the different explanatory variables was summarized by median and 25th and 75th percentile values. The significance of the relation between the admission delay and the explanatory variables was established by the Mann-Whitney test or the Kruskal-Wallis test in the case of categorical variables and by the Spearman test in the case of continuous variables. The mode of transport was dichotomized into 2 groups (EMS and FD ambulances versus other modes of transport) to evaluate the significance of the relation of this variable to the explanatory variables by simple logistic regression. The logarithm of the admission delay was normally distributed. Thus, multivariate analysis of the admission delay logarithm was performed by linear regression. Concerning the mode of transport, multivariate analysis was performed by logistic regression. Explanatory variables were selected with liberal criteria ($P<0.20$). The final model was determined by the stepwise method. Differences of $P<0.05$ were considered statistically significant. SPSS (version 10) was used for all calculations.

**Results**

One hundred sixty-six patients with acute stroke were primarily referred to the stroke unit from July 2, 1998, to July 2, 1999. Of these 166 patients, 84% had ischemic stroke, 14% had intracerebral hemorrhage, and 2% had subarachnoid hemorrhage. Fifty-eight percent of the patients were able to respond to the interview questions within the first 48 hours after admission. Information was obtained from the proxy in 42% of cases, mainly because of aphasia (36% of cases).

**Demographic Data**

Mean age was 63 years (SD 13). Fifty-eight percent of the study population were men, and 93% were white. Seventy-two percent had some high school education, and 90% were receiving regular medical care from a private physician. Twenty-three percent of patients were professionally active at the time of stroke.

**Clinical Data**

Mean baseline NIHSS score was 12.2 (SD 7.4). Median baseline NIHSS score was 11. Thirty-five percent of the patients had a baseline NIHSS score $>15$. The onset of symptoms was sudden in 90% of cases. The course of symptoms was stable in 22% of cases. Headache was present at stroke onset in 31% of cases, vomiting in 16%, and lowered consciousness in 19%.

**Recognition of Symptoms**

Stroke symptoms were recognized by the patient in 43% of cases and by bystanders in 44%.

**Initial Reaction, EMS Activation**

Data regarding the initial reaction of the patient or bystanders and EMS activation are presented in Figure 1.

**Mode of Transport**

Data regarding the mode of transport to the stroke unit are presented in Figure 2.

**Place of Stroke**

Mean distance from the place of stroke to the stroke unit was 16 km (SD 19). Median distance was 9 km (range, 1 to 150 km). Twenty-five percent of the patients traveled $>20$ km to reach the stroke unit. Seventy-five percent of the patients had their stroke at home.

**Delay**

The exact time of stroke onset could be determined in 164 patients. Twenty-two percent of the strokes had a nocturnal onset.

The positive skewness in the distribution of admission times accounts for the difference between the mean and the median data. Mean time from the onset of symptoms to
arrival in the stroke unit was 5 hours 10 minutes (SD 4 hours). Median time from the onset of symptoms to arrival in the stroke unit was 4 hours 5 minutes (range, 40 minutes to 27 hours 25 minutes). Twenty-nine percent of the patients reached the stroke unit within 3 hours, 75% within 6 hours, 91% within 9 hours, and 99% within 24 hours.

Brain CT scan was performed in all 166 patients. The median time from the onset of symptoms to brain CT scan was 3 hours 35 minutes. Thirty-four percent of the CT scans were performed within 3 hours, 83% within 6 hours, 91% within 9 hours, and 95% within 12 hours.

Patients’ Awareness of Stroke Signs and Risk Factors
Of the 166 patients, 58% were able to respond to the interview questions. Ninety-three percent of the patients considered stroke a medical emergency. When asked to name the signs and symptoms of a stroke, 42% of the patients could not identify a single sign or symptom of stroke. Thirty-six percent of the patients did not know a single risk factor for stroke. Nine percent of the patients had a prior stroke, and 15% had a prior TIA.

Univariate Analysis of Admission Delay
As shown in Table 1, early admission was significantly associated with different variables: female sex, stroke severity as assessed by baseline NIHSS score, lowered consciousness, sudden onset of stroke, not living alone, recognition of stroke symptoms by bystanders, and transport by EMS or FD ambulances. Patients transported by EMS or FD ambulances were more likely to be admitted within the first 3 hours than

<table>
<thead>
<tr>
<th>Variables</th>
<th>Admission Delay, min</th>
<th>P</th>
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</thead>
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<tr>
<td><strong>General data</strong></td>
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<td></td>
</tr>
<tr>
<td>Mode of transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal vehicle (n=15)</td>
<td>350 (165–555)</td>
<td>&lt;0.001</td>
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<tr>
<td>Private ambulance (n=87)</td>
<td>285 (210–390)</td>
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</tr>
<tr>
<td>FD ambulance (n=34)</td>
<td>218 (146–278)</td>
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</tr>
<tr>
<td>EMS ambulance (n=24)</td>
<td>195 (140–225)</td>
<td></td>
</tr>
<tr>
<td>Without information (n=4)</td>
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<td></td>
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<tr>
<td>Mode of transport</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Personal vehicle or private</td>
<td>293 (209–421)</td>
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<tr>
<td>ambulance (n=102)</td>
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<tr>
<td>FD or EMS ambulance (n=58)</td>
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</tr>
<tr>
<td>Without information (n=4)</td>
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<td>Male (n=96)</td>
<td>265 (210–388)</td>
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</tr>
<tr>
<td>Female (n=68)</td>
<td>218 (146–326)</td>
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<tr>
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<td>225 (173–325)</td>
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<tr>
<td>Yes (n=46)</td>
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<tr>
<td>Without information (n=1)</td>
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<tr>
<td>Onset of symptoms</td>
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<tr>
<td>Progressive (n=16)</td>
<td>465 (259–793)</td>
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<tr>
<td>Sudden (n=148)</td>
<td>238 (175–330)</td>
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<tr>
<td>Recognition of symptoms</td>
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<tr>
<td>Patient (n=71)</td>
<td>300 (195–425)</td>
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<tr>
<td>Bystander (n=91)</td>
<td>225 (165–300)</td>
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<tr>
<td>Without information (n=2)</td>
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<td></td>
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<tr>
<td><strong>Clinical data</strong></td>
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<td></td>
</tr>
<tr>
<td>Lowered consciousness</td>
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<td>0.01</td>
</tr>
<tr>
<td>No (n=133)</td>
<td>270 (180–390)</td>
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<td>Yes (n=31)</td>
<td>215 (150–260)</td>
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<td>Baseline NIHSS score</td>
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<td>0.02</td>
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<tr>
<td>&lt;15 (n=105)</td>
<td>270 (175–413)</td>
<td></td>
</tr>
<tr>
<td>≥15 (n=56)</td>
<td>223 (175–270)</td>
<td></td>
</tr>
<tr>
<td>Without information (n=3)</td>
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</tr>
<tr>
<td>Baseline NIHSS score (points)</td>
<td>−0.261*</td>
<td>0.001</td>
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</table>

Values are median (25th–75th percentile).
*Spearman ρ.
patients who were transported by other means (46% versus 23%; P=0.02, Fisher exact test).

Age, ethnicity, level of education, employment status, nocturnal onset, or distance from place of stroke to the stroke unit had no visible influence on admission delay. Headache and vomiting at stroke onset had no relation to early admission. Hemorrhagic stroke patients did not present significantly earlier than ischemic stroke patients. Left hemispheric stroke patients were not admitted significantly earlier than right hemispheric stroke patients. Left hemispheric stroke patients were not admitted significantly earlier than right hemispheric stroke patients. Awareness about the symptoms and risk factors of stroke had no measurable effect on early admission. Prior TIA and stroke had no visible influence on mode of transport. Hemorrhagic stroke patients were not significantly more frequently transported by EMS or FD ambulances than ischemic stroke patients.

**Multivariate Analysis of Admission Delay**

As shown in Table 2, of the potential predictors of early stroke unit arrival included in the preliminary analysis, only sex, living alone, stroke severity as assessed by baseline NIHSS score, lower consciousness, mode of stroke onset, course of symptoms, patient’s location at the time of stroke, recognition of symptoms, first medical contact, and mode of transport were significant enough to be included in the multiple linear regression model.

Two major contributors to early stroke unit admission were revealed with the use of multiple linear regression analysis. These were EMS or FD ambulance transport as opposed to the other modes of transport and sudden onset of stroke symptoms. Not living alone and female sex were also significantly associated with early admission. The model accounted for approximately 24% of the total variation of the stroke unit admission delay.

**Univariate Analysis of Mode of Transport**

As shown in Table 3, transport by the EMS or the FD ambulances was significantly associated with the following factors: female sex, sudden onset of the stroke symptoms, stroke severity as assessed by baseline NIHSS score, lower consciousness, recognition of stroke symptoms by bystanders, and first medical contact other than the general practitioner.

Age, ethnicity, level of education, and prior medical history of TIA and stroke had no visible influence on mode of transport. Hemorrhagic stroke patients were not significantly more frequently transported by EMS or FD ambulances than ischemic stroke patients.

**Discussion**

We present the first data regarding factors influencing the admission delay of acute stroke patients in a French stroke unit. As many as 75% of patients are admitted within the first 6 hours, but only approximately 30% reach the stroke unit within 3 hours, which is commonly considered to be the time
TABLE 4. Multivariate Analysis of Mode of Transport: Binary Logistic Regression Model (n=160)*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Regression Coefficient</th>
<th>SE</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>P</th>
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<td>First medical contact</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0=General practitioner</td>
<td>1.172</td>
<td>0.449</td>
<td>3.23</td>
<td>1.34–7.78</td>
<td>0.01</td>
</tr>
<tr>
<td>1=Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recognition of symptoms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0=Patient</td>
<td>0.741</td>
<td>0.376</td>
<td>2.10</td>
<td>1.01–4.39</td>
<td>0.05</td>
</tr>
<tr>
<td>1=Bystander</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
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</tr>
<tr>
<td>0=Male</td>
<td>0.858</td>
<td>0.360</td>
<td>2.36</td>
<td>1.17–4.78</td>
<td>0.02</td>
</tr>
<tr>
<td>1=Female</td>
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<tr>
<td>Constant</td>
<td>−1.647</td>
<td>1.072</td>
<td>...</td>
<td>...</td>
<td>0.124</td>
</tr>
</tbody>
</table>

Adjusted R² (Nagelkerke) = 0.18.

*0=Personal vehicle or private ambulance; 1=FD or EMS ambulance.

window for intravenous rtPA. A major challenge would be to increase the rate of admission within 3 hours to 50%. To achieve this goal, an analysis of the factors delaying admission is mandatory. We will highlight the main factors influencing admission delay and EMS transport in France. It should be kept in mind that our study reflects factors influencing delay of patients admitted to a stroke unit and may not be applicable to all stroke patients.

Demographic Data

Sex

We have demonstrated that French women are admitted significantly earlier than men, mainly because of a >2 times more frequent use of the EMS or FD as the mode of transport. The available information on the effect of sex on access to acute stroke care appears somewhat conflicting. Some studies showed no influence of sex on admission delay.7,14,15 Conversely, Menon et al16 found an association between female sex and delay time to obtaining acute stroke treatment in Houston, Tex. This study showed that women arrived at the hospital significantly more slowly than men. Men were also seen significantly more quickly than women by physicians when other related factors, including stroke type and severity, were controlled. Further studies are needed to evaluate the reasons accounting for these conflicting data. Differences in women’s knowledge of stroke and treatment-seeking behavior may account for this discrepancy.

Clinical Data

Stroke Severity

Univariate analysis of our study showed that the initial stroke severity has a significant influence on early admission. Admission delay was significantly reduced in patients with NIHSS score ≥15 and in patients with lowered consciousness. This result is in agreement with other studies. Williams et al17 found that the early arrivals within the first 3 hours of stroke had more severe strokes. Jorgensen et al18 have also shown that the milder the stroke, the higher is the risk of delayed admission. Our study points out that an effort should be made to increase early stroke unit admission of French patients with moderate stroke. All patients should be encouraged to seek immediate medical attention by using the emergency telephone system, and health professional education should focus on early hospitalization of all stroke patients, whatever their clinical severity. Indeed, Jorgensen et al have shown that every third stroke patient with mild/moderate symptoms experiences early and marked progression with increased risk of mortality and handicap.19

Mode of Onset

Multivariate analysis of our study showed that early stroke unit admission was influenced by the mode of symptom onset. Patients were admitted significantly earlier if the neurological deficit was of sudden onset. Feldmann et al9 have also shown that the sudden onset of symptoms correlated with early presentation of stroke patients: the sudden onset of a deficit that remained stable was strongly associated with the initial recognition that the symptoms signified stroke.

Stroke Knowledge and Treatment-Seeking Process

Stroke Awareness

Patients with prior TIA or stroke, patients who stated that they knew somebody who had a stroke, and patients who knew symptoms and risk factors of stroke were not admitted significantly earlier in our study. Other studies have failed to demonstrate a notable impact of stroke knowledge on prompt hospital arrival. Kothari et al20 found no difference in emergency department arrival within 3 hours between stroke patients who knew a sign, symptom, or risk factor of stroke and those who did not. Similarly, Williams et al17 found no association between prior experience and knowledge of stroke and early arrival. Patients who had a prior stroke or who knew stroke warning signs did not present earlier than those with no knowledge of stroke signs. Studies and surveys clearly show that it is easier to arouse awareness than to change behavior in health-related problems. Improvement of acute stroke care in particular requires attention to factors that go beyond stroke awareness, such as motivation, perception of the benefits associated with behavior change, and impediments to healthcare access.21

Recognition of Symptoms

Our data confirm an earlier finding that living alone increases admission time in acute stroke.7,18 Univariate analysis of our study showed that the recognition of symptoms by bystanders significantly shortened the admission delay. Multiple logistic regression of the mode of transport showed that patients whose symptoms were recognized by bystanders were >2 times more likely than patients who recognized their symptoms themselves to be transported by EMS or FD ambulances. These findings indicate that efforts should be made in France to increase the use of portable alert systems among patients at high risk of stroke who are living alone. A recent Danish study also showed that living alone doubled the relative risk of delayed admission.18 Feldmann et al9 showed that the median delay to contact the first physician was 1 hour when stroke symptoms were recognized by bystanders versus 7 hours when symptoms were recognized by the patient (P<0.05). The process a stroke patient goes through when
seeking acute care is different from the process used by patients with other diseases. Consequently, an important variable in the treatment-seeking process of stroke patients is the role played by witnesses, especially in patients with aphasia, neglect, altered cognition, or somnolence. Thus, the educational programs regarding stroke warning signs should not only focus on high-risk patients but should be aimed at the general public.

**Activation of EMS and Mode of Transport**

Our study demonstrates that early stroke unit admission in France is strongly associated with EMS and FD transport. Thus, strategies to increase the activation of EMS by patients and bystanders are needed to attain better early care of French stroke patients. Stroke management should also be reprioritized in the French EMS as a time-dependent medical emergency with a high priority similar to that for myocardial infarction. Our study shows that EMS was initially activated in 19% of cases, but EMS personnel were actually dispatched in only 15% of cases. French EMS professionals require increased awareness regarding the importance of urgent transport of acute stroke patients to a hospital with expert stroke care. It has been demonstrated that the pre-hospital and in-hospital management of emergency conditions such as myocardial infarction or trauma is clearly influenced by the availability of an efficient treatment. It is hoped that the impending approval of intravenous tPA in Europe for ischemic stroke within the first 3 hours will sensitize medical professionals to the early care of stroke patients and mandate changes in the hospital care system.

The general practitioner’s role in the early assessment of stroke in France should also be reconsidered because our study shows that patients who do not initially contact their personal physician are >3 times more likely to be transported by the EMS or FD. Other studies performed in Europe and the United States have shown that the initial call of the general practitioner is a factor of delayed admission in acute stroke. Harbison et al have also demonstrated that the establishment of a rapid ambulance protocol for acute stroke in Newcastle, United Kingdom, successfully diverted patients to a stroke unit. Time from symptom onset to admission for patients with stroke or TIA was 1 hour 12 minutes for ambulance admissions compared with 6 hours for general practitioners’ admissions (P < 0.001).

The mode of transport is obviously one of the most important factors of early stroke unit admission. Our study clearly shows that the use of EMS or FD transport is insufficient among French stroke patients (35% of cases). In contrast, Barsan et al found that as many as 47% of American stroke patients in 3 metropolitan communities used the emergency telephone system (911) as their first medical contact, and this number increased to 65% for those patients presenting within the first 90 minutes. Other American studies have also shown that stroke patients transported by the EMS were more likely to arrive within the first 3 hours than those transported by other means. Times from stroke onset to hospital arrival decreased significantly during the course of the National Institutes of Health Tissue Plasminogen Activator Pilot Study, and significantly increased use of 911 was the major explanation for the shortened arrival times.

In summary, we have provided the first information on the stroke unit admission delay of French stroke patients and have stressed the readily modifiable factors of early admission, mainly mode of transport by EMS or FD ambulances and direct activation of the emergency telephone system by patients or proxies without prior medical contact. Our study demonstrates that early stroke unit arrival is feasible in France but also that a higher priority should be given to stroke in terms of emergency transport and management. Widespread and repetitive public information is needed to improve the recognition of stroke symptoms and facilitate the proper response, ie, the activation of the emergency telephone system. French health system improvements are also mandatory to provide rapid EMS transport and urgent treatment to a greater number of acute stroke patients.

**Acknowledgment**

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**References**

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