Evaluation Times for Patients With In-Hospital Strokes

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Background: **Each year at least 35 000 people suffer a stroke while hospitalized, but little is known about the clinical characteristics of such patients or how rapidly they are identified and evaluated. With a recent emphasis on the very early treatment of stroke, in-hospital stroke patients may be candidates for some early interventions.**

Methods: **This was a retrospective study using the stroke registries at two academic medical centers. Data were collected about the clinical characteristics of patients with an in-hospital stroke and who recognized the stroke. Detailed time data were analyzed to determine the time of stroke recognition, medical evaluation, and neurological evaluation. These specific time epochs were analyzed to determine which were responsible for any delays in stroke identification and assessment. Data were analyzed using nonparametric methods, including the Wilcoxon rank sum and Kruskal-Wallis procedure.**

Results: **Sixty-three patients were identified with in-hospital strokes and adequate time data. In-hospital stroke patients were recognized most frequently by nurses (63%) and by the patient (16%). Patients on a cardiology service and general surgery service accounted for 48% of all in-hospital strokes. The mean and median times from stroke recognition to a neurology evaluation were 14.5 and 2.5 hours, respectively. Total delays differed significantly with service and locale ($P=.004$). Patients on the Duke neurology service were evaluated significantly sooner (median delay, 0.5 hour) than patients on the Duke medical (median delay, 5.8 hours) or Duke surgical (median delay, 20.5 hours; $P<.01$ by Wilcoxon rank sum) services. Patients on the Yale surgical service were evaluated significantly sooner than patients on the Duke medical ($P=.0006$) or surgical ($P=.0001$) services. The time between physician notification and calling for a neurology evaluation accounted for >60% of the total time delay for patients not on a neurology service.**

Conclusions: **A substantial number of in-hospital stroke patients experience a long delay between symptom recognition and a neurological evaluation. While medical personnel are usually notified very soon after an in-hospital stroke is recognized, such patients often do not receive a rapid neurological evaluation. Additional education of hospital staff may reduce these time delays. (*Stroke*. 1993;24:1817-1822.)**

KEY WORDS • **cerebrovascular disease** • **cerebrovascular disorders** • **epidemiology** • **stroke management** • **hospitalization**

In-hospital stroke is a common problem that has not been studied adequately. Review of the Stroke Data Bank shows that approximately 7% of recorded strokes affected hospitalized patients.[1] Other studies report that 6.5% to 15% of strokes occur in hospitalized patients.[2,3] When viewed on a national scale, between 33 000 and 75 000 patients may suffer a stroke while hospitalized. However, few clinical details about these patients have been published, and no time data have been reported.

Patients with an in-hospital stroke may be excellent candidates for participation in trials of various stroke therapies. Recent and ongoing studies of such agents have emphasized the need for the rapid initiation of therapy.[4-6] However, the accrual of large numbers of acute stroke patients within minutes to hours of symptom onset is problematic. One major problem is the lack of rapid identification and transportation of patients to study centers.[7] A recent study of thrombolytic therapy in acute stroke found that 83% of patients had to be excluded from participation because of delayed presentation.[8] While public education and a well-organized referral and triage system can improve the rapidity of patient referral, the vast majority of stroke patients still do not present soon enough to qualify for many acute treatment studies.[9,10]

The expeditious identification and evaluation of in-hospital stroke patients could also lead to a more rapid specific diagnosis and initiation of standard therapy. An early brain computed tomographic (CT) scan or magnetic resonance imaging (MRI) study may distinguish a cerebral hemorrhage from an ischemic stroke, each of which requires different treatments.[11,12] The early initiation of anticoagulants may prevent subsequent strokes in selected patients.[13] Other aspects of stroke care, such

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TABLE 1. Descriptive Data

Locale	Men	Women	Hospital Service			
			Medicine	Surgery	Neurology	Psychiatry
Duke	23	22	27	12	5	1
Yale	11	7	6	12	0	0
Total	34	29	33	24	5	1

as the prevention of aspiration pneumonia,[14] treatment of blood pressure abnormalities,[15] and initiation of rehabilitation, could also be applied more quickly.[16]

Patients with in-hospital strokes could be evaluated and treated rapidly since delays in transportation are obviously eliminated. Since they are already hospitalized, their medical problems, medications, and some laboratory data are readily available. However, it is not known how rapidly these patients are recognized and evaluated or what factors contribute to delays. We conducted a retrospective, two-hospital study to investigate these issues. Our hypothesis was that despite being hospitalized, many in-hospital stroke patients are not rapidly recognized and evaluated.

Subjects and Methods

In-hospital stroke patients were ascertained by review of the stroke registries at Duke University Medical Center (Duke) and Yale–New Haven Hospital (Yale). Patients admitted for evaluation of an initial diagnosis of stroke or transient ischemic attack were excluded unless they sustained another neurovascular event that was clearly new and distinct from their admitting episode. In cases for which no useful time data were recorded in the chart, the patient was excluded from the study.

Charts of patients who suffered a stroke while hospitalized were reviewed to determine specific time points for the following events: (1) initial symptom recognition; (2) the time that any medical personnel were notified; (3) the time a physician was notified; (4) the time a neurologist or neurology house officer was called; and (5) the time that the patient was seen by a neurologist or neurology house officer. The times were obtained by reviewing physician notes, nursing notes, and other relevant chart documents. Using these time points, specific time epochs were defined and calculated as follows: D1, epoch between initial symptom recognition and notification of any medical personnel; D2, epoch between medical personnel notification and physician notification; D3, epoch between physician notification and calling neurology; and D4, epoch between calling neurology and a neurologist's or a neurology house officer's seeing the patient. These epochs (D1 through D4) were summed to determine the total delay.

Information was collected about which service the patient was admitted to (ie, medical, surgical, neurology), the admitting diagnosis, who first recognized the stroke symptoms, and any obvious reasons for the delay(s) in seeing the patient. Service classifications were based on standard hospital organization (ie, cardiology was recorded as a medical service, orthopedics was classified as a surgical service). The stroke type as determined by the patient's physician was recorded. Data on the patient's disposition were also collected.

In cases in which there was no delay in a particular time epoch, a "0" was used for calculations. If data for one of the time points were missing, the time epoch defined by that time point was not calculated. However, overall total time delay, and other time epochs, were calculated using the available data. For example, if data for calculation of a specific time epoch (eg, D2) were missing, the total delay was calculated using the time of onset and the time of the neurology evaluation. Records without sufficient time data for calculation of the total time delay were excluded from the study, as were records without sufficient data for calculation of at least two time epochs.

Nonparametric methods based on ranks were used for data analysis. Simple comparisons between locales and service categories were made using the Wilcoxon rank sum and Kruskal-Wallis procedure. Since outcomes departed significantly from the assumptions of normality and equal variances required by the model, rank transformations were used in conjunction with linear modeling techniques.[17,18] Due to the skewed nature of the data, median outcomes were used for descriptive purposes.

Results

From May 1989 through October 1991, 64 patients in the Duke stroke registry suffered in-hospital strokes; 19 patients were excluded for the reasons described above. At Yale, from 1989 through 1991, 59 patients were registered with in-hospital strokes, and 41 were excluded due to insufficient time data. A total of 63 patients were available for total time analysis. There were 34 men (54%) and 29 women (46%) (Table 1).

Combined data from both centers showed 33 patients on medical services, 24 on surgical services, 5 on neurology, and 1 on psychiatry (Table 1). Among specific services, cardiology was the most common (18 patients, 29%), followed by general surgery (12 patients, 19%), general medicine (9 patients, 14%), and thoracic surgery (8 patients, 12%). The most frequent admission diagnosis was myocardial infarction (9 patients, 14%), followed by coronary artery bypass surgery (7 patients, 11%). Three patients had an admission diagnosis of stroke.

Stroke symptoms were first recognized most frequently by a nurse (40 patients, 64%), followed by the patient (10 patients, 16%) and a physician (6 patients, 10%) (Table 2). The most common in-hospital stroke type was embolic (32 patients, 51%), followed by hypoperfusion (6 patients, 10%) and intracerebral hemorrhage (3 patients, 5%). In many cases the precise

TABLE 2. Symptom Recognition

Locale	Nurse	Patient	Physician	Family	MD/Nurse	Total
Duke	27 (43)	8 (13)	6 (10)	2 (3)	2 (3)	45 (71)
Yale	13 (21)	2 (3)	0 (0)	3 (5)	0 (0)	18 (28)
Total	40 (63)	10 (16)	6 (10)	5 (8)	2 (3)	63 (100)

Numbers in parentheses are percentages. Percentages do not add up due to rounding off.

etiology of the stroke could not be determined or there was more than one likely etiology. Disposition data were available for 62 patients. Twenty-two patients (36%) were sent home, 13 (21%) went to a rehabilitation service or facility, and 8 (13%) died. The other patients remained hospitalized or were transferred to another hospital.

Since 41 Yale patients were excluded due to insufficient time data, we analyzed 13 such patients (7 men and 6 women, consecutively selected) to determine if they differed significantly from the overall study group. Seven patients were on a surgical service when they had a stroke, and four were on a medical service. An embolic mechanism was the most common etiology (7), followed by small vessel disease (3), intracerebral hemorrhage (2), and large vessel occlusion (1). These characteristics were quite similar to the profile of the patients in the included Yale group, making it unlikely that there were any substantial clinical differences between the excluded and included Yale patients (Table 1).

Based on the 63 patients with complete total time data, the mean and median times between stroke recognition and a neurology evaluation were 14.5 and 2.5 hours, respectively (Table 3). The total times differed significantly with service and locale ($P=.004$). The Duke surgical service had the longest median delay (20.5 hours) and the Duke neurology service had the shortest delay (median, 0.5 hour). When the neurology service is excluded, the Yale surgical service had the shortest median delay (1.3 hours). Patients on the Duke neurology service were evaluated significantly faster (median delay, 0.5 hour) than patients on the Duke medical services (median delay, 5.8 hours) or Duke surgical services (median delay, 20.5 hours; $P<.01$ by Wilcoxon rank sum).

The contribution of each time epoch to the delay from symptom recognition to a neurology evaluation can be seen in Tables 4 and 5. Using median data, the time delays defined by epochs D1 and D2 accounted for 0% to 8% of the total delay, whereas epochs D3 and D4 accounted for the vast majority of the total delay. For all services except the Yale medical service, epoch D3 accounted for over 50% of the total delay (Table 5). The overall results were similar when mean data were analyzed. Epochs D1 and D2 accounted for 0.3% to 18.5% of the delay; epochs D3 and D4 accounted for 23.3% to 71.3% of the total time. Epoch D3 accounted for the largest delay in all cases except the Yale medical service. These results indicated that once an in-hospital stroke patient is recognized, some medical personnel are notified fairly promptly. However, significant delays are incurred between physician notification and calling for a neurology consultation and then in waiting for neurology to actually see the patient.

Total evaluation times with respect to specific time points were analyzed to determine the impact of in-hospital delays on patient recruitment into some typical stroke trials. The time delays analyzed were 90 minutes, 180 minutes, 6 hours, and 12 hours. Less than 30% of the patients were seen and evaluated by neurology within 90 minutes of symptom recognition, but 55% of patients were evaluated within 180 minutes of symptom recognition (Table 6). However, 25% of the patients were not evaluated by neurology within 12 hours of symptom recognition.

We also collected information about the reasons for any delays. Reasons were available from 28 records. The most common explanation was "busy" in 5 cases, followed by "waiting for a CT scan" in 2 cases. In some cases the house staff did not perceive that the patient was having a stroke, since alternative diagnoses such as hypoglycemia, narcotic effect, and anxiety were made initially.

Discussion

We tested the hypothesis that in-hospital stroke patients are not rapidly recognized and evaluated. Our study found that in most cases medical personnel are rapidly notified about in-hospital stroke patients. However, with the exception of patients who have a stroke

TABLE 3. Descriptive Statistics for Total Time by Hospital Service and Locale

Service	n	Mean	SD	Median	Min-Max
Duke medical	27	669.8	819	350	50-2820
Duke surgical	12	2663.0	3541	1230	60-9830
Yale medical	6	322.2	350	127	60-803
Yale surgical	12	130.4	171	80	20-660
Duke neurology	5	35.0	24	30	10-60
Duke psychiatry	1	1260.0	. . .	1260	. . .
Total	63	872.5	1831	150	10-9830

SD indicates standard deviation; Min, minimum; Max, maximum. All times are in minutes.

TABLE 4. Median Times by Epoch for Locale and Hospital Service

Epoch	Medical+Surgical, n=57	All Records, n=63	Duke		Yale	
			Medical, n=27	Surgical, n=12	Medical, n=6	Surgical, n=12
D1	0	0	0	0	0	0
D2	0	0	0	0	10	5
D3*	87.5	60.0	90	840	37.5	29.5
D4*	52.5	42.5	60	105	60	22.5

All times are in minutes. See "Methods" for definitions of the D1 through D4 epochs.
*Descriptors for epochs D3 and D4 are based on 50 observations for the combined medical and surgical groups, 56 subjects for the total data set, 21 observations for the Duke medical group, and 11 observations for the Duke surgical group.

while on a neurology service, most patients are not evaluated by neurology for at least several hours from symptom onset or recognition.

This is one of the largest studies of in-hospital stroke patients in the English literature. Kelley and Kovacs[3] found that 46% of in-hospital strokes occurred perioperatively, but that study consisted of only 26 patients. Schoenberg et al[2] reported that acute heart disease and surgical procedures accounted for 48% of in-hospital strokes in a cohort of 65 patients. Neither study addressed issues of stroke recognition or time delays between recognition and obtaining a neurology evaluation.

The relatively brief delays between symptom recognition and notification of medical personnel and a physician may indicate that patients, family members, and particularly nurses recognize some stroke symptoms, or at least perceive that something unusual is happening. This awareness may be heightened for hospitalized patients, since many patients who suffer a stroke out of the hospital are either not readily recognized or the seriousness of the symptoms may not be appreciated.[7,19] The time of recognition may not reflect the actual time of stroke onset, since some patients were likely to be alone in their rooms before stroke recognition. Some patients may have been unaware of the time of onset or unable to communicate with hospital personnel immediately due to the nature of some stroke symptoms (eg, neglect, aphasia). Patients who awoke with their deficit would also have an unclear time of onset.

The long delay between physician notification and calling neurology is somewhat unexpected. There are several possible explanations for this delay. The physician called to evaluate the patient is likely to be a house officer with many other responsibilities. If called by a nurse to evaluate a patient with "altered mental status" or "confusion" (which is how a patient with a new aphasia may appear), the house officer may assign such a patient a low priority compared with other emergent situations. In some cases they may begin diagnostic testing, including blood tests and a head CT scan or MRI, before obtaining a neurological consultation. Another possibility is that the house officer may not recognize the patient's new problem as being due to a stroke or may not perceive an acute stroke as an emergent problem.

Another concern was the relatively large contribution of epoch D4 to the total delay. This epoch, which represents the delay between calling for a neurology consultation and a neurologist's or neurology house officer's seeing the patient, accounted for a median of 11% to 53% of the total delay. This delay is particularly worrisome, since neurology house officers should recognize the importance of new stroke symptoms. This applies not just to enrolling stroke patients in research

TABLE 5. Median and Mean Percentages for Each Time Epoch by Locale and Hospital Service

Epoch	Median Percentages			
	Duke Medical, n=27*	Duke Surgical, n=12*	Yale Medical, n=6	Yale Surgical, n=12
D1	0	0	0	0
D2	0	0	7.6	8.0
D3	68.1	78.4	27.5	54.4
D4	15.6	11.1	53.3	37.5
	Mean Percentages			
D1	6.8	0.3	1.3	1.3
D2	2.5	4.6	18.5	6.3
D3	61.0	71.3	34.8	53.7
D4	28.6	23.3	45.4	38.7

See "Methods" for definitions of each time epoch.
*Descriptors for epochs D3 and D4 are based on 21 observations for the Duke medical group and 11 observations for the Duke surgical group.

TABLE 6. Data for Specific Time Intervals

Locale	≤90	91–180	181–360	361–720	>720	Total
Duke	9 (14)	11 (17)	4 (6)	7 (11)	14 (22)	47 (70)
Yale	9 (14)	6 (10)	0	1 (2)	2 (3)	18 (29)
Total	18 (28)	17 (27)	4 (6)	8 (13)	16 (25)	65 (99)*

All times are in minutes. Numbers in parentheses are percentages.
*Numbers do not add up to 100% due to rounding off.

trials but also affects obtaining a prompt diagnostic evaluation and beginning standard therapy.[16]

There were several reasons that we chose the time delay involved in obtaining a neurological evaluation as a key end point. A recent study[20] showed that elderly stroke patients cared for by neurologists were discharged sooner and had less disability than stroke patients cared for on a medical service. Another study[21] reported that stroke patients cared for in a stroke unit had a better functional outcome and were more likely to go home than patients on medical wards. As the present study showed, nonneurologists may have some problem with the recognition and diagnosis of a new stroke, leading to a delay in initiating proper therapy. These findings support the idea that stroke patients are best cared for by neurologists and that such care should be delivered as soon as possible.

The finding that patients on neurology with a new stroke can be recognized and evaluated within 30 to 35 minutes is encouraging, since it demonstrates that with proper training and observation it is possible to rapidly begin treatment of some in-hospital stroke patients. However, the finding that a quarter of all in-hospital stroke patients in our study were not seen by neurology for more than 12 hours after symptom recognition clearly indicates the need for improved education of hospital staff and physicians about stroke.

Several potential limitations of this study should be noted. Since we analyzed patients from only two hospitals, our results may not reflect the pattern of care received by patients at other institutions. Both hospitals in our study have active stroke programs with several ongoing treatment trials that are well publicized within each center. One might expect a heightened awareness of the hospital staff to new stroke patients, yet this was not apparent in the overall delay times. The situation may be even worse at other hospitals without active stroke programs and physicians in-house on a 24-h/d basis.

Since our study was retrospective, detailed time data were not available for some patients at each institution, particularly at Yale. Therefore, the patients included in our study may represent a skewed population. A prospective study may have complete data on more patients, but may also skew the results since it would heighten awareness of in-hospital stroke and likely alter assessment patterns. Although there were no atypical clinical features of the patients in our study and the range of presentation times was quite wide, the overall representativeness of this sample to the entire target population is unknown. Nevertheless, the numbers of patients with extended times to evaluation suggest considerable cause for concern and room for improvement in a substantial segment of that population. Since we recorded time of symptom recognition, it is possible that some patients had the onset of symptoms minutes to hours before the time of recognition. This could lead to an underestimation of the total time delay seen in our study.

Several steps could be taken to shorten the delays observed in evaluating in-patients with a new stroke. The hospital staff, particularly physicians, should receive additional training focusing on the recognition of stroke symptoms and the need for a rapid neurological evaluation.[9] House officers on all services, including neurology, should avoid a nihilistic approach to acute stroke, since early diagnosis and treatment may help to reduce neurological deficits and prevent poststroke complications.[16] The formation of specially designated stroke teams has helped to reduce peristroke complications.[22] A similar team approach could be undertaken to provide a mechanism for the rapid evaluation and treatment of in-hospital stroke patients. Such a rapid-response stroke team would also provide a pool of health care professionals motivated and trained to provide care to stroke patients.

The validation of several new potential stroke therapies will require large numbers of patients that can be identified, diagnosed, and treated very soon after stroke onset. Even routine stroke care can be optimized by the immediate identification and aggressive management of acute stroke patients.[16,21] In both cases, the in-hospital stroke population is an important source of such patients. Based on our study, 55% of patients would theoretically be eligible for an interventional study with a 3-hour enrollment window, and 61% of patients could enroll in a study with a 6-hour time limit. Some in-hospital stroke patients may have preexisting medical conditions that exclude them from treatment protocols, but many will qualify for inclusion in some trials. Considering the difficulties encountered with the recruitment of out-of-hospital acute stroke patients and the importance of making a rapid and accurate diagnosis of a stroke, the in-hospital stroke population deserves considerable attention.

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