Surgical Neurology International

OPEN ACCESS

For entire Editorial Board visit : http://www.surgicalneurologyint.com

Original Article

Characteristics of the stroke alert process in a general Hospital

Mark M. Stecker, Kathleen Michel, Karin Antaky, Adam Wolin, Feliks Koyfman

Department of Neuroscience, Winthrop University Hospital, Mineola, NY 11501, USA

E-mail: *Mark Stecker - mmstecker@gmail.com; Kathleen Michel - kmichel@winthrop.org; Karin Antaky - kantaky@winthrop.org; Adam Wolin - awolin96@gmail.com; Feliks Koyfman - fkoyfman@winthrop.org
*Corresponding author

Received: 18 April 14 Accepted: 23 September 14 Published: 14 January 15

This article may be cited as:
Stecker MM, Michel K, Antaky K, Wolin A, Koyfman F. Characteristics of the stroke alert process in a general Hospital. Surg Neurol Int 2015;6:5.
Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2015/6/1/5/149387

Abstract

Background: The organized stroke alert is critical in quickly evaluating and treating patients with acute stroke. The purpose of this paper was to further understand how this process functions in a moderate sized general hospital by exploring the effects of patient location and time of day on the pace of evaluation and the eventual outcome of evaluation.

Methods: Retrospective chart review.

Results: The rate of stroke alerts depended on the time of day and patient location. There was a low probability (41%) that the eventual diagnosis was stroke after a stroke alert, but there was no effect of diagnosis on the pace of evaluation. The time between stroke alert and a computed tomography (CT) scan being read was shortest for patients in the emergency room (ER) and longer for patients in the intensive care unit (ICU) or medical/surgical floors. Patients evaluated on medical/surgical floors were less likely to receive tissue plasminogen activator (tPA) than those evaluated in the ER, even though the comorbidities were similar. This may be due to the greater severity of the comorbidities in patients who were already admitted to the hospital.

Conclusion: The rate of tPA administration was lower for stroke alerts called from medical/surgical floors than from the ER. Stroke alerts were most frequent in late afternoon.

Key Words: Stroke, tissue plasminogen activator, treatment

Access this article online
Website:
www.surgicalneurologyint.com
DOI:
10.4103/2152-7806.149387
Quick Response Code:

INTRODUCTION

Providing appropriate care to patients with acute strokes as quickly as possible is critical in ensuring good outcomes.[9] Because of this, hospitals have created "stroke alert" systems to notify the appropriate team of providers about an acute stroke and to dedicate hospital resources to the immediate diagnosis and treatment of these patients. This process must intrinsically have a very high sensitivity so that as many patients as possible receive appropriate acute therapy. Consequently, specificity is not extremely high. Previous studies[7,11,13] have found that 20-30% of patients evaluated for acute stroke had another disorder. However, this number is much smaller in patients who were actually treated with tissue plasminogen activator (tPA).[1] The speed at which the diagnosis is made and at which appropriate testing is performed is also important because of the need to administer tPA as quickly as possible after an acute stroke,[9] as shorter treatment times have been associated with improved outcomes.[10] Further understanding the factors that modulate the sensitivity and speed of this process is important in optimizing the stroke alert process. Some studies have indicated that the time of day when the patient arrives in the hospital may influence outcome,[3,5] but other studies are equivocal.[8,12] Another factor that might influence the stroke alert process is the location in the hospital where the stroke is first noticed. Many of the previous studies[2,4,6,14-16] have compared in-hospital and out-of-hospital strokes. However, the in-hospital strokes form a heterogeneous group including patients residing on medical/surgical floors and intensive care and the influence of this factor has not been fully explored.

This study was conducted to evaluate the effect of the location in the hospital where the patient first presented with stroke-like symptoms and the time of day when this occurred on the stroke alert process. The stroke alert process is characterized by a number of factors including the ultimate patient diagnosis, the accuracy of the initial identification of a stroke, the chance that tPA is administered, and the time to various treatment milestones.

METHODS

Under an institutional review board (IRB)-approved protocol (#368728-1 Winthrop University Hospital), data from the existing stroke logs and "Get with the Guidelines®" (American Heart Association) database were obtained and de-identified. During the period from 3 January 2011 through 28 March 2013, there were 983 activations of the hospital stroke alert system. The Cincinnati Stroke Scale was used as a guide to assess patients who may be experiencing a stroke. If a patient demonstrates a positive Cincinnati stroke sign within 6 h of last known normal, then a stroke code should be activated. However, any hospital staff member may activate the hospital stroke alert system at any time if there is any concern of an acute stroke. A low threshold to activate this system is encouraged even if there is doubt as to whether a patient is experiencing an acute stroke. Once this system is activated, the beepers of every member of the stroke team are activated. The patient is then quickly assessed by the stroke team so that appropriate therapy can be initiated. The stroke team consisted of a neurologist with experience in vascular neurology, as well as a midlevel provider (physician assistant or nurse practitioner). In addition, for stroke alerts called outside the emergency room (ER) or intensive care unit (ICU), an ICU nurse and a respiratory therapist responded for every stroke alert. Also, there was an inte rventionist (either neurosurgeon or interventional radiologist) on call at all times to perform intra-arterial clot retrieval or intra-arterial tPA. A neurosurgeon was on call at all times to handle emergencies related to intracranial hemorrhage, increased intracranial pressure, or severe post-stroke edema. Overall, the stroke alert system was very sensitive for an acute stroke since it was activated properly in 95.6% of stroke patients.

Of the 983 activations, there was information on the final diagnosis and the location from which the stroke alert was activated in 883. The most frequent 13 diagnoses were given a numerical code and the the 14th code was used to designate all other diagnoses. In addition, all locations were classified into one of five groups: ER, medical/surgical floor, neurology floor, ICU, or other. The other category included the special procedures unit, the cardiac catheterization laboratory, recovery room, and magnetic resonance imaging (MRI) among other locations.

A number of metrics for response were computed. These included five different times: The time from last known well time to activation of the stroke alert (T_{act}), time from stroke alert to stroke team assessment (T_{as}), last known well time to symptom onset (T_{onset}), stroke alert to computed tomography (CT) read (T_{CT}), and the time between the stroke page and lab studies completed (T_{lab}).

The length of stay was computed as the time between the stroke alert and discharge rounded to the number of days.

Cross-tabulation analysis was used to determine whether the distribution of diagnoses or rate of giving tPA was dependent on the location or the time of day. These tables were analyzed using the χ^2 statistic with a significance level of $P = 0.05$. Intra-arterial tPA was given or intra-arterial clot removal was performed on only two occasions, and so the processes associated with its administration were not studied.

One-way analysis of variance (ANOVA) was used to determine whether there were differences in a variable under different conditions. Because of the large differences in the time measures mentioned above and their variances, a repeated measures ANOVA was not the primary test. Instead, multiple one-way ANOVAs were used. Because this involved five separate tests, the P value for significance was taken at 0.01 rather than 0.05, according to the Bonferroni correction.

Whether the characteristics of the patients were different at different locations and different times of day was determined by computing multiple cross-tabulation analyses in the population of patients diagnosed with a stroke. Thus, a total of 23 cross-tabulations were computed, one for each demographic factor. Using the Bonferroni correction for multiple testing, the significance level for each test was taken at 0.05/23 or 0.002 as our significa nce level. The demographic factors studied included: Gender, atrial fibrillation, coronary artery disease, carotid stenosis, pregnancy, diabetes, drug/

alcohol abuse, dyslipidemia, family history of stroke, hypertension, heart failure, obesity, previous stroke, previous transient ischemic attack (TIA), prosthetic heart valve, peripheral vascular disease, renal failure, smoking, weakness, altered mental status, aphasia, and deep vein thrombosis (DVT).

RESULTS

Effects of location

Table 1 shows that the stroke alerts were most frequently initiated from the ER followed by the medical/surgical floors of the hospital and the ICU. Stroke is the eventual diagnosis in roughly half of the stroke alerts in the ER or ICU, but in only one-third of patients who were on a medical/surgical floor, which shows a statistically significant difference. The rate of seizures being the cause of a stroke alert was lowest in the ER and highest on the neurology floor. In addition, the frequency at which tPA is administered is statistically different in the various hospital locations with the highest rate in the ER and the lowest on the neurology and medical/surgical floors. If only those patients with a diagnosis of stroke are considered, the rates of tPA administration range from 16.2% for the ER to 2.1% for the medical/surgical floors, a difference that shows a trend toward statistical significance.

Diagnosis after evaluation

A high sensitivity for the stroke alert process is encouraged and so it is expected that the final diagnosis is not always stroke. Table 2 shows the frequency at which the most frequent diagnoses were encountered. Note that many of the diagnoses fell into the "other" category. These included diagnoses such as cardiac arrest, transient global amnesia, and non-specific weakness, as well as other less frequent diagnoses. A cross-tabulation table of LOCATION × DIAGNOSIS was statistically significant with $\chi^2 = 148$, df = 60, and $P < 0.001$.

Times of treatment milestones

Table 3 shows the mean and standard deviation of each time (T_{act}, T_{as}, T_{onset}, T_{CT}, T_{LAB}) in minutes. Using the multiple ANOVAs, only T_{CT} was significantly dependent [Table 4] on the location of the stroke alert [$F (3, 835) = 32.089$, $P < 0.001$]. The longest times were in the ICU and the shortest in the ER. This is as expected since the CT scan is the only test the patient has to physically travel to and the CT is in close physical proximity to the ER. There was no statistically significant effect of diagnosis on any of the times.

Time of day

Overall, the frequency of stroke alerts varied throughout the day and they were most frequent [Figure 1] between 9 a.m. and 6 p.m. ($\chi^2 = 250$, df = 23, $P < 0.001$). The only time that showed any statistically significant variation with the time of day was T_{LAB}. This was more than three times longer for stroke alerts at 7 a.m. than at any other time of day [$F (23, 401) = 5.3307$, $P = 0.00000$].

There was no effect of the time of day on the rate at which tPA was given or the diagnosis of stroke made. However, the location of the stroke alert did depend on the time of day ($\chi^2 = 163$, df = 115, $P = 0.002$). The highest chance that a stroke alert comes from the medical/surgical floor is 5–7 a.m. at which time 44–62% of all stroke alerts come to these units. At this same time of day, only 12–55% of stroke alerts are from the ER, which is the lowest of the 24-h period.

NIH stroke scale

The NIH stroke scale (NIHSS) at evaluation was on average 7.0 (±7.2). There is a significant difference between the initial NIHSSs in the different locations, with the higher stroke scales in the ICU and lowest in the ER as shown in Table 1. As can be seen in Table 2, the NIHSSs were significantly different in patients with different diagnoses [$F (12, 689) = 9.4007$, $P < 0.001$]. The scores were highest in patients with intracranial hemorrhage and lowest for syncope, headache, and multiple sclerosis. The NIHSS for patients judged to have a psychiatric problem was relatively high.

As a measure of outcome, the difference between the NIHSS on discharge and the NIHSS at the time of the

Table 1: Characteristics of patient population that depends on location at which the stroke alert was initiated

Location	% of all stroke alerts	% stroke	% tPA	% tPA of strokes	% seizure	NIHSS	LOS
ER	67	49.4	8.8	16.2	11	6.3 (0.32)	6.3 (.3)
Medical/surgical	21	34.0	3.1	2.1	21	8.2 (0.60)	11.6 (.9)
Neuro floor	1	0.0	0	0	33	8.0 (2.9)	9.0 (5)
ICU	6	55.8	3.9	9.1	23	11.7 (1.2)	14.8 (1.3)
Other	5	61.3	5.0	5.6	8	6.6 (1.3)	0.2 (1.4)
Statistics		$\chi^2=115$ df=40 $P<0.001$	$\chi^2=11$ df=5 $P=0.05$	$\chi^2=11$ df=4 $P=0.07$		$F (5, 671) = 4.6740$ $P=0.0003$	$F (5, 354) = 13.7$ $P<0.001$

Frequency of stroke alerts from various locations along with the chance that a stroke alert patient was diagnosed by the stroke team as having a stroke or seizure, as well as the chance that a patient eventually received tPA. NIHSS: NIH stroke scale, LOS: Length of stay in days, ICU: Intensive care unit, ER: Emergency room

Table 2: Distribution of diagnoses in patients with stroke alerts and the average NIH stroke scale values in the group of patients with that diagnosis

Diagnosis	% of all stroke alerts	NIHSS
CVA	40.8	8.5 (0.37)
TIA	15.4	2.5 (0.61)
Sz	12.4	7.3 (0.71)
Encephalopathy	9.1	8.2 (0.81)
ICH	5.1	11.7 (1.1)
Syncope	1.9	2.2 (1.7)
Cranial nerve palsy	1.7	1.7 (1.9)
Headache	1.3	3.6 (2.1)
SDH	0.84	5.4 (2.5)
Psychiatric	0.6	8.8 (3)
MS	0.7	1.4 (3)
Hydrocephalus	0.1	4.0 (6.7)
Tumor	0.7	7.2 (3)
Other	9.2%	

NIHSS: NIH stroke scale, CVA: Cerebrovascular accident, TIA: Transient ischemic attack, ICH: Intracerebral hemorrhage, SDH: Subdural hematoma, MS: Multiple sclerosis, NIH: National institute of health

Table 3: Mean times for various milestones after a stroke alert, and the mean values for all times for patients whose stroke alerts initiated from the ER and the medical/surgical flow are shown with standard deviations

Time	Mean (SD), minutes	ER	Medical/ surgical floor
Last known well time to stroke alert (T_{act})	287 (457)	289 (410)	214 (395)
Stroke alert to stroke team assessment (T_{as})	4.4 (5.4)	4.2 (3.4)	5.2 (9.2)
Last known well time to onset of symptoms (T_{onset})	198 (432)	173 (381)	184 (378)
Stroke alert to CT read (T_{CT})	30.6 (23)	25.3 (14)	38.5 (29.6)
Stroke alert to labs complete (T_{lab})	43.8 (57)	44.5 (59.8)	60 (–)

ER: Emergency room, SD: Standard deviation

Table 4: Location effect on T_{CT}

Location	Mean time (SD), minutes
ER	25.3 (0.87)
Medical/surgical	38.5 (1.6)
Neuro floor	32.4 (6.4)
ICU	50.1 (3.5)
Other	36.7 (3.4)
Statistics	F (5, 857) =19.517, $P<0.0001$

T_{CT}: To computed tomography, ER: Emergency room, SD: Standard deviation, ICU: Intensive care unit

stroke alert was computed. This information was available in only 226 patients and averaged −2.6 units with a standard deviation of 4.8, indicating improvement in the neurologic examination. This difference did not have a statistically significant relationship to the location from which the stroke alert was initiated [F (5, 220) =1.0484, *P* = 0.4]. It was also not influenced by the time of day [F (22, 203) =1.45, *P* = 0.10]. A *t*-test showed that the discharge minus initial NIHSSs was on average −2.5 in patients not given tPA and −3.9 in patients given tPA, a difference that was not statistically significant (df = 218, *t* = 1.37, *P* = 0.17).

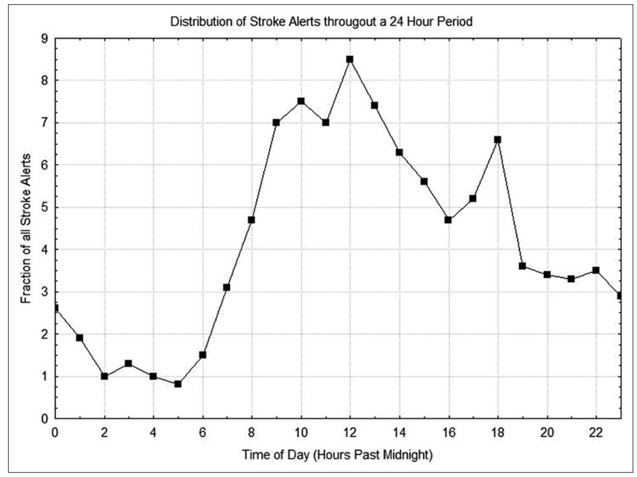

Figure 1: Distribution of stroke alerts throughout the day

Length of stay

There was no statistically significant effect of time of day on the length of stay [F (23, 328) =0.96299, *P* = 0.51354]. However, the location from which the stroke alert was initiated was significantly related to the length of stay, with the longest lengths of stay in the patients in the ICU and the medical/surgical floor and the shortest length of stay for patients whose stroke alert was called from the ER or the neuro floor.

Demographics/comorbidities

There was no statistically significant effect of location of the stroke alert on the frequency of any demographic factor, except for the risk of DVT which was 1.2% in patients whose stroke alert was in the ER and 0 in others (χ^2 = 17.9, df = 4, *P* = 0.001). There was no significant effect of time of day on the presence of any demographic factor.

DISCUSSION

One important issue brought forward by the data in the paper is the accuracy of the initial stroke diagnosis. Data from our institution show that there is a larger overall percentage of diagnoses other than stroke in this study (60%) than in other studies[1,13] (20–30%). The number of patients with encephalopathy, seizure, TIA, and other medical diagnoses is large. This is likely a result of the fact that our institution has set a very low threshold for activating a stroke alert in order to minimize the number of acute strokes that might go unidentified. It is important to know whether the low specificity of the initial diagnosis of stroke causes any problems in the care of these patients. Although it might be expected that patients with evident stroke might be evaluated more promptly than other patients, the times to various diagnostic milestones are not dependent on the diagnosis. In addition, none of the times describing the pace of diagnosis except for T_{CT} are dependent on the location of the patient. In our institution, it is likely that T_{CT} is longer for patients in the ICU and medical/surgical units than in the ER because they are further from the CT scanner than the ER. It is also possible that it takes additional time to get an ICU patient ready for transport because of the presence of significant medical comorbidities in those patients. Overall, these indices do not suggest that patients with strokes on the medical/surgical floors receive reduced levels of care because of the lack of specificity of the stroke alert process. However, there was a trend toward lower rate of administering tPA to patients diagnosed with stroke on the medical/surgical floors. This could be due to the fact that patients already admitted to the hospital had medical contra-indications to tPA, but the analysis of the comorbidities in the database showed no difference in the various locations. Factors such as anticoagulant use and platelet count at the time of assessment that might influence the decision to administer tPA are not included in the database and would influence the decision to give tPA. It is important to note that the lower rate of tPA administration is not due to longer times from last known well to stroke team activation that might place the patient outside the window to receive tPA. There also was a longer length of stay for patients whose onset of symptoms was first noted on a medical/surgical floor. Although there was no difference in the presence of comorbidities, the prolonged length of stay may be related to the fact that patients on medical/surgical floors would necessarily be treated for another acute medical condition. Thus, they may have more severe comorbidities that could lead a prolonged hospital stay as well as to an increased risk of DVT. A full evaluation of this issue would require additional studies collecting more detailed information on the severity of other acute medical problems, as well as more detailed information regarding laboratory studies and medications.

Although time of day did significantly influence the rate at which stroke alerts were issued, neither the rate at which tPA was administered to stroke patients nor any of the performance times was influenced by the time of day. This suggests that the rate at which stroke alerts occur does not influence the care received by the patient and goes to support the idea that a low specificity does not compromise treatment.

Measuring the sensitivity of the process is also important for continuing efforts to design the optimal stroke alert process. This would require also tabulating the number of patients with a discharge diagnosis of an acute stroke within 6 h, but this information was not part of the current study.

As part of making the diagnosis of stroke, the data in this paper indicate clearly that the NIHSS alone cannot make the diagnosis of stroke since higher NIHSS scores were neither the largest nor the smallest in patients with stroke. In addition, the NIHSS was higher on units such as the ICU and medical/surgical floor where the rate of stroke diagnosis was lower.

In summary, compiling a comprehensive descriptive study of the stroke alert process reveals some important issues that can be used to improve the process. First, the eventual diagnosis after a stroke alert is not a stroke and so the stroke team must be able to handle or triage patients with a large variety of neurological conditions. Second, the stroke team must be able to do a complete neurological evaluation rather than just the NIHSS, as this could not be used independently to make the diagnosis of stroke. Third, it is important to maintain surveillance over the stroke alert process so that factors such as the location of the alert and time of day do not affect the ability of the team to treat patients.

REFERENCES

1. Artto V, Putaala J, Strbian D, Meretoja A, Piironen K, Liebkind R, *et al*. Helsinki Stroke Thrombolysis Registry Group. Stroke mimics and intravenous thrombolysis. Ann Emerg Med 2012;59:27-32.
2. Bhalla A, Smeeton N, Rudd AG, Heuschmann P, Wolfe CD. A comparison of characteristics and resource use between in-hospital and admitted patients with stroke. J Stroke Cerebrovasc Dis 2010;19:357-63.
3. Bodenant M, Leys D, Debette S, Cordonnier C, Dumont F, Henon H, *et al*. Intravenous thrombolysis for acute cerebral ischaemia: Comparison of outcomes between patients treated at working versus nonworking hours. Cerebrovasc Dis 2010;30:148-56.
4. Cumbler E, Murphy P, Jones WJ, Wald HL, Kutner JS, Smith DB. Quality of care for in-hospital stroke: Analysis of a statewide registry. Stroke 2011;42:207-10.
5. Fang K, Churilov L, Weir L, Dong Q, Davis S, Yan B. Thrombolysis for acute ischemic stroke: Do patients treated out of hours have a worse outcome? J Stroke Cerebrovasc Dis 2014;23:427-32.
6. Farooq MU, Reeves MJ, Gargano J, Wehner S, Hickenbottom S, Majid A, *et al.* Paul Coverdell National Acute Stroke Registry Michigan Prototype Investigators. In-hospital stroke in a statewide stroke registry. Cerebrovasc Dis 2008;25:12-20.
7. Hand PJ, Kwan J, Lindley RI, Dennis MS, Wardlaw JM. Distinguishing between stroke and mimic at the bedside: The brain attack study. Stroke 2006;37:769-75.
8. Helsinki Stroke Thrombolysis Registry Group. Does time of day or physician experience affect outcome of acute ischemic stroke patients treated with thrombolysis? A study from Finland. Int J Stroke 2012;7:511-6.
9. Jauch EC, Saver JL, Adams HP Jr, Bruno A, Connors JJ, Demaerschalk BM, *et al*. Guidelines for the early management of patients with acute ischemic stroke: A guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2013;44:870-947.
10. Lees KR, Bluhmki E, von Kummer R, Brott TG, Toni D, Grotta JC, *et al*. Time to treatment with intravenous alteplase and outcome in stroke: An updated pooled analysis of ECASS, ATLANTIS, NINDS, and EPITHET trials. Lancet 2010;375:1695-703.
11. Libman RB, Wirkowski E, Alvir J, Rao TH. Conditions that mimic stroke in the emergency department. Implications for acute stroke trials. Arch Neurol 1995;52:1119-22.

12. Martinez-Martinez MM, Fernandez-Travieso J, Fuentes B, Ruiz-Ares G, Martinez-Sanchez P, Cazorla Garcia R, *et al*. Off-hour effects on stroke care and outcome in stroke centres. Eur J Neurol 2012;19:1140-5.
13. Merino JG, Luby M, Benson RT, Davis LA, Hsia AW, Latour LL, *et al*. Predictors of acute stroke mimics in 8187 patients referred to a stroke service. J Stroke Cerebrovasc Dis 2013;22:e397-403.
14. Moradiya Y, Levine SR. Comparison of short-term outcomes of thrombolysis for in-hospital stroke and out-of-hospital stroke in United States. Stroke 2013;44:1903-8.
15. Vera R, Lago A, Fuentes B, Gallego J, Tejada J, Casado I, *et al*. In-hospital ischemic strokes in patients admitted to Cardiology and Cardiac Surgery departments. Multi-centre registry. Med Clin (Barc) 2011;137:479-83.
16. Vera R, Lago A, Fuentes B, Gallego J, Tejada J, Casado I, *et al*. In-hospital stroke: A multi-centre prospective registry. Eur J Neurol 2011;18:170-6.