Published in final edited form as:
Am J Emerg Med. 2010 June ; 28(5): 607–612. doi:10.1016/j.ajem.2009.02.016.

Which Stroke Symptoms Prompt a 911 Call? A Population-Based Study

Dawn Kleindorfer, MD,
University of Cincinnati, Department of Neurology

Christopher J. Lindsell, PhD,
University of Cincinnati, Department of Emergency Medicine

Charles J. Moomaw, PhD,
University of Cincinnati, Department Neurology

Kathleen Alwell, RN,
University of Cincinnati, Department of Neurology

Daniel Woo, MD,
University of Cincinnati, Department of Neurology

Matthew L. Flaherty, MD,
University of Cincinnati, Department of Neurology

Opeolu Adeoye, MD,
University of Cincinnati, Department of Emergency Medicine

Tarek Zakaria, MD,
Mayo Clinic, Department of Neurology

Joseph P. Broderick, MD, and
University of Cincinnati, Department of Neurology

Brett M. Kissela, MD
University of Cincinnati, Department of Neurology

Keywords

Stroke; Symptoms; Emergency medical services; 911

Introduction

Stroke is one of the leading causes of major disability in the United States(1). Currently, the only FDA-approved medication for treatment of acute ischemic stroke is rt-PA(2). National estimates of rt-PA use are extremely low, approximately 2% of all ischemic strokes(3–5). Several studies have confirmed that one important contributor to the low rates of rt-PA use is patient delay in presenting for medical care; rt-PA has a short therapeutic window (<3 hours from symptom onset), and in most studies, only 20–25% of ischemic stroke patients arrive within 3 hours from symptom onset(6,7).

Reprint requests: Dawn Kleindorfer, MD, 260 Stetson Street, Suite 2300, Cincinnati, OH 45267-0525.
Presented in abstract form at the 2008 International Stroke Conference in New Orleans

The use of emergency medical services (EMS) has been shown to significantly reduce a stroke patient's pre-hospital delay, both in the speed of transport to the hospital and the speed of initiation of treatment upon arrival in the emergency department (ED)(8–10). Patients who arrive via EMS are also more likely to receive rt-PA than patients who do not use EMS(11). A prior study within our Greater Cincinnati/Northern Kentucky population found that increasing age, pre-stroke disability, higher stroke severity, and hemorrhagic stroke subtype are independently predictive of using EMS, while race and sex are not(12). This study, however, did not examine the relationship between stroke symptom types and use of EMS. For example, when patients experience sudden weakness of an arm, a symptom of stroke, are they more likely to call 911 (or have 911 called for them) than when they don't experience sudden weakness of an arm? We sought to explore how the presence or absence of different stroke symptoms affects the lay public's likelihood of calling 911 for stroke and TIA.

Methods

The Greater Cincinnati/Northern Kentucky Stroke Study (GCNKSS) is a population-based epidemiological study of stroke(13). Our methodology has been previously described in detail including quality assurance, data collection methods, and case ascertainment techniques and sensitivity(14). The GCNKSS study population includes the 1.3 million residents of the Greater Cincinnati/Northern Kentucky region, which encompasses Hamilton and Clermont County in Ohio and Boone, Kenton, and Campbell County in Northern Kentucky. Included in this region are 17 acute-care hospitals. Although residents of non-study region counties also seek care at these 17 hospitals, only residents of the five study region counties are included as cases. The study period for the current analysis included patients whose stroke occurred from 1/1/99 to 12/31/99.

Study nurses reviewed the medical records of all inpatients with primary or secondary stroke-related ICD-9 discharge diagnoses (430–436) from the 17 acute-care hospitals in the study region. Zip code of residence was used to determine whether a patient lived inside the study region. A study nurse abstracted the medical records for all possible or likely stroke and TIA cases. To qualify as a GCNKSS case, a patient must have met the criteria for one of the five stroke categories adapted from the Classification for Cerebrovascular Diseases III (15) and from epidemiological studies of stroke in Rochester, MN(16): cerebral ischemia, intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), or stroke of uncertain cause. Transient ischemic attacks (TIA) were defined as symptoms lasting less than 24 hours regardless of imaging results. Abstracted data included type of residence (e.g., own home, nursing home), site of onset (at patient's residence vs. outside the home), stroke symptoms, point of first healthcare provider contact (e.g., 911/EMS, ED, primary doctor, etc), ED physical exam findings and complete vital signs, past medical and surgical history, medications prior to stroke, social history/habits, diagnostic tests performed and results, treatments, and short-term outcomes. Stroke severity was estimated using a retrospective NIH Stroke Scale Score (NIHSSS) that was obtained from review of the physician exam as documented in the emergency department evaluation, which has been previously validated(14). A study physician reviewed each abstract to verify whether or not a stroke or TIA occurred. For each verified case, the physician assigned stroke subtype based on all available information, using definitions previously reported.

Stroke symptoms were recorded as documented in the medical record, including symptoms that had resolved prior to arrival to medical attention. Data collection included variables for the most common symptoms; a symptom not documented in the chart as being present was considered for the purpose of this analysis as being absent. Symptoms specifically collected were weakness, numbness, headache, speech abnormalities (including both aphasia and dysarthria), mental status, vision changes, trouble walking or a fall, and dizziness or vertigo.

For less common symptoms, free text fields were used. Symptom data were then reviewed by a study physician and collapsed into 7 groups thought to be the most relevant to the lay public: 1) weakness of arm, leg, or face, 2) numbness of arm, leg, or face, 3) slurred speech or language problems, 4) confusion or decreased level of consciousness, 5) headache, 6) visual abnormalities, and 7) dizziness (including vertigo, and problems with balance or coordination). Patients could have more than one symptom category assigned to them; for example, a patient could have had weakness, numbness, and slurred speech.

Use of EMS was defined to have occurred if 911 was called, as opposed to using an ambulance for routine transportation to the hospital; dispatch and EMS records were reviewed to confirm that a 911 call was placed. For the current analysis, cases of childhood stroke (age less than 18 years) were excluded. Because the intent of this analysis was to study the lay public's response to stroke symptoms, patients were excluded if their residence, site of onset, or site of EMS response was a medically supervised environment. Therefore, cases in residents of nursing homes or rehabilitation facilities, cases that occurred during an acute hospitalization for another diagnosis, and cases that occurred or were first evaluated in a medical facility other than a hospital emergency room (where the patient was an outpatient or a visitor) were excluded. Subjects who were found dead and a coroner determined that stroke was the cause of death, cases in people who were in jail, cases where the onset of stroke was out of town, cases where the site of onset was unknown, and cases that had missing symptom documentation were also excluded.

Data were managed with SAS version 8.02 (SAS Institute, Cary NC), and descriptive and comparative analyses were performed using SPSS v15.0 (SPSS Inc., Chicago, IL). Logistic regression was used to model symptom predictors of EMS use. Several independent variables were hypothesized to impact the likelihood that a patient would call 911 for their symptoms, based on prior examinations of EMS use in our population. The following variables were considered for inclusion in the model: the 7 stroke symptom categories described above, overall stroke severity (estimated retrospectively), age, stroke subtype, race (black vs. non-black), gender, pre-stroke disability (estimated using the modified Rankin score), and prior history of stroke. Variables significant in univariable analyses were included in a multivariable model. A manual backwards stepwise procedure was used to parse the model of insignificant variables.

Results

Of 3,949 cases of stroke or TIA, 24 occurred in patients under 18 years of age, 383 occurred in residents of nursing homes or rehabilitation facilities, 258 occurred during acute hospitalization for another diagnosis, 207 occurred or were first evaluated at a medical facility other than an emergency room setting, 7 were coroner's cases, 3 occurred in jailed inmates, 12 occurred out of town, the site of onset was unknown for 60, and 20 had missing symptom data. Therefore, 2,975 cases were included in the analysis. These cases had a median age of 72 years (range 18–98); 17% were black, and 54% were female. Included and excluded cases are described in Table 1. Among included cases, 61% were ischemic strokes, 11% were hemorrhagic strokes (intracerebral or subarachnoid), and 28% were TIAs. EMS was called for emergency transport to the ED for 1,205 cases (40.5%, CI_{95} 38.7% to 42.3%). Table 2 describes those who used EMS and those who did not.

In univariable models testing for the effects of individual factors on the likelihood EMS was called, age, patient location at time of stroke onset, prior stroke, pre stroke disability, stroke severity, and type of stroke were all significant (Table 3). Weakness, decreased level of consciousness, speech/language, and dizziness were all associated with increased odds of calling EMS. Numbness, headache, and vision symptoms were all associated with decreased odds of calling 911.

A multivariable logistic regression model was constructed to adjust the odds of calling 911 for those variables found to be significant on univariable analysis, and for other symptoms experienced. After adjustment, weakness, decreased level of consciousness, speech/language, and dizziness remained associated with increased odds of calling 911, and numbness and vision symptoms remained associated with decreased odds of calling 911. Headache was no longer associated with calling 911.

Discussion

We identified specific stroke symptoms that independently affected the lay public's use of emergency medical services, in addition to severity of stroke, type of stroke, and age, which had been previously reported. This suggests that some symptoms are more readily recognizable by the public as an emergency. To our knowledge, this is the first description of the effect of stroke symptomatology on stroke patients' use of emergency medical services within a well-defined population.

The most powerful symptom associated with increased EMS use was weakness, with an odds ratio (OR) of 1.42 (95% CI 1.17, 1.73). The effect of numbness, however, was in the opposite direction, with an OR of 0.73 (95% CI 0.59, 0.90). There was also a strong trend suggesting that visual symptoms are associated with decreased EMS use (OR 0.78, 95% CI 0.61–1.0). Decreased level of consciousness, speech abnormalities, and dizziness were all associated with increased use of EMS.

The numbness finding is particularly surprising: serial population-based telephone surveys of stroke warning sign awareness have been performed within this study population, and in the year 2000, the most commonly cited symptom of stroke within those surveyed was numbness/tingling (36%), followed by dizziness (26%), and weakness (20%)(17,18). This exemplifies a disconnect between knowledge and action. Just because people understand that numbness may be a symptom of stroke, it does not necessarily mean that they will call 911 when numbness occurs. Our results are consistent with a random-digit dial survey in Australia, in which respondents were most likely to say they would call 911 for weakness or paralysis (20%), and were less likely to do so for numbness (15%)(19).

We initially hypothesized that pain, specifically headache, would be a motivating symptom for calling 911. We thought that this might explain why hemorrhagic stroke patients used EMS more than ischemic stroke patients independent of severity, since previously we had found that 20% of intracerebral hemorrhage patients present with a headache as their only typical stroke symptom(20). However, headache was the only symptom <u>not</u> associated with EMS use. We suspect that this may be related to a limitation of our data collection, since it is very difficult to retrospectively assign a severity designation to headache based on documentation in the medical chart. It may be that a sudden, thunderclap headache is associated with EMS use, but a milder headache may not be.

Limitations of this analysis include a potential bias related to the method of symptom ascertainment using retrospective chart review. There may be a bias for medical personnel to record symptoms of stroke that are more "typical," or there may be incomplete symptom ascertainment related to incomplete documentation. Prospective symptom ascertainment would be ideal, including a description of headache severity, but this is not feasible in a population-based epidemiology study of this size. Another limitation is that we excluded those who did not reside in their own home at the time of their stroke, especially nursing home patients, which could potentially bias our sample. However, since we intended this analysis to be the response of the public to stroke symptoms, we could not include those living in a medically supervised environment. Independent living patients were included in this analysis.

We did not consider interactions in the model; the complexity of possible symptom combinations would make such multi-way interactions impossible to interpret. Our intent is simply to determine whether symptoms should be considered as possible determinants of calling 911. Finally, another limitation is the age of the data, in that this data was collected in 1999. However, this is well within the time-frame of other publications from population-based studies (including Rochester, Minnesota(16)). Changes over time, especially in public knowledge, could potentially impact the public's decision to call 911 for stroke symptoms. Unfortunately, we have not found significant improvement in knowledge of stroke warning signs, nor the plan of action to call 911, in our community between 1995 and 2005 in a large, population-based telephone survey(21) designed to evaluate public stroke knowledge.

In summary, the response of the public to a stroke is influenced by stroke symptom type, after adjusting for severity, and EMS is more likely to be contacted when a stroke patient has symptoms of weakness, decreased level of consciousness, speech abnormality, and trouble with dizziness/vertigo/balance/coordination, and EMS is less likely to be contacted for numbness and vision changes. Future public awareness campaigns may need to further emphasize numbness, vision symptoms, and sudden onset of a severe headache as potential stroke symptoms. Furthermore, all stroke awareness campaigns should link the symptoms of stroke with a plan of action to call 911 if the symptoms occur.

Acknowledgments

Sources of support: National Institutes of Health NINDS division, R-01

References

1. Heart Disease and Stroke Statistics-2006 Update: A Report From the American Heart Association. Circulation 2006;113:85–151.
2. NINDS rt-PA Stroke Study Group. Tissue plasminogen activator for acute ischemic stroke. N Engl J Med 1995;333:1581–7. [PubMed: 7477192]
3. Kleindorfer DLC, White G, Curtis T, Brass L, Koroshetz W, Broderick JP. National US Estimates of rt-PA Use: ICD-9 Codes Substantially Underestimate. Stroke 2008;39(3):924–8. [PubMed: 18239184]
4. Qureshi AI, Suri MF, Nasar A, et al. Thrombolysis for ischemic stroke in the United States: data from National Hospital Discharge Survey 1999–2001. Neurosurgery 2005;57(4):647–54. discussion -54. [PubMed: 16239876]
5. Reeves MJ, Arora S, Broderick JP, et al. Acute stroke care in the US: results from 4 pilot prototypes of the Paul Coverdell National Acute Stroke Registry. Stroke 2005;36(6):1232–40. [PubMed: 15890989]
6. CASPR. Prioritizing interventions to improve rates of thrombolysis for ischemic stroke. Neurology 2005;64(4):654–9. [PubMed: 15728287]
7. Kleindorfer DO, Broderick JP, Khoury J, et al. Emergency department arrival times after acute ischemic stroke during the 1990s. Neurocrit Care 2007;7(1):31–5. [PubMed: 17622492]
8. Schroeder EB, Rosamond WD, Morris DL, Evenson KR, Hinn AR. Determinants of use of emergency medical services in a population with stroke symptoms: the Second Delay in Accessing Stroke Healthcare (DASH II) Study. Stroke 2000;31(11):2591–6. [PubMed: 11062280]
9. Rosamond WD, Gorton RA, Hinn AR, Hohenhaus SM, Morris DL. Rapid response to stroke symptoms: the Delay in Accessing Stroke Healthcare (DASH) study. Acad Emerg Med 1998;5(1):45–51. [PubMed: 9444342]
10. Evenson KR, Rosamond WD, Vallee JA, Morris DL. Concordance of stroke symptom onset time. The Second Delay in Accessing Stroke Healthcare (DASH II) Study. Ann Epidemiol 2001;11(3): 202–7. [PubMed: 11248584]
11. Abdullah AR, Smith EE, Biddinger PD, Kalenderian D, Schwamm LH. Advance hospital notification by EMS in acute stroke is associated with shorter door-to-computed tomography time and increased

likelihood of administration of tissue-plasminogen activator. Prehosp Emerg Care 2008;12(4):426–31. [PubMed: 18924004]

12. Adeoye OLC, Broderick JP, Jauch E, Alwell K, Moomaw CJ, Flaherty ML, Pancioli A, Kissela BM, Kleindorfer D. Emergency Medical Services Utilization by Stroke Patients: A Population-Based Study. American Journal of Emergency Medicine. 2008 in press. accepted 1/08.
13. Broderick J, Brott T, Kothari R, et al. The Greater Cincinnati/Northern Kentucky Stroke Study: preliminary first-ever total incidence rates of stroke among blacks. Stroke 1998;29:415–21. [PubMed: 9472883]
14. Kleindorfer D, Broderick J, Khoury J, et al. The unchanging incidence and case-fatality of stroke in the 1990s: a population-based study. Stroke 2006;37(10):2473–8. [PubMed: 16946146]
15. (NINDS) NIoNDaS. Classification of Neurological Disorders III. Stroke 1990;21:637–76. [PubMed: 2326846]
16. Brown R, Whisnant J, Sicks J, O'Fallon W, Wiebers D. Stroke incidence, prevalence, and survival: secular trends in Rochester, Minnesota, through 1989. Stroke 1996;27:373–80. [PubMed: 8610298]
17. Pancioli AM, Broderick J, Kothari R, et al. Public perception of stroke warning signs and knowledge of potential risk factors. JAMA 1998;279(16):1288–92. [PubMed: 9565010]
18. Schneider AT, Pancioli AM, Khoury JC, et al. Trends in community knowledge of the warning signs and risk factors for stroke. JAMA 2003;289(3):343–6. [PubMed: 12525235]
19. Mosley I, Nicol M, Donnan G, Patrick I, Dewey H. Stroke symptoms and the decision to call for an ambulance. Stroke 2007;38(2):361–6. [PubMed: 17204685]
20. Kleindorfer DO, Miller R, Moomaw CJ, et al. Designing a Message for Public Education Regarding Stroke. Does FAST Capture Enough Stroke? Stroke 2007;38(10):2864–68. [PubMed: 17761926]
21. Kleindorfer DKJ, Broderick JP, Rademacher E, Woo D, Flaherty ML, Moomaw CJ, Schneider A, Pancioli A, Miller R, Kissela BM. Public Knowledge of Stroke Treatment, Warning Signs and Risk Factors during the Last Decade. Stroke, abstract 2007;38(2):531–32.

Table 1

Characteristics and of stroke and TIA patients included and excluded from the analyses

	Included, N=2,975	Excluded, N=974
Age	72 (18–98)	77 (0–99)
Black	516 (17.3)	149 (15.3)
Non-black	2,459 (82.7)	825 (84.7)
Female	1,614 (54.3)	619 (63.6)
Male	1,361 (45.7)	355 (36.4)
Prior stroke	774 (26.0)	295 (30.3)
Resides at home	2,904 (97.6)	544 (57.0)
Resides elsewhere	71 (2.4)	24 (2.5)
Resides at nursing home	0 (0.0)	378 (39.6)
Unknown residence	0 (0.0)	9 (0.9)
Stroke at place of residence	2,731 (91.8)	507 (53.1)
Stroke at work	90 (3.0)	2 (0.2)
Stroke elsewhere	154 (5.2)	112 (11.7)
Stroke in hospital	0 (0.0)	280 (29.3)
Unknown site of stroke	0 (0.0)	54 (5.7)
Estimated NIHSS	5 (0–42)	8 (0–42)
Pre-stroke Rankin	0 (0–5)	3 (0–5)
Stroke type		
ICH	239 (8.0)	91 (9.3)
Infarct	1,805 (60.7)	663 (68.1)
SAH	83 (2.8)	17 (1.7)
TIA	846 (28.4)	199 (20.4)
Unknown	2 (0.1)	4 (0.4)

Data are medians (ranges) or frequencies (percents)

Table 2

Characteristics and symptoms of stroke among those calling EMS and those not calling EMS.

	Did not call EMS, N=1,770	Called EMS, N=1,205
Median Age (range)	71 (18–98)	75 (18–98)
Black (%)	299(16.9)	217 (18.0)
Female (%)	943 (53.3)	671 (55.7)
Prior stroke history (%)	437 (24.7)	337 (28.0)
Median pre-stroke mRS (range)	0 (0–5)	0 (0–5)
Stroke at place of residence (%)	1,636 (92.4)	1,095 (90.9)
Stroke at work (%)	57 (3.2)	33 (2.7)
Stroke elsewhere (%)	77 (4.4)	77 (6.4)
Median Estimated NIHSSS (range)	4 (0–42)	8 (0–42)
Stroke subtype (%)		
ICH	98 (5.5)	141 (11.7)
Infarct	1,020 (57.6)	785 (65.1)
SAH	43 (2.4)	40 (3.3)
TIA	608 (34.4)	238 (19.8)
Unknown	1 (0.1)	1 (0.1)
Stroke symptoms (%)		
Weakness	1,092 (61.7)	849 (70.5)
Numbness	587 (33.2)	222 (18.4)
Decreased level of consciousness	326 (18.4)	465 (38.6)
Speech	872 (49.3)	771 (64.0)
Headache	403 (22.8)	217 (18.0)
Vision	296 (16.7)	137 (11.4)
Dizziness, vertigo, balance or coordination	644 (36.4)	664 (55.1)

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 3

Univariable and multivariable logistic regression models predicting use of EMS

Univariable models	**Odds ratio**	**95%CI (odds ratio)**	**p-value**
Age (years)	1.02	(1.02 – 1.03)	0.000
Non-black vs. black	0.93	(0.76 – 1.12)	0.430
Male vs. female	0.91	(0.78 – 1.05)	0.196
Prior stroke	1.18	(1.00 – 1.40)	0.046
Stroke at work vs. stroke at home	0.87	(0.56 – 1.34)	0.514
Stroke elsewhere vs. stroke at home	1.49	(1.08 – 2.07)	0.015
pre-stroke mRS (per unit of scale)	1.16	(1.10 – 1.21)	0.000
Estimated NIHSSS (per unit of scale)	1.10	(1.09 – 1.12)	0.000
Hemorrhage vs. Infarct	1.67	(1.31 – 2.12)	0.000
TIA vs. Infarct	0.51	(0.43 – 0.61)	0.000
Weakness	1.48	(1.27 – 1.73)	0.000
Numbness	0.46	(0.38 – 0.54)	0.000
Decreased level of consciousness	2.78	(2.36 – 3.29)	0.000
Speech	1.83	(1.58 – 2.13)	0.000
Headache	0.75	(0.62 – 0.90)	0.002
Vision	0.64	(0.51 – 0.79)	0.000
Dizziness, vertigo, balance, or coordination	2.15	(1.85 – 2.49)	0.000
Multivariable model (adjusted for age, prior stroke, location of stroke, pre-stroke mRS, estimated NIHSSS and stroke type)			
Weakness	1.42	(1.17 – 1.73)	0.000
Numbness	0.73	(0.59– 0.90)	0.003
Decreased level of consciousness	1.56	(1.27 – 1.92)	0.000
Speech	1.22	(1.02 – 1.46)	0.034
Headache	0.97	(0.78– 1.21)	0.791
Vision	0.78	(0.61– 1.00)	0.048
Dizziness, vertigo, balance, or coordination	1.42	(1.17 – 1.73)	0.000