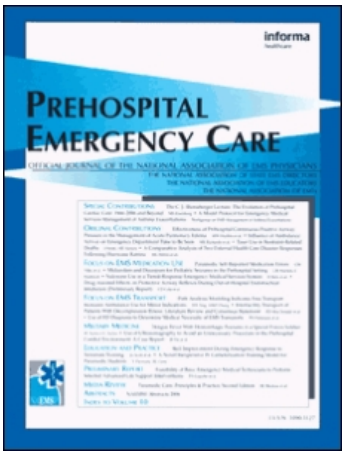

Prehospital Emergency Care
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713698281

An Interventional Study to Improve Paramedic Diagnosis of Stroke

Janet E. Bray; Jenepher Martin; Greg Cooper; Bill Barger; Stephen Bernard; Christopher Bladin

Online Publication Date: 01 July 2005

To cite this Article Bray, Janet E., Martin, Jenepher, Cooper, Greg, Barger, Bill, Bernard, Stephen and Bladin, Christopher(2005)'An Interventional Study to Improve Paramedic Diagnosis of Stroke',Prehospital Emergency Care,9:3,297 — 302

To link to this Article: DOI: 10.1080/10903120590962382

URL: http://dx.doi.org/10.1080/10903120590962382

FOCUS ON PATIENT ASSESSMENT

AN INTERVENTIONAL STUDY TO IMPROVE PARAMEDIC DIAGNOSIS OF STROKE

Janet E. Bray, RN, Jenepher Martin, MD, Greg Cooper, ADHS, Bill Barger, ADHS, Stephen Bernard, MD, Christopher Bladin, MD

ABSTRACT

Objective. The aim of the Faster Access to Stroke Therapy (FAST) study was to determine the effect of educational intervention and the use of a prehospital stroke tool on the paramedic diagnosis of stroke. **Methods.** Paramedics in emergency medical service units servicing a university teaching hospital were divided into two groups: FAST study paramedics ($n = 18$) and non-FAST study paramedics ($n = 43$). The FAST study paramedics received stroke education and instruction in the use of a prehospital stroke assessment tool [Melbourne Ambulance Stroke Screen (MASS)] to assist in stroke diagnosis. Based on final hospital diagnosis, the sensitivities of paramedic stroke diagnosis in the two groups were compared for a 12-month period before and after the intervention. **Results.** The sensitivity for the FAST study paramedics in identifying stroke improved from 78% (95% confidence interval [CI]: 63% to 88%) to 94% (95% CI: 86% to 98%) ($p = 0.006$) after receiving the stroke education session and with use of the MASS tool. There was no change in stroke diagnosis for the non-study paramedics 78% (95% CI: 71% to 84%) to 80% (95% CI: 72% to 87%) ($p = 0.695$). Prenotification of impending arrival to the emergency department was associated with higher-priority triage in the emergency department, and subsequent shorter times for door to medical review (15 min vs. 31 min, $p < 0.001$) and door to computed tomography (CT) scanning (94 min vs. 144 min, $p < 0.001$). **Conclusions.** Targeted stroke education and the use of a simple clinical tool can significantly improve the diagnostic sensitivity of stroke by paramedics in the prehospital setting. Accurate diagnosis combined with prenotification of the pending arrival of stroke patients will allow for the focused and timely application of resources for the management of acute stroke.

Key words: emergency medical services; cerebrovascular accident; stroke; diagnosis.

PREHOSPITAL EMERGENCY CARE 2005;9:297–302

Acute stroke management now begins in the prehospital setting.[1] The introduction of thrombolytic therapy for stroke has resulted in a transition in stroke care from supportive medical therapy to that of an acute medical emergency. "Time is brain," and the accurate prehospital identification of stroke patients is vital to the prompt delivery of neurorestorative thrombolytic therapy and supportive treatment.[1,2]

Paramedics are the first medical contact in 38% to 70%[3–6] of stroke patients. However, studies have demonstrated that paramedics have inadequate levels of stroke knowledge[7] and identify only 61% to 72%[8–10] of stroke patients. Results demonstrate that the prehospital diagnosis of stroke by paramedics can be improved by use of a standardized clinical examination and medical history.[11,12] These prehospital "stroke assessment tools" are simple to perform and have been validated in both hospital and community environments. No study has yet examined the combined effect of stroke education and the use of a stroke tool on paramedic diagnosis in an Australian setting.

The Faster Access to Stroke Therapy (FAST) study was designed to assess the effect of stroke education and use of a standardized stroke assessment tool on the paramedic diagnosis of stroke. It was hypothesized that paramedics undergoing this intervention would demonstrate a statistically significant improvement in their diagnosis of stroke.

METHODS

Study Design and Setting

The design of this study was a prospective interventional cohort study. Paramedics work for the Melbourne Metropolitan Ambulance Service, which

Received December 22, 2004, from Eastern Melbourne Neurosciences (JEB, CB), Deakin University (JEB), Melbourne University (JM), Melbourne Metropolitan Ambulance Service (GC, BB, SB), and Monash University (CB), Melbourne, Victoria, Australia. Revision received March 8, 2005; accepted for publication March 10, 2005.

Presented at the 29th International Stroke Conference, San Diego, California, February 2004.

Address correspondence and reprint requests to: Prof. Christopher Bladin, Eastern Melbourne Neurosciences, Box Hill Hospital, Nelson Road, Box Hill, Victoria, Australia, 3128. e-mail: <chris.bladin@boxhill.org.au>.

doi:10.1080/10903120590962382

serves 3.4 million people in a metropolitan region in Australia. This service has a two-tiered response (paramedic and intensive care paramedic) to emergency calls in an area of approximately 10,000 square kilometers. Paramedics are divided into units geographically located throughout the suburban city of Melbourne. The FAST study was approved by both the Eastern Health and the Metropolitan Ambulance Service ethics committees.

Population

Paramedics ($n = 61$) were recruited from nine units in the geographic area surrounding Box Hill Hospital (BHH), a university teaching hospital and the primary receiving hospital for these units. The paramedics were examined for baseline stroke knowledge and ability to diagnose stroke. Of these 61 paramedics, 18 paramedics from one district unit were recruited to participate as FAST study paramedics. This unit was selected as paramedics were located at one site and were identified as transporting approximately half of all stroke patients admitted via ambulance to BHH in 2000.

Experimental Protocol

The FAST study paramedics were offered a one-hour education session covering stroke etiology, symptoms, risk factors, assessment, documentation of onset, diagnosis, management, and use of the prehospital stroke assessment tool. This session used a PowerPoint presentation given by authors (CB and JEB). Two paramedics were unable to attend this session and were trained at a later date using the same presentation given by the paramedic unit leader. The remaining 43 non-study paramedics received no further contact apart from initial testing.

All paramedics ($n = 61$) were asked to complete an anonymous 29-question multiple-choice questionnaire, assessing knowledge of etiology, signs and symptoms, risk factors, diagnosis, and treatment of stroke. Questions were derived from multiple sources, including published stroke knowledge tests.[7,13] Prior to testing, questions were reviewed by a panel of nursing and medical experts for clarity, relevance, and usefulness. The questions were then validated through testing of emergency department (ED) consultants.

To standardize the prehospital assessment of stroke, FAST study paramedics were instructed in the use of the Melbourne Ambulance Stroke Screen (MASS) tool to assist in the diagnosis of stroke. The MASS is a combination of two validated prehospital stroke assessment tools, the Los Angeles Prehospital Stroke Screen (LAPSS)[11] and the Cincinnati Prehospital Stroke Scale (CPSS),[12] and takes advantage of the differing strengths of the two stroke assessment tools. CPSS has a greater sensitivity to detect stroke patients, whereas LAPSS has a greater specificity to exclude potential stroke mimics. Criteria used in the MASS are given in Table 1. The MASS tool has been prospectively validated with accurate identification of stroke, in particular, patients suitable for thrombolytic therapy.[14] FAST paramedics were encouraged to prenotify the BHH ED for the pending arrival of all stroke patients meeting MASS criteria with an onset of less than six hours (a time chosen to allow the use of thrombolytic therapy and recruitment into stroke trials).

TABLE 1. Criteria for the Melbourne Ambulance Stroke Screen (MASS)

History items
1. Age >45 years
2. No history of seizure or epilepsy
3. At baseline, patient is not wheelchair-bound or bedridden
4. Blood glucose level between 2.8 and 22.1 mmol/L
Motor items
5. Unilateral facial droop
6. Unilateral hand grip weakness
7. Unilateral arm drift
8. Abnormal speech
History items 1–4 must all be "yes" in the presence of at least one motor item for MASS criteria to be met and stroke diagnosis given.

Medical records for all confirmed stroke or transient ischemic attack (TIA) patients admitted by ambulance to the hospital were retrospectively reviewed for a 12-month period before undertaking the intervention (January through December 2000, $n = 212$ patients) and for a 12-month period following the intervention (September 2002 though August 2003, $n = 210$ patients). Discharge diagnosis is documented in medical histories and is made by senior medical staff. Data extracted included patient data (demographics and clinical) and paramedic data (team, diagnosis, prenotification, MASS, and time of onset documentation).

Analytical Methods

All data were entered into a Microsoft Access database and analysed using Stata software (Version 6.0, Stata Corp LP, College Station, TX). Scores from the stroke questionnaire were given as percentages for the overall score and for individual correct answers, and were compared between paramedics groups (study vs. non-study) using Student's t-test. Sensitivity and confidence intervals (95% CIs) for paramedic stroke diagnosis were calculated by comparing the paramedic diagnosis of stroke with the final hospital discharge diagnosis. Sensitivities were compared first by study paramedic groups (study vs. non-study) and second only for study paramedics by completion of the MASS. Data were compared using chi-square analysis. A post-hoc analysis was performed to determine the effect of paramedic prenotification on the ED triage code and inhospital times (arrival to: medical review and computed tomography (CT) scanning) using chi-square test

and nonparametric Mann-Whitney rank test. A p-value <0.05 was considered statistically significant.

RESULTS

Stroke Knowledge Questionnaire

Of 61 tests sent, 45 (74%) were returned ($n = 13$ FAST study paramedics, $n = 32$ non-FAST study paramedics). The majority of the paramedics (76%) reported no educational sessions or updates on stroke since initial training. The median years of paramedic experience was 6 years (range 1 to 27). The average score achieved was 73% (range 49% to 90%), with no statistical difference in test scores between the FAST study and non-FAST study paramedics (74% vs. 73%, $p = 0.798$). Questions regarding general stroke knowledge, signs and symptoms, and stroke mimics were generally answered correctly. However, questions regarding treatment of ischemic stroke were often incorrect: only 24% identified aspirin as beneficial, 29% identified tissue plasminogen activator (t-PA) as the thrombolytic used in stroke, and 40% knew that thrombolytic therapy must be commenced within three hours of onset. Only 47% were able to correctly define "time of stroke onset."

Paramedic Diagnosis

For the retrospective (January to December 2000) and prospective (September 2002 to August 2003) periods examined, 79% and 82% of all confirmed strokes were admitted by ambulance, respectively, with 41.5% and 48% calling the emergency number within two hours of onset. Patient characteristics are given in Table 2.

Documentation of the MASS stroke tool was complete for 88% (73 of 83) of stroke patients admitted by the FAST study paramedics. Sensitivity in identifying stroke improved from 78% (95% CI: 63% to 88%, $n = 45$) to 94% (95% CI: 86% to 98%, $n = 83$) ($p = 0.006$) for the FAST paramedics following education in stroke and use of the MASS tool. Stroke diagnosis for the non-FAST study paramedics did not change significantly, 78% (95% CI: 71% to 84%, $n = 167$) vs. 80% (95% CI: 72% to 87%, $n = 127$) ($p = 0.695$). For the FAST paramedics, the sensitivity of stroke diagnosis was greater when the MASS tool was used compared with strokes for which there was no documented assessment (97% vs. 70%, $p = 0.001$).

TABLE 2. Characteristics of Patients Arriving via Ambulance

	2000 ($n = 212$)	2002 ($n = 210$)
Gender—female	127 (60%)	106 (50%)
Age—mean	79 years	78 years
Ischemic stroke	148 (70%)	155 (74%)
Hemorrhagic stroke	47 (22%)	30 (14%)
Transient ischemic attack	17 (8%)	25 (12%)
Received tissue plasminogen activator		12 (5.7%)
Onset to emergency call		
<1 hour	73 (34%)	87 (41%)
<2 hours	88 (41.5%)	100 (48%)
<3 hours	100 (47%)	107 (51%)
Prenotification	24 (11%)	53 (25%)
Priority triage code (1–2)	28 (13%)	92 (44%)
Arrival to medical review	43.5 (0–402) min	26 (0–355) min
Arrival to computed tomography scan	187 (28–1538) min	127 (12–630) min

Documentation of Stroke Onset

Documentation of the exact time of stroke onset statistically improved in the FAST paramedics, from 53% to 82% ($p = 0.001$). Documentation in the non-FAST study paramedics also improved over the time period (36% to 49%, $p = 0.001$), but remained unacceptably low.

Paramedic Prenotification

For the prospective phase of the FAST study, the ED was prenotified of the pending arrival for 53 (25%) of the 210 stroke patients admitted. Overall, prenotification was higher among the patients transported by FAST paramedics (36% vs. 18%, $p = 0.003$); however, this was given by FAST paramedics for only 45% (19 of 42) of patients meeting MASS criteria less than six hours from onset. There was no statistical difference in triage codes or inhospital times between the paramedic groups, and due to the small number of patients with prenotification ($n = 53$), the paramedic study groups were pooled to examine the effect of prenotification on hospital triage codes and inhospital times. Patients arriving with prenotification were given a higher priority by triage nurses (triage code 1–2 74% vs. 34%, $p < 0.001$) and had shorter times for arrival to medical review (median, 15 min vs. 31 min, $p < 0.001$) and arrival to CT scan (median, 94 min vs. 144 min, $p < 0.001$). The effect of prenotification on triage coding did not change when examined separately by paramedic groups or in acute patients (symptom onset less than three hours). Also, there was no statistical difference between the patients with and without prenotification for level of consciousness (Glasgow Coma Scale, median 13.5 vs. 14, $p = 0.085$) or admission disability (modified Rankin score, median 4 vs. 4, $p = 0.539$). Unfortunately, the door-to-needle time could not be examined due to the small numbers of patients who received thrombolytic therapy for the study period ($n = 12$).

DISCUSSION

The FAST study is the first to examine the efficacy of paramedic stroke education combined with the use of

a prehospital stroke assessment tool. The results of this study demonstrate that the sensitivity of paramedic diagnosis of stroke significantly improved to 94%, and documentation of time of onset of stroke symptoms significantly improved to 82%.

The FAST study, undertaken in an Australian population, showed higher use of emergency medical services (EMS) (79% in 2000, and 82% in 2002), than previous international studies (38% to 70%).[3–6] However, less than half used this service in time to be considered for thrombolytic therapy. Patient use of EMS has been associated with earlier hospital arrival and reduced in-hospital delays.[3,15,16] High utilization of EMS in Australia, combined with public awareness campaigns and paramedic stroke protocols, could potentially result in higher treatment rates of thrombolytic therapy than those achieved internationally.

Paramedic stroke care has evolved to include identification of potential candidates for thrombolytic therapy, with rapid transport and notification of pending arrival to EDs. The stroke education of paramedics clearly requires urgent review in light of these changes and must stress the need to treat acute stroke as a medical emergency.

Although the testing of paramedics occurred prior to the licensing and widespread use of t-PA for stroke in Australia, the results indicate where educational efforts need to be directed. A number of studies have assessed paramedic stroke knowledge in the form of written questionnaires;[7,11,17] however, little information is given on the questions used and the subsequent responses. The results of the FAST study stroke questionnaire were similar to those of Crocco et al.,[7] revealing inadequate knowledge of current stroke treatments, in particular thrombolytic therapy, and a lack of stroke education since initial training.

Several interventional studies have attempted to use educational sessions to improve the sensitivity of paramedic stroke diagnosis.[17,18] These studies showed improvement in stroke diagnosis; however, methodologic issues resulted in the inability to attribute these changes to the educational programs alone. Smith et al.[17] provided paramedics with four hours of stroke education and found a significant improvement in stroke diagnosis, from 61% to 91%. However, the control group, who received no education, also demonstrated improved sensitivity (90%). The authors were unable to distinguish whether this occurred as a result of knowledge sharing between study paramedics and non-study paramedics or due to some other external factor. Zweifler et al.[18] found no significant improvement in paramedic diagnosis from a high initial sensitivity (94% to 97%). However, issues with study design (small patient numbers, no control group) and possible crossover of information (community stroke awareness campaign prior to study) limit the value of these results.

In the FAST study, the benefit of a stroke assessment tool to improve paramedic diagnosis was highlighted by a significant improvement in diagnostic sensitivity for patients in whom the MASS was used. The sensitivity achieved using the MASS tool is comparable to that seen in validation studies of the LAPSS, CPSS, and MASS stroke tools.[11,12,14]

Intravenous thrombolytic therapy for stroke must be given within three hours of stroke onset. Early accurate identification of the onset time of stroke symptoms is therefore critical to proceeding with this therapy. However, the importance in obtaining an on-scene time of stroke onset has often been overlooked in acute stroke guidelines[19–23] and in studies of EMS. Only two studies were found to have examined exact documentation of stroke onset; both examined inhospital documentation and obtained rates of 46%[6] and 62%.[24] The results of the paramedic stroke questionnaire confirm the need to provide a detailed definition of "time of stroke onset." For example, only 47% of paramedics were able to correctly identify that when a patient wakes with a new stroke, the time of onset is defined as the last time the patient was seen to be normal (usually the night before). The FAST study initially found exact documentation of stroke onset by paramedics in only half of stroke patients; this increased to 82% by simply providing paramedics with a definition of onset and the imperative of determining time of stroke onset prior to thrombolytic therapy.

No study to date has examined the effect of hospital prenotification on ED triage coding and inhospital times. Prenotification is important for potential candidates of thrombolytic therapy to assemble resources and reduce delays for arrival. The Melbourne Metropolitan Ambulance Service prenotification protocol at the time of this study allowed paramedics to prenotify the EDs of the pending arrival of patients according to "time-critical" guidelines. Stroke patients are included in these guidelines; however, paramedics do not appear to consider these patients "time-critical," as is evident in low prenotification numbers (11% in 2000). This was most likely to due the perceived lack of need for emergency care for this patient group prior to the use of thrombolytic therapy; however, this was not measured in this study.

In this study, patients with prenotification were allocated higher-priority triage classification (code 1 or 2) in the ED, and subsequently were seen 16 minutes sooner by medical staff and underwent CT scanning 50 minutes sooner than patients who were transported with no prenotification. It is important to note that thrombolytic therapy in stroke was commenced halfway through this study (March 2003), so this effect may have been related to the prioritizing of acute patients following introduction of this treatment. However, the statistical differences seen between prenotification and triage coding did not change when examined separately for acute

(less than three hours from onset) and non-acute stroke patients, or before and after institution of thrombolytic therapy. This is the first study to demonstrate the prioritizing of stroke patients with prenotification signals.

LIMITATIONS

With emergency response systems and paramedic education varying both within and between countries, the generalization of these results may be questioned. Although baseline sensitivities of paramedic diagnosis of stroke and results from the stroke knowledge questionnaire may differ between regions, the general effect of the educational and stroke tool intervention should not. The prehospital stroke tool is designed to standardize stroke assessment and should be universally applicable. Items contained within the tool are easily taught and are well within the capabilities of emergency-trained personnel. In fact, studies have shown that items in the CPSS tool (facial droop, arm drift, and abnormal speech) have been correctly performed and communicated by laypersons over the telephone.[25,27]

A further limitation of this study was the inability to examine specificity of paramedic diagnosis. Studies have shown that paramedics tend to overdiagnosis stroke, with difficulties distinguishing stroke from mimics such as hypoglycemias, seizures, drug intoxication, or syncope.[8,9] The inability to accurately diagnose stroke can lead to the inefficient use of medical/nursing staff and other resources in the ED. This study did not examine paramedic diagnosis of stroke in non-stroke patients. The specificity of paramedic diagnosis in stroke has been examined only retrospectively in one study[27] (60%) and in the field in prospective validation studies of the LAPSS.[11] (97%) and MASS.[14] (74%). However, all of these studies tested specificity in selected populations. In order to examine specificity accurately, all paramedic runs with a paramedic diagnosis of stroke would have to be compared with final hospital discharge diagnosis. Unfortunately, due to lack of computerized paramedic records for the study periods, this was beyond the scope of this study.

Reliability of results in this study is subject to potential bias due to the retrospective nature of the data collection. Attempts were made in the methods to reduce this potential bias by using published methodologic criteria.[28] Methods used include experienced abstractors, clear inclusion and exclusion criteria, clear definitions and abstraction points for variables, a standardized data-collection form, description of sampling methods, predetermined plan for missing data, ethics approval, and disclosure of funding. Due to limitations in resources, blinding of the abstractor and random independent reviews of data with analysis of reliability and agreement were unable to be performed.

CONCLUSION

With recent changes in stroke therapies and the lack of stroke education since initial training, it is not surprising that paramedics are unaware of current treatments and the important role they now play in the treatment of stroke. Results of this study demonstrate the need for revision of paramedic education, the effectiveness of the combined use of education with a prehospital stroke tool on the identification of stroke by paramedics, and the need for prenotification for patients within the treatment window for thrombolytic therapy.

References

1. Suyama J, Crocco T. Prehospital care of the stroke patient. Emerg Med Clin North Am. 2002;20:537–52.
2. Diez-Tejedor E, Fuentes B. Acute care in stroke: the importance of early intervention to achieve better brain protection. Cerebrovasc Dis. 2004;17 (suppl 1):130–7.
3. Lacy CR, Suh DC, Bueno M, Kostis JB. Delay in presentation and evaluation for acute stroke: Stroke Time Registry for Outcomes Knowledge and Epidemiology (S.T.R.O.K.E.). Stroke. 2001;32:63–9.
4. Bratina P, Greenberg L, Pasteur W, Grotta JC. Current emergency department management of stroke in Houston, Texas. Stroke. 1995;26:409–14.
5. Wein TH, Staub L, Felberg R, et al. Activation of emergency medical services for acute stroke in a nonurban population: the T.L.L. Temple Foundation Stroke Project. Stroke. 2000;31:1925–28.
6. Kothari R, Jauch E, Broderick J, et al. Acute stroke: delays to presentation and emergency department evaluation. Ann Emerg Med. 1999;33:3–8.
7. Crocco TJ, Kothari RU, Sayre MR, Liu T. A nationwide prehospital stroke survey. Prehosp Emerg Care. 1999;3:201–6.
8. Smith WS, Isaacs M, Corry MD. Accuracy of paramedic identification of stroke and transient ischemic attack in the field. Prehosp Emerg Care. 1998;2:170–5.
9. Kothari R, Barsan W, Brott T, Broderick J, Ashbrock S. Frequency and accuracy of prehospital diagnosis of acute stroke. Stroke. 1995;26:937–41.
10. Wojner AW, Morgenstern L, Alexandrov AV, Rodriguez D, Persse D, Grotta JC. Paramedic and emergency department care of stroke: baseline data from a citywide performance improvement study. Am J Crit Care. 2003;12:411–7.
11. Kidwell CS, Starkman S, Eckstein M, Weems K, Saver JL. Identifying stroke in the field. Prospective validation of the Los Angeles Prehospital Stroke Screen (LAPSS). Stroke. 2000;31:71–6.
12. Kothari RU, Pancioli A, Liu T, Brutt T, Broderick J. Cincinnati Prehospital Stroke Scale: reproducibility and validity. Ann Emerg Med. 1999;33:373–8.
13. Rapp K, Bratina P, Barch C, et al. Code Stroke: rapid transport, triage and treatment using rt-PA therapy. The NINDS rt-PA Stroke Study Group. J Neurosci Nurs. 1997;29:361–6.
14. Bray JE, Martin J, Cooper G, Barger B, Bernard S, Bladin C. Paramedic identification of stroke: community validation of the Melbourne Ambulance Stroke Screen (MASS). Cerebrovasc Dis. 2005;20:28–33.
15. Barsan WG, Brott TG, Broderick JP, Haley EC, Levy DE, Marler JR. Time of hospital presentation in patients with acute stroke. Arch Intern Med. 1993;153:2558–61.
16. 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;5:45–51.

17. Saver JL, Kidwell C, Eckstein M, et al. Prehospital neuroprotective therapy for acute stroke: results of the Field Administration of Stroke Therapy–Magnesium (FAST-MAG) pilot trial. Stroke. 2004;35(5):e106–e108.
18. Smith WS, Corry MD, Fazackerley J, Issacs SM. Improved paramedic sensitivity in identifying stroke victims in the prehospital setting. Prehosp Emerg Care. 1999;3:207–10.
19. Zweifler RM, York D, U TT, Mendizabal JE, Rothrock JF. Accuracy of paramedic diagnosis of stroke. J Stroke Cerebrovasc Dis. 1998;7:446–9.
20. National Stroke Unit Program Steering Committee. National guidelines for acute stroke management. National Stroke Foundation. Available at: http://203.89.231.189/pages/image.aspx?assetId=RDM38248.6090587269. Last accessed May 11, 2005.
21. Adams HP Jr, Adams RJ, Brott T, et al. Guidelines for the early management of patients with ischemic stroke: a scientific statement from the Stroke Council of the American Stroke Association. Stroke. 2003;34:1056–83.
22. Adams HP Jr, Brott TG, Furlan AJ, et al. Guidelines for thrombolytic therapy for acute stroke: a supplement to the guidelines for the management of patients with acute ischemic stroke. A statement for healthcare professionals from a Special Writing Group of the Stroke Council, American Heart Association. Stroke. 1996;27:1711–8.
23. European Stroke Initiative recommendations for stroke management. European Stroke Council, European Neurological Society, and European Federation of Neurological Societies. Cerebrovasc Dis . 2000;10:335–51.
24. Hack W, Kaste M, Bogousslavsky J, et al. European Stroke Initiative Recommendations for Stroke Management—update 2003. Cerebrovasc Dis. 2003;16:311–37.
25. 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;11:202–7.
26. Hurwitz AS, Overby BA, Brice JH, Evenson KR. Untrained adults can identify symptoms of stroke by directed use of the Cincinnati Prehospital Stroke Scale [abstract]. Stroke. 2004;34:279.
27. Liferidge AT, Brice JH, Overby BA, Evenson KR. Ability of laypersons to utilize the Cincinnati Prehospital Stroke Scale Prehosp Emerg Care. 2004;8:384–7.
28. Bray J, Bladin C, Martin J, Bernard S. Can prehospital stroke screening tools improve paramedic diagnosis of stroke? [abstract]. Int Med J. 2003;33:A42.
29. Worster A, Haines T. Advanced statistics: understanding medical record review (MRR) studies. Acad Emerg Med. 2004;11:187–92.