HHS Public Access
Author manuscript
Prehosp Emerg Care. Author manuscript; available in PMC 2018 November 01.

Published in final edited form as:
Prehosp Emerg Care. 2017 ; 21(6): 761–766. doi:10.1080/10903127.2017.1332124.

Identifying Key Words in 9-1-1 Calls for Stroke: A Mixed Methods Approach

Christopher T. Richards, MD, MS, FAEMS[1,2,3], **Baiyang Wang**[4], **Eddie Markul, MD**[2,5], **Frank Albarran, EMT-B, EMD**[6], **Doreen Rottman, EMT-P, EMD**[6], **Neelum T. Aggarwal**[7], **Patricia Lindeman, RN, MBA**[1,2], **Leslee Stein-Spencer, RN, MS**[2,6], **Joseph M. Weber, MD**[2,8], **Kenneth S. Pearlman, MD**[1,2], **Katie L. Tataris, MD, MPH, FAEMS**[2,9], **Jane L. Holl, MD, MPH**[3], **Diego Klabjan, PhD**[4], and **Shyam Prabhakaran, MD, MS**[2,3,10]

[1]Department of Emergency Medicine, Northwestern Feinberg School of Medicine, *in Chicago, Illinois*

[2]Chicago EMS System, *in Chicago, Illinois*

[3]Center for Healthcare Studies, Northwestern Feinberg School of Medicine, *in Chicago, Illinois*

[4]Department of Industrial Engineering and Management Sciences, Northwestern University McCormick School of Engineering, *in Evanston, Illinois.*

[5]Department of Emergency Medicine, Advocate Illinois Masonic Medical Center, *in Chicago, Illinois*

[6]City of Chicago, *in Chicago, Illinois*

[7]Department of Neurology, Rush University Medical Center, *in Chicago, Illinois*

[8]Department of Emergency Medicine, John H. Stroger, Jr. Hospital of Cook County, *in Chicago, Illinois*

[9]Section of Emergency Medicine, University of Chicago Medicine, *in Chicago, Illinois*

[10]Department of Neurology, Northwestern Feinberg School of Medicine, *in Chicago, Illinois*

Abstract

Objectives—Identifying stroke during a 9–1-1 call is critical to timely prehospital care. However, emergency medical dispatchers (EMDs) recognize stroke in less than half of 9–1-1 calls, potentially due to the words used by callers to communicate stroke signs and symptoms. We hypothesized that callers do not typically use words and phrases considered to be classical descriptors of stroke, such as focal neurologic deficits, but that a mixed-methods approach can identify words and phrases commonly used by 9–1-1 callers to describe acute stroke victims.

Corresponding Author: Christopher T. Richards, MD, MS, 211 East Ontario St., Suite 200, Chicago, IL 60611, (P) 312-694-7000, (F) 312-926-6274, (e) c-richards@northwestern.edu.
Author Contributions:
CTR, NTA, JLH, DK, and SP conceived the study and designed the trial. CTR, EM, FA, DR, PL, and SP acquired data. CTR, BW, EM, JLH, DK, and SP performed analysis and interpretation of the data. BW and DK provided statistical expertise. FA, DR, PL, LSS, JMW, KSP, and KLT provided administrative and technical support. CTR drafted the manuscript. All authors provided critical revision of the manuscript for important intellectual content.

Disclosures: None.

Methods—We performed a mixed-methods, retrospective study of 9–1-1 call audio recordings for adult patients with confirmed stroke who were transported by ambulance in a large urban city. Content analysis, a qualitative methodology, and computational linguistics, a quantitative methodology, were used to identify key words and phrases used by 9–1-1 callers to describe acute stroke victims. Because a caller's level of emotional distress contributes to the communication during a 9–1-1 call, the Emotional Content and Cooperation Score was scored by a multidisciplinary team.

Results—A total of 110 9–1-1 calls, received between June and September 2013, were analyzed. EMDs recognized stroke in 48% of calls, and the emotional state of most callers (95%) was calm. In 77% of calls in which EMDs recognized stroke, callers specifically used the word "stroke"; however, the word "stroke" was used in only 38% of calls. Vague, non-specific words and phrases were used to describe stroke victims' symptoms in 55% of calls, and 45% of callers used distractor words and phrases suggestive of non-stroke emergencies. Focal neurologic symptoms were described in 39% of calls. Computational linguistics identified 9 key words that were more commonly used in calls where the EMD identified stroke. These words were concordant with terms identified through qualitative content analysis.

Conclusions—Most 9–1-1 callers used vague, non-specific, or distractor words and phrases and infrequently provide classic stroke descriptions during 9–1-1 calls for stroke. Both qualitative and quantitative methodologies identified similar key words and phrases associated with accurate EMD stroke recognition. This study suggests that tools incorporating commonly used words and phrases could potentially improve EMD stroke recognition.

Keywords

Emergency Medical Service Communication Systems; Emergency Medical Services; Stroke; Prehospital Care; Emergency Medical Dispatch

Introduction

Prompt recognition, transport, and treatment of patients experiencing acute stroke is critical to patient outcomes.1–5 The first medical contact for stroke often is with the emergency medical dispatcher (EMD) who serves as a critical link in the stroke chain of survival by notifying subsequent providers and providing pre-arrival instructions to callers.[5] Accurate EMD and paramedic identification of stroke leads to high-priority dispatch of responding personnel, shorter on-scene time, quicker transport of patients to stroke center hospitals, and improved emergency department time metric quality measures for stroke.5–8 Timely stroke care is critical for patient outcomes, as every 15 minute delay to thrombolysis results in a 4% increase in poor outcomes and most patients become ineligible for any form of revascularization therapy six hours after symptom onset.3,4 Additionally, patients with acute ischemic stroke from large vessel occlusion benefit from timely mechanical thrombectomy, emphasizing the importance of prehospital identification of severe stroke and coordination of all members of a prehospital stroke system of care.1,9–15 Currently, however, EMDs identify stroke in fewer than half of 9–1-1 calls for acute stroke.7,16–21

Limiting EMD protocols to classical stroke descriptors, such as focal weakness, slurred speech, and facial droop, may not account for commonly used words and phrases used by lay callers and may hamper stroke recognition by EMDs.[22,23] Our goal was to describe the words and phrases commonly used during 9–1-1 calls for acute stroke in a large United States city using both qualitative and quantitative methodologies. We hypothesized that layperson callers commonly use words and phrases that are not considered classical descriptors of stroke, such as focal neurologic deficits, when calling 9–1-1 for victims of acute stroke.

Methods

Study Design

We performed a retrospective, mixed methods study of 9–1-1 calls for patients with confirmed acute stroke. Detailed field notes of each 9–1-1 call audio recording were transcribed by research team members (CTR, SP, EM, FA), and the call duration was recorded. In Chicago during the study period, EMDs used locally-developed dispatch protocols that first prompt the EMD to ask the caller if the patient is conscious and breathing normally once the nature of the emergency is determined. Next, the EMD is prompted to ask the age and sex of the patient. If the nature of the emergency raises the possibility of stroke for the EMD, the EMD will ask if the patient is having any stroke symptoms, specifically slurred speech, numbness/tingling, and paralysis, as well as the time of symptom onset. After on-scene paramedic evaluation, patients with suspected stroke are transported directly to a primary stroke center.

Research team members (CTR, SP, EM, FA) also scored the Emotional Content and Cooperation Score (ECCS) by consensus. The ECCS is a five-point scale from 1 (“normal conversational speech”) to 5 (“uncontrollable, hysterical”) that describes the level of emotional distress of 9–1-1 callers,[24,25] and research team members were trained in the application of the ECCS. The research team members listened to the audio recordings as a group with the goal of achieving consensus in determining the ECCS. Actual audio-recordings for this analysis were used, rather than the field notes, because some aspects of the “emotion” of the call can be missed on transcription (e.g., tone of voice, background noise, crying). If initial scores differed amongst the members, the call was re-played for the group and discussed until consensus on ECCS was reached.

Study Population and Setting

Patients older than 18 years of age who arrived by ambulance to one of eight primary stroke centers in Chicago with confirmed acute ischemic stroke (AIS), from June through November 2013, were identified through the Get With The Guidelines-Stroke registry. The corresponding 9–1-1 call was matched for each patient who was diagnosed with stroke at the receiving stroke center.

Analytical Methods

A qualitative analysis, using content analysis, was performed on the field notes of the 9–1-1 calls, using an *a priori* codebook. The code for “focal neurologic symptoms” was defined as clear neurologic deficits consistent with classic stroke syndromes, such as arm weakness, facial droop, and slurred speech. The code for “vague, non-specific symptoms” included words and phrases that were not stroke-specific but consistent with stroke syndromes, such as “cannot walk” and “nausea.” “Distractors” were defined as words or phrases suggestive of non-stroke emergencies (e.g., “can’t breathe”).

A quantitative analysis, using computational linguistics, was performed by assessing the frequency of each word in 9–1-1 calls with EMD-recognized stroke compared to the frequency of each word in 9–1-1 calls without EMD-recognized stroke. EMD recognition of stroke was defined as the EMD assigning “stroke patient” for “incident type” at the time of ambulance dispatch. A Welch’s t-test was applied to calculate the difference of word frequency,

$$t_w = \frac{f_{w,s}/N_s - f_{w,n}/N_n}{\sqrt{f_{w,s}\left(1 - f_{w,s}/N_s\right)/N_s^2 + f_{w,n}\left(1 - f_{w,n}/N_n\right)/N_n^2}},$$

where $f_{w,s}$ and $f_{w,n}$ represent the number of appearances of word w in calls with and without EMD-recognized stroke, respectively, and N_s and N_n represent the total word counts of calls with and without EMD-recognized stroke, respectively.[26] Assuming an equal variance, the degree of freedom was roughly proportional to the total number of words $N_s + N_n$. Each word in a call was analyzed as an independent sample which resulted in all degrees of freedom >1000, and, therefore, a normal approximation was used. The analysis was repeated by extracting key phrases (e.g. “chest pain” and “had a stroke”) using the key phrases as a unit of analysis. A p-value of <0.05 using the t_w values was considered significant.

Human Subjects Review

The study was reviewed and approved as an exempt protocol by the Northwestern University Institutional Review Board (STU00202203).

Results

We analyzed 110 audio recordings. Median call duration was 61 (interquartile range 47–81) seconds with an average of 89.3 words per call. Six of 110 calls (5%) were from medical facilities (e.g., clinic or nursing home). EMDs correctly identified stroke in 53/110 (48%) of calls.

Content analysis revealed that vague, non-specific words and phrases (e.g., “She’s confused and distressed”) were used to describe stroke by 60/110 (55%) of callers, and distractor terms, suggestive of non-stroke emergencies (e.g., “I think he’s having a heart attack”), were used in 49/110 (45%) of calls. In 43/110 (39%) of calls, the caller described focal neurologic deficits (e.g., “Right arm’s not lifting”). Only 42/110 (38%) of callers used the word “stroke”; however, in 41 of 53 (77%) calls with accurate EMD recognition of stroke, the caller used the word "stroke." Symptom onset time was communicated in only 5/110 (5%) of calls.

Quantitative analysis using computational linguistics identified key words and phrases associated with EMD recognition of stroke that were similar to those identified through qualitative content analysis. Caller use of the word "stroke" was most strongly associated with EMD recognition of stroke (p<0.0005). Similarly, the phrases "having a stroke" (p<0.0005) and "had a stroke" (p=0.001) were also associated with EMD recognition of stroke. Other words used by callers during calls with EMD-recognized stroke included words associated with classic descriptions of stroke: "face" (p=0.017), "mouth" (p=0.007), "slurred" (p=0.004), and "side" (p=0.011). "Twisted," as a lay descriptor for facial weakness, was also more common in calls with EMD-recognized stroke (p=0.007). The use of the non-specific word "think" (p<0.0005) suggests a degree of uncertainty on the caller's behalf about the patient's clinical condition (Table 1).

The EMD dispatch protocol used during the study period prompts EMDs to ask all callers if the patient is "awake" and "breathing normally." The word "awake" (p=0.004) and the phrase "awake and breathing" (p=0.014) were more commonly used by callers in which EMDs recognized stroke. The words and phrases used by EMDs during calls with EMD-recognized stroke included "side" (p=0.001), "slurred" (p=0.001), "speech" (p=0.004), "slurred speech" (0.013), and "mouth" (p=0.051 (Table 2).

Most (71/110, 65%) callers used normal conversational speech patterns (ECCS=1), and 33/110 (30%) of callers were anxious but cooperative (ECCS=2). No callers were so emotional that they were unable to be directed by the EMD (ECCS=5).

Discussion

We found that the majority of lay callers use vague words and phrases not specific to stroke to describe acute stroke victims during 9–1-1 calls. Additionally, many callers used words and phrases suggestive of non-stroke emergencies, which may hinder EMD stroke recognition. Focal neurologic signs and symptoms were infrequently described by callers, but these classic descriptors were more commonly associated with EMD recognition of stroke. Fewer than 2 in 5 callers used the word "stroke" despite use of this word being associated with accurate EMD stroke identification, a finding consistent with prior studies. 21,27 These findings suggest that, in order for EMDs to recognize stroke, caller descriptions of symptoms characteristic of stroke syndromes with preserved mental status (i.e., "slurred speech" <u>and</u> "awake [and breathing]") are critical. However, callers more commonly used vague and non-specific descriptors of stroke during 9–1-1 calls. Lastly, most callers were calm during 9–1-1 calls. This calmness not only suggests that callers may not recognize the time-sensitive nature of acute stroke but also suggests potential opportunities for EMD-directed pre-arrival stroke assessments with callers.

Early identification of stroke is critical to improving stroke outcomes.[5] Stroke recognition by EMDs can result in notifying responding paramedics and timelier stroke care.7,8,22 Additionally, early, accurate identification of stroke is important to prehospital stroke systems of care that triage patients with suspected large vessel occlusions (LVO) to comprehensive stroke centers.14,15 With evidence demonstrating that rapid reperfusion improves outcome, recent emphasis has been placed on the prehospital screening for LVO. 11,14,15 Prehospital LVO screening tools have been validated, mobile stroke unit programs have been developed, and transport by helicopter emergency medical services to CSCs have been investigated.15,28–37 Identifying patients with suspected stroke during the 9–1-1 call carries the potential to improve on-scene detection and the "downstream" deployment of appropriate resources to the screen, particularly in systems where response and transport times are greater than recommended guidelines.[38]

Currently, EMD recognition of acute stroke is suboptimal, and, similar to this investigation where EMD stroke detection was 48%, most prior studies have reported EMD stroke recognition less than 50% though with a range between 31%−80%.7,16–21,39 One key barrier may be the words and phrases used by 9–1-1 callers. A prior study of emergency calls for stroke, conducted in the ethnically and linguistically homogenous region of North West England, found that only 25% of callers conveyed a concern for stroke and even fewer described focal neurologic deficits.22,23,27 Our results confirm these prior findings for a diverse, urban population in the United States.

Both qualitative and quantitative methods were used to identify key words and phrases used in 9–1-1 calls for acute stroke. Computational linguistics has been applied in other settings but, to our knowledge, never to analyze healthcare communication. This successful application of a novel methodological approach provides preliminary proof of concept data for further application of computational linguistics in health services research, specifically emergency care research. For example, a novel extension of this work would be to implement algorithms into enhanced decision support tools for EMDs to detect words and phrases associated with a high probability of stroke.

This study is limited in the use of data from a single city, Chicago, Illinois. Despite the diverse racial-ethnic background of the city's population, the findings may not be generalizable to other urban settings in the United States with different EMD protocols and linguistic heritages of its population. While prehospital metrics, such as on-scene time and demographic characteristics of callers, were not available for this analysis, future studies should attempt to gather these data to investigate the influence of words used during 9–1-1 calls to assess the representativeness of the data regarding prehospital care and treatment delays. Additionally, the demographic characteristics of the 9–1-1 caller and EMD, such as race, gender, and level of health literacy were not recorded or not knowable. These demographic characteristics of callers and subsequent interaction with EMDs may influence stroke detection by EMDs and can be investigated in further studies. Lastly, only 9–1-1 calls for patients with confirmed AIS were included for analysis, and future studies can apply similar methodology to other stroke types (e.g., hemorrhagic stroke) and stroke mimics. Furthermore, future studies can use the methodology described here to investigate ways of incorporating highly predictive words used by laypersons into EMD screens to prompt EMDs to consider stroke during the first point of medical contact during the 9–1-1 call. In future studies, real-time machine learning could be implemented to analyze callers' words and phrases and prompt EMDs to consider specific conditions, such as stroke.

Conclusions

The EMD-caller interaction is a critical link in the stroke chain of survival, and optimizing stroke recognition during 9–1-1 calls could improve stroke outcomes. Our mixed methods approach suggests that layperson callers use words and phrases that are not considered classical descriptors of stroke when calling 9–1-1 for victims of acute stroke. With current technology, adaptation of 9–1-1 dispatch protocols to incorporate the key words and phrases used by callers for stroke victims could assist EMDs in recognizing words and phrases associated with acute stroke to improve stroke detection at the point of first medical contact during the 9–1-1 call.

Acknowledgments

Sources of Funding:

CTR was supported by AHRQ/NRSA T32-HS000078–16 (PI Holl), NINDS Stroke Trials Network–Regional Coordinating Center U10-NS086608 (PI Prabhakaran), and NINDS R25-NS088248 Clinical Trials Methodology Course (PI Meurer) for work related to this publication.

References

1. Saver JL, Goyal M, van der Lugt A, Menon BK, Majoie CB, Dippel DW, Campbell BC, Nogueira RG, Demchuk AM, Tomasello A, Cardona P, Devlin TG, Frei DF, du Mesnil de Rochemont R, Berkhemer OA, Jovin TG, Siddiqui AH, van Zwam WH, Davis SM, Castano C, Sapkota BL, Fransen PS, Molina C, van Oostenbrugge RJ, Chamorro A, Lingsma H, Silver FL, Donnan GA, Shuaib A, Brown S, Stouch B, Mitchell PJ, Davalos A, Roos YB, Hill MD. Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: A meta-analysis. JAMA. 2016;316(12):1279–1288. [PubMed: 27673305]
2. Goyal M, Jadhav AP, Bonafe A, Diener H, Mendes Pereira V, Levy E, Baxter B, Jovin T, Jahan R, Menon BK, Saver JL. Analysis of workflow and time to treatment and the effects on outcome in endovascular treatment of acute ischemic stroke: Results from the SWIFT PRIME randomized controlled trial. Radiology. 2016;279(3):888–897. [PubMed: 27092472]
3. Kim JT, Fonarow GC, Smith EE, Reeves MJ, Navalkele DD, Grotta JC, Grau-Sepulveda MV, Hernandez AF, Peterson ED, Schwamm LH, Saver JL. Treatment with tissue plasminogen activator in the golden hour and the shape of the 4.5-hour time-benefit curve in the national United States get with the guidelines-stroke population. Circulation. 2017;135(2):128–139. [PubMed: 27815374]
4. Saver JL, Fonarow GC, Smith EE, Reeves MJ, Grau-Sepulveda MV, Pan W, Olson DM, Hernandez AF, Peterson ED, Schwamm LH. Time to treatment with intravenous tissue plasminogen activator and outcome from acute ischemic stroke. JAMA. 2013;309(23):2480–2488. [PubMed: 23780461]
5. Jauch EC, Saver JL, Adams HP, Jr., Bruno A, Connors JJ, Demaerschalk BM, Khatri P, McMullan PW, Jr., Qureshi AI, Rosenfield K, Scott PA, Summers DR, Wang DZ, Wintermark M, Yonas H. 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(3):870–947. [PubMed: 23370205]
6. Ramanujam P, Castillo E, Patel E, Vilke G, Wilson MP, Dunford JV. Prehospital transport time intervals for acute stroke patients. J Emerg Med. 2009;37(1):40–45. [PubMed: 18722734]
7. Caceres JA, Adil MM, Jadhav V, Chaudhry SA, Pawar S, Rodriguez GJ, Suri MF, Qureshi AI. Diagnosis of stroke by emergency medical dispatchers and its impact on the prehospital care of patients. J Stroke Cerebrovasc Dis. 2013;22(8):e610–614. [PubMed: 24075587]
8. Abboud ME, Band R, Jia J, Pajerowski W, David G, Guo M, Mechem CC, Messe SR, Carr BG, Mullen MT. Recognition of stroke by EMS is associated with improvement in emergency department quality measures. Prehosp Emerg Care. 2016;20(6):729–736. [PubMed: 27246289]

9. Prabhakaran S, O'Neill K, Stein-Spencer L, Walter J, Alberts MJ. Prehospital triage to primary stroke centers and rate of stroke thrombolysis. JAMA Neurol. 2013;70(9):1126–1132. [PubMed: 23817961]

10. Goyal M, Menon BK, van Zwam WH, Dippel DW, Mitchell PJ, Demchuk AM, Davalos A, Majoie CB, van der Lugt A, de Miquel MA, Donnan GA, Roos YB, Bonafe A, Jahan R, Diener HC, van den Berg LA, Levy EI, Berkhemer OA, Pereira VM, Rempel J, Millan M, Davis SM, Roy D, Thornton J, Roman LS, Ribo M, Beumer D, Stouch B, Brown S, Campbell BC, van Oostenbrugge RJ, Saver JL, Hill MD, Jovin TG. Endovascular thrombectomy after large-vessel ischaemic stroke: A meta-analysis of individual patient data from five randomised trials. Lancet. 2016;387(10029): 1723–1731. [PubMed: 26898852]

11. Richards CT, Adams JG, Prabhakaran S. Recent evidence for endovascular therapy in acute ischemic stroke. Ann Emerg Med. 2015;66(4):441–442. [PubMed: 26398177]

12. Prabhakaran S, Ruff I, Bernstein RA. Acute stroke intervention: A systematic review. JAMA. 2015;313(14):1451–1462. [PubMed: 25871671]

13. Furlan AJ. Endovascular therapy for stroke--it's about time. N Engl J Med. 2015;372(24):2347–2349. [PubMed: 25882509]

14. Powers WJ, Derdeyn CP, Biller J, Coffey CS, Hoh BL, Jauch EC, Johnston KC, Johnston SC, Khalessi AA, Kidwell CS, Meschia JF, Ovbiagele B, Yavagal DR. 2015 American Heart Association/American Stroke Association focused update of the 2013 guidelines for the early management of patients with acute ischemic stroke regarding endovascular treatment: A guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2015;46(10):3020–3035. [PubMed: 26123479]

15. Pride GL, Fraser JF, Gupta R, Alberts MJ, Rutledge JN, Fowler R, Ansari SA, Abruzzo T, Albani B, Arthur A, Baxter B, Bulsara KR, Chen M, Delgado Almandoz JE, Gandhi CD, Heck D, Hetts SW, Hirsch JA, Hussain MS, Klucznik R, Lee SK, Mack WJ, Leslie-Mazwi T, McTaggart RA, Meyers PM, Mocco J, Prestigiacomo C, Patsalides A, Rasmussen P, Starke RM, Sunenshine P, Frei D, Jayaraman MV. Prehospital care delivery and triage of stroke with emergent large vessel occlusion (ELVO): Report of the standards and guidelines committee of the Society of Neurointerventional Surgery. J Neurointerv Surg. 2016.

16. Buck BH, Starkman S, Eckstein M, Kidwell CS, Haines J, Huang R, Colby D, Saver JL. Dispatcher recognition of stroke using the National Academy Medical Priority Dispatch System. Stroke. 2009;40(6):2027–2030. [PubMed: 19390065]

17. Ellison SR, Gratton MC, Schwab RA, Ma OJ. Prehospital dispatch assessment of stroke. Mo Med. 2004;101(1):64–66. [PubMed: 15017757]

18. Kothari R, Barsan W, Brott T, Broderick J, Ashbrock S. Frequency and accuracy of prehospital diagnosis of acute stroke. Stroke. 1995;26(6):937–941. [PubMed: 7762041]

19. Porteous GH, Corry MD, Smith WS. Emergency medical services dispatcher identification of stroke and transient ischemic attack. Prehosp Emerg Care. 1999;3(3):211–216. [PubMed: 10424858]

20. Ramanujam P, Guluma KZ, Castillo EM, Chacon M, Jensen MB, Patel E, Linnick W, Dunford JV. Accuracy of stroke recognition by emergency medical dispatchers and paramedics-San Diego experience. Prehosp Emerg Care. 2008;12(3):307–313. [PubMed: 18584497]

21. Reginella RL, Crocco T, Tadros A, Shackleford A, Davis SM. Predictors of stroke during 9–1-1 calls: Opportunities for improving EMS response. Prehosp Emerg Care. 2006;10(3):369–373. [PubMed: 16801282]

22. Watkins CL, Leathley MJ, Jones SP, Ford GA, Quinn T, Sutton CJ. Training emergency services' dispatchers to recognise stroke: An interrupted time-series analysis. BMC Health Serv Res. 2013;13318.

23. Watkins CL, Jones SP, Leathley MJ, Ford GA, Quinn T, McAdam J, Gibson JM, Mackway-Jones K, Durham S, Britt D, Morris S, O'Donnell M, Emsley H, Punekar S. Emergency stroke calls: Obtaining rapid telephone triage (ESCORTT)-a programme of research to facilitate recognition of stroke by emergency medical dispatchers. Programme Grants Appl Res. 2014;2(1).

24. Clawson JJ, Sinclair R. The emotional content and cooperation score in emergency medical dispatching. Prehosp Emerg Care. 2001;5(1):29–35. [PubMed: 11194066]

25. Eisenberg MS, Carter W, Hallstrom A, Cummins R, Litwin P, Hearne T. Identification of cardiac arrest by emergency dispatchers. Am J Emerg Med. 1986;4(4):299–301. [PubMed: 3718618]
26. Welch BL. The generalization of students problem when several different population variances are involved. Biometrika. 1947;34(1–2):28–35. [PubMed: 20287819]
27. Jones SP, Carter B, Ford GA, Gibson JM, Leathley MJ, McAdam JJ, O'Donnell M, Punekar S, Quinn T, Watkins CL. The identification of acute stroke: An analysis of emergency calls. Int J Stroke. 2013;8(6):408–412. [PubMed: 22335960]
28. Parker SA, Bowry R, Wu TC, Noser EA, Jackson K, Richardson L, Persse D, Grotta JC. Establishing the first mobile stroke unit in the United States. Stroke. 2015;46(5):1384–1391. [PubMed: 25782464]
29. Cerejo R, John S, Buletko AB, Taqui A, Itrat A, Organek N, Cho SM, Sheikhi L, Uchino K, Briggs F, Reimer AP, Winners S, Toth G, Rasmussen P, Hussain MS. A mobile stroke treatment unit for field triage of patients for intraarterial revascularization therapy. J Neuroimaging. 2015;25(6):940–945. [PubMed: 26179631]
30. Bowry R, Parker S, Rajan SS, Yamal JM, Wu TC, Richardson L, Noser E, Persse D, Jackson K, Grotta JC. Benefits of stroke treatment using a mobile stroke unit compared with standard management: The BEST-MSU study run-in phase. Stroke. 2015;46(12):3370–3374. [PubMed: 26508753]
31. Ebinger M, Winter B, Wendt M, Weber JE, Waldschmidt C, Rozanski M, Kunz A, Koch P, Kellner PA, Gierhake D, Villringer K, Fiebach JB, Grittner U, Hartmann A, Mackert BM, Endres M, Audebert HJ. Effect of the use of ambulance-based thrombolysis on time to thrombolysis in acute ischemic stroke: A randomized clinical trial. JAMA. 2014;311(16):1622–1631. [PubMed: 24756512]
32. Walter S, Kostopoulos P, Haass A, Keller I, Lesmeister M, Schlechtriemen T, Roth C, Papanagiotou P, Grunwald I, Schumacher H, Helwig S, Viera J, Korner H, Alexandrou M, Yilmaz U, Ziegler K, Schmidt K, Dabew R, Kubulus D, Liu Y, Volk T, Kronfeld K, Ruckes C, Bertsch T, Reith W, Fassbender K. Diagnosis and treatment of patients with stroke in a mobile stroke unit versus in hospital: A randomised controlled trial. Lancet Neurol. 2012;11(5):397–404. [PubMed: 22497929]
33. McMullan JT, Katz B, Broderick J, Schmit P, Sucharew H, Adeoye O. Prospective prehospital evaluation of the Cincinnati Stroke Triage Assessment Tool. Prehosp Emerg Care. 20171–8.
34. Sequeira D, Martin-Gill C, Kesinger MR, Thompson LR, Jovin TG, Massaro LM, Guyette FX. Characterizing strokes and stroke mimics transported by helicopter emergency medical services. Prehosp Emerg Care. 2016;20(6):723–728. [PubMed: 27082420]
35. Hastrup S, Damgaard D, Johnsen SP, Andersen G. Prehospital Acute Stroke Severity scale to predict large artery occlusion: Design and comparison with other scales. Stroke. 2016;47(7):1772–1776. [PubMed: 27272487]
36. Kim JT, Chung PW, Starkman S, Sanossian N, Stratton SJ, Eckstein M, Pratt FD, Conwit R, Liebeskind DS, Sharma L, Restrepo L, Tenser MK, Valdes-Sueiras M, Gornbein J, Hamilton S, Saver JL. Field validation of the Los Angeles Motor Scale as a tool for paramedic assessment of stroke severity. Stroke. 2017;48(2):298–306. [PubMed: 28087807]
37. Carrera D, Campbell BC, Cortes J, Gorchs M, Querol M, Jimenez X, Millan M, Davalos A, Perez de la Ossa N. Predictive value of modifications of the prehospital Rapid Arterial Occlusion Evaluation scale for large vessel occlusion in patients with acute stroke. J Stroke Cerebrovasc Dis. 2017;26(1):74–77. [PubMed: 27720525]
38. Schwartz J, Dreyer RP, Murugiah K, Ranasinghe I. Contemporary prehospital emergency medical services response times for suspected stroke in the United States. Prehosp Emerg Care. 2016;20(5):560–565. [PubMed: 26953776]
39. Rosamond WD, Evenson KR, Schroeder EB, Morris DL, Johnson AM, Brice JH. Calling emergency medical services for acute stroke: A study of 9–1-1 tapes. Prehosp Emerg Care. 2005;9(1):19–23. [PubMed: 16036823]

Prior Presentation of this Work:

- *Poster presentation at:* Academy Health Annual Research Meeting, Minneapolis, MN. 6/2015.
- *Oral presentation at:* StrokeNet Trainees Symposium at the International Stroke Conference, Nashville, TN. 2/2015.
- *Moderated poster presentation at:* National Association of EMS Physicians Annual Conference, New Orleans, LA. 1/2015.
- *Poster presentation at:* Building Health Equity through Community Engaged Research throughout Chicago Conference for the Chicago Consortium for Community Engagement. 10/2014.

Table 1.

Number and percentage of 9–1-1 calls for confirmed acute stroke containing specific words and phrases used by the 9–1-1 caller that are significantly associated with emergency medical dispatcher identification of stroke.

Word/Phrase Used by the 9–1-1 Caller	EMD Recognized Stroke (n=53)	EMD Unrecognized Stroke (n=57)	p-value[a]
Stroke	43 (81.1%)	1 (1.8%)	<0.0005
Think	28 (52.8%)	4 (7.0%)	<0.0005
Having a stroke	21 (39.6%)	1 (1.8%)	<0.0005
Had a stroke	10 (18.9%)	0 (0%)	0.001
Slurred	12 (22.6%)	2 (3.5%)	0.004
Awake	9 (17.0%)	1 (1.8%)	0.006
Mouth	6 (11.3%)	0 (0%)	0.007
Twisted	6 (11.3%)	0 (0%)	0.007
Side	17 (32.1%)	6 (10.5%)	0.011
Face	7 (13.2%)	1 (1.8%)	0.017
Awake and breathing	4 (7.5%)	0 (0%)	0.023

EMD: emergency medical dispatcher.

[a]Welch's t test used as test of significance.26

Table 2.

Number and percentage of 9–1-1 calls for confirmed acute stroke containing specific words and phrases used by emergency medical dispatchers (EMD) that are significantly associated with EMD identification of stroke.

Word/Phrase Used by the EMD	EMD Recognized Stroke (n=53)	EMD Unrecognized Stroke (n=57)	p-value[a]
Stroke	23 (43.4%)	0 (0%)	<0.0005
Side	10 (18.9%)	0 (0%)	0.001
Slurred	9 (17.0%)	0 (0%)	0.001
Had a stroke	8 (15.1%)	0 (0%)	0.002
Speech	7 (13.2%)	0 (0%)	0.004
Awake	27 (50.9%)	11 (19.3%)	0.004
Sitting	10 (18.9%)	2 (3.5%)	0.010
Slurred speech	5 (9.4%)	0 (0%)	0.013
Awake and breathing	13 (24.5%)	4 (7.0%)	0.014
Down	19 (35.8%)	9 (15.8%)	0.028
Mouth	5 (9.4%)	1 (1.8%)	0.051

EMD: emergency medical dispatcher.

[a]Welch’s t test used as test of significance.26