Relationship Between Time from Ambulance Call to Arrival at Emergency Center and Level of Consciousness at Admission in Severe Stroke Patients

Kazuhiro Ohwaki, MD, PhD;[1] Takehiro Watanabe, MD;[2] Takayuki Shinohara, MD;[2] Tadayoshi Nakagomi, MD, PhD;[2] Eiji Yano, MD, PhD[1]

1. Department of Hygiene and Public Health, Teikyo University School of Medicine, Tokyo, Japan
2. Department of Neurosurgery, Teikyo University School of Medicine, Tokyo, Japan

Correspondence:
Kazuhiro Ohwaki, MD, PhD
Department of Hygiene and Public Health
Teikyo University School of Medicine
2-11-1 Kaga Itabashi
Tokyo 173-8605, Japan
E-mail: ns-waki@med.teikyo-u.ac.jp

Conflict of interest: The authors have no funding or conflicts of interest to report.

Keywords: ambulance; Emergency Medical Services; Glasgow Coma Scale; Japan; prehospital; stroke

Abbreviations:
GCS: Glasgow Coma Scale
EMS: Emergency Medical Services

Received: February 17, 2011
Accepted: October 14, 2011

doi:10.1017/S1049023X12001549

Abstract

Introduction: Timely access to acute medical treatment can be critical for patients suffering from severe stroke. Little information is available about the impact of prehospital delays on the clinical conditions of stroke patients, but it is possible that prehospital delays lead to neurological deterioration. The aim of this study was to examine the impact of prehospital delays related to emergency medical services on the level of consciousness at admission in patients with severe stroke.

Methods: This retrospective study assessed 712 consecutive patients diagnosed with cerebrovascular diseases who were admitted to an intensive care unit in Tokyo, Japan, from April 1998 through March 2008. Data, including the time from the call to the ambulance service to the arrival of the ambulance at the patient location (on-scene), and the time from the arrival of the ambulance on-scene to its arrival at the emergency center were obtained. The following demographic and clinical information also were obtained from medical records: sex, age, and Glasgow Coma Scale (GCS) score at admission.

Results: The mean time from ambulance call to arrival on-scene was 7 (SD=3) minutes, and the mean time from ambulance call to arrival at the center was 37 (SD=8) minutes. A logistic regression model for predicting GCS scores of 3 and 4 at admission was produced. After adjusting for sex, age, and time from arrival on-scene to arrival at the center, a longer call-to-on-scene time was significantly associated with poor GCS scores (OR = 1.056/min; 95% confidence interval, [CI] = 1.008-1.107). After adjusting for sex and age, a longer call-to-arrival at the center time also was significantly associated with poor GCS scores (OR = 1.020; 95% CI = 1.002-1.038).

Conclusions: Prehospital delays were significantly associated with decreased levels of consciousness at admission in patients suffering from a stroke. As level of consciousness is the strongest predictor of outcome, reducing prehospital delays may be necessary to improve the outcomes in patients with severe stroke.

Ohwaki K, Watanabe T, Shinohara T, Nakagomi T, Yano E. Relationship between time from ambulance call to arrival at emergency center and level of consciousness at admission in severe stroke patients. ***Prehosp Disaster Med.*** **2013;28(1):39-42.**

Introduction

The demand for out-of-hospital emergency medical services (EMS) has increased worldwide.[1,2] This is also the case in Japan, where the number of ambulances dispatched in many cities has continued to increase over several decades. In Tokyo, for example, the number of emergency transports of patients increased from 480,139 in 1998 to 583,082 in 2008, an increase of approximately 21%.[3]

For critical patients, the first link in the chain of survival is prehospital time, and attempts have been made to improve survival after cardiac arrest, in particular, by minimizing this time. It has been shown convincingly that the delay from estimated time of collapse until defibrillation is of ultimate importance among patients who are found in ventricular fibrillation.[4,5] Additionally, it has been shown that the outcome of acute myocardial infarction is related to the time between the onset of symptoms and the start of thrombolytic treatment.[6,7]

In Japan, stroke represents a leading cause of death and serious long-term disability, and imposes the greatest burden on health care resources. Timely access to acute medical treatment may be critical for patients with severe stroke. In cases of acute ischemic stroke, reducing the time to treatment with a tissue plasminogen activator, even within the three-hour time window, is crucial for improved outcome.[8] More recently, a new treatment for intracerebral hemorrhage, which must be administered within a limited period of time (four hours) after symptom onset, has emerged.[9] Thus, delays in the prehospital setting must be minimized in order that patients suffering a stroke can receive effective treatment as quickly as possible. Several studies have investigated social and demographic factors associated with prehospital delays among stroke patients.[10-12] However, little information is available about the impact of prehospital delays on the subsequent clinical conditions of stroke patients.

The impact of a short prehospital delay on the mortality rates of stroke patients may be less relevant than the impact of such delays on the mortality rates of those experiencing heart attacks. However, it is possible that prehospital delays lead to neurological deterioration. One of the most important indicators of neurological status is level of consciousness, which is strongly associated with outcome in stroke patients. Clinicians often decide whether treatment should proceed aggressively or be discontinued on the basis of the patient's level of consciousness. In particular, the withdrawal of care occurs most frequently in patients with Glasgow Coma Scale (GCS) scores of 3 or 4 (decerebrate status and no response, respectively), values that indicate irreversible brain damage. Thus, the GCS at admission may greatly influence a patient's prognosis.

The aim of this study was to examine the impact of prehospital delays on the level of consciousness exhibited by patients with severe stroke at admission who had been transported by Emergency Medical Services (EMS).

Methods

This retrospective study assessed patients diagnosed with cerebrovascular diseases and admitted to the Trauma and Critical Care Unit of a hospital in Tokyo, Japan from April 1998 through March 2008. The Trauma and Critical Care Unit, in which all patients with neurological symptoms are evaluated, serves tertiary emergency cases. The diagnosis of cerebrovascular diseases is based on computed tomography and/or magnetic resonance imaging performed on all patients. The study protocol was approved by the internal review board of Teikyo University School of Medicine.

Data on the time of the following prehospital events were obtained: (1) time of the call to the ambulance service; (2) time of the arrival of the ambulance at the patient's location (on-scene); and (3) time of the arrival of the ambulance at the hospital. Additionally, the following demographic and clinical data were obtained from medical records: sex; age; type of stroke; and GCS score at admission.

The medical records of all patients diagnosed with cerebrovascular diseases and admitted to the Trauma and Critical Care Unit of the hospital were reviewed. Cases with the following exclusions were not included in the study: (1) missing data for the time from call to the time of ambulance arrival on-scene, or from the time from ambulance arrival on-scene to arrival at the emergency center (hereafter referred to as the center); (2) missing data on the patient's GCS score at admission; and (3) >60 min elapsed time from call to arrival at the center.

Glasgow Coma Scale scores at admission were categorized as: 3 and 4; 5 through 8; 9 through 12; and 13 through 15. Data were collected on the distributions of GCS scores in 5-minute intervals from call to arrival at the center. A Cochran-Armitage trend test was used to determine whether the proportion of GCS scores of 3 and 4 increased as a function of the time from call to arrival at the center. A logistic regression model was constructed to predict GCS scores of 3 and 4 at admission. Two multivariate models were produced: Model 1 included sex, age, time from call to arrival on-scene, and time from arrival on-scene to arrival at the center; and Model 2 included sex, age, and time from call to arrival at the center (time from call to arrival on-scene plus time from arrival on-scene to arrival at the center). Values of $P < .05$ were deemed to indicate statistical significance. All analyses were performed using SAS v. 9.1 software (SAS Institute Inc., Cary North Carolina, USA).

Results

A total of 882 patients with symptoms of a stroke were admitted to the hospital Trauma and Critical Care Unit from April 1998 through March 2008. Of these, data from the charts of 170 patients met exclusion criteria, and were excluded from analysis, leaving a sample size of 712. The sample consisted of 51% males and 49% females of ages ranging from 10 to 95 years (mean 64, SD = 13 years with missing age data for one patient). Of the total sample, 375 patients (53%) were diagnosed with intracerebral hemorrhage, 280 (39%) with subarachnoid hemorrhage, 54 (8%) with cerebral infarction, and three with other diagnoses. The mean GCS score at admission was 6 (SD = 3), and nearly 80% (n = 551) of the patients were deeply comatose; 313 (44%) patients had GCS scores of 3 and 4; 238 patients (33%) had GCS scores of 5-8; 101 (14%) patients had GCS scores of 9-12; and 60 (8%) patients had GCS scores of 13-15.

The mean time from call to arrival on-scene was 7 (SD = 3) minutes (median 7; interquartile range 5-9); mean time from arrival on-scene to arrival at the center was 30 (SD = 8) minutes (median 29; interquartile range 25-35); and mean time from call to arrival at the center was 37 (SD = 8) minutes (median 36; interquartile range 32-42). Figure 1 presents the distribution of GCS scores at admission according to time from call to arrival at the center. Results of the Cochran-Armitage trend test indicated that the proportion of patients with GCS scores of 3 and 4 increased significantly as a function of time from call to arrival at the center ($P = .032$).

A logistic regression model for predicting GCS scores of 3 and 4 was produced. In Model 1, a longer call-to-on-scene time was significantly associated with poor GCS scores (OR = 1.056/min; 95%CI = 1.008-1.107) (Table 1). When the data on prehospital times were analyzed in terms of 5-minute intervals, odds ratios were greater in patients with shorter call-to-on-scene times, with the exception of patients with delays of $\leq$30 min.The effect of call-to-on-scene time was the greatest when the analyses were restricted to patients waiting for $\leq$35 min (OR = 1.176; 95% CI = 1.063-1.301). Similarly, in Model 2, a longer call-to-center time was significantly associated with poor GCS scores (OR = 1.020; 95% CI = 1.002-1.038). The effect of call-to-center time was the greatest in patients with waiting times of $\leq$35 min (OR = 1.076; 95% CI = 1.015–1.140).

https://doi.org/10.1017/S1049023X12001549 Published online by Cambridge University Press

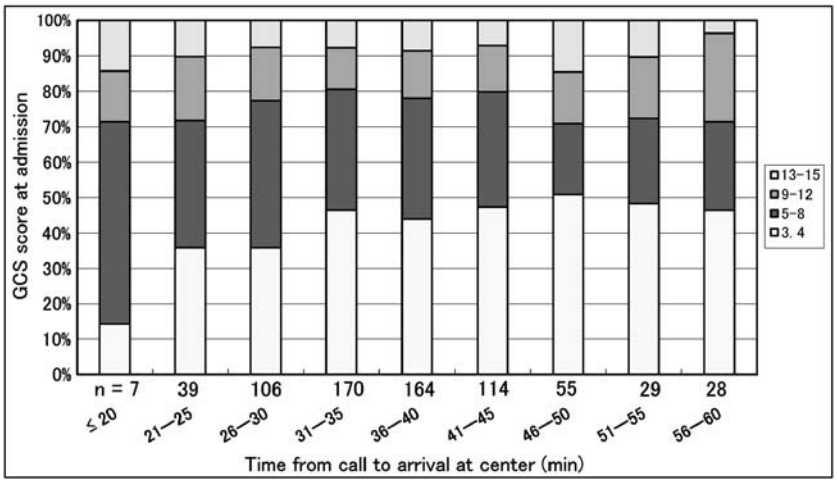

Figure 1. Distribution of the Glasgow Coma Scale (GCS) Scores at Admission by 5-minute Intervals from Call to Arrival at the Center. The proportion of patients with GCS scores 3 and 4 significantly increased over time ($P = .032$).

Minutes from call to arrival at center	Total (n)	GCS 3 and 4 (n)	Odds ratio (95% CI) per minute		
			Model 1[a]		Model 2[b]
			From call to arrival on scene	From scene to arrival at center	From call to arrival at center
All (≤ 60)	711	312	1.056 (1.008-1.107)	1.015 (0.996-1.034)	1.020 (1.002-1.038)
≤ 55	683	299	1.059 (1.009-1.112)	1.020 (0.998-1.042)	1.026 (1.005-1.047)
≤ 50	654	285	1.071 (1.018-1.128)	1.024 (0.999-1.049)	1.031 (1.007-1.055)
≤ 45	599	257	1.086 (1.023-1.152)	1.026 (0.997-1.055)	1.033 (1.005-1.062)
≤ 40	485	203	1.112 (1.034-1.196)	1.030 (0.992-1.069)	1.040 (1.003-1.078)
≤ 35	321	131	1.176 (1.063-1.301)	1.060 (0.999-1.125)	1.076 (1.015-1.140)
≤ 30	151	52	1.121 (0.927-1.357)	1.063 (0.945-1.195)	1.066 (0.947-1.200)

Table 1. Logistic Regression Analysis Predicting GCS Scores of 3 and 4 at Admission[c]

[a]Model 1 included sex, age, time from call to arrival on-scene, and time from arrival on-scene to arrival at the center.
[b]Model 2 included sex, age, and time from call to arrival at the center.
[c]One patient was excluded due to missing age data.
Abbreviations: CI, confidence interval; GCS, Glasgow Coma Scale.

Discussion

In this study, prehospital delays were significantly associated with poorer GCS scores at admission in patients with severe stroke. While the observed differences between GCS groups in prehospital delays were relatively small in terms of minutes, they were clinically significant. The influence of these time intervals on consciousness level is relevant and important, as it may underscore larger issues that affect the overall access to care among these patients.

On average, the time following a call for an ambulance to its on-scene arrival was very short, just seven minutes. The average time from ambulance call to arrival at the center for the acute stroke patients in the study was 37 minutes. These time intervals are similar to previously published prehospital waiting times for both myocardial infarction and stroke.[10,13,14]

However, in this study the time from the call for an ambulance to the ambulance's arrival on-scene significantly influenced the level of consciousness of patients, independent of the time from the ambulance's arrival on-scene to its arrival at the center. The findings from this study indicate that patients who experienced a shorter interval between the call for an ambulance and the arrival of the ambulance on-scene exhibited a more favorable risk profile than patients who experienced a longer time interval. It is not clear why a small difference in the time from the emergency call to the arrival on -scene precipitated poor GCS scores. Indeed, EMS in Japan is intended to provide

https://doi.org/10.1017/S1049023X12001549 Published online by Cambridge University Press

transportation rather than prehospital medical care, and only a few members of the ambulance teams are qualified as Emergency Life-Saving Technicians and are allowed to administer defibrillation and medication.[15] It is unclear how early arrival on the scene related to preventing neurological deterioration. Members of ambulance teams usually give supplemental oxygen to unconscious patients, which may have affected patients' levels of consciousness, although oxygen supplementation after admission did not appear to be of benefit to stroke patients studied in previous research.[16]

Patients in Japan are not responsible for the costs associated with prehospital care. Calling for an ambulance for minor conditions or when one's own transportation to the hospital is unavailable occurs frequently in Japan. Given that increased use of ambulances consumes capital and human resources, it is important to limit the use of ambulances for non-essential services to minimize delays within the EMS system.

This study has some limitations that must be considered when interpreting the results. Importantly, the results may not be directly applicable to other emergency service groups, particularly those providing non-urban emergency services. This study did not investigate the direct association between prehospital delays and deterioration in consciousness. Information on the level of consciousness at onset, at ambulance call, or on-scene was not available. Thus, it is unclear whether prehospital delays led directly to neurological deterioration. However, it is unlikely that it took longer to transport patients with poor GCS scores than to transport those with better GCS scores, given that ambulance members would likely take note of patients with poor GCS scores and try to transport them as rapidly as possible. The data did not reveal any association between prehospital delays and patients' outcomes, measured in terms of survival or neurological functioning at discharge (data not shown). However, admission GCS scores of 3 or 4 compared with GCS scores of ≥5 were significantly associated with mortality at discharge (74% vs 25%; chi-square test = $P < .001$; missing data = 27).

Conclusions

This study showed that prehospital delays were significantly associated with poor levels of consciousness at admission among patients suffering from severe stroke. As level of consciousness is strongly associated with outcome in stroke patients, reducing prehospital time may be essential to improving outcomes in patients with severe stroke.

References

1. Wrigley H, George S, Smith H, Snooks H, Glasper A, Thomas E. Trends in demand for emergency ambulance services in Wiltshire over nine years: observational study. *BMJ*. 2002;324(7338):646-647.
2. Lambe S, Washington DL, Fink A, et al. Trends in the use and capacity of California's emergency departments, 1990-1999. *Ann Emerg Med*. 2002;39(4):389-396.
3. Tokyo Fire Department Web site. www.tfd.metro.tokyo.jp/ts/sa/p15.html. Accessed February 16, 2011.
4. Herlitz J, Ekström L, Wennerblom B, Axelsson A, Bång A, Holmberg S. Survival in patients found to have ventricular fibrillation after cardiac arrest witnessed outside hospital. *Eur Heart J*. 1994;15(12):1628-1633.
5. Holmberg M, Holmberg S, Herlitz J. Incidence, duration and survival of ventricular fibrillation in out-of-hospital cardiac arrest patients in Sweden. *Resuscitation*. 2000;44(1):7-17.
6. White HD, Norris RM, Brown MA, et al. Effect of intravenous streptokinase on left ventricular function and early survival after acute myocardial infarction. *N Engl J Med*. 1987;317(14):850-855.
7. Fibrinolytic Therapy Trialists' (FTT) Collaborative Group. Indications for fibrinolytic therapy in suspected acute myocardial infarction: collaborative overview of early mortality and major morbidity results from all randomised trials of more than 1000 patients. *Lancet*. 1994;343(8893):311-322.
8. Marler JR, Tilley BC, Lu M, et al. Early stroke treatment associated with better outcome: The NINDS rt-PA stroke study. *Neurology*. 2000;55(11):1649-1655.
9. Mayer SA, Brun NC, Begtrup K, et al. Recombinant activated factor VII for acute intracerebral hemorrhage. *N Engl J Med*. 2005;352(8):777-785.
10. Kleindorfer DO, Lindsell CJ, Broderick JP, et al. Community socioeconomic status and prehospital times in acute stroke and transient ischemic attack: do poorer patients have longer delays from 911 call to the emergency department? *Stroke*. 2006; 37(6):1508-1513.
11. 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(1):63-69.
12. Chang KC, Tseng MC, Tan TY. Prehospital delay after acute stroke in Kaohsiung, Taiwan. *Stroke*. 2004;35(3):700-704.
13. Hutchings CB, Mann NC, Daya M, et al. Patients with chest pain calling 9-1-1 or self-transporting to reach definitive care: which mode is quicker? *Am Heart J*. 2004;147(1):35-41.
14. Evenson KR, Schroeder EB, Legare TB, Brice JH, Rosamond WD, Morris DL. A comparison of emergency medical services times for stroke and myocardial infarction. *Prehosp Emerg Care*. 2001;5(4):335-339.
15. Japan Ministry of Internal Affairs and Communications, Fire and Disaster Management Agency Web site. www.fdma.go.jp/en/pam09.html#chapter4_1. Accessed February 16, 2011.
16. Rønning OM, Guldvog B. Should stroke victims routinely receive supplemental oxygen? A quasi-randomized controlled trial. *Stroke*. 1999;30(10):2033-2037.