ORIGINAL RESEARCH

Fire Engine Support and On-scene Time in Prehospital Stroke Care – A Prospective Observational Study

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Abbreviations:
EMS: Emergency Medical Services
GCS: Glasgow Coma Score
OST: on-scene time

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Abstract

Introduction: On-scene time (OST) previously has been shown to be a significant component of Emergency Medical Services' (EMS') operational delay in acute stroke. Since stroke patients are managed routinely by two-person ambulance crews, increasing the number of personnel available on the scene is a possible method to improve their performance.

Hypothesis: Using fire engine crews to support ambulances on the scene in acute stroke is hypothesized to be associated with a shorter OST.

Methods: All patients transported to hospital as thrombolysis candidates during a one-year study period were registered by the ambulance crews using a case report form that included patient characteristics and operational EMS data.

Results: Seventy-seven patients (41 [53%] male; mean age of 68.9 years [SD = 15]; mean Glasgow Coma Score [GCS] of 15 points [IQR = 14-15]) were eligible for the study. Forty-five cases were managed by ambulance and fire engine crews together and 32 by the ambulance crews alone. The median ambulance response time was seven minutes (IQR = 5-10) and the fire engine response time was six minutes (IQR = 5-8). The number of EMS personnel on the scene was six (IQR = 5-7) and two (IQR = 2-2), and the OST was 21 minutes (IQR = 18-26) and 24 minutes (IQR = 20-32; P = .073) for the groups, respectively. In a following regression analysis, using stroke as the dispatch code was the only variable associated with short (<22 minutes) OST with an odds ratio of 3.952 (95% CI, 1.279-12.207).

Conclusion: Dispatching fire engine crews to support ambulances in acute stroke care was not associated with a shorter on-scene stay when compared to standard management by two-person ambulance crews alone. Using stroke as the dispatch code was the only variable that was associated independently with a short OST.

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Introduction

Acute stroke is a neurological emergency and a major cause of death and disability worldwide.[1] Despite continuing efforts, the patients' late hospital admission remains as the most important bottle-neck to recanalization therapies, and only a few percent of all stroke patients can be treated within the appropriate time window.[2,3] Recent studies have emphasized that even modest improvements achieved in the onset-to-treatment time can be translated to a significant patient benefit.[2,4]

Using the Emergency Medical Services (EMS) previously has been associated with both early arrival and increased likelihood of thrombolysis.[2,5] However, while the in-hospital, door-to-treatment time has decreased dramatically, the prehospital, onset-to-door time has remained practically unchanged.[6] In a sequential analysis, the on-scene time (OST) was found to be the longest prehospital time interval forming over one-third of the prehospital operational delay.[7] This is significantly longer than the 15 minutes or less that the most recent guidelines by the American Stroke Association (Dallas, Texas USA) recommend.[8]

In many EMS systems, patients are managed routinely by two-person ambulance crews, and challenging circumstances on-scene easily can lead to increased delay. However, additional EMS or fire-rescue units have been used successfully to support ambulance

crews in selected, work-intensive, emergency scenarios (ie, out-of-hospital cardiac arrest) to improve the quality of prehospital care and minimize the delay.[9] It was hypothesized that increasing the number of EMS personnel on the scene could be a possible method of enhancing prehospital stroke care as well. This study aimed to find out whether the dispatch of fire engine crews to support ambulances in acute stroke care was associated with a shorter OST than the dispatch of ambulances alone.

Methods

This was a prospective cohort study based on prehospital EMS data. The study plan was approved by Tampere Department of Social Services and Health Care (City of Tampere, Finland) and Tampere Area Rescue Department (Tampere, Finland). The study was conducted in accordance with the principles of the Declaration of Helsinki and laws governing research conducted in Finland. Personal identifying information was omitted from the study registry.

Tampere is the second largest city in Finland with 220,000 inhabitants. The Tampere Area Rescue Department is responsible for fire, rescue, and EMS within the city and the surrounding suburban area. It has a fleet of 14 ambulances and six multi-purpose fire engines, in addition to other fire-rescue vehicles. The dispatchers in the regional emergency medical communication center use the Face Arm Speech Time (FAST)-recognition tool, with other information acquired during the emergency call, to identify a patient with acute stroke.[10] The nearest ambulance and fire engine are then dispatched using the stroke code and a high priority (lights and sirens). The current protocol has been in use since the year 2004.

On the scene, the ambulance personnel are responsible for the prehospital care of the patient, but the fire engine crew assists them in selected tasks such as patient examination, interview, reporting, and carrying/loading the patient into the ambulance. If the patient's stroke symptoms are not identified by the dispatcher (other dispatch codes are used), a fire engine is not dispatched to the scene and the ambulance crew manages the situation independently. The hospital neurologist is consulted/pre-notified via telephone by the ambulance crews in all suspected stroke cases within the 4.5-hour treatment window of intravenous thrombolysis. If the patient is deemed to be a thrombolysis candidate, a prompt high priority transport to the emergency department quickly follows. The rest of the stroke cases (ie, patients with a transient ischemic attack) are transported using normal priority without consulting the neurologist.

The study period was one year from October 1, 2010 through September 30, 2011, during which the ambulance personnel completed a case report form of each thrombolysis candidate. Patients' age, sex, body weight, Glasgow Coma Score (GCS), symptom onset time, floor number of the location, operational EMS information including dispatch and transport codes, time-stamps, and the total number of personnel on the scene were registered. The patient's body weight was estimated if not available during patient interview. The time stamps were based on real-time, radio-guided clocks of the dispatch system and ambulance computers. The OST and other prehospital time intervals were calculated based on the acquired time stamps. In case of missing or incomplete data, a study emergency medical technician retrieved the EMS patient report in question and contacted the ambulance crew to complete the missing information, whenever possible.

	N	n (SD/IQR)[a]
Age, years	77	69 (SD = 15)
Men, %	77	53.2
Body weight, kilograms	75	80 (SD = 15)
Glasgow Coma Score	77	15 (IQR = 14-15)
Building floor on the scene	77	0 (IQR = 0-2)
Fire engine crew on the scene, %	77	58.4
Number of personnel on the scene	77	5 (IQR = 2-6)
High priority dispatch, %	77	80.5
Dispatch code stroke, %	77	67.5
Symptom-to-alarm time, min	77	22 (IQR = 7-59)
Ambulance response time, min	77	7 (IQR = 5-10)
Fire engine response time, min	45	6 (IQR = 5-8)
On-scene time, min	77	22 (IQR = 19-29)
Transport time, min	77	8 (IQR = 6-12)
Alarm-to-door time, min	77	40 (IQR = 33-49)
Onset-to-door time, min	77	69 (IQR = 48-102)
Neurologist consulted, %	77	98.7

Table 1. Characteristics of Study Sample

[a] If not otherwise stated, the data are presented as median (interquartile range) or mean (standard deviation).

Calls related to hospital transfers were excluded from the study since they differed significantly from the usual EMS protocol. The patients were divided into groups for univariate analysis based on the use of fire engine support and (short vs long) OST duration. The median OST was used as a cut-off value. Mann-Whitney U, Pearson chi-square, and student-t-test were used for comparison of groups, where appropriate. A binary, backwards logistic, regression analysis was then conducted with selected variables ($P < .3$) to identify the factors independently associated with a short OST. Two-tailed significance was set up to $P < .05$. Statistical analysis was performed using the SPSS software version 21 (IBM Corporation; Armonk, New York USA).

Results

A total of 79 thrombolysis candidates were identified. Two patients transferred from other health care institutions and were excluded from the study. The patient characteristics and the prehospital time intervals of the sample are described in Table 1. The ambulance dispatch was made more frequently using stroke code and a high priority in the patient group managed by ambulance and fire engine crews together, as expected (Table 2). The patients in this group also were heavier than those managed by ambulances alone but did not differ in terms of GCS or building floor height. Despite that the fire engine support more than doubled the number of EMS personnel on the scene, no change in the OST or other prehospital time intervals was seen (Table 2).

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	With Fire Engine Support (n = 45)[a]	Ambulance Only (n = 32)[a]	P[b]
Age, years	69 (SD = 15)	68 (SD = 15)	.687
Men, %	62.2	40.6	.069
Body weight, kilograms	84 (SD = 16)	76 (SD = 13)	.017
Glasgow Coma Score	15 (IQR = 14-15)	15 (IQR = 13-15)	.671
Building floor on the scene	1 (IQR = 0-3)	0 (IQR = 0-1)	.006
Number of personnel on the scene	6 (IQR = 5-7)	2 (IQR = 2-2)	<.0001
High priority dispatch, %	100.0	53.1	<.0001
Dispatch code stroke, %	91.1	34.3	<.0001
Symptom-to-alarm time, min	25 (IQR = 7-67)	19 (IQR = 6-41)	.368
Ambulance response time, min	7 (IQR = 5-10)	8 (IQR = 5-11)	.340
On-scene time, min	21 (IQR = 18-26)	24 (IQR = 20-32)	.073
Transport time, min	8 (IQR = 6-12)	9 (IQR = 6-13)	.457
Alarm-to-door time, min	38 (IQR = 33-46)	41 (IQR = 35-53)	.109
Onset-to-door time, min	68 (IQR = 48-106)	69 (IQR = 48-97)	.713

Table 2. Comparison[c] of Patients Managed by Ambulances with and without Fire Engine Support
[a] If not otherwise stated, the data are presented as median (interquartile range) or mean (standard deviation).
[b] P values below.05 were considered significant.
[c] Student-t-test, chi-square, and Mann-Whitney U were used to compare groups, as appropriate.

	Short OST (n = 33)[a]	Long OST (n = 44)[a]	P[b]
Age, years	69 (SD = 16)	69 (SD = 13)	.858
Men, %	54.5	52.2	1.000
Weight, kilograms	78 (SD = 15)	82 (SD = 15)	.273
Fire engine on the scene, %	69.6	50.0	.104
Personnel	5 (IQR = 3-6)	4 (IQR = 2-6)	.564
Building floor	0 (IQR = 0-2)	0 (IQR = 0-0)	.901
Dispatch code stroke, %	81.8	56.8	.027
Dispatch using high priority, %	90.9	72.7	.079
Symptom-to-alarm time, min	17 (IQR = 7-81)	23 (IQR = 8-56)	.943
Ambulance response time, min	7 (IQR = 4-10)	7 (IQR = 5-10)	.653

Table 3. Comparison[c] of Patients with Short (<22 minutes) and Long (≥22 minutes) On-scene Times
Abbreviation: OST, on-scene time.
[a] If not otherwise stated, the data are presented as median (interquartile range) or mean (standard deviation).
[b] P values below.05 were considered significant. Variables with P < .3 were entered to a separate backwards logistic regression analysis.
[c] Student-t-test, chi-square, and Mann-Whitney U were used to compare groups as appropriate.

An additional analysis was conducted to compare patients with short and long OST (Table 3). In a following regression analysis, only the use of stroke code in ambulance dispatch was associated independently with a short (<22 minutes) on-scene stay (odds ratio 3.952 [95% CI, 1.279-12.207]).

Discussion

This was the first study to report the use of fire engine crews to support ambulances in prehospital stroke care. The fire engines responded promptly and more than doubled the number of personnel on the scene, but the measured OST did not differ when compared

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to standard prehospital management by two-person ambulance crews. However, using the fire engines as a part of the stroke protocol increased the units' workload and utility costs, and thus hindered them from responding to simultaneous fire-rescue calls in their area.

It is important to note that the patients' high GCS, average body weight, and easily accessible location near the street level all favored a short on-scene stay, but the overall median OST measured in this study was still well over 20 minutes. The ambulance dispatch using the stroke code was the only variable associated with a short (<22 minutes) on-scene stay. The result is similar to an earlier report from another Finnish setting,[7] but it clearly is inferior to recent international studies. Patel and colleagues reported a median OST of 15 minutes in the United States and concluded that setting a specific time limit for the on-scene stay was associated with a shorter OST when compared to using only "general instructions."[11] In another US study, Oostema and colleagues stated that nearly 50% of the confirmed stroke patients in their EMS system already had an OST of 15 minutes and thus fulfilled the current guidelines criteria.[12] Danish investigators reached a fairly short on-scene stay of 18 minutes in Copenhagen but argued that a further decrease in the OST could still be achieved by conducting some of the common emergency procedures (ie, intravenous cannula placement) and the neurologist consultation during ambulance transport.[13]

The OST is dependent on several factors, such as the attitude of the EMS personnel, "sense of urgency" regarding the severity of patient's symptoms, and awareness of elapsed overall time. Therefore, decreasing the duration of the on-scene stay requires a multi-factorial approach. The identification of stroke symptoms during the emergency phone call and dispatching the ambulance using the stroke code are the first steps since this gives the paramedics the possibility to prepare themselves to act according to the stroke protocol. A "time limit" for the OST could be a logical extension to this mindset.[11] Stroke patients could be paralleled with other patient groups (ie, penetrating trauma) already managed using a true "load-and-go" prehospital care strategy in most EMS systems. However, some discretion and knowledge of local circumstances are required. If the time limit is set too tight, it may lead to a decrease in the quality of prehospital patient examination and reporting, and eventually increase the door-to-needle time. Unfortunately, none of the earlier reports with OSTs of less than 20 minutes have included a description of the respective in-hospital delays or the total onset-to-treatment times to address this potential problem properly.

The possible benefit gained from the use of additional manpower on the scene remains questionable after this study. However, it might become more evident in metropolitan settings where people reside in tall apartment buildings and the ambulances cannot drive near the patient's location.[14] Another important aspect is the increasing patient obesity seen in prehospital care that has already caused problems in some countries.[15] Conducting emergency procedures during ambulance transport is a difficult subject since it can become dangerous for both the ambulance crew and their patients (ie, lack of safety belts and accidental pinpricks). In general, this practice should be avoided. Finally, careful scrutiny should be focused on patient cases with a very long on-scene stay (>25 minutes) to help to identify possible bottle-necks in the current prehospital protocol. Hospital-based feedback to the EMS staff has also been shown to be an effective method to adhere the personnel to act according to the guidelines.[16]

Limitations

This study had some limitations. The sample was based on a single EMS system and consisted only of thrombolysis candidates. The calls managed by ambulance crews without fire engine support were less often dispatched using a high priority or the stroke code which could have resulted in longer prehospital time intervals. The severity of stroke symptoms was not measured, partly due to the fact that dedicated symptom severity scales, such as the National Institutes of Health (Bethesda, Maryland USA) Stroke Scale, have not been implemented to the prehospital setting. Finally, the study was based on patients with suspected stroke whose hospital diagnosis, in-hospital delay, and treatment data were not available to the investigators.

Conclusion

Dispatching fire engine crews to support ambulances in acute stroke care did not change the prehospital time intervals when compared to the standard management by two-person ambulance crews. However, using the stroke code for ambulance dispatch was associated independently with a short OST.

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