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Characteristics and Outcomes of Trauma Patients via Emergency Medical Services

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Purpose: The aim of this study was to identify clinical outcome and characteristics of trauma patients via emergency medical services (EMS).
Methods: Medical records of the trauma patients visiting the emergency department were retrospectively collected and analyzed from January 2015 to June 2016 in the single institution. Of 529 registered patients, 371 patients were transported by - were enrolled. The parameters including age, gender, injury mechanism, Glasgow coma scale on arrival, presence of shock (systemic blood pressure <90 mmHg) on arrival, time to arrival from accident to emergency room (ER), need for emergency procedures such as operation or angioembolization, need for intensive care unit (ICU) admission, injury severity score (ISS), the trauma and injury severity score, revised trauma score (RTS), length of stay, and mortality rate were collected. The SAS version 9.4 (SAS Institute, Cary, NC, USA) was used for the data analysis.
Results: Arrival time from the field to the ER was significantly shorter in EMS group. However, overall outcomes including mortalities, length of stay in the ICU and hospital were same between both groups. Age, ISS, RTS, and injury mechanisms were significantly different in both groups. ISS, RTS, and age showed significant influence on mortality statistically (p<0.05).
Conclusions: The time to arrival of EMS was fast but had no effect on length of hospital stay, mortality rate. Further research that incorporates pre-hospital factors influence clinical outcomes should be conducted to evaluate the effectiveness of such a system in trauma care of Korea.

Keywords: Trauma; Emergency medical services

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INTRODUCTION

According to the Cause of Death category of the National Statistical Office in 2011, among the 257,396 people, the number of deaths due to non-illness (accident) 32,445 people accounted for 12.6% of the total deaths [1]. In particular, trauma patients have a high socioeconomic loss due to high mortality rates at the age of production. The socioeconomic cost of trauma was estimated at about 13.7 trillion KRW in 2003, and the ratio of loss of productivity due to damage deaths in total socioeconomic cost was 60.2-62.4%, respectively [2]. One study reported in 2006 found that the cost of production loss per trauma death was about 350 million KRW. However, the preventable mortality rate in Korea trauma patients was 50.4% in 1998, 39.6% in 2004, and 32.6% in 2007, respectively [3], to improve this, the Korea government started a serious trauma specialization center project from 2012 to support the installation of the regional trauma center [4]. In Korea, emergency medical services (EMS) may be crucial role in fire department- or hospital-based ground transportation of trauma patients in both rural and urban areas, with few exceptions (accidents or disasters occurring on a mountain or on the sea) [5]. Although there are some private ambulance companies in Korea, they mostly assist with non-emergencies, transfers of stable patients between hospitals, or the transportation of the dead. Since its broad inception, there has been many published data on the characteristics of trauma patients via EMS and effectiveness of the Korean urban EMS system. In Korea, there are not many studies on the characteristics of the patients before the hospital, the factors affecting mortality and treatment outcome. This study aim to access the difference in outcomes of patients included by urban EMS versus those transported by non-EMS (transferred from other hospital, privately) to the single institution between January 2015 and June 2016.

METHODS

This is a retrospective study of trauma patients transported by EMS between January 2015 and June 2016. Since the introduction of the Trauma critical pathway (CP) alerting system in 2011 (Table 1), we have been working with the emergency department to investigate the mechanism of the accident and the condition of the accident. If it is appropriate, we send a letter to the trauma team immediately. Data were collected from the trauma CP database.

The statistical analysis was performed using the SAS version 9.4 (SAS Institute, Cary, NC, USA) program. Mann-Whitney test was used to check statistical significance for continuous variables. Chi-square test and Student *t*-test were used for categorical variables. If *p*-value is 0.05, data was considered significant.

Continuous variables were represented as mean (±standard deviation) or median (interquartile range). The retrieved data included demographic characteristics and other variables, which were controlled for in the final

Table 1. Critical pathway activation criteria

Injury mechanism	Clinical suspicion
Any motor vehicle at high speed (>60 kph)	Systolic blood pressure
Ejection or rollover or death of vehicle occupants	Respiratory rates<10
Pedestrian struck by moving vehicle	GCS<14
Bicycle accident >20 kph impact	Flail chest, penetrating torso injury
Definite hemo/pneumothorax	
Fall down injury >3 m	Open skull fracture, limb paralysis (spinal cord injury)
Motorcycle accident with separation from vehicle	Pelvic bone fracture, amputation wrist/ankle
	Upper elbow & knee penetrating injury
Crushing injury in head, neck, chest, abdomen, and pelvis	Penetrating head & neck injury

GCS: Glasgow coma scale.

analysis as potential confounders. The differences between the variables were examined using a univariate analysis.

The linear multivariate regression analysis was performed to compare with EMS and non-EMS patients in hospital mortality, length of hospital stay and need for emergency operation or angioembolization. A logistic regression model was applied to find the factors affecting mortality in the EMS group. The analysis controlled for several co-variants that have a potential confounding events. These included age, gender, Glasgow coma scale (GCS) at emergency room (ER) admission, shock status at ER admission, emergency operation, emergency angioembolization, injury severity score (ISS), revised trauma score (RTS), trauma and injury severity score (TRISS), time to arrival from accident to ER, and intensive care unit (ICU) admission. The SAS version 9.4 (SAS Institute) was used for the data analysis. This study was approved by Institutional review board committee.

RESULTS

Comparison of characteristics (EMS vs. non-EMS)

From January 2015 to June 2016, CP was expressed in the emergency department in 529 trauma, all included in this study. Of the total, 70% (371) were transported by EMS and the rest by other non-EMS root transport.

Table 2 shows the demographics, injury mechanism, and outcomes of EMS vs. non-EMS patients. The mean age of EMS group is 44.2 (±19.7) years. In contrast, the mean age of the non-EMS group was 50.2 (±18.1) years and there was a significant difference between the two groups. There was no significant difference in sex ratio, need for emergency operation or angioembolization. ISS and RTS were higher in the non-EMS group and TRISS was not significantly different between the two groups. There was a significant difference between the two groups about injury mechanism, pedestrian traffic accident, motorcycle, bicycle, fall, suicidal falls and stab injuries were more common in the EMS group. The rate of admission to ICU was higher in the non-EMS group and there was no significant difference between the two groups in the presence of GCS and shock at the ER visit. The number of hospitalized patients for seven days or more was significantly higher than that of the non-EMS group.

Overall clinical outcomes

There was no significant difference in the mortality rate, length of hospital stay, and need for emergency operation or angioembolization between the two groups (Table 3). There was no significant difference in mortality between the two groups and the mortality rate of the EMS group was 6.4% (17/371). A logistic regression model was used to examine the factors affecting mortality in the EMS group (Table 4). The time taken to arrive at the ER was not significant for death. In univariate analysis, age, GCS, need for angioembolization, ER admission, ISS, RTS, and TRISS were analyzed as significant factors for death in the EMS group. Among these factors, age, ISS, and RTS were significant factors for death in multivariate analysis.

DISCUSSION

Because trauma causes enormous national, social, economic, and health consequences, proper treatment of trauma patients is critical to minimize trauma. In order to do this, introduction of the trauma system is essential, and Korea has also started to build a trauma system including the establishment of a regional trauma center [3,6]. The system should be improved at the pre-hospital stage and the transfer stage as well as a process to efficiently operate the trauma system and make continuous efforts to supplement it.

In Korea, it was taken latter of the concept of on-the-spot transfer of the concept of 'scoop and run' which transfers the severely impaired patients to the medical institution after relatively simple primary treatment and stabilization in the field [7]. In order to improve the survival rate of these two models, it is said that appropriate selection is required according to the severity of the injury, the general condition of the patient, the travel time to the transfer hospital, and the expertise of the transfer hospital.

Our aim of this study was to compare of injured patients transported by EMS with patients transported by other means. We therefore aimed to develop a baseline database to analyze the characteristics of pre-hospital

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Table 2. Characteristics of trauma patients (EMS vs. non-EMS)

	Total (n=529)	EMS (n=371)	Non-EMS (n=158)	*p*-value
Sex				0.8996
Male	377 (71.2)	265 (71.4)	112 (70.9)	
Female	152 (28.7)	106 (28.6)	46 (29.1)	
Age	45.9±19.4	44.2±19.7	50.2±18.1	0.001
Emergency operation or angioembolization				0.191
No	397 (75.1)	310 (83.6)	123 (77.9)	
Yes	132 (24.9)	61 (16.4)	35 (22.1)	
ISS	14.7±12.0	13.5±12.2	17.4±11.2	0.001
RTS	7.16±1.7	7.0±1.9	7.4±1.0	0.003
TRISS	0.9±0.2	0.9±0.2	0.9±0.2	0.117
Injury mechanism				<0.0001
TA (pedestrian)	123 (23.2)	93 (25.1)	30 (19.0)	
TA (motorcycle)	111 (20.9)	88 (23.7)	23 (14.6)	
TA (driver)	71 (13.4)	34 (9.2)	37 (23.4)	
TA (passenger)	26 (4.9)	13 (3.5)	12 (7.6)	
TA (bicycle)	25 (4.7)	20 (5.4)	5 (3.2)	
Falling	99 (18.7)	71 (19.1)	28 (17.7)	
Falling (suicidal)	13 (2.4)	11 (3.0)	2 (1.3)	
Crushing	6 (1)	3 (0.8)	3 (1.9)	
Stab	25 (4.7)	21 (5.7)	4 (2.5)	
Others	31 (5.8)	17 (4.6)	14 (8.9)	
Hospitalization				<0.0001
GW	116 (21.9)	77 (20.8)	39 (24.7)	
ICU	253 (47.8)	148 (39.9)	105 (66.5)	
ER admission	14 (2.6)	12 (3.2)	2 (1.3)	
Discharge from ER	146 (27.5)	134 (36.1)	12 (7.6)	
GCS	13.4±3.0	13.4±3.4	13.5±2.3	0.799
Time to arrive to ER		19.6(±7.6)		

Values are presented as mean±standard deviation or number (%).

EMS: emergency medical services, ISS: injury severity score, RTS: revised trauma score, TRISS: trauma and injury severity score, TA: traffic accident, GW: general ward, ICU: intensive care unit, ER: emergency room, GCS: Glasgow coma scale.

patients and the correction factors needed to prevent preventable mortality. This study did not show any difference outcome between EMS groups and non-EMS group.

Our findings are not consistent with other previous studies. Previous studies have reported that patients with EMS have higher injury severity, worse outcomes, and higher mortality [8-10] and come to hospital later than patients who arrive by other means of delivery [11]. However, our study did not show a significant difference in clinical outcome between both groups.

The characteristics of the EMS patients group show different results depending on the environment (rural, or not) and the national healthcare system. Interestingly, the time to arrive at the hospital in an accident does not affect the clinical outcome. It may be because the arrival time in the urban system is very short, around 18 minutes. Rahman et al. [12] presented EMS systems in seven Asian countries including Seoul were compared. Seoul showed a

Table 3. Comparison of clinical outcomes EMS and non-EMS group

	EMS (n=371)	Non-EMS (n=158)	Relative ratio (CI)	*p*-value
Mortality	17 (6.4)	6 (5.0)	1.014 (0.963-1.068)	0.612
Length of stay (days)				
≥7	162	129	0.275 (0.191-0.396)	<0.0001
<7	209	29		
Emergency operation	51 (19.1)	26 (21.8)	0.966 (0.864-1.080)	0.533
Emergency angioembolization	16 (6.0)	11 (9.2)	0.965 (0.905-1.030)	0.247

Values are presented as number (%) unless otherwise indicated.
EMS: emergency medical services, CI: confidence interval.

Table 4. Factors related to mortality by univariate and multivariate analysis

Variable	Univariable		Multivariable	
	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Age	0.964 (0.942-0.987)	0.0019	1.042 (1.012-1.074)	0.0063
Sex				
Male	r			
Female	0.591 (0.248-1.410)	0.2360		
GCS	1.324 (1.202-1.460)	<0.0001	0.943 (0.825-1.078)	0.3913
SBP <90 mmHg	0.328 (0.132-0.810)	0.0157	0.729 (0.200-2.653)	0.6313
Emergency operation	0.440 (0.179-1.079)	0.0729		
Emergency angioembolization	0.232 (0.079-0.684)	0.0081	2.45 (0.609-9.863)	0.2071
Hospitalization				
GW	15.525 (0.905-266.322)	0.0586	2.173 (0.122-38.650)	0.5972
ER admission	49.124 (2.076-999.99)	0.0158	6.835 (0.141-331.264)	0.3317
Discharge from ER	9.619 (0.515-179.633)	0.1296	2.882 (0.136-61.048)	0.4968
ISS	0.9 (0.868-0.932)	<0.0001	1.058 (1.014-1.105)	0.0101
RTS	2.359 (1.810-3.056)	<0.0001	0.575 (0.432-0.766)	0.0002
TRISS	0.003 (0.001-0.016)	<0.0001		
Time to arrive to ER >19.6 minutes	0.215 (0.046-1.003)	0.0510		

OR: odds ratio, CI: confidence interval, GCS: Glasgow coma scale, SBP: systemic blood pressure, GW: general ward, ER: emergency room, ISS: injury severity score, RTS: revised trauma score, TRISS: trauma and injury severity score.

higher rate of cardiac arrest than those in Tokyo and Osaka. Seoul has an EMS system that matches scoop and run similar to Japan and Taiwan [13,14].

Trauma and cardiac arrest are known preventable [9,15] interestingly, the TRISS score was not a significant factor affecting mortality in the EMS group. This may be a question of whether the predictable mortality rate created in other countries is indeed applicable to Seoul with a city-based EMS system.

In countries where the trauma system is well organized, field triage is performed by EMS in the pre-hospital stage, and the patient is transferred to the trauma center. In Korea, however, this field triage is not utilized well and the patient is transferred to a nearby hospital by a scoop and run system. In addition, there is selection and composition bias in the present study because patients who cannot

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be transferred faced with mortality. Also, it can be possible that critically ill patients were included to non-EMS group who had been transferred from other hospitals.

Major limitations of our study are small number and retrospective nature. Patients transferred by EMS have not known prior information such as ISS, and there is a possibility that the trauma team alert system has overestimated relative to the patients transferred from other hospitals. The patients via EMS showed relatively lower ISS, ICU admission and ED discharge rate. Although we have not identified an obvious risk factor that affects the clinical outcome of the EMS group in this study, this study can be used to identify the basic demographics of the EMS group and to determine whether the scoop and run models in the specific urban environment of Seoul.

CONCLUSION

The time to arrival of EMS was fast but had no effect on length of hospital stay, mortality rate. ISS, RTS, and age showed significant influence on mortality statistically. Further research that incorporates pre-hospital factors influence clinical outcomes should be conducted to evaluate the effectiveness of such a system in trauma care of Korea.

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