

ORIGINAL RESEARCH

Characteristics and Outcomes of Patient Transport to the Hospital by Emergency Medical Services (EMS); a Cross-sectional Study

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Abstract: **Introduction:** To enhance the efficiency, it is essential to understand the patterns of service users and develop policies that facilitate effective personnel and resource management. This study aimed to compare the characteristic and outcomes of patients who were transferred to emergency department (ED) by emergency medical services (EMS) and patients transported by other means. **Methods:** This retrospective cross-sectional study was conducted at Srinagarind Hospital, Thailand, over a 5-year period from 2017-2021. The baseline characteristics, treatment modalities, and outcomes of patients who were transported to ED using EMS and Non-EMS were gathered and compared using STATA software. **Results:** The study included 15,501 patients with the median age of 51 (interquartile range (IQR): 23-71) years who were referred by EMS over the five-year period (51.72% male). EMS patients had significantly higher median age (51 (23 - 71) vs. 37 (21 - 60); $p < 0.001$) with male preference ($p < 0.001$). In the EMS group, the triage level 1 (need for resuscitation) was higher than the non-EMS group ($p < 0.001$), most of the patients referred following trauma ($p < 0.001$), and the frequency of cardiac arrest was considerably higher than non-EMS group (2.54% vs 0.05%; $p < 0.001$). Patients in the EMS group received a higher number of blood tests ($p < 0.001$), plain radiographic exams ($p < 0.001$), computerized tomography (CT) scans ($p < 0.001$), and complex procedures ($p < 0.001$) than the non-EMS group. The EMS group had a greater number of hospital admissions ($p < 0.001$) and intensive care unit (ICU) admissions ($p < 0.001$) compared to the non-EMS group. The EMS group exhibited a significantly higher mortality rate compared to the non-EMS group ($p < 0.001$). **Conclusion:** The population utilizing EMS services had higher median age, higher frequency of emergency cases and trauma related complaint, higher need for treatment interventions and imaging procedures, higher rate of hospital and ICU admissions, as well as higher rate of mortality compared to the non-EMS group.

Keywords: Ambulances; Emergency service, hospital; Emergency medical services; Health policy; Mortality

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1. Introduction

The primary goal of public health policy for emergency care is to provide convenient and efficient access to needed services (1, 2). It poses a significant challenge to those organizing healthcare systems, particularly in developing countries where the number of emergency patients has increased dramatically, affecting both Emergency Departments (ED) and

Emergency Medical Services (EMS) (3-5). Managing limited resources, including personnel and medical equipment, is of paramount importance for promoting sustainable development and ensuring the provision of high-quality emergency services for patients.

Thailand's EMS system was officially established approximately 15 years ago, in 2008. The National Institute of Emergency Medicine (NIEM) plays a vital role as the primary agency responsible for regulating and establishing standards for medical response operations within the country. Nowadays, the EMS is actively in the process of developing services in accordance with international quality and standards. The medical operation units are divided into three levels: ba-

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sic, advanced, and specialized. The teams are composed of a wide range of EMS personnel including emergency physicians, nurses, paramedics, and emergency medical technicians.

In Thailand, access to emergency services is divided into two categories: those who arrive at the hospital in their own vehicle or via public transportation services. The second group consists of patients who use the EMS transport by dialing the Thai universal emergency number 1669 for those services (6). There is currently no cost to use the services for any category of patient or level of emergency (7). This results in unnecessary use of the services and tends to overwhelm the resources of the services.

Transporting emergency patients to the hospital by EMS is crucial for several different reasons. EMS providers are trained experts who are exceptionally knowledgeable about the type of care each patient needs for best results. Patients who use non-EMS transportation may be taken to the nearest hospital rather than the most suitable.

However, patterns of EMS use, and outcome of patients have been given little study. The findings of such research will provide the understanding of patterns of service use, particularly emergency patients who use EMS services, which can facilitate developing policies regarding personnel and resource management for maximum efficiency, in order to reduce mortality and disability, resulting in the development of a drastically more sustainable program and society (8-10). This study aimed to compare the characteristics and outcomes of patients who were transferred to ED by EMS and patients who were transported via other modes of transportation.

2. Methods

2.1. Study design and setting

This retrospective cross-sectional study was conducted at Srinagarind Hospital in Khon Kaen, Thailand. The characteristics as well as outcomes of patients referred to ED by EMS were gathered and compared with those who presented to ED using other means. The university hospital serves as the primary care facility in the Northeastern region of the country with approximately 60,000 ED visits, and 2,500 EMS services performed annually. In Thailand, the primary access point for emergency patients to access EMS services is through the emergency number 1669. When individuals encounter a medical emergency, they can dial this number to request assistance and access EMS.

This study was conducted in accordance with the Declaration of Helsinki 1975 and its revisions in 2000. Ethical approval was provided by the Khon Kaen University Ethics Committee for Human Research (HE651569). Requirement for informed consent from the patients was waived since pa-

tient confidentiality protection had been guaranteed, as patients were not identified by name, but by a unique study number.

2.2. Participants

The participants in this study included all the patients who visited our ED during the period from 2017 to 2021. These patients were emergency patients using EMS and non-EMS transportation. The exclusion criteria were patients who were referred from other hospitals and those with incomplete data.

2.3. Data collection

The data were gathered and extracted from our EMS reports and computerized hospital information system, Health Object Program®, an authorized electronic medical records program, at Srinagarind Hospital, Faculty of Medicine, Khon Kaen University, Thailand.

Data were obtained in XML format and compiled into a research dataset Using Microsoft excel (Microsoft Window 10, Khon Kaen University license). We used automated electronic data abstraction to collect patient's demographic data, triage level, initial hemodynamic parameters at ED, patients' arrival time, treatment at the ED, clinical outcome, and ED management.

These data were then evaluated by two independent investigators. In the cases of missing values (values left blank in the study data set) and values outside of a preset normal physiologic range were found, the senior investigators were consulted, and the correct data was acquired.

2.4. Statistical analysis

The statistical analysis in the study was conducted using STATA version 10.1, which is a statistical software program developed by StataCorp based in College Station, Texas, USA. The analysis was performed under the license of Khon Kaen University. The categorical data obtained are presented as frequencies and percentages. Continuous data are presented using the median and interquartile range (IQR). The chi-square test was used to assess the relationship between categorical variables. A two-tailed $P < 0.05$ was considered statistically significant.

3. Results

3.1. Baseline characteristics

The study included 15,501 patients with the median age of 51 (IQR: 23-71) years who were referred to ED by EMS over the five-year period (51.72% male). Table 1 compares the baseline characteristics of cases who referred to ED by EMS with those who arrived by other means (non-EMS). EMS patients had a significantly higher median age (51 (23 - 71) vs. 37 (21

Table 1: Comparing the baseline characteristics of cases who referred to ED by EMS with those who arrived by other means (non-EMS)

Category	EMS (n=15,501)	Non-EMS (n=315,681)	P-value
Age (year)			
Median (IQR)	51 (23 - 71)	37 (21 - 60)	< 0.001
0-2	100 (0.65)	13,334 (4.22)	< 0.001
3-17	857 (5.53)	33,327 (10.56)	
18-64	9,411 (60.71)	209,994 (66.52)	
≥65	5,133 (33.11)	59,026 (18.70)	
Gender			
Male	8,017 (51.72)	137,470 (43.55)	< 0.001
Female	7,484 (48.28)	178,211 (56.45)	
Visit time			
8am-4pm	6,304 (40.67)	132,295 (41.91)	< 0.001
4pm-12am	6,343 (40.92)	141,969 (44.97)	
12am-8am	2,854 (18.41)	41,417 (13.12)	
ED triage level			
I	1,382 (8.92)	2,979 (0.94)	< 0.001
II	5,609 (36.18)	41,221 (13.06)	
III	5,484 (35.37)	108,354 (34.32)	
VI	2,988 (19.28)	129,320 (40.97)	
V	38 (0.25)	33,807 (10.71)	
Type of complaint			
Non-trauma	9,821 (63.36)	269,475 (85.36)	< 0.001
Trauma non-traffic	1,865 (12.03)	37,194 (11.78)	
Trauma traffic	3,815 (24.61)	9,012 (2.86)	
Presenting vital signs			
Systolic blood pressure (mmHg)	131 (116 - 150)	126 (113 - 142)	< 0.001
Diastolic blood pressure (mmHg)	78 (68 - 88)	77 (68 - 86)	< 0.001
Temperature > 38.0 °c	1,243 (9.32)	27,444 (9.61)	0.275
Respiratory rate>22/min	4,589 (30.53)	44,156 (14.7)	< 0.001
Heart rate>100/min	2,981 (19.8)	75,221 (25.02)	< 0.001
Oxygen saturation (%)	98 (96 - 99)	99 (98 - 99)	< 0.001
GCS			
Eye Score	4 (4 - 4)	4 (4 - 4)	< 0.001
Voice Score	5 (5 - 5)	5 (5 - 5)	
Movement Score	6 (5 - 6)	6 (6 - 6)	
Cardiac arrest			
Yes	393 (2.54)	147 (0.05)	< 0.001

Data are presented as median and Interquartile range (IQR) or frequency (%).
 EMS: emergency medical services, ED: emergency department, GCS: Glasgow Coma Scale.

Table 2: Comparing the management and outcomes of cases who referred to ED by EMS with those who arrived by other means (non-EMS)

Category	EMS patients (n=15,501)	Non-EMS patients (n=315,681)	P-value
Management at ED			
Blood tests	10,360 (66.83)	132,175 (39.91)	< 0.001
Plain radiography	10,744 (71.04)	113,227 (34.79)	< 0.001
CT scan	2,747 (17.72)	14,510 (4.38)	< 0.001
Complex procedure	2,074 (13.71)	10,997 (3.38)	< 0.001
Outcome			
Hospital admission	6,517 (42.04)	54,896 (16.58)	< 0.001
ICU admission	1,472 (9.5)	8,262 (2.49)	< 0.001
Death in ED	235 (1.52)	323 (0.1)	< 0.001
Death in hospital	707 (4.56)	1,829 (0.55)	< 0.001
28-day mortality	650 (4.19)	1,598 (0.48)	< 0.001
60-day mortality	691 (4.46)	1,780 (0.54)	< 0.001

Data are presented as frequency (%). EMS: emergency medical services; ED: emergency department; CT: computed tomography; ICU: intensive care unit.

- 60); $p < 0.001$) with male preference ($p < 0.001$). The afternoon shift (4 pm-12 am) was when the highest number of patients arrived. In the EMS group, the triage level 1 (need for resuscitation) was higher than the non-EMS group ($p < 0.001$), most of the patients referred following trauma ($p < 0.001$), and the frequency of cardiac arrest was considerably higher than non-EMS group (2.54% vs 0.05%; $p < 0.001$).

3.2. Managements and outcomes

Table 2 compares the managements and outcomes of cases who referred to ED by EMS with those who arrived via other means. In terms of the treatment at the ED, patients in the EMS group received a higher number of blood tests ($p < 0.001$), plain radiographic exams ($p < 0.001$), computed tomography (CT) scans ($p < 0.001$), and complex procedures ($p < 0.001$) than the non-EMS group. The EMS group had a greater number of hospital admissions ($p < 0.001$) and intensive care unit (ICU) admissions ($p < 0.001$) compared to the non-EMS group. The EMS group exhibited a significantly higher mortality rate compared to the non-EMS group ($p < 0.001$).

4. Discussion

Based on the study findings, the population utilizing EMS services had higher median age, higher frequency of emergency cases and trauma-related complaints, higher need for treatment interventions and imaging procedures, higher rate of hospital and ICU admissions, as well as higher rate of mortality compared to the non-EMS group.

This study focused on the characteristics of patients who presented to the ED via EMS or other means over a five-year period. Thailand is still in the early stages of EMS services, primarily focused on promoting presented to the ED via EMS or other means. This has had an overwhelmingly positive impact in terms of providing people with access to timely treatment (11, 12). However, effective resource management and rapid patient access fall outside their objectives as the number of patients using the EMS has increased considerably over the last five years.

In terms of patients' age, this study showed that patients who arrived at the hospital via EMS had a higher median age than those who arrived via non-EMS. This clearly demonstrated that the elderly population has more underlying diseases than the working-age population, which can easily result in various emergencies. Thailand's population pattern is entering an aging society; this of course means the implications concerning using EMS become all the more important. The study showed that most of them arrived during the afternoon shift (4 pm-12 am), which is consistent with previous studies that concluded that most service users in a government hospital's ED present during the afternoon shift (13,

14). This is because the elderly has to wait for a family member, which mostly was in the working age, to be brought to the hospital after work hours.

The analysis of triage levels revealed that patients arriving with EMS had a higher proportion of levels 1 and 2 compared to non-EMS patients. This finding indicates that the EMS system has been successful in providing access to timely and appropriate care for patients with genuine emergencies and critical conditions. Public relations regarding effective access to EMS will inevitably result in emergency patients being able to access services quickly (15-17). On the other hand, the analysis of non-EMS patients revealed that the majority of patients were classified as triage levels 3 and 4. These levels suggest that these patients were in less urgent conditions and were able to move independently or travel to the hospital on their own. This finding highlights that patients in non-urgent conditions may not require immediate EMS assistance and can seek medical care through alternative means. Furthermore, it has been found that trauma patients are more frequently transported by EMS rather than non-EMS means. Thailand is one of the top ten countries regarding traffic problems and accidents (18). In the event of a traffic accident, patients may be affected by disorders of the musculoskeletal system that cause severe pain, which make them unable to access the hospital on their own, so patients are frequently transported to the hospital by EMS.

Regarding vital signs, the factors to consider among EMS and non-EMS patients included respiratory rates greater than 22 breaths per minute. Furthermore, it was discovered that the number of cardiac arrest patients presenting to the ED via EMS was significantly higher than those presenting via non-EMS means, indicating that society better understood the initial assessment and indicators to classify resuscitation conditions, particularly cardiac arrest out of the hospital. They are also aware of how to obtain services through EMS. In terms of management and admission rates, it has been determined that most patients who use EMS are in critical condition, resulting in higher admission rates and higher mortality rates than those who travel to the hospital via non-EMS means.

These findings emphasize the unique needs and healthcare utilization patterns of patients relying on EMS services, highlighting the importance of tailored strategies and resource allocation to ensure optimal care and outcomes.

This study will help Thailand's public health system policy-making; the goal is to make efficient use of limited resources for long-term development (19-21).

5. Limitations

Since the study was conducted retrospectively, there are certain limitations and factors that were not investigated. Some

values were missing in over a fourth of cases. It's important to acknowledge these limitations to interpret the findings appropriately. Additionally, the number of patients in the database was significant, which could lead to errors or incompleteness. However, efforts have been made to mitigate errors in study data by determining the upper and lower limits of the factors to be studied. Moreover, the data used in the study were derived from a single hospital, which might not fully represent the population patterns and characteristics of other geographical areas or healthcare settings. Variations in demographics, healthcare practices, and resource availability across different regions could influence the generalizability of the study findings. Finally, our institution was a teaching hospital, which meant that the comorbidity and illness patterns were more severe and convoluted, which may affect the pattern of patients who visited our hospital.

6. Conclusion

The population utilizing EMS services had higher median age, higher frequency of emergency cases and trauma-related complaints, higher need for treatment interventions and imaging procedures, higher rate of hospital and ICU admissions, as well as higher rate of mortality compared to the non-EMS group.

7. Declarations

7.1. Acknowledgments

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7.2. Conflict of interest

We declare that we have no conflicts of interest.

7.3. Funding and support

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7.4. Authors' contribution

Conceptualization: Pariwat Phungoen, Kamonwon Ienghong, Korakot Apiratwarakul; Methodology: Pariwat Phungoen, Kamonwon Ienghong, Korakot Apiratwarakul, Lap Woon Cheung; Software: Pariwat Phungoen; Validation: Pariwat Phungoen, Kamonwon Ienghong, Korakot Apiratwarakul; Formal analysis: Pariwat Phungoen, Kamonwon Ienghong, Korakot Apiratwarakul, Lap Woon Cheung; Investigation: Pariwat Phungoen, Kamonwon Ienghong, Korakot Apiratwarakul; Data Curation: Pariwat Phungoen, Kamonwon Ienghong, Korakot Apiratwarakul; Writing – Original Draft: Kamonwon Ienghong, Korakot Apiratwarakul; Writing - Review & Editing: Kamonwon Ienghong,

Korakot Apiratwarakul, Lap Woon Cheung; Visualization: Pariwat Phungoen; Supervision: Pariwat Phungoen; Project administration: Korakot Apiratwarakul; Funding acquisition: Korakot Apiratwarakul. All authors read and approved the final version of the manuscript.

7.5. Availability of data

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

7.6. Using the artificial intelligent chatbots

None.

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