Survival Rates and Determinants of Mortality in Life-Threatening Trauma Patients Transferred via Emergency Medical Services

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DOI: https://doi.org/10.52939/ijg.v20i10.3633

Abstract
Trauma remains a leading cause of global morbidity and mortality, particularly in life-threatening situations that require immediate medical intervention. Understanding the factors that influence survival outcomes in trauma patients is essential for improving emergency medical services (EMS) and refining trauma care protocols. This study aimed to assess survival rates and identify predictors of mortality among patients with life-threatening trauma transported by Vajira Emergency Medical Services (V-EMS) in Bangkok, Thailand. We conducted a retrospective cohort study utilizing data from V-EMS and hospital records, including patients aged 15 years or older with life-threatening injuries categorized under Response Codes 21-25 and critical emergency levels 1-5, transported to Vajira Hospital between January 1, 2019, and December 31, 2022. Kaplan-Meier survival analysis was employed to estimate survival rates, while Cox proportional hazards regression identified predictors of mortality. The Injury Severity Score (ISS) was also evaluated. Out of 146 patients with life-threatening trauma, 107 survived. The cohort primarily consisted of males, with a median age of 39 years and a median follow-up period of 180 days. The overall median survival time was 120.79 days (95% CI: 65.20-176.38). Survival rates at 30, 60, 90, and 120 days were 63.06%, with a decline to 31.53% at 150 and 180 days. Significant predictors of mortality included male gender (HR_adj = 39.35, 95% CI: 2.76-560.23, p = 0.007), age ≥60 years (HR_adj = 16.24, 95% CI: 2.19-120.30, p = 0.006), pre-hospital systolic blood pressure ≥90 mmHg (HR_adj = 0.10, 95% CI: 0.02-0.45, p = 0.003), severe (ISS 25-49) and critical (ISS 50-74) injury severity scores (HR_adj = 93.92, 95% CI: 1.22-7239.97, p = 0.04; HR_adj = 821.48, 95% CI: 1.16-579279, p = 0.045), and pre-hospital airway management using a bag valve mask (HR_adj = 28.98, 95% CI: 1.92-438.53, p = 0.015). Notably, undergoing a major operation was linked to significantly reduced mortality (HR_adj = 0.04, 95% CI: 0.005-0.28, p = 0.001). This study highlights critical factors affecting survival in patients with life-threatening trauma, emphasizing the necessity of effective EMS and in-hospital care. The results advocate for enhanced EMS training, improved pre-hospital care protocols, and timely surgical interventions to optimize survival outcomes in trauma patients.

Keywords: Emergency Medical Services, Life-Threatening Trauma, Major Trauma, Mortality Rate, Survival

1. Introduction

Trauma is a major public health concern globally, contributing significantly to morbidity and mortality across all age groups [1]. Life-threatening trauma, characterized by severe injuries that pose an immediate risk to life, presents a critical challenge for emergency medical services (EMS) and trauma care systems. Effective and timely management of these patients is essential for improving survival outcomes [2]. EMS plays a pivotal role in the pre-hospital care of trauma patients, with the efficiency and quality of EMS interventions having a substantial impact on patient outcomes, particularly in life-threatening cases [3]. Key components of EMS, such as rapid identification, stabilization, and transportation to appropriate medical facilities, are crucial determinants of survival in trauma patients [4].

ISSN: 1686-6576 (Printed) | ISSN 2673-0014 (Online)

In urban environments like Bangkok, Thailand, EMS systems face the challenge of managing a high volume of trauma cases resulting from traffic accidents, falls, and other incidents. The Vajira Emergency Medical Services (V-EMS), affiliated with the Faculty of Medicine Vajira Hospital at Navamindradhiraj University, plays a critical role within the Bangkok Emergency Medical Service Center (Erawan Center), serving a vast and densely populated urban area. Despite advancements in trauma care, survival rates among life-threatening trauma patients remain variable, influenced by numerous factors, including the severity of injuries and the efficiency of both pre-hospital and in-hospital care [5]. Identifying predictors of mortality and survival rates among these patients is crucial for developing targeted interventions and optimizing trauma care protocols [6] and [7].

Previous research has largely focused on pre-hospital factors influencing trauma outcomes. While these studies have yielded important insights, there remains a gap in understanding how both pre-hospital and in-hospital factors interact to influence survival rates in life-threatening trauma patients. A more comprehensive approach that considers the entire continuum of care is necessary to inform the development of holistic and effective trauma care protocols.

The objective of this study is to examine survival rates and identify predictors of mortality among life-threatening trauma patients transported by Vajira Emergency Medical Services. By analyzing retrospective data from EMS reports and hospital records, this study aims to identify key factors associated with patient outcomes. The findings will provide valuable insights into optimizing EMS protocols and improving trauma care practices to enhance the survival of life-threatening trauma patients.

2. Methodology

2.1 Participants

The study population consisted of trauma patients with life-threatening conditions who met the following inclusion criteria: 1) aged 15 years or older, 2) assigned response codes 21-25 and classified as critical-level emergencies 1-5, and 3) transported to the emergency department of Vajira Hospital by Vajira Emergency Medical Services (V-EMS). Exclusion criteria included trauma patients who could not be tracked for survival within 24 hours, those who died at the scene, and cases with incomplete data from the emergency medical service performance records of the Bangkok Emergency Medical Service Center. The sample size was calculated using data from a pilot study and the STATA version 16.0 statistical software. The calculation was based on a two-sample comparison of proportions for qualitative variables and a two-sample comparison of means for quantitative variables, with assumptions of alpha = 0.05 (one-sided), power = 0.8, and a two-sided test [8]. The minimum sample size required to achieve statistical significance was determined to be 72 cases. To account for potential incomplete data, the sample size was increased by 10%, yielding a target of 80 cases. However, the final sample included 146 patients who met the inclusion criteria between January 1, 2019, and December 31, 2022.

2.2 Study Setting and Data Sources

The study area is located in Bangkok, the capital of Thailand (Figure 1). Vajira Emergency Medical Services (V-EMS) is based at the Faculty of Medicine, Vajira Hospital, Navamindradhiraj University, Thailand. V-EMS serves as the lead facility for Zone 1 of the Bangkok Emergency Medical Service Center (Figure 2), one of eleven designated zones across the city. The study utilized data from V-EMS and hospital records to investigate survival outcomes and predictors of mortality among trauma patients.

2.3 Data Sources

Data were collected from EMS trauma patient care reports, standard operational reports of advanced EMS, and records from the Bangkok Emergency Medical Service Center. One author retrospectively collected and entered the data into Microsoft Excel (Microsoft, Redmond, WA, USA), eliminating the need for inter-rater reliability assessment. The dataset comprised patient characteristics, clinical symptoms, pre-hospital and in-hospital provider processes, as well as 180-day follow-up data. Survival outcomes were tracked using patient registration numbers in the electronic “ePHIS” database of Vajira Hospital.

2.4 Operational Definitions

Censored: Refers to trauma patients who were not transported to Vajira Hospital by Vajira Emergency Medical Services or who could not be monitored for survival within 24 hours or died at the scene. Event: Defined as the occurrence of death among life-threatening trauma patients during the follow-up period. Response Code: One of 26 severity codes assigned at the scene based on patient symptoms reported by informants. This study focuses on Response Codes 21-25, which refer to Abuse (21), Burn (22), Submersion (23), Fall (24), and Road Traffic Accident (25), as defined by the National Institute for Emergency Medicine [9].

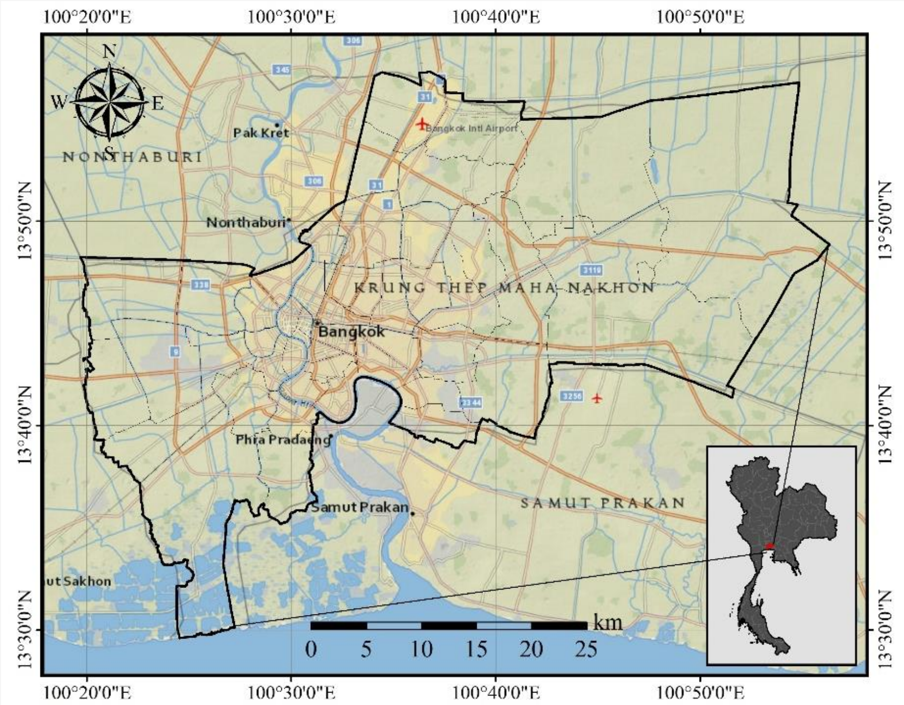

Figure 1: Bangkok, the capital of Thailand

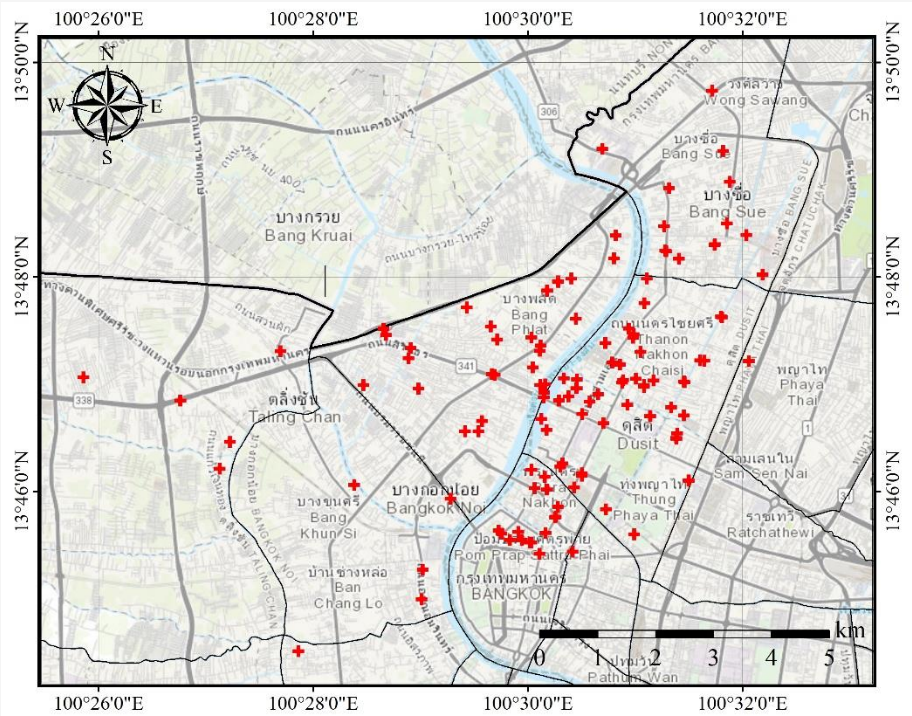

Figure 2: Location of Vajira Emergency Medical Services (V-EMS)

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Critical Level Emergency: Refers to one of five severity levels of crises that threaten the life of trauma patients at the scene: 1) Cardiac arrest, 2) Airway obstruction, 3) Respiratory rate >29 or <10 bpm, 4) Shock, and 5) Coma/Glasgow Coma Scale (GCS) ≤8.

2.5 Statistical Analysis

This retrospective cohort study utilized survival analysis to investigate survival rates and predictors of mortality among life-threatening trauma patients transported by EMS. Data were cleaned, coded, and entered into Excel 2019 before being exported to STATA 16.0 for analysis. Descriptive statistics were presented as medians with interquartile ranges for continuous variables and frequencies with percentages for categorical variables. Outcomes were categorized as either censored or event. The incidence density rate of mortality was calculated for the entire follow-up period. Kaplan-Meier survival curves were used to estimate the median survival time and cumulative probability of survival, while the log-rank test assessed differences in mortality probability between groups [10]. Bi-variable and multivariable regression analyses were conducted to identify predictor variables. Variables with a p-value <0.25 in the bi-variable analysis were included in the multivariable analysis. Adjusted hazard ratios (HR_adj) with 95% confidence intervals (CI) were used to assess the strength of associations, with p-values <0.05 considered statistically significant.

2.6 Ethical Considerations

This study was approved by the Ethics Committee on Research Involving Human Subjects, Faculty of Medicine Vajira Hospital, Navamindradhiraj University (COA 207/65).

3. Results

3.1 Characteristics and Clinical Symptoms

The study monitored 146 cases of life-threatening trauma over a 180-day follow-up period, of which 107 patients survived. The majority of the trauma patients were male (84 patients, 78.50%), with a median age of 39 years (IQR: 27-52 years). The median Glasgow Coma Scale (GCS) score was 11 (IQR: 3-14). A total of 88 patients (82.24%) had a pre-hospital systolic blood pressure ≥90 mmHg, and 56 patients (52.34%) had a pre-hospital oxygen saturation ≥94%. The median Injury Severity Score (ISS) was 17 (IQR: 12-24). The most common response code was 25 (Road Traffic Accident), affecting 61 patients (57%), and the most frequent critical level emergency was shock, present in 43 patients (40.19%) (Table 1).

Table 1: Characteristic and clinical symptom of life-threatening trauma patients transported by EMS

Factors	**Survived n=107 Number (%)**	**Non-Survived n=39 Number (%)**
Gender		
Female	23 (21.50)	6 (15.38)
Male	84 (78.50)	33 (84.62)
Age (year)		
Median (max, min)	39 (27,52)	38 (30, 62)
Glasgow coma scale (GCS)		
Median (max, min)	11 (3, 14)	3 (3, 9)
Pre-hospital Systolic blood pressure (mmHg)		
<90	19 (17.76)	17 (43.59)
≥90	88 (82.24)	22 (56.41)
Pre-hospital oxygen saturation (percentage)		
<94	51 (47.66)	26 (66.67)
≥94	56 (52.34)	13 (33.33)
Injury Severity Score (ISS)		
Median (max, min)	17 (12-24)	29 (22, 40)
Injury (Response Code; RC)		
Abuse (21)	23 (21.50)	4 (10.26)
Burn (22)	2 (1.87)	-
Fall (24)	21 (19.63)	11 (28.20)
Road traffic accident (25)	61 (57.00)	24 (61.54)
Level of critical level emergency		
1. Cardiac arrest	5 (4.67)	17 (43.60)
2. Airway Obstruction	18 (16.82)	10 (25.64)
3. Respiratory Rate >29 or <10	20 (18.69)	3 (7.70)
4. Shock	43 (40.19)	5 (12.80)
5. Coma/ GCS ≤8	21 (19.63)	4 (10.26)

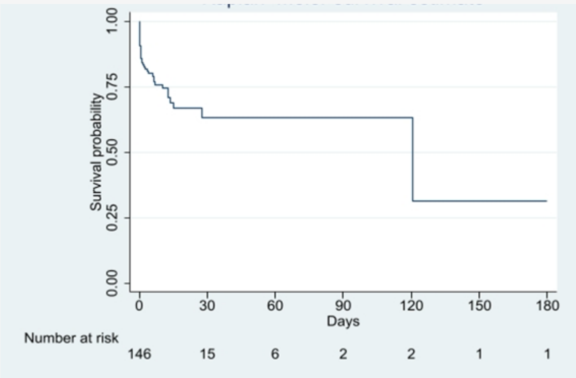

Figure 3: Overall Kaplan-Meier survival estimation of life-threatening trauma patients transported by EMS

3.2 Incidence of Mortality

The total time at risk for the 146 patients included in this study was 1,839 person-days, resulting in an incidence density rate of 2.21 (95% CI: 1.55–2.90) per 100 person-days. The maximum follow-up period was 180 days. Kaplan-Meier survival curves were employed to estimate survival rates, revealing that survival rates at 30, 60, 90, and 120 days were approximately 63.06%, decreasing to 31.53% at 150 and 180 days. The overall median survival time was 120.79 days (95% CI: 65.20–176.38) (Figure 3). Kaplan-Meier curves, along with log-rank tests, were used to evaluate differences in mortality among various categorical variables. The incidence of mortality among trauma patients with a Glasgow Coma Scale (GCS) score of 13-15 (mild injury) was 3.83 per 100 person-days, compared to 1.45 and 0.72 per 100 person-days for patients with GCS scores of 9-12 (moderate injury) and ≤8 (severe injury), respectively (Figure 4(a)).

The median survival time for patients with a responsive pupillary light reflex was 120 days, whereas those with a non-responsive pupillary light reflex had a median survival time of 0.71 days. The incidence density rates of mortality for these groups were 1.6 and 12.49 per 100 person-days, respectively (Figure 4(b)). For patients with dilated pupil size (>5 mm), the incidence of mortality was 20 per 100 person-days, while it was 2.2 and 0.7 per 100 person-days for patients with equal pupil size (3-5 mm) and unequal pupil size (difference >1 mm), respectively (Figure 4(c)).

The median survival time for patients with pre-hospital systolic blood pressure <90 mmHg was 27.54 days, compared to 120 days for those with systolic blood pressure ≥90 mmHg. The incidence density rates of mortality for these groups were 3.57 and 1.61 per 100 person-days, respectively (Figure 4(d)). For patients with pre-hospital oxygen saturation levels <94%, the incidence of mortality was 3.88 per 100 person-days, compared to 1.11 per 100 person-days for those with oxygen saturation levels ≥94% (Figure 4(e)). Patients with an Injury Severity Score (ISS) of 50–74 (critical injuries) had an incidence of mortality of 7.25 per 100 person-days, compared to 4.89, 1.11, 0.42, and 0.34 per 100 person-days for patients with ISS scores of 25–49 (severe), 9–15 (moderate), and 1–8 (minor), respectively (Figure 4(f)). Among patients with critical level emergency 1 (cardiac arrest), the incidence of mortality was 14.93 per 100 person-days. In comparison, it was 5.22, 1.23, 1.06, and 0.54 per 100 person-days for those with airway obstruction, coma (GCS ≤8), respiratory rate >29 or <10 bpm, and shock, respectively (Figure 4(g)).

The incidence of mortality among patients who underwent airway management using a Laryngeal Mask Airway (LMA) was 606.06 per 100 person-days, compared to 5.85, 4.75, 0.94, and 0.28 per 100 person-days for patients who received endotracheal intubation, bag valve mask (BVM), oxygen mask with reservoir bag, and no airway management, respectively (Figure 4(h)).

Patients who underwent pre-hospital cardiopulmonary resuscitation (CPR) had a median survival time of 0.29 days, while those who did not receive CPR had a median survival time of 120 days. The incidence density rates of mortality were 40.48 and 1.76 per 100 person-days, respectively (Figure 4(i)). The incidence of mortality in trauma patients for whom the trauma fast track was activated was 3.09 per 100 person-days, compared to 0.87 per 100 person-days for non-activated fast track cases (Figure 4(j)). The median survival time for patients who received a massive blood transfusion was 27.54 days, compared to 120 days for those who did not. The incidence density rates of mortality were 4.26 and 1.48 per 100 person-days, respectively (Figure 4(k)).

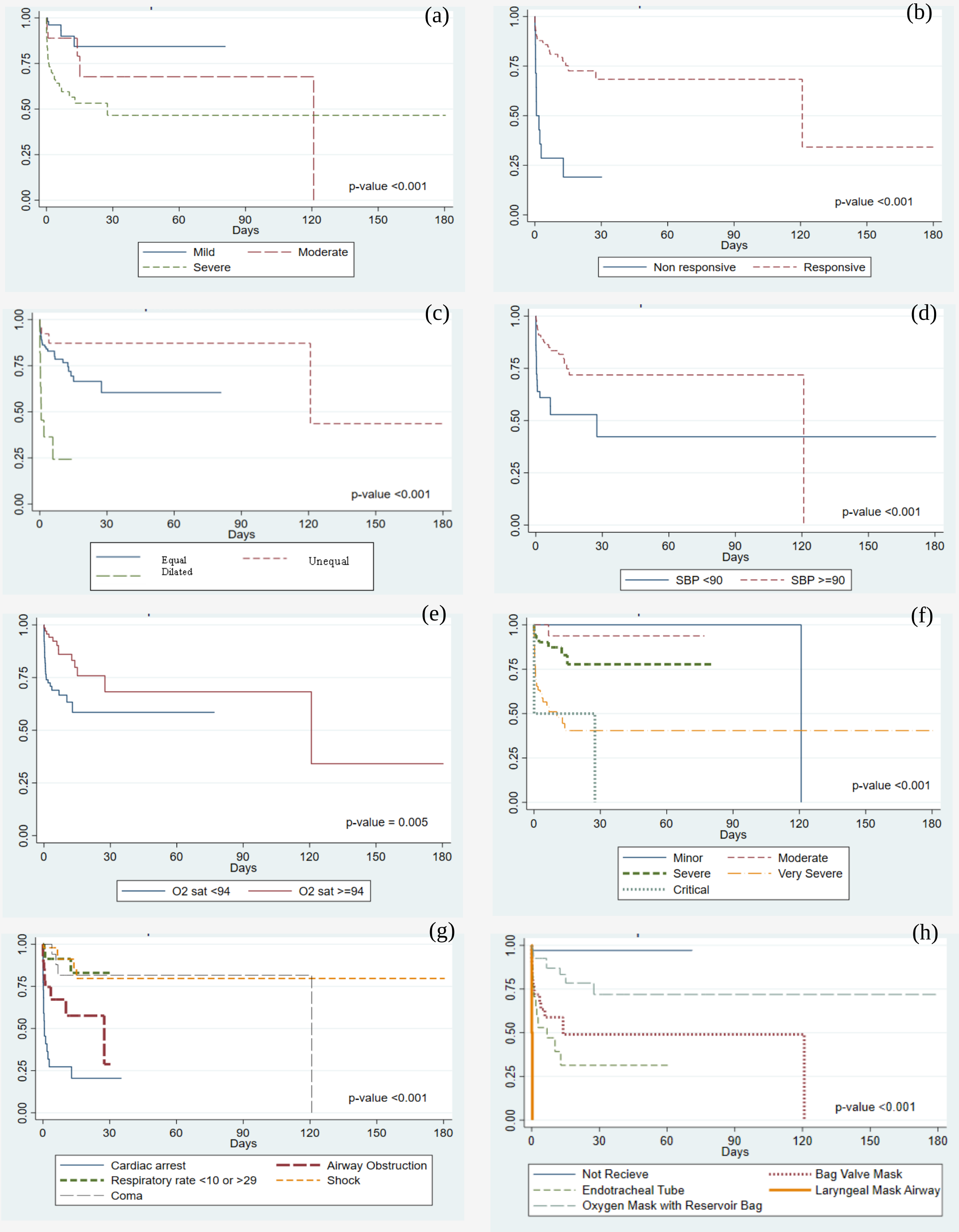

Figure 4: Kaplan-Meier survival curve for trauma patients transported by EMS by (a) GCS (b) Pupillary light reflex, (c) Pupil size (d) Pre-hospital Systolic blood pressure (e) Pre-hospital oxygen saturation (f) ISS, (g) Critical level emergency (h) Airway management

ISSN: 1686-6576 (Printed) | ISSN 2673-0014 (Online) |

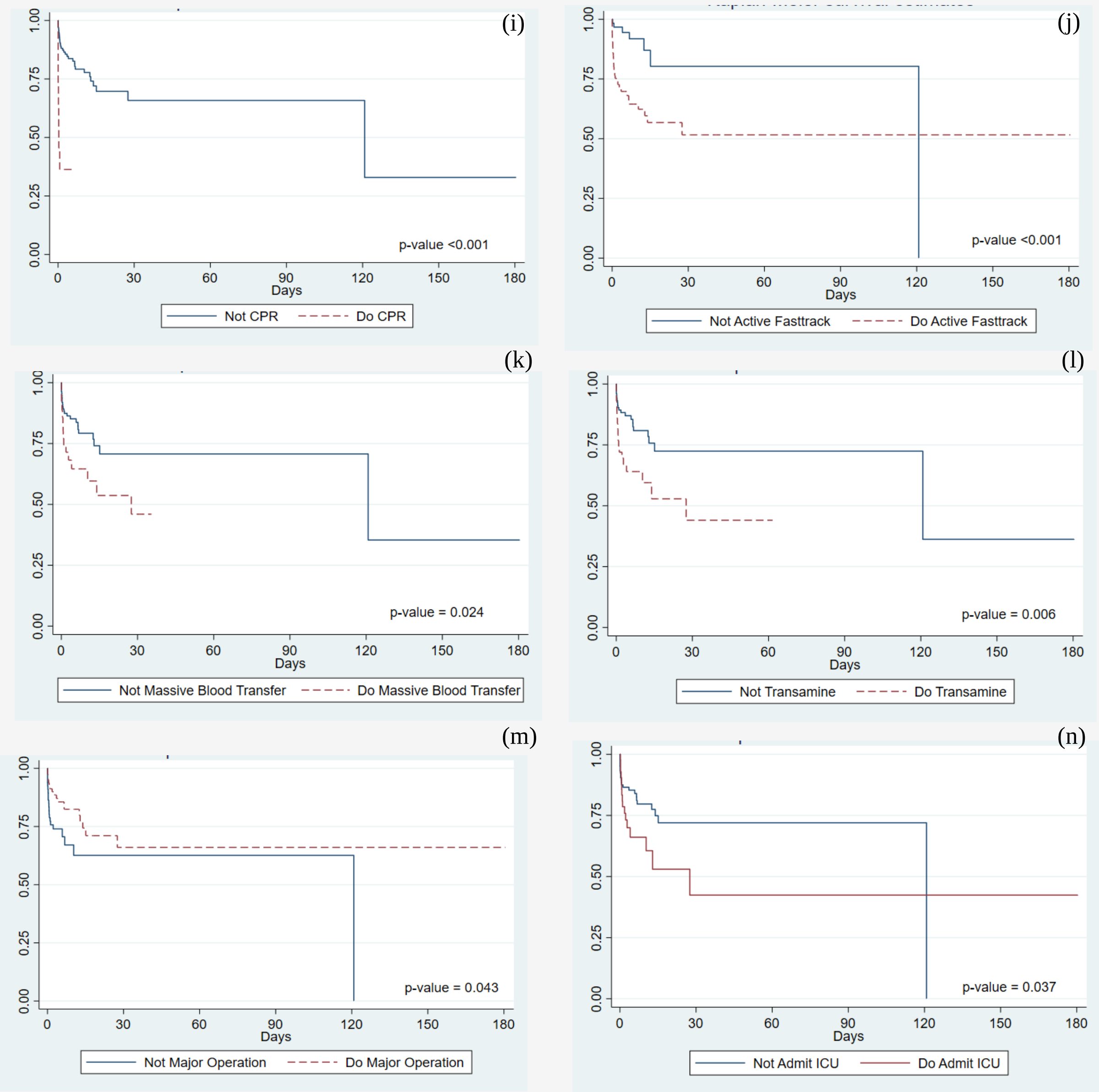

Figure 4: Kaplan-Meier survival curve for trauma patients transported by EMS by (i) Pre-hospital CPR (j) Activate trauma fast track (k) Massive blood transfusion (l) Tranexamic acid (m) Undergoing major operation (n) Admitted to intensive care unit

The incidence of mortality for patients treated with tranexamic acid was 4.26 per 100 person-days, compared to 1.48 per 100 person-days for those who did not receive the drug (Figure 4(l)). Patients who did not undergo major surgery had an incidence of mortality of 3.96 per 100 person-days, compared to 1.38 per 100 person-days for those who underwent major surgery (Figure 4(m)). The median survival time for patients admitted to the Intensive Care Unit (ICU) was 27.54 days, compared to 120 days for those who were not admitted. The incidence density rates of mortality for ICU and non-ICU patients were 3.15 and 1.73 per 100 person-days, respectively (Figure 4(n)).

3.3 Predictors of Mortality among of Life-Threatening Trauma Patients Transported by EMS

In this study, factors influencing the survival rates of life-threatening trauma patients over a 180-day follow-up period were analyzed using the Cox proportional hazards regression model. The results are presented as adjusted hazard ratios (HR_adj) with 95% confidence intervals (CI), with statistical significance set at $p < 0.05$.

ISSN: 1686-6576 (Printed) | ISSN 2673-0014 (Online) |

The analysis was categorized into three key sections: 1) patient characteristics and clinical symptom factors, 2) pre-hospital care process factors, and 3) in-hospital care process factors, as outlined below:

The presence of characteristic and clinical symptom factors associated with mortality includes male gender (HR_adj = 39.35, 95% CI: 2.76–560.23, p = 0.007), age ≥60 (HR_adj = 16.24, 95% CI: 2.19–120.30, p = 0.006), pre-hospital systolic blood pressure ≥90 mmHg (HR_adj = 0.10, 95% CI: 0.02–0.45, p = 0.003), ISS 25–49 (severe) (HR_adj = 93.92, 95% CI: 1.22–7239.97, p = 0.04), ISS 50–74 (critical) (HR_adj = 821.48, 95% CI: 1.16–579279, p = 0.045), critical level emergency 4 (shock) (HR_adj = 0.01, 95% CI: 0.001–0.17, p = 0.001), and critical level emergency 5 (coma/GCS ≤8) (HR_adj = 0.02, 95% CI: 0.007–0.32, p < 0.007). The risk of mortality in each group differed significantly (p < 0.05) (Table 2).

Table 2: Characteristic and clinical symptom factors associated with the survival rates of life-threatening trauma patients the entire study follow-up period (180 days)

Factors	Univariable		Multivariable	
	Crude HR (95% CI)	***p*-value**	**Adjusted HR (95% CI)**	***p*-value**
Gender				
Female	1.00		1.00	
Male	1.38 (0.58-3.31)	0.465	39.35 (2.76-560.23)	0.007**
Age (year)				
<60	1.00		1.00	
≥60	1.25 (0.62-2.52)	0.535	16.24 (2.19-120.30)	0.006**
Glasgow coma scale (score)				
13-15 (mild)	1.00		1.00	
9-12 (moderate)	2.21 (0.67-7.26)	0.190	2.05 (0.21-19.90)	0.535
≤8 (severe)	5.12 (1.97-13.29)	<0.001**	.63 (0.06-7.12)	0.706
Pupillary light reflex				
Non responsive	1.00		1.00	
Responsive	0.18 (0.09-0.37)	<0.001**	0.21 (0.03-1.35)	0.100
Pupil size (mm)				
Equal (3-5)	1.00		1.00	
Unequal (different sizes >1)	0.42 (0.13-1.39)	0.155	0.37 (0.04-3.17)	0.365
Dilated (size >5)	4.94 (2.22-11.00)	<0.001**	1.06 (0.09-12.18)	0.963
Pre-hospital Systolic blood pressure (mmHg)				
<90	1.00		1.00	
≥90	0.33 (0.17-0.62)	0.001**	0.10 (0.02-0.45)	0.003**
Pre-hospital oxygen saturation (percentage)				
<94	1.00		1.00	
≥94	0.38 (0.19-0.76)	0.006**	1.03 (0.22-4.93)	0.967
Physics of trauma				
Blunt	1.00		1.00	
Penetrating	0.23 (0.03-1.66)	0.144	0.27 (0.02-4.10)	0.344
Injury Severity Score (severity)				
1–8 (Minor)	1.00		1.00	
9–15 (Moderate)	0.43 (0.03-6.99)	0.555	2.38 (0.02-239.36)	0.712
16–24 (Serious)	1.81 (0.22-14.65)	0.579	34.2 (0.45-2616.47)	0.110
25–49 (Severe)	7.52 (1.01-55.74)	0.049*	93.92 (1.22-7239.97)	0.040*
50–74 (Critical)	14.18 (1.26-159.85)	0.032*	821.48 (1.16-579279)	0.045*
Injury (Response Code; RC)				
Abuse (21)	1.00		-	
Fall (24)	1.91 (0.60-6.05)	0.270		
Road traffic accident (25)	1.77 (0.61-5.51)	0.291		
Level of critical level emergency				
1. Cardiac arrest	1.00		1.00	
2. Airway Obstruction	0.35 (0.16-0.76)	0.008**	0.27 (0.04-1.72)	0.166
3. Respiratory Rate >29 or <10	0.09 (0.02-0.29)	<0.001*	0.17 (0.00-0.25)	0.159
4. Shock	0.07 (0.02-0.18)	<0.001*	0.01 (0.001-0.17)	0.001*
5. Coma/ GCS ≤8	0.10 (0.03-0.32)	<0.001*	0.02 (0.007-0.32)	0.007*
Hematocrit (percentage)				
<25	1.00		1.00	
≥25	0.49 (0.15- 1.61)	0.240	0.17 (0.02-1.77)	0.139

Note: The symbol * indicates statistical significance at the 0.05 level, while ** denotes statistical significance at the 0.01 level. An HR (Hazard Ratio) greater than 1 indicates an increased risk of mortality, and an HR less than 1 indicates a decreased risk of mortality. The symbol - signifies that the variable was not included in the model fitting

Pre-hospital provider process factors associated with mortality include pre-hospital airway management using a bag valve mask (HR_adj = 28.98, 95% CI: 1.92–438.53, p = 0.015). The risk of mortality in each group differed significantly (p < 0.05) (Table 3).

In-hospital provider process factors associated with mortality include trauma patients who underwent major operations (HR_adj = 0.04, 95% CI: 0.005–0.28, p = 0.001). The risk of mortality in each group differed significantly (p < 0.05) (Table 4).

Table 3: Pre-hospital provider process factors associated with the survival rates of life-threatening trauma patients the entire study follow-up period (180 days)

Factors	Univariable		Multivariable	
	Crude HR (95% CI)	***p*-value**	**Adjusted HR (95% CI)**	***p*-value**
Pre-hospital time intervals (minute)				
Response times				
≤8	1.00	0.182	1.00	0.059
>8	1.56 (.81-3.00)		4.21 (.95-18.66)	
On-scene times				
≤10	1.00		1.00	
>10	1.61 (.84-3.11)	0.153	2.93 (.65-13.26)	0.164
Transportation times				
≤20	1.00		1.00	
>20	2.39 (.93-6.13)	0.070	1.94 (.23-16.59)	0.544
Total pre-hospital time				
≤60	1.00		1.00	
>60	1.42 (.43-4.64)	0.652	0.23 (.02-2.68)	0.243
Hemorrhage control				
No	1.00		1.00	
Yes	0.76 (.40-1.46)	0.415	3.39 (.86-13.40)	0.082
Airway management				
None	1.00		1.00	
Bag valve mask (BVM)	17.05 (2.25-128.98)	0.006**	28.98 (1.92-438.53)	0.015**
Endotracheal tube	24.45 (3.15-189.54)	0.002**	1.1 (0.05-25.58)	0.951
Laryngeal Mask Airway	177.15 (15.13-2074.19)	<0.001**	7.76 (0.17-36.32)	0.105
Oxygen Mask with Reservoir Bag	4.97 (0.63-39.29)	0.129	22.35 (0.53-949.06)	0.548
Intravenous fluid access				
None	1.00		1.00	
0.9%NSS	1.02 (0.37-2.85)	0.966	0.30 (0.06-1.54)	0.149
RLS	0.89 (0.39-2.05)	0.785	0.68 (0.17-2.73)	0.589
Acetar	2.88 (0.86-9.62)	0.086	1.36 (0.13-14.72)	0.801
Hard collar				
No	1.00		1.00	
Yes	3.41 (.82-14.21)	0.091	0.83 (0.08-8.76)	0.880
Cardiopulmonary resuscitation	1.00		1.00	
No	6.77 (2.87-15.96)	<0.001**	0.12 (0.008-1.84)	0.127
Yes				

Note: The symbol * indicates statistical significance at the 0.05 level, while ** denotes statistical significance at the 0.01 level. An HR (Hazard Ratio) greater than 1 indicates an increased risk of mortality, and an HR less than 1 indicates a decreased risk of mortality. The symbol - signifies that the variable was not included in the model fitting.

Table 4: In-hospital provider process factors associated with the survival rates of life-threatening trauma patients the entire study follow-up period (180 days)

Factors	Univariable		Multivariable	
	Crude HR (95% CI)	*p*-value	Adjusted HR (95% CI)	*p*-value
Activate trauma fast track				
No	1.00		1.00	
Yes	3.8 (1.68-8.62)	0.001**	.88 (0.17-4.58)	0.875
Massive blood transfusion				
No	1.00		1.00	
Yes	2.08 (1.08-4.00)	0.028*	4.01 (0.88-18.33)	0.073
Tranexamic acid				
No	1.00		1.00	
Yes	2.39 (1.27-4.53)	0.007**	0.33 (0.06-1.85)	0.205
Major Operation				
No	1.00		1.00	
Yes	0.52 (0.28-0.99)	0.047*	0.04 (0.005-0.28)	0.001**
In-hospital endotracheal intubation				
No	1.00		1.00	
Yes	1.62 (0.85-3.08)	0.140	0.46 (0.09-2.44)	0.365
Intensive care unit				
No	1.00		1.00	
Yes	1.96 (1.03-3.74)	0.041*	1.32 (0.26-6.57)	0.738

Note: The symbol * indicates statistical significance at the 0.05 level, while ** denotes statistical significance at the 0.01 level. An HR (Hazard Ratio) greater than 1 indicates an increased risk of mortality, and an HR less than 1 indicates a decreased risk of mortality. The symbol - signifies that the variable was not included in the model fitting

4. Discussion

The results of this study highlight several critical factors influencing the survival rates of life-threatening trauma patients transported by Vajira Emergency Medical Services (V-EMS). The overall median survival time of 120.79 days aligns with findings from similar contexts, such as studies on traumatic brain injury patients in the Amhara region, where the median survival time was 106 days. This consistency reinforces the generalizability of these findings across different populations [11]. The Kaplan-Meier survival analysis revealed significant variations in survival rates over time, with a marked decline as the follow-up period extended. Survival rates were approximately 63.06% at 30, 60, 90, and 120 days but decreased to 31.53% at 150 and 180 days. This trend is consistent with the well-established trimodal distribution of trauma deaths, where the third phase, accounting for 20% of deaths occurring several days to weeks post-injury, is often due to complications such as multiple organ failure [12].

4.1 Patient Characteristics and Clinical Symptoms

The multivariable analysis identified several patient-related factors significantly associated with mortality. Male patients exhibited a notably higher risk of mortality compared to female patients, a finding consistent with existing literature. This may be attributed to male patients often presenting with more severe injuries or differing physiological responses to trauma [7]. Moreover, patients aged 60 years or older were at significantly higher risk, underscoring the increased vulnerability of older trauma patients and highlighting the need for targeted interventions in this demographic [6].

Pre-Hospital Systolic Blood Pressure: Systolic blood pressure was a crucial predictor of survival. Patients with a pre-hospital systolic blood pressure of 90 mmHg or higher had a significantly lower risk of mortality compared to those with lower blood pressure readings. This finding emphasizes the importance of early identification and effective management of hypotension in trauma patients to improve survival outcomes [5]. Injury Severity Score (ISS): The severity of injuries, as measured by the ISS, was a strong predictor of mortality.

Patients with severe (ISS 25–49) and critical (ISS 50–74) injuries had significantly higher risks of mortality compared to those with less severe injuries. This result is consistent with previous studies that demonstrate worse outcomes in patients with higher ISS scores, reinforcing the need for rapid and effective management of severe trauma cases [3].

ISSN: 1686-6576 (Printed) | ISSN 2673-0014 (Online) | © Geoinformatics International

4.2 Pre-Hospital and In-Hospital Processes

The study also underscored the significant impact of both pre-hospital and in-hospital care processes on patient outcomes. Pre-hospital airway management using a bag valve mask was associated with a significantly higher risk of mortality. While airway management is essential, these findings suggest that the method and timing of the intervention are critical factors influencing outcomes. Optimizing pre-hospital care protocols and ensuring adequate training for EMS personnel are necessary to improve survival in such cases [2]. Among in-hospital care processes, undergoing major surgery was associated with a significantly reduced risk of mortality. This highlights the vital role of timely surgical intervention in improving the survival rates of life-threatening trauma patients. Hospitals must prioritize a rapid surgical response and ensure the availability of specialized teams and resources to effectively manage severe trauma cases [4].

5. Conclusion

In conclusion, this study underscores the critical factors influencing survival rates among life-threatening trauma patients transported by Vajira Emergency Medical Services (V-EMS). The findings highlight the importance of timely and effective pre-hospital and in-hospital interventions, particularly for vulnerable populations such as older adults and males. Enhanced training for EMS personnel and the optimization of trauma care protocols are essential for improving patient outcomes. Moreover, while the study's retrospective design provides valuable insights, it also emphasizes the need for further research, including prospective multicenter studies, to validate these findings and explore additional determinants of trauma outcomes. By addressing these factors, healthcare systems can better equip themselves to manage severe trauma cases and ultimately enhance survival rates in this high-risk population.

6. Recommendations

6.1 Implications for Practice

The findings from this study have several implications for improving trauma care. First, there is a need for enhanced EMS training and protocols to optimize pre-hospital care and ensure timely and appropriate interventions. Hospitals should also focus on strengthening their trauma response capabilities, particularly for managing severe and critical injuries. This includes ensuring the availability of surgical teams and necessary resources to provide timely and effective care. Additionally, targeted interventions aimed at vulnerable populations, such as older adults and males, could further enhance outcomes.

6.2 Limitations and Future Research

This study has several limitations. Its retrospective design and reliance on medical records and EMS reports may have introduced issues related to data completeness and accuracy. Furthermore, since the study was conducted at a single institution, the generalizability of the findings may be limited. Future research should focus on prospective multicenter studies to validate these findings and explore additional factors influencing trauma outcomes. Additionally, investigating the impact of EMS personnel training and protocol enhancements on patient outcomes could provide valuable insights for improving pre-hospital care.

Acknowledgments

This research was supported by the Navamindradhiraj University Research Fund.

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