Archives of Academic Emergency Medicine. 2026; 14(1): e22

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ORIGINAL RESEARCH

Factors Associated with Emergency Department Survival of Out-of-Hospital Cardiac Arrest following Traumatic Brain Injury: A Retrospective Cohort Study

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Received: March 2026; Accepted: May 2026; Published online: 14 June 2026

Abstract: **Introduction:** Traumatic out-of-hospital cardiac arrest (TOHCA) in patients with traumatic brain injury (TBI) is associated with exceptionally poor survival. However, prehospital prognostic factors influencing early survival in this high-risk population remain poorly defined. This study aimed to identify prehospital factors associated with survival to hospital admission among TOHCA patients with TBI in Thailand. **Methods:** We conducted an 11-year nationwide retrospective cohort study using the Information Technology of Emergency Medicine System (ITEMS), Thailand's national EMS registry (2012–2022). TOHCA patients with documented TBI who were transported to the emergency department (ED) by emergency medical services (EMS) were included. The primary outcome was survival to hospital admission. Multivariable logistic regression was used to identify independent prehospital factors associated with survival.
Results: Of 46,760 TOHCA cases, 22,821 involved TBI, and 16,885 met inclusion criteria with recorded ED outcomes. Overall, 2,872 patients (17.0%) survived to hospital admission. Younger age, longer on scene time, and shorter hospital-to-scene distance were independently associated with improved odds of survival. Several prehospital interventions showed significant benefit, including external bleeding control (adjusted odds ratio (aOR) 1.38, 95% confidence interval (CI): 1.20–1.58), endotracheal intubation (aOR 2.09, 95% CI: 1.69–2.57), intravenous fluid administration (aOR 1.56, 95% CI: 1.24–1.96), and defibrillation (aOR 2.05, 95% CI: 1.66–2.53). In contrast, on-scene time <10 minutes (aOR 0.65, 95% CI: 0.53–0.79) and bone and joint injuries, including closed fractures, open fractures, and dislocations, were associated with reduced survival. **Conclusion:** Despite the generally poor prognosis of TOHCA patients, particularly those with TBI, our findings demonstrate that adequate on-scene time and the prompt delivery of critical prehospital interventions, including external bleeding control, intubation, hydration, and defibrillation, were independently associated with improved survival to hospital admission.

Keywords: Heart arrest; Brain injuries; Emergency medical services; Prehospital emergency care; Prognosis; Survival

Cite this article as: Laksanamapune T, Yuksen C, Preechanarit T, et al. Factors Associated with Emergency Department Survival of Out-of-Hospital Cardiac Arrest following Traumatic Brain Injury: A Retrospective Cohort Study. Arch Acad Emerg Med. 2026; 14(1): e22. https://doi.org/10.22037/aaem.v14i1.2962.

1. Introduction

Trauma remains a major global cause of morbidity and mortality, particularly among adolescents and young adults (1, 2). According to the World Health Organization's 2023 Global Status Report, road traffic injuries continue to be the leading cause of death among individuals aged 5–29 years (2). Traumatic out-of-hospital cardiac arrest (TOHCA), defined as cardiac arrest resulting from blunt, penetrating, or burn-related injuries occurring outside healthcare facilities (3), represents one of the most severe consequences of trauma. Despite advancements in prehospital care and resuscitation strategies, survival to hospital discharge among TOHCA patients remains exceedingly low, with reported rates ranging from 0% to 11% (4-11).

Most trauma-related deaths occur in the early phase after injury, with a substantial proportion taking place in the prehospital setting and within the first 24–48 hours (12-16). During this critical period, hemorrhage, and traumatic brain injury (TBI) constitute the leading causes of mortality (12, 14-16). In well-established trauma systems, the implementation of damage-control resuscitation and hemostatic interventions has contributed to a reduction in hemorrhage-related deaths (16). However, TBI remains a predominant cause of mortality across all phases of trauma care, particularly beyond the first day, accounting for approximately 40–60% of trauma-related deaths (14-16). Patients with severe TBI may sustain immediate, non-survivable central nervous system (CNS) injuries (12-16) and are highly susceptible to secondary insults such as hypoxia, hypotension, and hypocapnia, each of which in-

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dependently worsens survival outcomes (17, 18). These challenges complicate the prognosis of TBI patients and place significant pressure on emergency medical services (EMS) personnel, who must rapidly evaluate and manage critically injured patients in the prehospital environment (17, 18).

Recent evidence demonstrates that the presence of TBI is strongly associated with poorer outcomes among patients with TOHCA (8, 19). A national multicenter analysis from the German TraumaRegister DGU® reported that severe head injury, defined as an Abbreviated Injury Scale (AIS) score ≥3, was independently associated with increased in-hospital mortality among TOHCA patients who achieved return of spontaneous circulation (ROSC) prior to hospital admission (8). Similarly, a retrospective cohort study using the United States national trauma registry found that head and neck injuries were significantly associated with reduced survival to hospital discharge in TOHCA patients (19).

However, Zhao et al. (2021) reported that favorable outcomes may still be achievable in selected cases. In their study of 42 patients with severe TBI who experienced TOHCA, eight patients survived to hospital discharge. At follow-up conducted six months to one year later, seven of these survivors demonstrated good neurological function. The study further identified that certain initial clinical characteristics, including higher Glasgow Coma Scale (GCS) scores and the presence of bilateral reactive pupils upon arrival at the emergency department (ED), were associated with improved survival and neurological outcomes (20).

Despite these promising findings, the specific prehospital factors that predict survival to hospital admission among TOHCA patients with TBI remain insufficiently understood. Identifying such prognostic factors is essential for strengthening prehospital treatment protocols, promoting evidence-based resuscitation practices, and informing transport decisions for definitive trauma care. Therefore, the primary objective of this study was to identify and evaluate prehospital factors associated with survival to hospital admission in TOHCA patients with TBI using data from Thailand's national EMS registry.

2. Methods

2.1. Study design and setting

We conducted a retrospective cohort study using data from the Information Technology of Emergency Medicine System (ITEMS), Thailand's national EMS informatics platform managed by the National Institute of Emergency Medicine (NIEM).

The ITEMS platform is an informatics system developed by the Information Technology Division of the NIEM in Thailand. Initially piloted in selected provinces in 2009, it was expanded to nationwide implementation in 2011. The system was designed specifically to support dispatch centers through a criteria-based dispatch protocol (21, 22), using the caller's chief complaint and integrating comprehensive data from EMS operations. These data elements include emergency chief complaints, dispatch information, patient characteristics, EMS time intervals, prehospital assessments, interventions, and outcomes such as survival to the ED and survival to hospital admission. The ITEMS registry represents the largest national EMS database in Thailand and is mandated under the Emergency Medicine Act (22).

In Thailand, TOHCA patients typically access the EMS system through the national 1669 emergency number, which connects callers to provincial dispatch centers operating under a criteria-based dispatch (CBD) protocol (22). Using information provided during the emergency call, the ITEMS system generates an Incident Dispatch Code (IDC) and facilitates the deployment of the most appropriate medical response team. Thailand's EMS response teams are stratified into three levels based on anticipated patient acuity and mortality risk: Comprehensive Life Support (CLS), Advanced Life Support (ALS), and Basic Life Support (BLS) teams.

TOHCA patients receive the highest priority within Thailand's EMS system, prompting the simultaneous dispatch of both a BLS team and either a CLS or ALS team (21). The BLS team, expected to arrive within 4 minutes, provides essential basic life support interventions, including chest compressions, basic airway management, oxygen administration, spinal immobilization, and application of an Automated External Defibrillator (AED). The CLS or ALS team, targeted to arrive within 8 minutes, is equipped with advanced life support capabilities and staffed by trained prehospital providers such as paramedics, emergency nurses, and, in some cases, emergency physicians. These advanced teams deliver critical life-saving interventions, including endotracheal tube intubation (ETI), intravenous fluid (IVF) administration, defibrillation, and emergency medication administration, performed by skilled healthcare professionals.

Thailand's national EMS protocol, based on the Anglo-American model (23), follows a scoop-and-run approach, particularly for TOHCA patients. The system emphasizes minimizing on-scene time, with a target of less than 10 minutes, commonly referred to as the "Platinum 10 minutes", before transporting the patient to the nearest appropriate hospital for definitive care (24).

This study received ethical approval from the Committee on Human Rights Related to Research Involving Human Subjects, Faculty of Medicine, Ramathibodi Hospital, Mahidol University (COA No. MURA2024/892). As a retrospective study involving the review of medical records and analysis of fully de-identified data, the requirement for informed consent was waived in accordance with the Declaration of Helsinki (1964) and institutional guidelines.

2.2. Participants

We included all TOHCA patients who were transported by EMS from the scene to the ED, as recorded in the ITEMS registry between January 2012 and December 2022. Patients were eligible if TBI was identified as the cause of TOHCA.

Patients with missing survival outcome data, defined as the absence of documented survival status at ED disposition or hospital admission, were excluded from the analysis.

2.3. Data gathering and outcome measures

Prehospital operational data were extracted from the ITEMS registry, including patient demographics (age and sex), EMS time and distance intervals (response time, on-scene time, transport time, distance to the scene, and distance to the hospital). Information on the mechanism and nature of injury (such as blunt trauma, burn injuries, penetrating injuries, amputation, gunshot wounds, and laceration injuries) was collected, along with bone and joint injuries, including closed fractures, open fractures, and dislocations. Indicators of exsanguination, such as external bleeding, were also recorded. Prehospital interventions, including external bleeding control, ETI, IVF administration, defibrillation, and adrenaline administration, were extracted for analysis. Missing data were handled using complete-case analysis.

In the ITEMS registry, traumatic brain injury (TBI) was defined as a traumatic head injury documented by EMS or emergency physicians, with clinical evidence of brain injury and/or a recorded diagnosis of intracranial injury.

The primary outcome was survival to hospital admission, defined as achieving sustained ROSC in the ED followed by admission to either the inpatient department (IPD) or the intensive care unit (ICU).

2.4. Statistical analysis

All data extracted from the ITEMS registry were analyzed using STATA version 17.0. Descriptive and analytical statistics were applied to examine prehospital prognostic factors, with baseline characteristics presented in tabular format. The study population was categorized into two groups based on survival to ED status. Continuous variables with normal distributions were summarized using means and standard deviations (SD), whereas those with non-normal distributions were reported as medians and interquartile ranges (IQR). Categorical variables were summarized using frequencies and percentages.

To assess the associations between prehospital factors and survival outcomes, Fisher's exact test was used for categorical variables. The Wilcoxon rank-sum test was applied for continuous variables with non-normal distributions, and independent samples t-tests were used for continuous variables that met the assumptions of normality.

Multivariable logistic regression analysis was conducted to identify independent prehospital prognostic factors associated with survival to hospital admission among TOHCA patients with TBI. An exploratory model incorporating all prespecified covariates was fitted. Results are reported as crude odds ratios (cOR) and adjusted odds ratios (aOR), each with corresponding 95% confidence intervals (CIs) and p-values. A p-value of <0.05 was considered statistically significant.

3. Results

3.1. Baseline Characteristics of the studied population

Data from the ITEMS registry was analyzed for the period between January 2012 and December 2022. Over this 11-year period, a total of 46,760 TOHCA patients were identified. Among these, 22,821 patients were documented as having sustained TBI. A total of 5,936 patients were excluded due to missing ED outcome data. The remaining 16,885 patients had complete ED outcome information; of whom 2,872 (17.0%) survived to hospital admission.

The baseline characteristics of the 16,885 patients are summarized in Table 1.

3.2. Univariable analysis

Most participants were male, with no statistically significant difference in sex distribution between the two groups. Patients in the ED survival group were significantly younger than those in the non-survival group, with a mean age of 37.38 ± 17.94 years compared to 39.30 ± 18.91 years (P < 0.001).

The ED survival group had a significantly shorter response time compared with the non-survival group (8 [IQR: 6–12] vs. 9 [IQR: 6–13] minutes, P < 0.001). A greater proportion of patients in the ED survival group achieved a response time of less than 8 minutes (50.62% vs. 46.30%, P < 0.001). In contrast, an on-scene time of less than 10 minutes was associated with a significantly lower likelihood of survival to ED admission (81.20% vs. 86.76%, P < 0.001). No statistically significant differences in transport time were observed between the two groups. The ED survival group had significantly shorter hospital-to-scene distances (5 km [IQR 3–9] vs. 6 km [IQR 3–10], P < 0.001) and scene-to-hospital distances (6 km [IQR: 3–10] vs. 6 km [IQR: 3–11], P < 0.001). Additionally, a greater proportion of patients in the ED survival group had a scene-to-hospital distance of less than 8 kilometers.

Regarding the mechanism of injury, blunt trauma was not significantly associated with survival to hospital admission (92.25% vs. 93.01%, P = 0.183). Among associated injuries, laceration wounds were observed less frequently in the ED survival group than in the non-survival group (70.74% vs. 74.24%, P < 0.001). In contrast, other associated injuries including burn injuries, penetrating injuries, amputations, and gunshot wounds did not show statistically significant differences between the groups. TOHCA patients with TBI who sustained skeletal injuries exhibited markedly lower survival rates, with both closed fractures (29.97% vs. 36.39%, P < 0.001) and open fractures (21.27% vs. 28.37%, P < 0.001) associated with significantly reduced survival to hospital admission. No significant differences were observed regarding dislocations. Additionally, exsanguination-related external bleeding was significantly less common in the ED survival group (30.37% vs. 36.92%, P < 0.001).

Patients who received specific prehospital interventions including external hemorrhage control, administration of IVF, endotracheal intubation, and defibrillation demonstrated significantly higher rates of survival to hospital admission compared with non-survivors (40.89% vs. 34.45%, P < 0.001; 95.5% vs, 93.67%, P = 0.008; 5.85% vs. 2.97%, P < 0.001; and 6.20% vs. 2.99%, P < 0.001, respectively). Additionally, a significantly lower proportion of patients in the survival-to-ED-admission group were managed by advanced life support (ALS) teams compared with non-survivors (88.30% vs. 89.87%, P = 0.013).

3.3. Multivariable analysis

A multivariable logistic regression analysis was performed to identify independent prognostic factors associated with survival to hospital admission in TOHCA patients with TBI, and the results are presented in Table 2.

After adjusting for potential confounders, increasing age was associated with decreased odds of survival to hospital admission (aOR = 0.99, 95% CI: 0.99–0.99, P < 0.001). An on-scene time of less than 10 minutes was also associated with lower odds of survival (aOR = 0.65, 95% CI: 0.53–0.79, P < 0.001). In contrast, longer transport times were associated with increased odds of survival (aOR = 1.01, 95% CI: 1.00–1.03, P = 0.022). Additionally, greater hospital-to-scene distance was associated with decreased odds of survival to hospital admission (aOR = 0.97, 95% CI: 0.95–0.98, P < 0.001).

Regarding the types of injuries, bone and joint injuries including closed fractures, open fractures, and dislocations were all associated with lower odds of survival to hospital admission. Specifically, closed fractures (aOR = 0.55, 95% CI: 0.49–0.62, P < 0.001), open fractures (aOR = 0.51, 95% CI: 0.44–0.59, P < 0.001), and dislocations (aOR = 0.57, 95% CI: 0.41–0.80, P < 0.001) demonstrated significantly reduced survival likelihood.

Notably, several prehospital interventions demonstrated positive associations with survival to hospital admission. These included external bleeding control (aOR = 1.38, 95% CI: 1.20–1.58, P < 0.001), ETI (aOR = 2.09, 95% CI: 1.69–2.57, P < 0.001), IVF administration (aOR = 1.56, 95% CI: 1.24–1.96, P < 0.001), and defibrillation (aOR = 2.05, 95% CI: 1.66–2.53, P < 0.001).

4. Discussion

This national retrospective cohort study examined prehospital prognostic factors independently associated with survival to hospital admission among TOHCA patients with TBI in Thailand. Among patient and operational characteristics, younger age, longer transport times, and shorter hospital-to-scene distances were significantly associated with increased odds of survival. In addition, several life-saving prehospital interventions (external bleeding control, ETI, IVF administration, and defibrillation) were independently associated with improved survival. Conversely, an on-scene time of less than 10 minutes and the presence of bone and joint injuries were associated with significantly decreased survival to hospital admission. These findings suggest that, for TOHCA patients with TBI, prioritizing essential life-saving interventions during an adequate on-scene period may be more beneficial than rapid scene departure alone, underscoring the importance of a balanced approach between timely interventions and timely transport in the prehospital phase.

The survival-to-hospital-admission rate in our cohort, specifically examining the subgroup of TOHCA patients with TBI, was 17.0%. This rate is slightly lower than the 19% survival-to-discharge rate reported by Zhao et al. (2021) among TOHCA patients with severe TBI, although their study applied stricter exclusion criteria, such as excluding patients who experienced cardiac arrest after hospital arrival or those whose arrest was medically induced (20). Despite this variation, the presence of TBI among TOHCA patients is consistently associated with poorer survival outcomes across multiple studies (8, 19).

When compared with general TOHCA populations, the survival-to-admission rate observed in our study is higher than the 14.4% reported in a 10-year London registry study by Lockey et al. (2006), which included TOHCA patients who were pronounced dead at the scene and therefore not transported to the hospital (4). Our rate is also substantially higher than the 0% survival reported in a 3-month multicenter study from Karachi, Pakistan, where prehospital cardiopulmonary resuscitation (CPR) and life-saving interventions were performed in only 1.1% and 1.6% of TOHCA cases, respectively (7). In contrast, a study from a level 1 trauma center in Sweden demonstrated a higher survival-to-admission rate of 29.9%, supported by a well-developed trauma care system with frequent use of resuscitative thoracotomy in TOHCA management (9). These wide variations in survival outcomes across studies likely reflect differences in inclusion and exclusion criteria, definitions of survival endpoints, prehospital care capacity, and the overall maturity of trauma systems (5, 8, 9, 19).

Several prehospital prognostic factors independently influenced survival outcomes among TOHCA patients with TBI. Increasing age was associated with reduced survival, consistent with previous findings in TOHCA populations (8, 19). This association may be explained by diminished physiological reserve, a higher burden of comorbidities, and reduced tolerance to secondary insults such as hypoxia and hypotension (25), both of which are strong independent predictors of mortality following TBI (17, 18).

With respect to operational factors, longer on-scene times (>10 minutes) were associated with increased odds of ED survival. In patients with TBI-related TOHCA, prehospital interventions such as external bleeding control, ETI, IVF administration, and defibrillation may prolong on-scene time; however, these interventions were associated with improved survival to ED admission in our study. Importantly, this study was conducted in a middle-income country with a structured EMS system, which may influence the balance between on-scene resuscitation and rapid transport. These findings suggest that excessively rapid evacuation without adequate stabilization may adversely impact outcomes, underscoring the importance of balancing timely transport with essential on-scene resuscitative efforts (7, 26, 27).

However, shorter hospital-to-scene distances were independently associated with improved survival outcomes. In terms of injury patterns, closed fractures, open fractures, and dislocations were all independently associated with reduced odds of survival in our cohort. Certain bone and joint injuries (particularly open fractures, axial skeleton fractures, and pelvic fractures) often indicate high-energy mechanisms of injury (27), which are strongly associated with higher injury severity scores, multisystem trauma, and severe hemorrhagic shock (26).

Although major hemorrhage accounts for approximately 30%–50% of trauma-related deaths (12, 14-16) and remains a critical determinant of survival, particularly among patients with TBI, where hemorrhagic shock can exacerbate secondary brain injury (17, 18), our regression analysis found that the presence of external bleeding was not independently associated with survival outcomes. This may be explained by the broad categorization of "external bleeding" in the dataset, which included both minor and major bleeding, thereby diluting its prognostic specificity. Additionally, the timely application of bleeding control measures may have mitigated the expected negative impact of external bleeding on survival.

Importantly, our study demonstrated that effective prehospital external bleeding control interventions were independently associated with improved survival among TOHCA patients with TBI. This finding aligns with prior evidence showing that timely tourniquet application significantly reduces mortality in patients with major extremity vascular injuries (28).

In TOHCA patients with TBI, who are highly vulnerable to secondary brain insults (17, 18), prompt correction of reversible causes of cardiac arrest such as hypoxia and hypovolemia should take priority over chest compressions (29, 30). In our study, ETI was associated with a twofold increase in the odds of survival, consistent with previous findings (31). This underscores the critical importance of correcting hypoxia, which may result from airway obstruction, inadequate ventilation, or traumatic asphyxia. However, one observational cohort reported decreased survival among TOHCA patients who received advanced airway interventions (5), including supraglottic airways and ETI, likely reflecting confounding by indication, whereby more severely injured patients were preferentially selected for advanced airway procedures.

The profound hypovolemia associated with major hemorrhage limits the effectiveness of standard CPR in TOHCA patients (32). Accordingly, current recommendations emphasize early administration of blood products, alongside hemorrhage control, to reverse hypovolemia during resuscitation (29, 30). In Thailand, blood products are not yet available in the prehospital setting. Consequently, IVF used as a surrogate for early volume resuscitation were independently associated with improved survival in our analysis. This finding aligns with results from a German national registry study (8), although another observational cohort found no significant association between prehospital IVF administration and survival among TOHCA patients (5), possibly due to limited statistical power or heterogeneity in resuscitation protocols.

Regarding adrenaline use, our study found no association between prehospital adrenaline administration and survival among TOHCA patients with TBI. In contrast, previous national cohort data and a post-hoc analysis of a multicenter prospective cohort demonstrated that adrenaline administration was independently associated with decreased survival outcomes in TOHCA populations (11, 33).

In TOHCA patients, initial shockable rhythms are relatively uncommon, with reported prevalence ranging from approximately 1% to 11% (6, 8-10). By comparison, shockable rhythms are more frequently observed in non-traumatic OHCA, with rates ranging from 4.1% to 19.8% in systematic reviews from Asia (34), and a prevalence of 19.2% reported in a U.S. study included in the same review (35). In our study, initial rhythm data were unavailable; therefore, we used defibrillation attempts as a surrogate indicator of shockable rhythm. Defibrillation was independently associated with improved survival among TOHCA patients with TBI, consistent with findings from previous research (8, 10, 11). Some TOHCA patients may develop malignant ventricular arrhythmias precipitated by sympathetic hyperactivity, a physiological response correlated with the severity of TBI (36), and these arrhythmias may be promptly reversed with timely defibrillation.

A key strength of this study is the use of an 11-year national, standardized EMS dataset from Thailand, which provides consistent documentation, high data reliability, and strong generalizability. Additionally, this study specifically focuses on the TBI subgroup of TOHCA patients, a population that remains underrepresented in the existing literature despite its substantial contribution to overall mortality in TOHCA.

5. Limitations

Several limitations of this study should be acknowledged. First, the retrospective cohort design precludes the establishment of causal relationships and may leave residual confounding despite multivariable adjustment. Information bias arising from the retrospective review of the ITEMS registry represents a major limitation of this study, as the accuracy of the recorded data could not be independently verified or corrected. Second, the ITEMS registry lacks several clinically important variables that could influence mortality in TOHCA patients with TBI, including injury severity score (ISS), bystander CPR, severity of external bleeding, whether the cardiac arrest was witnessed, initial rhythm, and prehospital procedures such as needle thoracostomy. Third, the study reports only survival to hospital admission, which likely underestimates the true mortality burden of TOHCA, particularly in the TBI subgroup, where death may occur later in the clinical course compared with other causes of traumatic arrest (15, 16). Finally, the study population included only TOHCA patients with TBI who were transported by EMS, excluding those pronounced dead at the scene. This introduces survivorship bias and likely underestimates the overall mortality associated with TOHCA.

6. Conclusions

The findings demonstrate that adequate on-scene time and the prompt delivery of critical prehospital interventions, including external bleeding control, ETI, IVF administration, and defibrillation, were independently associated with improved survival to hospital admission.
Among TOHCA patients with TBI, early survival is strongly influenced by both operational factors and critical prehospital interventions. Findings highlight the importance of allocating sufficient on-scene time for essential life-saving procedures rather than prioritizing rapid transport alone. Strengthening airway management, hemorrhage control, and early resuscitation capabilities within EMS systems may improve survival outcomes in this highly vulnerable population.

7. Declarations

7.1. Acknowledgments

The authors gratefully acknowledge the National Institute for Emergency Medicine (NIEM) for granting access to the data used in this study.

7.2. Authors' contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work. All authors read and approved the final version of manuscript.

7.3. Funding/Support

No funding was obtained for this study.

7.4. Ethical considerations

This study was approved by The Committee on Human Rights Related to Research, Faculty of Medicine, Ramathibodi Hospital, Mahidol University (IRB COA. MURA2024/892).

7.5. Availability of data and material

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

7.6. Competing interests

The authors declare that they have no competing interests.

7.7. Using artificial intelligence chatbots

During the preparation of this work the authors used ChatGPT4.0 and Grammarly's AI in order to check and correct grammatical errors during the manuscript writing process. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Table 1: Comparing the baseline characteristics of traumatic out-of-hospital cardiac arrest (TOHCA) patients with traumatic brain injury (TBI) between patients with and without emergency department (ED) survival

Prognostic factor	**ED survival (n = 16885)**		**P value**
	Yes (n=2,872)	**No (n=14,013)**	
Sex			
Male	2,203 (78.90)	10,843 (79.30)	0.645
Age (years)			
Mean ± SD	37.38 ± 17.94	39.30 ± 18.91	<0.001
Time of operation (min)			
Response time	8 (6–12)	9 (6–13)	<0.001
Response time ≤ 8 minutes	1,437 (50.62)	6,427 (46.30)	<0.001
On-scene time	5 (3–10)	5 (3–8)	<0.001
On-scene time ≤ 10 minutes	2,328 (81.20)	12,142 (86.76)	<0.001
Transport time	7 (4–10)	7 (4–10)	0.321
Distance (km)			
Hospital to scene	5 (3–9)	6 (3–10)	<0.001
Scene to hospital	6 (3–10)	6 (3–11)	<0.001
Scene to hospital ≤ 8 kilometer	1,950 (67.90)	8,874 (63.33)	<0.001
Nature of trauma			
Blunt injury	2,273 (92.25)	11,358 (93.01)	0.183
Associated injuries			
Burn injury	10 (0.41)	60 (0.49)	0.748
Penetrating injury	10 (0.41)	37 (0.30)	0.432
Amputation	2 (0.08)	23 (0.19)	0.417
Gunshot wounds	28 (1.14)	90 (0.74)	0.248
Laceration wounds	1,743 (70.74)	9,066 (74.24)	<0.001
Bone and joint injuries			
Closed fracture	668 (29.97)	4,162 (36.39)	<0.001
Open fracture	474 (21.27)	3,245 (28.37)	<0.001
Dislocation	54 (2.42)	307 (2.68)	0.516
Exsanguination bleeding			
External bleeding	705 (30.37)	4,293 (36.92)	<0.001
Prehospital procedure			
Stop external bleeding	949 (40.89)	4,005 (34.45)	<0.001
ETT intubation	166 (5.85)	412 (2.97)	<0.001
IV fluid administration	2,363 (95.05)	11,571 (93.67)	0.008
Defibrillation	178 (6.20)	419 (2.99)	<0.001
Adrenaline use	786 (27.37)	3,991 (28.48)	0.237
Operation level			
Advanced life support	2,535 (88.30)	12,594 (89.87)	0.013

Data are presented as mean ± standard deviation (SD), frequency (%) or median (IQR). IQR: interquartile range, km: kilometer, ETT: Endotracheal tube, IV: intravenous.

Table 2: Multivariable logistic regression analysis of independent prognostic factors of emergency department (ED) survival in traumatic out-of-hospital cardiac arrest (TOHCA) patients with traumatic brain injury (TBI)

Prognostic factor	cOR (95% CI)	P-value	aOR (95% CI)	P-value
Sex				
Male	1.02 (0.93–1.13)	0.636	1.09 (0.97–1.23)	0.144
Age (year)				
Age	0.99 (0.99–1.00)	<0.001	0.99 (0.99–0.99)	<0.001
Time of operation (min)				
Response time	0.98 (0.98–0.99)	<0.001	1.00 (0.98–1.00)	0.491
Response time < 8 minutes	1.19 (1.10–1.29)	<0.001	0.99 (0.86–1.14)	0.929
On-scene time	1.02 (1.01–1.03)	<0.001	1.00 (1.00–1.02)	0.115
On-scene time < 10 minutes	1.42 (1.29–1.55)	<0.001	0.65 (0.53–0.79)	<0.001
Transport time	1.00 (0.99–1.00)	0.231	1.01 (1.00–1.03)	0.022
Distance (km)				
Hospital to the scene	0.97 (0.96–0.98)	<0.001	0.97 (0.95–0.98)	<0.001
Scene to hospital	0.98 (0.98–0.99)	<0.001	1.00 (0.98–1.02)	0.682
Scene to hospital < 8 km	1.22 (1.12–1.33)	<0.001	1.02 (0.86–1.22)	0.810
Nature of trauma				
Blunt wound	0.89 (0.76–1.05)	0.182	1.08 (0.86–1.35)	0.521
Associated injuries				
Burn	0.83 (0.42–1.61)	0.575	0.59 (0.26–1.36)	0.220
Penetrating	1.34 (0.67–2.70)	0.411	1.22 (0.55–2.69)	0.623
Amputation	0.43 (0.10–1.83)	0.253	0.68 (0.15–3.05)	0.617
Gunshot wounds	1.54 (1.01–2.37)	0.045	1.06 (0.59–1.88)	0.848
Laceration wounds	0.84 (0.76–0.92)	<0.001	0.97 (0.85–1.11)	0.651
Bone and joint injuries				
Closed fracture	0.74 (0.68–0.83)	<0.001	0.55 (0.49–0.62)	<0.001
Open fracture	0.68 (0.61–0.76)	<0.001	0.51 (0.44–0.59)	<0.001
Dislocation	0.90 (0.67–1.20)	0.481	0.57 (0.41–0.80)	0.001
Exsanguination bleeding				
External bleeding	0.74 (0.68–0.82)	<0.001	0.96 (0.83–1.11)	0.595
Prehospital procedure				
Stop external bleeding	1.32 (1.20–1.44)	<0.001	1.38 (1.20–1.58)	<0.001
ETT intubation	2.02 (1.69–2.44)	<0.001	2.09 (1.69–2.57)	<0.001
IV fluid administration	1.30 (1.07–1.58)	<0.001	1.56 (1.24–1.96)	<0.001
Defibrillation	2.14 (1.79–2.57)	<0.001	2.05 (1.66–2.53)	<0.001
Adrenaline use	0.95 (0.86–1.04)	0.228	0.94 (0.84–1.04)	0.265
Level operation				
ALS	0.85 (0.75–0.96)	0.012	0.98 (0.21–4.55)	0.977

Data are presented with 95% confidence interval (CI). km: kilometer, ETT: Endotracheal tube, IV: intravenous, ALS: advanced life support; cOR: crude Odds ratio; aOR: adjusted Odds ratio.

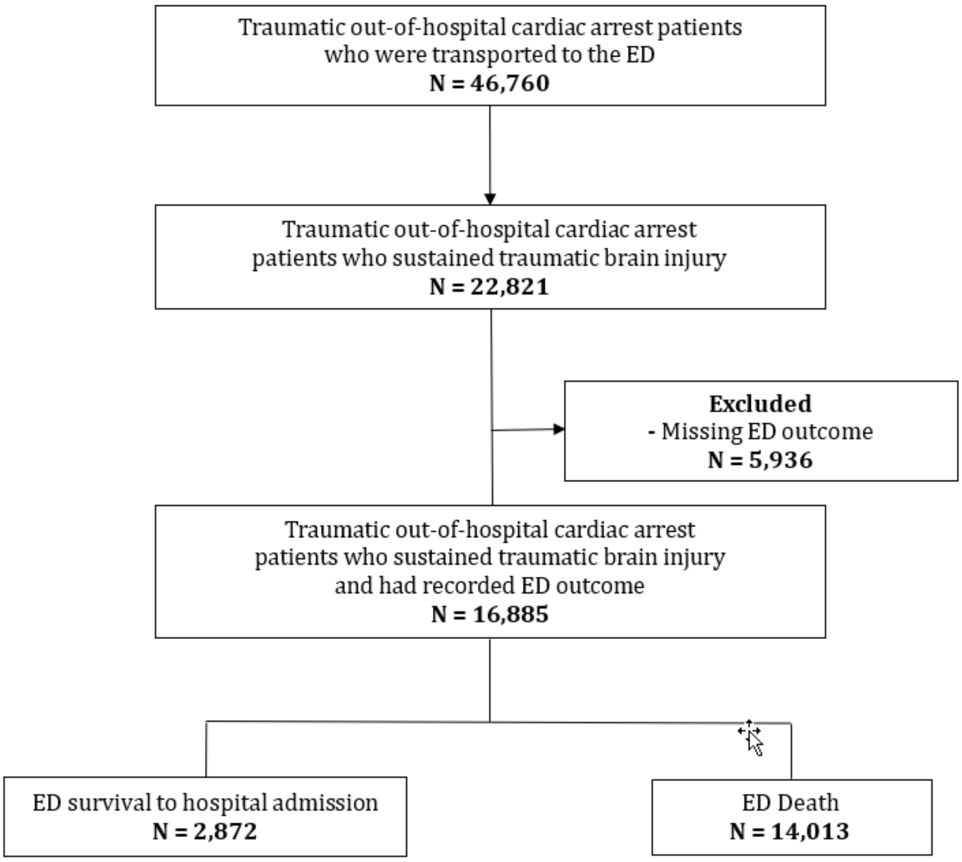

Figure 1: Study flowchart of patients' inclusion. ED: emergency department.