Archives of Academic Emergency Medicine. 2025; 13(1): e15

OPEN ACCESS

ORIGINAL RESEARCH

Pre-hospital Associated Factors of Survival in Traumatic Out-of-hospital Cardiac Arrests: An 11-Year Retrospective Cohort Study

Thanakorn Laksanamapune[1], Chaiyaporn Yuksen[1]*, Natthaphong Thiamdao[1]

1. Department of Emergency Medicine, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok 10400, Thailand.

Received: August 2024; Accepted: September 2024; Published online: 31 October 2024

Abstract: **Introduction:** Traumatic out-of-hospital cardiac arrest (TOHCA) presents significant public health challenges. The high accident rates and variability in prehospital management in Thailand further complicate TOHCA treatment. This study aimed to analyze prehospital prognostic factors of survival in TOHCA cases. **Methods:** This study is a retrospective cohort study utilizing data from the Information Technology of Emergency Medicine System (ITEMS) from January 2012 to December 2022. It included TOHCA patients who received prehospital care and were transported to the emergency department (ED). We used an exploratory approach, incorporating all prognostic variables into a multivariable logistic regression model. Results are presented as odds ratios (OR) with 95% confidence intervals (CIs) and p-values. **Results:** Over an 11-year period, 35,724 patients with the mean age of 39.69±20.53 (range: 1-99) years were included in the final analysis (78.69% male). Of these, 6,590 (18.45%) survived to hospital admission, while 29,134 (81.55%) died in the ED. Prehospital management factors significantly increasing the likelihood of survival to hospital admission included stopping bleeding (OR=1.38, 95% CI=1.24-1.54, P<0.001), endotracheal intubation (ETT) (OR=2.09, 95% CI=1.74-2.50, P<0.001), intravenous fluid administration (OR=1.66, 95% CI=1.35-2.05, P<0.001), defibrillation (OR = 2.35, 95% CI=1.96-2.81, P<0.001), age (aOR = 0.99, 95% CI = 0.98-0.99, P < 0.001), closed fracture (aOR = 0.59, 95% CI = 0.53-0.66, P < 0.001), open fracture (aOR = 0.54, 95% CI = 0.48-0.61, P < 0.001), dislocation (aOR = 0.60, 95% CI = 0.45-0.81, P = 0.001), and on scene time <10 min (aOR = 0.63, 95% CI = 0.54-0.75, P < 0.001). **Conclusion:** To improve survival to hospital admission in TOHCA, several factors should be prioritized. These include administering intravenous fluid boluses, controlling external bleeding, delivering defibrillation when indicated, and performing ETT.

Keywords: Wounds and Injuries; Out-of-hospital cardiac arrest; Emergency Medical Services; Emergency Service, Hospital; Advanced Trauma Life Support Care; Prognosis

Cite this article as: Laksanamapune T, Yuksen C, Thiamdao N. Pre-hospital Associated Factors of Survival in Traumatic Out-of-hospital Cardiac Arrests: An 11-Year Retrospective Cohort Study. Arch Acad Emerg Med. 2025; 13(1): e15. https://doi.org/10.22037/aaem.v13i1.2458.

1. Introduction

Traumatic out-of-hospital cardiac arrest (TOHCA) represents a significant public health concern due to its poor survival rates globally (1, 2). TOHCA presents unique challenges for emergency medical services (EMS), with survival rates significantly lower than non-traumatic OHCA.

Recent studies have reported improved survival rates ranging from 5.7% to 7.5 %, comparable to non-traumatic OHCA (3-6). According to a global report from the World Health Organization (WHO) in 2023, there were 1.3 million deaths attributable to traffic accidents, with an average of 155 fatalities per hour. Traffic injuries are also a leading cause of death among individuals aged 5 to 29 years (7). In the United States, traffic accidents are the most common cause of death for individuals aged 1 to 44 years. The majority of TOHCA patients are young, with an average age of 39 to 40 years, predominantly male (79%), and most injuries are caused by blunt trauma (67-68%) (8).

Several studies have investigated the prognostic factors for TOHCA, including the mechanism of injury, the time to first medical contact, pre-hospital intervention, and the patient's physiological status upon EMS arrival (9-11). Studies have highlighted the importance of rapid and effective pre-hospital interventions, such as advanced airway management, intravenous (IV) fluid administration, and timely transportation to definitive care facilities. Additionally, bystander cardiopulmonary resuscitation (CPR) and the use of automated external defibrillators (AEDs) have been shown to improve outcomes in non-traumatic OHCA, but their impact on TOHCA remains less well established (12-14).

Research conducted in ASEAN countries has provided insights into the prognostic factors associated with survival in TOHCA. A study in Japan found that pre-hospital epinephrine administration was associated with increased survival rates in TOHCA patients (15). Another study in Korea identified the presence of a shockable rhythm and early defibrillation as significant predictors of survival (16). However,

*Corresponding Author: Chaiyaporn Yuksen; Department of Emergency Medicine, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, 270 Rama VI Road, Thung Phaya Thai, Ratchathewi, Bangkok 10400, Thailand. E-mail: chaipool0634@hotmail.com, ORCID: https://orcid.org/0000-0002-4890-7176.

the applicability of these findings to the Thai context requires careful consideration due to differences in EMS systems, injury patterns, and healthcare infrastructure.

Thailand's EMS system was officially established under the Emergency Medicine Act B.E. 2551 in 2008 and is administered by the National Institute for Emergency Medicine (NIEM), a national regulatory body. Initially, Thailand's EMS system was hospital-based and categorized into three operational levels: First Responder (FR), Basic Life Support (BLS), and Advanced Life Support (ALS). The team leaders at each level are FR, Emergency Medical Technician (EMT)-Basics, and nurses, paramedics, or doctors, respectively. This approach focuses on initial on-scene resuscitation and rapid transportation of the patient to the nearest appropriate medical facility and performing resuscitation in the emergency department (ED), particularly for out-of-hospital trauma patients (17, 18).

Over the past ten years, there have been significant developments in Thailand's EMS system. Emergency physicians (EPs), paramedics, and emergency nurse practitioners (ENPs) have been trained to serve as team leaders in Comprehensive Life Support (CLS) and ALS operations.

The development of offline and online medical protocols has improved the quality of managing various medical conditions. In prehospital trauma care, ongoing training and adherence to the principles of Prehospital Trauma Life Support (PHTLS) remain the main guidelines for managing trauma patients outside of hospitals, continuing to the present day.

According to a WHO report, Thailand has the ninth-highest accident rate in the world and the highest number of deaths from traffic accidents in Southeast Asia, with a rate of 32.7 deaths per 100,000 population (7). The unique demographic and geographic characteristics of Thailand pose additional challenges to the management of TOHCA. The diverse landscape, which includes urban centers and remote rural areas, significantly affects the accessibility and response times of EMS providers. Furthermore, the variation in training and resources among EMS personnel across different regions may influence the quality of pre-hospital care.

Therefore, a comprehensive analysis of pre-hospital prognostic factors specific to the Thai context is essential for tailoring interventions and improving survival outcomes in TOHCA patients. This study aimed to identify and evaluate the pre-hospital prognostic factors associated with survival in TOHCA patients in Thailand, using a national database for the analysis.

2. Methods

2.1. Study design and setting

This study is a retrospective cohort study on the associated factors of survival in TOHCA cases. We utilized the national database from the Information Technology of Emergency Medicine System (ITEMS) program of NIEM. Under Thailand's Emergency Medicine Act, recording critical data on out-of-hospital emergency operations in the ITEMS database has been mandatory since 2012. Subsequently, this information is forwarded to NIEM to be included in the national database and used for the reimbursement of operational expenses. Therefore, our research data collection began in 2012, the first year the ITEMS program was implemented.

This study was approved by the Faculty of Medicine, Committee on Human Rights Related to Research Involving Human Subjects, Ramathibodi Hospital, Mahidol University (COA. NO MURA2023/833). The ethics committee did not require consent for this research since only medical records were reviewed, and a statement covering patient data confidentiality and compliance with the Declaration of Helsinki was deemed sufficient.

2.2. Participants

The data obtained from the ITEMS program encompass out-of-hospital emergency operations throughout Thailand. We collected retrospective data on TOHCA patients from the ITEMS program database over an 11-year period, from January 2012 to December 2022. We included all TOHCA patients from the ITEMS program who received prehospital care and transport to the ED, including those attended by both basic and ALS teams. We excluded TOHCA patients who did not have recorded survival outcomes in the ED.

2.3. Data gathering and outcome measures

The study variables of on-scene physiological parameters were recorded to calculate operational times (response time, on-scene time, transport time) and distances (hospital to scene, scene to hospital). The nature of trauma, such as blunt wounds, burns, stab wounds, amputations, and gunshot wounds (GSW), was documented, along with types of fractures (closed fracture, open fracture, dislocation) and exsanguination (external bleeding). The location of injuries was categorized by body regions (head/neck, face, spine, chest/clavicle, abdomen, pelvis, extremity, multiple injuries). Prehospital procedures, including bleeding control, endotracheal intubation (ETI), intravenous (IV) fluid administration, AED/defibrillation use, and adrenaline use, were also recorded. Additionally, the level of operation (ALS, BLS) was noted.

We collected the outcome of ED survival from the recordings in the ITEMS program. Patients who were admitted to the inpatient department (IPD) or intensive care unit (ICU) were categorized in the ED survival group. Conversely, patients who were not admitted or died in the ED were categorized as ED deaths.

2.4. Definitions

Traumatic out-of-hospital cardiac arrest (TOHCA) is defined as cardiac arrest directly caused by external injuries at the scene, such as traffic accidents, falls, collisions, stab wounds, and GSW (16).

Response time is the duration from the time the EMS team is

notified until they arrive at the incident scene (19).

On scene time refers to the duration the EMS team spends at the location of the incident before transporting the patient to a hospital or appropriate facility (20).

Transport time is the duration it takes to transport a patient from the incident scene to the hospital (21).

ED survival refers to the patients who have achieved a sustained return of spontaneous circulation (ROSC) after receiving emergency treatment in the ED and are subsequently admitted to the IPD or ICU (22).

ED death refers to patients who, after receiving emergency treatment, did not achieve ROSC (22).

2.5. Statistical analysis

All study prognostic variables were compared between ED survival and death groups. Exact probability tests were used for categorical variables presented with frequency and percentage. For continuous variables, Student's t-test was used; these variables are presented as median and interquartile range for non-normally distributed variables and as mean ± standard deviation (SD) for normally distributed variables.

Data were analyzed using STATA version 16.0. Multivariable logistic regression was employed to evaluate the independent predictors of ED survival. An exploratory model was used to include all prognostic variables in the multivariable logistic regression model. Results are presented as adjusted odds ratios (aORs), with 95% confidence intervals (CIs) and P-values. A P-value of less than 0.05 was considered statistically significant. Since the data were collected through a retrospective review, we used a complete case analysis model to handle missing data without employing any imputation methods.

The sample size for our study was calculated based on the study by Kuo IM et al. (23) which enrolled TOHCA patients brought to the hospital by EMS. We used STATA version 16.1, with a significance level (α) of 0.05 and a power of 0.90. The survival rate of TOHCA patients in the ED was 10.7%. The sample size ratio was set at 1:10. All prognostic variables affecting ED survival were considered in the formula to calculate the sample size. The variable "blunt injury" showed the smallest difference between the two groups, with rates of 97.7% and 98.0% in the ED survival and death groups, respectively (p = 0.600). The minimal sample size required was 2,813 in the ED survival group and 28,130 in the ED death group. Based on this sample size calculation, we aimed to conduct a retrospective study covering 11 years to ensure an adequate sample size.

3. Results

During the study period (January 2012 to December 2022), 46,760 TOHCA patients sent to the ED met the eligibility criteria and were included. However, 11,036 patients were excluded due to missing ED outcome variables. Consequently, 35,724 patients with the mean age of 39.69±20.53 (range: 1-99) years were included in the final analysis (78.69% male). Among the TOHCA patients, 6,590 (18.45%) survived to hospital admission, while 29,134 (81.55%) died in the ED (as shown in Figure 1: Study Flowchart).

3.1. 11-Year trends in survival of TOHCA patients in Thailand

The overall average number of TOHCA patients who received resuscitation at the scene and were transported to the ED in Thailand over an 11-year period showed an increasing trend from 2012 to 2019. However, from 2019 to 2022, this trend reversed and showed a decline, as illustrated in Figure 2. This figure depicts the number of TOHCA patients who received resuscitation at the scene and were transported to the ED, including those with and without recorded outcomes in the ED. Data collected over an 11-year period in Thailand showed that the overall ED survival to admission rate for TOHCA patients who received resuscitation at the scene and were transported to the ED was approximately 18.4%. From 2012 to 2014, the survival rate remained stable at around 25%. However, from 2015 to 2022, the average survival rate dropped to approximately 17% and showed a declining trend over the past eight years, as illustrated in Figure 3.

3.2. Baseline prognosis factors of TOHCA survival

Baseline prognostic factors for TOHCA survival are shown in Table 1, which divides patients into ED survival and ED death groups. Out of the total, 6,590 patients (18.45%) had an ED survival outcome, while 29,134 patients (81.55%) had an ED death outcome. TOHCA patients who survived in the ED were significantly younger than those who did not survive (36 years [23-52] vs. 39 years [23-56], P-value <0.001).

The nature of trauma showed no statistically significant differences between two groups. Regarding fracture types, TOHCA patients with fractures, whether closed or open, had a higher rate of ED death (26.69% and 32.32%, P-value <0.001 for closed fractures; 19.08% and 24.60%, P-value <0.001 for open fractures). However, dislocations showed no statistically significant differences between the two groups.

Regarding the location of injury, we found that TOHCA patients with chest and abdominal injuries had higher rates of ED death, with chest injuries at 7.70% compared to 5.40% (P-value <0.001) and abdominal injuries at 1.29% compared to 1.27% (P-value = 0.045). For injuries in other locations, there were no statistically significant differences between the two groups.

TOHCA patients who received external hemorrhage control, ETT intubation, prehospital AED or defibrillation, and ALS level of prehospital care had higher survival rates in the ED. Specifically, the survival rates were 35.46% vs. 30.49% (P-value <0.001) for external hemorrhage control, 5.44% vs. 3.08% (P-value <0.001) for ETT intubation, 5.14% vs. 2.27% (P-value <0.001) for prehospital AED or defibrillation, and 11.31% vs. 5.62% (P-value <0.001) for ALS level of prehospital care. However, we found that TOHCA patients who re-

ceived adrenaline and IV fluid administration showed no statistically significant difference in survival rates.

We found that a response time of less than 8 minutes results in a higher survival rate for TOHCA patients (52.57% vs. 45.60%, P-value <0.001). Additionally, an on-scene time of more than 10 minutes resulted in a higher survival rate (85.53% vs. 80.29%, P-value <0.001).

However, for transport time, the study found no significant difference between ground transport times. Over the past 11 years, the response time, on-scene time, and transport time for emergency medical operations involving TOHCA patients in Thailand have consistently averaged within the standard benchmarks of no more than 8 minutes, 10 minutes, and 10 minutes, respectively. The trend over this period has remained stable, as shown in Figure 4. The average distance from the hospital base to the scene differed by 1 km between the two groups, as did the distance from the scene to the hospital (5 km [3-9] vs. 6 km [3-10], P-value <0.001; 6 km [3-11] vs. 7 km [4-12], P-value <0.001). However, when we set the cutoff distance at less than 8 km, we found that patients had a higher rate of ED survival when transported to hospitals within 8 km compared to those transported to hospitals farther than 8 km (64.28% vs. 59.97%, P-value <0.001).

3.3. Multivariable logistic regression

The results of the multivariable logistic regression analysis are shown in Table 2. Prognostic variables in the prehospital setting that increased the likelihood of ED survival to hospital admission in TOHCA patients include: stopping bleeding (aOR = 1.38, 95% CI = 1.24-1.54, P < 0.001), ETT intubation (aOR = 2.09, 95% CI = 1.74-2.50, P < 0.001), IV fluid administration (aOR = 1.66, 95% CI = 1.35-2.05, P < 0.001), and prehospital AED/defibrillation (aOR = 2.35, 95% CI = 1.96-2.81, P < 0.001), as well as age (aOR = 0.99, 95% CI = 0.98-0.99, P < 0.001), closed fracture (aOR = 0.59, 95% CI = 0.53-0.66, P < 0.001), open fracture (aOR = 0.54, 95% CI = 0.48-0.61, P < 0.001), dislocation(aOR = 0.60, 95% CI = 0.45-0.81, P = 0.001), and on scene time <10 min (aOR = 0.63, 95% CI = 0.54-0.75, P < 0.001).

With each additional year of age, the likelihood of ED survival to hospital admission for TOHCA patients decreased by 1% (P < 0.001). Additionally, TOHCA patients with bone injuries showed a significantly lower likelihood of ED survival to hospital admission. Specifically, this included closed fractures (aOR = 0.59, 95% CI = 0.53-0.66, P < 0.001), open fractures (aOR = 0.54, 95% CI = 0.48-0.61, P < 0.001), and dislocations (aOR = 0.60, 95% CI = 0.45-0.81, P = 0.001).

Additionally, response time and transport time did not significantly increase the likelihood of ED survival to hospital admission in TOHCA patients. However, an on-scene time of less than 10 minutes without performing necessary life-saving interventions significantly reduced the likelihood of ED survival to hospital admission (aOR = 0.63, 95% CI = 0.54-0.75, P < 0.001).

4. Discussion

In this study, we found that prehospital management strategies that significantly increased the likelihood of ED survival to hospital admission included controlling bleeding, performing ETT, administering intravenous fluids, and delivering defibrillation when indicated.

Prehospital management of TOHCA patients, through emergency care providers prioritizing the quality of chest compressions, monitoring the electrocardiogram (ECG) for shockable rhythms, and performing defibrillation when indicated, is crucial. If an AED or defibrillator is available, it should be used immediately to detect the shockable rhythm. Further treatments include ETT intubation, IV fluid administration, and stopping external bleeding from exsanguinating wounds. Additionally, managing TOHCA patients using the "scoop and run" principle alone, without performing appropriate life-saving interventions and spending less than 10 minutes at the scene, further decreases the chances of survival.

Although prehospital emergency medicine has advanced significantly, such as the emergency medical team at Ramathibodi Hospital in Bangkok, Thailand, which includes paramedics and EPs and employs point-of-care ultrasound (POCUS), point-of-care (POC) laboratory tests and life-saving procedures starting in the prehospital setting, the overall survival to hospital discharge for TOHCA patients remains very low, at approximately 2% (24). In contrast, data from North America, Spain, and England prehospital trauma registries report survival rates of approximately 5.7% to 7.5% (5, 6, 8). In Thailand, due to current limitations in data collection, only the data on ED survival to admission for TOHCA patients are available, rather than survival to hospital discharge (25).

The overall ED survival to admission of TOHCA patients in Thailand was approximately 18.4%, compared to 16% for patients who survived during ED resuscitation (26) and 10.7% survival to ED discharge in Taiwan (23). Study from EMS agencies across the US found that 14.6% of TOHCA patients had ROSC at the ED (27). In contrast, a study in Spain reported an ED survival rate of 49.1% and a complete neurologic recovery rate of 6.6% (6).

The first step of care in TOHCA is stabilization of the airway. Our study demonstrates that ETT intubation increases the odds of ED to hospital admission by 2.09 times. However, our findings differ from other studies, which have shown no significant difference in ROSC or ED survival to admission (23) between those with and without ETT intubation, and some studies have even reported a decrease in ROSC among those with ETT intubation (8). Conversely, in non-TOHCA cases, it is well known that prehospital ETT increases the chances of ROSC and improves neurological outcomes (28). We suggest that in TOHCA patients, if the prehospital emergency team has the competency to perform ETT intubation (paramedic or EP), they should not delay the procedure. In our study, 80.5% (28,751/35,724) of TOHCA patients received care by an

ALS team at the scene (as shown in Figure 5), which typically includes a team leader who is a paramedic, emergency nurse practitioner, or EP, all of whom are competent to perform ETT intubation in the prehospital setting. If the prehospital emergency team cannot perform ETT intubation, it is recommended to use other appropriate airway management devices to assist with ventilation.

The primary cause of death in TOHCA patients is brain injury, which currently lacks definitive treatment options in the prehospital setting (29).

The primary causes of TOHCA are exsanguination and internal blood loss in the abdominal, thoracic, and pelvic cavities, leading to reduced venous return and cardiac output (30, 31). Performing resuscitation on TOHCA patients with chest compressions alone and "scoop and run" to the hospital without administering fluids cannot adequately maintain perfusion (31, 32). We recommend that emergency responders focus on stopping external bleeding and administering IV fluids while performing chest compressions to adequately maintain perfusion (33, 34). The administration of more than 1,000 ml of crystalloids improves ROSC in TOHCA patients (6). Additionally, each one-minute delay in IV administration decreases the likelihood of ROSC in the ED by 3% (27).

In non-TOHCA cases, where the causes are often lethal cardiac arrhythmias, prehospital treatment priorities include defibrillation and the administration of adrenaline, which have been shown to increase ROSC. However, in TOHCA, the primary causes are not typically lethal cardiac arrhythmias (35). Our study found that in the rare cases where lethal cardiac arrhythmias are detected in TOHCA patients, prehospital defibrillation increases ED survival to admission by 2.35 times, which aligns with several previous studies (1, 36, 37).

The administration of adrenaline was associated with a decrease in ED survival to admission, consistent with prior research indicating that adrenaline administration in TOHCA patients reduces the chances of 7-day survival (38, 39). However, some studies have found that the administration of adrenaline in TOHCA patients can increase ROSC (27). We suggest that adrenaline administration should be prioritized after IV fluid administration, ETT intubation, and stopping external bleeding.

Life-threatening conditions in TOHCA can be treated by stopping external bleeding, administering IV fluids bolus, performing ETT, and defibrillation. Our study confirms that these interventions significantly increase ED survival to admission. Additional life-threatening conditions that may be encountered include tension pneumothorax and pericardial tamponade. Implementing additional diagnostic tools at the scene, such as POCUS and POC laboratory tests, can aid in the immediate diagnosis and treatment of these conditions, thereby increasing survival rates and return of spontaneous circulation (ROSC) (4, 23, 40).

The average response time in the ED survival and ED death groups was approximately 8 and 9 minutes, respectively, showing no statistically significant difference and no effect on ED survival to admission. A multicenter retrospective 5-year study of TOHCA in Taiwan found that response time did not significantly affect ROSC at ED (26). However, shorter response times were associated with increased 30-day mortality (26) and survival with complete neurologic recovery (6). In Thailand, the EMS system operates as a hospital-based ambulance service directed by a dispatch center and characterized by a multi-tier ambulance system with three levels of teams: BLS, ALS, and CLS. This structure necessitates coordination time to prepare the teams before deployment. According to Thailand's Emergency Medicine Act, emergency ambulances are restricted to a maximum speed of 80 kilometers per hour, establishing a standard response time of no more than 10 minutes.

Over the past 11 years, the average response time for managing TOHCA patients has consistently met this standard.

In the prehospital management of TOHCA patients, an on-scene time of less than 10 minutes reduces the likelihood of ED survival to admission by 31%. According to PHTLS principles, managing life-threatening conditions outside the hospital should not exceed 10 minutes. (41) However, for TOHCA cases, adhering strictly to the "scoop and run" principle without performing prehospital lifesaving interventions results in decreased ED survival to admission rates (6).

This study indicates that effective prehospital management of TOHCA patients should include lifesaving interventions such as IV fluid bolus administration, stopping external bleeding, defibrillation, and ETT intubation, combined with high-quality chest compressions, before transporting the patient to the hospital. This emphasizes the importance of the "On-Scene Lifesaving Interventions and Move" approach for TOHCA patients.

5. Limitations

This study has several limitations. First, due to the retrospective design of this study, which relied on data from the ITEMS database of NIEM, we had to exclude approximately 30% of TOHCA patients each year due to the absence of ED outcome data. This proportion remained constant throughout the study period (as shown in Figure 2). Additionally, there were missing data for several variables, necessitating the use of a complete case analysis model to handle missing data without employing any imputation methods. Second, we did not have data on TOHCA patients for whom resuscitation was terminated at the scene without transporting the patient to the hospital. Our study included only TOHCA patients who were transported to the hospital. Third, a limitation of the ITEMS data is that it only records the outcomes of ED survival to admission and ED death, without providing information on hospital discharge or the neurological outcomes of TOHCA patients at the time of hospital discharge. Finally, we did not have data representing patient severity, such as the injury severity score, which could be a potential confounder in our study.

6. Conclusions

To improve survival to hospital admission in TOHCA, several factors should be prioritized. These include administering intravenous fluid boluses, controlling external bleeding, delivering defibrillation when indicated, and performing ETT. These interventions must be combined with high-quality chest compressions, both before and during patient transport to the hospital.

7. Declarations

7.1. Acknowledgments

We would like to acknowledge the Information Technology of Emergency Medicine System (ITEMS) and the National Institute for Emergency Medicine (NIEM) for providing 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.

7.3. Ethical considerations

This study was approved by the Faculty of Medicine, Committee on Human Rights Related to Research Involving Human Subjects, Ramathibodi Hospital, Mahidol University (COA. NO MURA2023/833). The ethics committee did not require consent for this research since only medical records were reviewed, and a statement covering patient data confidentiality and compliance with the Declaration of Helsinki was deemed sufficient.

7.4. Availability of data and material

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

7.5. Funding source

No funding was obtained for this study.

7.6. Competing interests

The authors declare that they have no competing interests.

7.7. Using artificial inteligence chatbots

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

References

1. Jun GS, Kim JG, Choi HY, Kang GH, Kim W, Jang YS, et al. Prognostic factors related with outcomes in traumatic out-of-hospital cardiac arrest patients without prehospital return of spontaneous circulation: a nationwide observational study. Clin Exp Emerg Med. 2020;7(1):14-20.
2. Roh SY, Choi JI, Park SH, Kim YG, Shim J, Kim JS, et al. The 10-Year Trend of Out-of-hospital Cardiac Arrests: a Korean Nationwide Population-Based Study. Korean Circ J. 2021;51(10):866-74.
3. Huang JB, Lee KH, Ho YN, Tsai MT, Wu WT, Cheng FJ. Association between prehospital prognostic factors on out-of-hospital cardiac arrest in different age groups. BMC Emerg Med. 2021;21(1):3.
4. Beck B, Bray JE, Cameron P, Straney L, Andrew E, Bernard S, et al. Resuscitation attempts and duration in traumatic out-of-hospital cardiac arrest. Resuscitation. 2017;111:14-21.
5. Barnard E, Yates D, Edwards A, Fragoso-Iñiguez M, Jenks T, Smith JE. Epidemiology and aetiology of traumatic cardiac arrest in England and Wales - A retrospective database analysis. Resuscitation. 2017;110:90-4.
6. Leis CC, Hernández CC, Blanco MJ, Paterna PC, Hernández Rde E, Torres EC. Traumatic cardiac arrest: should advanced life support be initiated? J Trauma Acute Care Surg. 2013;74(2):634-8.
7. WHO. Global status report on road safety2023.
8. Evans CC, Petersen A, Meier EN, Buick JE, Schreiber M, Kannas D, et al. Prehospital traumatic cardiac arrest: Management and outcomes from the resuscitation outcomes consortium epistry-trauma and PROPHET registries. J Trauma Acute Care Surg. 2016;81(2):285-93.
9. Serpa E, Zimmerman SO, Bauman ZM, Kulvatunyou N. A Contemporary Study of Pre-hospital Traumatic Cardiac Arrest: Distinguishing Exsanguination From Non-exsanguination Arrest With a Review of Current Literature. Cureus. 2023;15(11):e48181.
10. Amacher SA, Bohren C, Blatter R, Becker C, Beck K, Mueller J, et al. Long-term Survival After Out-of-Hospital Cardiac Arrest: A Systematic Review and Meta-analysis. JAMA Cardiol. 2022;7(6):633-43.
11. Tran A, Fernando SM, Rochwerg B, Vaillancourt C, Inaba K, Kyeremanteng K, et al. Pre-arrest and intra-arrest prognostic factors associated with survival following traumatic out-of-hospital cardiac arrest - A systematic review and meta-analysis. Resuscitation. 2020;153:119-35.
12. Sirikul W, Piankusol C, Wittayachamnankul B, Riyapan S, Supasaovapak J, Wongtanasarasin W, et al. A retrospective multi-centre cohort study: Pre-hospital survival factors of out-of-hospital cardiac arrest (OHCA) patients in Thailand. Resusc Plus. 2022;9:100196.
13. Wang SA, Chang CJ, Do Shin S, Chu SE, Huang CY, Hsu LM, et al. Development of a prediction model for emergency medical service witnessed traumatic out-of-

hospital cardiac arrest: A multicenter cohort study. J Formos Med Assoc. 2024;123(1):23-35.
14. Lockey D, Crewdson K, Davies G. Traumatic cardiac arrest: who are the survivors? Ann Emerg Med. 2006;48(3):240-4.
15. Aoki M, Abe T, Oshima K. Association of Prehospital Epinephrine Administration With Survival Among Patients With Traumatic Cardiac Arrest Caused By Traffic Collisions. Sci Rep. 2019;9(1):9922.
16. Kim JG, Lee J, Choi HY, Kim W, Kim J, Moon S, et al. Outcome analysis of traumatic out-of-hospital cardiac arrest patients according to the mechanism of injury: A nationwide observation study. Medicine (Baltimore). 2020;99(45):e23095.
17. Sittichanbuncha Y, Prachanukool T, Sarathep P, Sawanyawisuth K. An emergency medical service system in Thailand: providers' perspectives. J Med Assoc Thai. 2014;97(10):1016-21.
18. Pochaisan O, Pattanarattanamolee R, Pongphuttha W, Chadbunchachai W, Nakahara S. Development of an emergency medical services system in Thailand: Roles of the universal health coverage and the national lead agency. Emerg Med Australas. 2021;33(4):756-8.
19. Cabral E, Castro WRS, Florentino DRM, Viana DA, Costa Junior JFD, Souza RP, et al. Response time in the emergency services. Systematic review. Acta Cir Bras. 2018;33(12):1110-21.
20. Pham H, Puckett Y, Dissanaike S. Faster on-scene times associated with decreased mortality in Helicopter Emergency Medical Services (HEMS) transported trauma patients. Trauma Surg Acute Care Open. 2017;2(1):e000122.
21. Olascoaga Arrate A, Freijo Guerrero MM, Fernández Maiztegi C, Azkune Calle I, Silvariño Fernández R, Fernández Rodríguez M, et al. Use of emergency medical transport and impact on time to care in patients with ischaemic stroke. Neurologia (Engl Ed). 2019;34(2):80-8.
22. Böttiger BW, Bernhard M, Knapp J, Nagele P. Influence of EMS-physician presence on survival after out-of-hospital cardiopulmonary resuscitation: systematic review and meta-analysis. Crit Care. 2016;20:4.
23. Kuo IM, Chen YF, Chien CY, Hong YW, Kang SC, Fu CY, et al. A novel scoring system using easily assessible predictors of return of spontaneous circulation and mortality in traumatic out-of-hospital cardiac arrest patients: A retrospective cohort study. Int J Surg. 2022;104:106731.
24. Millin MG, Galvagno SM, Khandker SR, Malki A, Bulger EM. Withholding and termination of resuscitation of adult cardiopulmonary arrest secondary to trauma: resource document to the joint NAEMSP-ACSCOT position statements. J Trauma Acute Care Surg. 2013;75(3):459-67.
25. Yuksen C, Phattharapornjaroen P, Kreethep W, Suwanmano C, Jenpanitpong C, Nonnongku R, et al. Bag-Valve Mask versus Endotracheal Intubation in Out-of-Hospital Cardiac Arrest on Return of Spontaneous Circulation: A National Database Study. Open Access Emerg Med. 2020;12:43-6.
26. Chen YC, Wu KH, Hsiao KY, Hung MS, Lai YC, Chen YS, et al. Factors associated with outcomes in traumatic cardiac arrest patients without prehospital return of spontaneous circulation. Injury. 2019;50(1):4-9.
27. Smida T, Price BS, Scheidler J, Crowe R, Wilson A, Bardes J. Stay and play or load and go? The association of on-scene advanced life support interventions with return of spontaneous circulation following traumatic cardiac arrest. Eur J Trauma Emerg Surg. 2023;49(5):2165-72.
28. McMullan J, Gerecht R, Bonomo J, Robb R, McNally B, Donnelly J, et al. Airway management and out-of-hospital cardiac arrest outcome in the CARES registry. Resuscitation. 2014;85(5):617-22.
29. Saar S, Lomp A, Laos J, Mihnovitš V, Šalkauskas R, Lustenberger T, et al. Population-Based Autopsy Study of Traumatic Fatalities. World J Surg. 2017;41(7):1790-5.
30. Harris T, Masud S, Lamond A, Abu-Habsa M. Traumatic cardiac arrest: a unique approach. Eur J Emerg Med. 2015;22(2):72-8.
31. Kutcher ME, Forsythe RM, Tisherman SA. Emergency preservation and resuscitation for cardiac arrest from trauma. Int J Surg. 2016;33(Pt B):209-12.
32. Vassallo J, Nutbeam T, Rickard AC, Lyttle MD, Scholefield B, Maconochie IK, et al. Paediatric traumatic cardiac arrest: the development of an algorithm to guide recognition, management and decisions to terminate resuscitation. Emerg Med J. 2018;35(11):669-74.
33. Evans C, Quinlan DO, Engels PT, Sherbino J. Reanimating Patients After Traumatic Cardiac Arrest: A Practical Approach Informed by Best Evidence. Emerg Med Clin North Am. 2018;36(1):19-40.
34. Lee HM, Wang CT, Hsu CC, Chen KT. Algorithm to Improve Resuscitation Outcomes in Patients With Traumatic Out-of-Hospital Cardiac Arrest. Cureus. 2022;14(3):e23194.
35. Deasy C, Bray J, Smith K, Harriss L, Morrison C, Bernard S, et al. Traumatic out-of-hospital cardiac arrests in Melbourne, Australia. Resuscitation. 2012;83(4):465-70.
36. Irfan FB, Consunji R, El-Menyar A, George P, Peralta R, Al-Thani H, et al. Cardiopulmonary resuscitation of out-of-hospital traumatic cardiac arrest in Qatar: A nationwide population-based study. Int J Cardiol. 2017;240:438-43.
37. Beck B, Bray JE, Cameron P, Straney L, Andrew E, Bernard S, et al. Predicting outcomes in traumatic out-of-hospital cardiac arrest: the relevance of Utstein factors. Emerg Med J. 2017;34(12):786-92.
38. Krychtiuk KA, Richter B, Lenz M, Hohensinner PJ, Huber K, Hengstenberg C, et al. Epinephrine treatment but not time to ROSC is associated with intestinal injury in patients with cardiac arrest. Resuscitation. 2020;155:32-8.
39. Yamamoto R, Suzuki M, Hayashida K, Yoshizawa J, Sakurai A, Kitamura N, et al. Epinephrine during resuscitation of traumatic cardiac arrest and increased mortality: a post hoc analysis of prospective observational study.

Scand J Trauma Resusc Emerg Med. 2019;27(1):74.
40. Escutnaire J, Genin M, Babykina E, Dumont C, Javaudin F, Baert V, et al. Traumatic cardiac arrest is associated with lower survival rate vs. medical cardiac arrest - Results from the French national registry. Resuscitation. 2018;131:48-54.
41. Harmsen AM, Giannakopoulos GF, Moerbeek PR, Jansma EP, Bonjer HJ, Bloemers FW. The influence of prehospital time on trauma patients outcome: a systematic review. Injury. 2015;46(4):602-9.

Table 1: Comparing the baseline characteristics of traumatic out of hospital cardiac arrest cases between cases with and without emergency departement (ED) survival

Prognostic factor	ED survival		P-value
	Yes (n=6,590)	No (n=29,134)	
Gender			
Male	5,025 (78.69)	22,384 (78.85)	0.774
Age (years)			
Median (IQR)	36 (22-52)	39(23-56)	<0.001
Time of operation (min)			
Response time	8 (5-12)	9 (6-14)	<0.001
Response time <8 minute	3,462 (52.57)	13,270 (45.60)	<0.001
On scene time	5 (3-10)	5 (2-8)	<0.001
On scene time <10 minute	5,284 (80.29)	24,879 (85.53)	<0.001
Transport time	7 (4-11)	7 (5-12)	0.001
Distance (km)			
Hospital to scene	5 (3-9)	6 (3-10)	<0.001
Scene to hospital	6 (3-11)	7 (4-12)	<0.001
Scene to hospital <8 km	4,236 (64.28)	17,472 (59.97)	<0.001
Nature of trauma			
Blunt injury	3,004 (81.56)	15,608 (82.23)	0.335
Burn	92 (2.50)	459 (2.42)	0.774
Penetrating injury	32 (0.87)	161 (0.85)	0.901
Amputation	5 (0.14)	40 (0.21)	0.350
Gunshot wounds	52 (1.41)	269 (1.42)	0.980
Type of fracture			
Closed fracture	866 (26.69)	5,634 (32.32)	<0.001
Open fracture	619 (19.08)	4,290 (24.6)	<0.001
Dislocation	70 (2.16)	410 (2.35)	0.498
Location of injury			
Head/neck	2,872 (75.60)	14,013 (73.67)	0.013
Spine	35 (0.92)	107 (0.56)	0.010
Chest/clavicle	205 (5.40)	1,465 (7.70)	<0.001
Abdomen	49 (1.29)	332 (1.75)	0.045
Pelvis	24 (0.63)	137 (0.72)	0.552
Multiple injury	83 (2.18)	482 (2.53)	0.206
Prehospital procedure			
Stop external bleeding	1,186 (35.46)	5,364 (30.49)	<0.001
ETT intubation	345 (5.44)	886 (3.08)	<0.001
IV fluid administration	4,306 (93.96)	21,771 (93.02)	0.022
Prehospital AED/Defibrillation	339 (5.14)	792 (2.72)	<0.001
Adrenaline use	1,436 (21.79)	7,691 (26.40)	<0.001
Level of operation			
Advanced life support	4,804 (72.91)	23,947 (82.20)	<0.001

Data are presented as frequency (%) or median (IQR). IQR: interquartile range, km: kilometer, ETT: Endotracheal tube, IV: intravenous, AED: Automated External Defibrillator.

Table 2: Comparing the baseline characteristics of traumatic out of hospital cardiac arrest cases between cases with and without emergency departement (ED) survival

Prognostic factor	cOR (95% CI)	P-value	aOR (95% CI)	P-value
Gender				
Male	1.00 (0.94-1.07)	0.774	1.10 (0.99-1.22)	0.081
Age (year)				
Median (IQR)	0.99 (0.99-1.00)	<0.001	0.99 (0.98-0.99)	<0.001
Time of operation (min)				
Response time	0.97 (0.96-0.97)	<0.001	0.99 (0.98-1.00)	0.123
Response time <8 minute	1.32 (1.25-1.39)	<0.001	0.98 (0.86-1.11)	0.710
On scene time	1.02 (1.01-1.02)	0.304	1.01 (1.00-1.01)	0.143
On scene time <10 minute	0.69 (0.64-0.74)	<0.001	0.63 (0.54-0.75)	<0.001
Transport time	1.01 (0.55-1.87)	0.966	1.01 (1.00-1.02)	0.050
Distance (km)				
Hospital to scene	0.96 (0.96-0.97)	<0.001	0.97 (0.98-1.01)	<0.001
Scene to hospital	0.99 (0.98-0.99)	<0.001	1.00 (0.96-0.99)	0.604
Scene to hospital <8 km	1.20 (1.14-1.27)	<0.001	1.05 (0.89-1.22)	0.575
Nature of trauma				
Blunt wound	0.95 (0.87-1.04)	0.336	0.95 (0.79-1.14)	0.568
Burn	1.07 (0.97-1.17)	0.164	0.79 (0.54-1.15)	0.221
Penetrating	1.02 (0.70-1.50)	0.901	1.16 (0.71-1.91)	0.549
Amputation	0.99 (0.97-1.00)	0.201	0.83 (0.28-2.45)	0.742
Gunshot wounds	1.00 (0.74-1.34)	0.980	0.76 (0.47-1.19)	0.232
Type of Fracture				
Closed fracture	0.76 (0.70-0.83)	<0.001	0.59 (0.53-0.66)	<0.001
Open Fracture	0.72 (0.66-0.79)	<0.001	0.54 (0.48-0.61)	<0.001
Dislocation	0.92 (0.71-1.18)	0.494	0.60 (0.45-0.81)	0.001
Exsanguination bleeding				
External bleeding	0.95 (0.94-1.10)	0.643	0.50 (0.84-1.08)	0.435
Location of injury				
Head/neck	1.11 (1.02-1.20)	0.013	1.07 (0.52-2.17)	0.859
Spine	1.64 (1.12-2.41)	0.015	0.98 (0.45-2.12)	0.479
Chest/clavicle	0.68 (0.58-0.79)	<0.001	0.63 (0.39-1.03)	0.963
Abdomen	0.74 (0.54-0.99)	0.039	0.63 (0.37-1.06)	0.066
Pelvis	0.88 (0.56-1.35)	0.546	1.04 (0.58-1.87)	0.900
Multiple injury	0.86 (0.68-1.08)	0.199	1.04 (0.43-2.54)	0.929
Prehospital procedure				
Stop bleeding	1.02 (0.99-1.06)	0.209	1.38 (1.24-1.54)	<0.001
ETT intubation	1.81 (1.59-2.05)	<0.001	2.09 (1.74-2.50)	<0.001
IV fluid administration	1.41 (1.25-1.60)	<0.001	1.66 (1.35-2.05)	<0.001
Prehospital AED/Defibrillation	1.94 (1.70-2.21)	<0.001	2.35 (1.96-2.81)	<0.001
Adrenaline use	0.78 (0.73-0.83)	<0.001	0.96 (0.88-1.06)	0.418
Level of operation				
ALS	0.58 (0.55-0.62)	<0.001	0.89 (0.08-1.88)	0.862

Data are presented as frequency (%) or medina (IQR). IQR: interquartile range, km: kilometer, ETT: Endotracheal tube, IV: intravenous, AED: Automated External Defibrillator, ALS: advanced life support; cOR: crude Odds ratio; aOR: addjusted Odds ratio; CI: confidence interval.

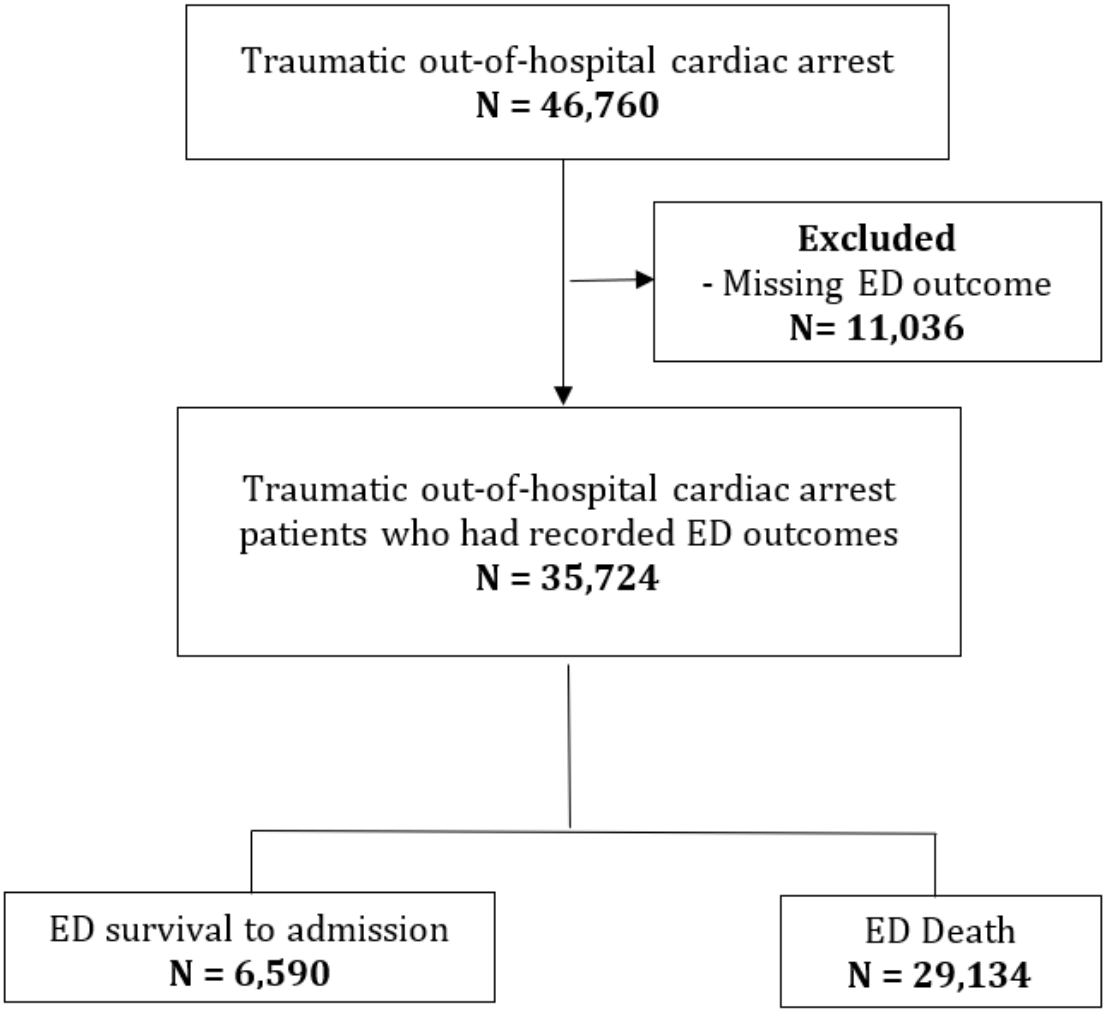

Figure 1: Study flowchart of patients' inclusion. ED: emergeny department.

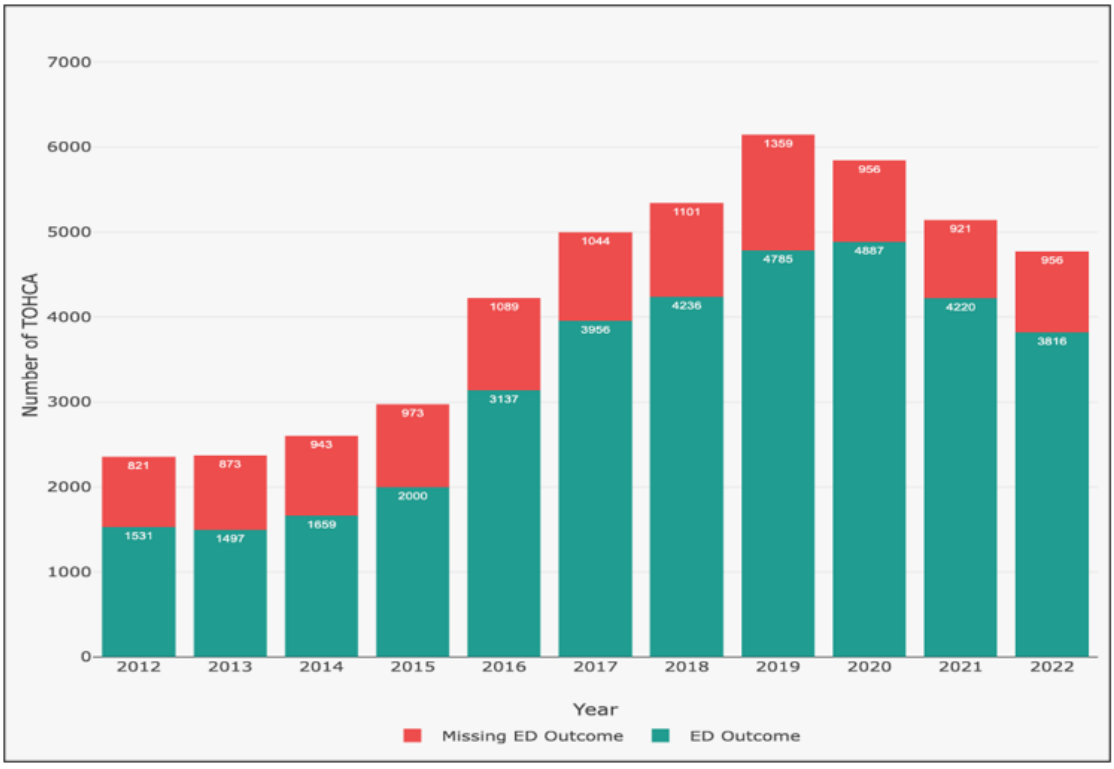

Figure 2: The number of traumatic out-of-hospital cardiac arrest (TOHCA) patients who received resuscitation at the scene and were transported to the emergency department in Thailand over an 11-year period. ED: emergency department.

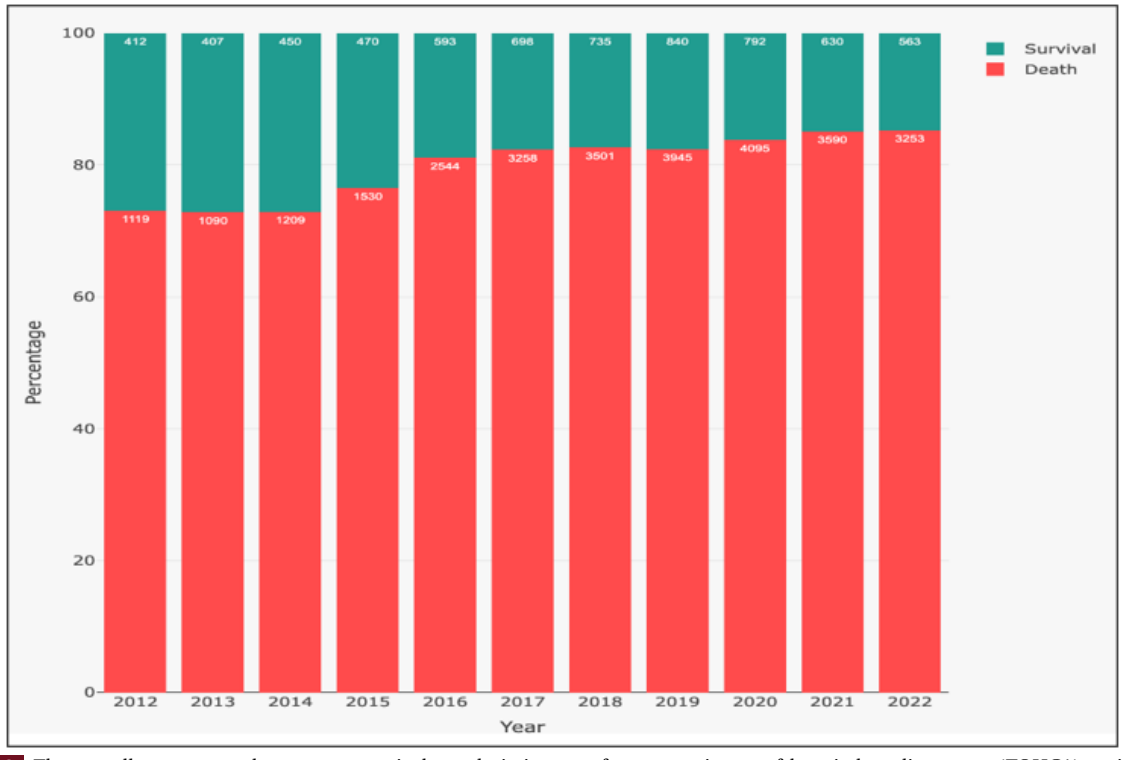

Figure 3: The overall emergency department survival-to-admission rate for traumatic out-of-hospital cardiac arrest (TOHCA) patients in Thailand over an 11-year period.

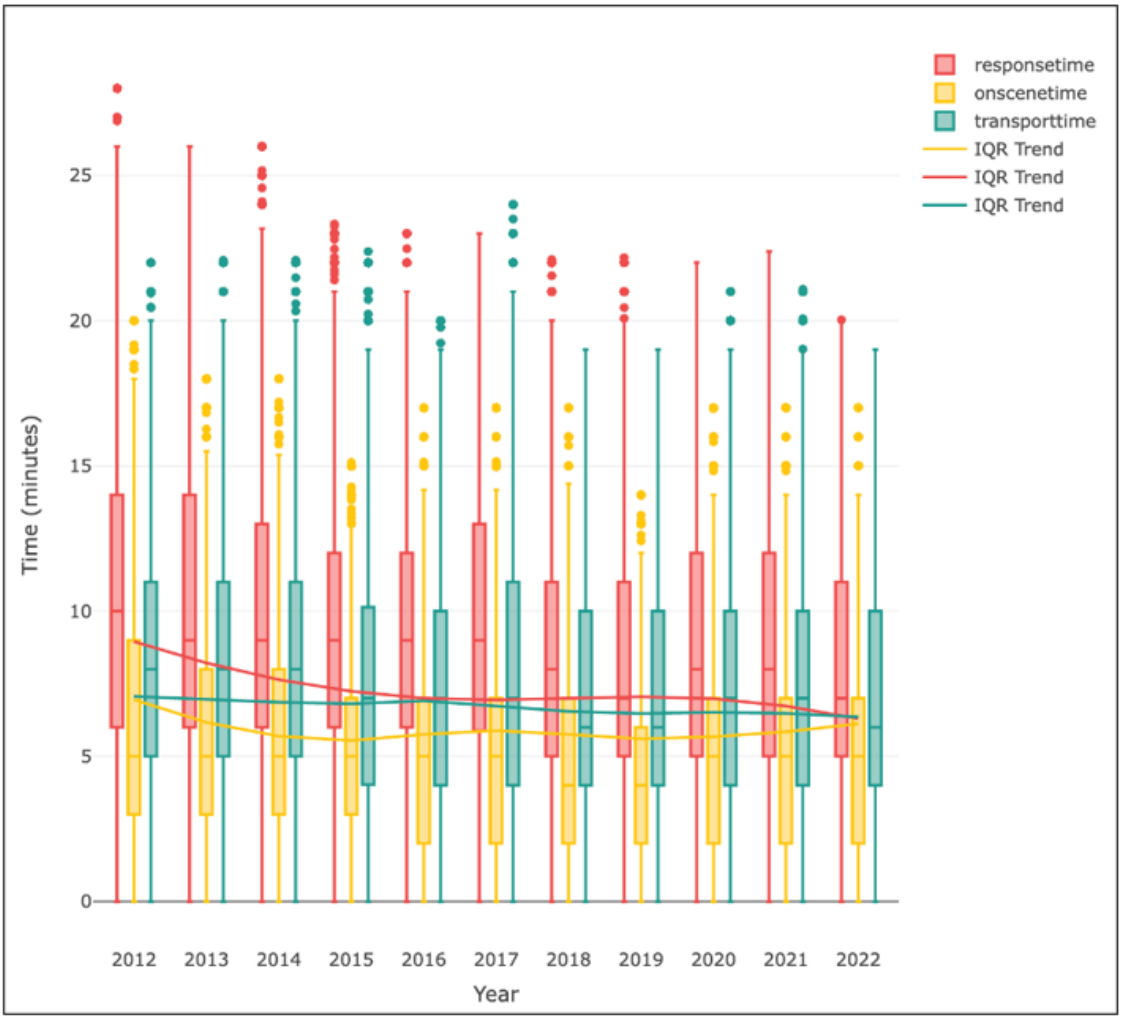

Figure 4: Response time, on-scene time, and transport time for emergency medical operations involving traumatic out-of-hospital cardiac arrest (TOHCA) patients in Thailand over an 11-year period. IQR: interquartule range.

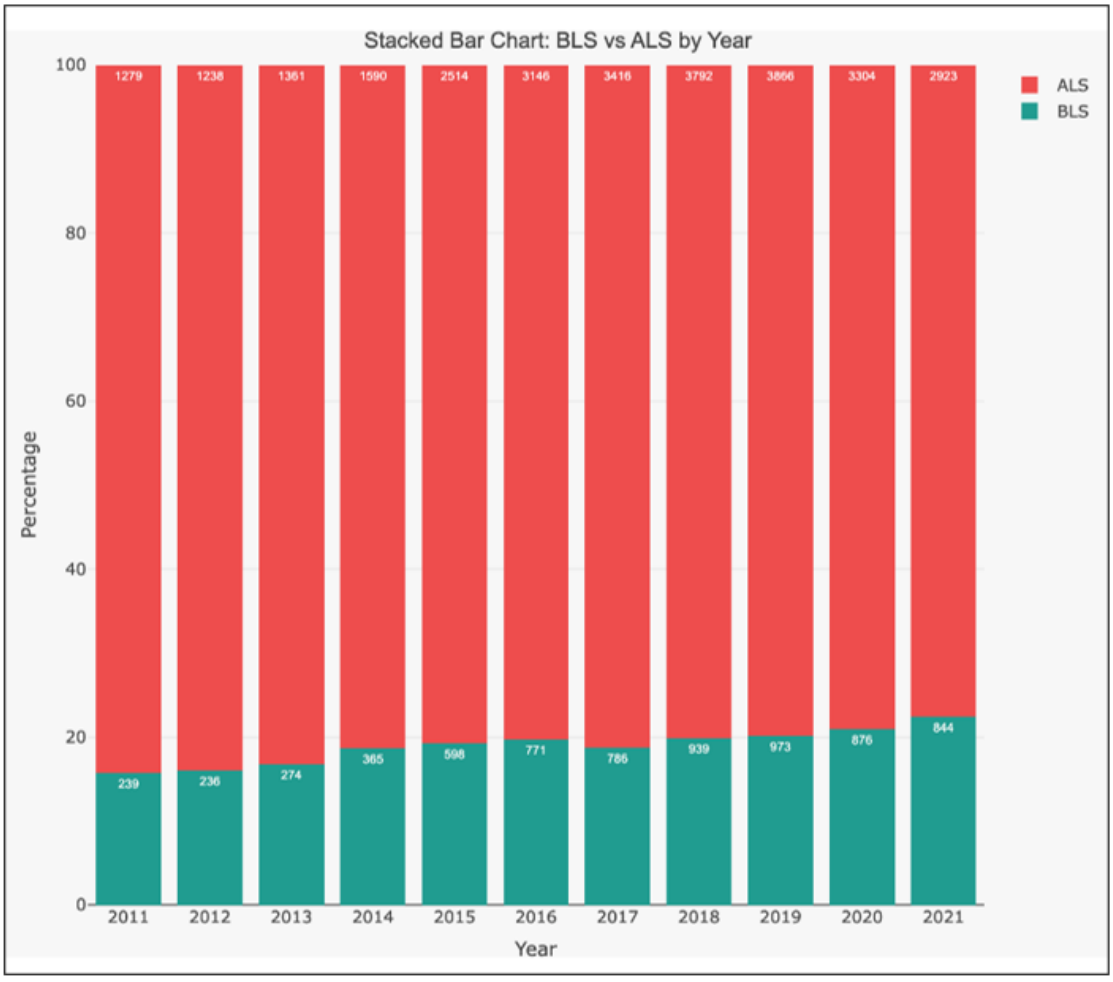

Figure 5: The overall percentage of prehospital Advanced Life Support (ALS) teams involved in the management of traumatic out-of-hospital cardiac arrest (TOHCA) patients in Thailand over an 11-year period. ALS: advanced life support, BLS: basic life support.