Anatolian Journal of Emergency Medicine 2025;8(4):150-157

ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA MAKALESİ

# Out-of-Hospital Cardiac Arrest in Türkiye: A Four-Year Retrospective Analysis of Survival Determinants in an Evolving Emergency Medical Services System

## *Türkiye'de Hastane Dışı Kardiyak Arrest: Gelişmekte Olan Bir Acil Sağlık Hizmetleri Sisteminde Sağkalım Belirleyicilerinin Dört Yıllık Retrospektif Analizi*

Orhun Demir[1], Aslı Türkmen Demir[2]

**ABSTRACT**

**Aim:** This study aims to examine prehospital and hospital factors influencing survival outcomes of out-of-hospital cardiac arrest (OHCA) patients in a developing Emergency Medical Services (EMS) context.

**Material and Methods:** This retrospective cohort study included OHCA patients (≥18 years) from January 1, 2021, to December 31, 2024, at Lokman Hekim University Ankara Hospital. Patients were divided into four groups according to their survival status; those who survived in the emergency department (Group I), those who did not survive in the emergency department (Group II), those who survived in the hospital (Group III), and those who did not survive in the hospital (Group IV).

**Results:** A total of 644 patients were included. The survival rate in the ED was 52.2%, while the overall survival rate was 6.4%. Significant univariate predictors of emergency department (ED) survival included shorter time to return of spontaneous circulation (ROSC), lower initial lactate levels, shockable first arrest rhythm, witnessed arrest, and location of the arrest. Bystander CPR was also strongly associated with ED survival in univariate analysis ($p < 0.001$), although it did not reach statistical significance in the multivariate model ($p = 0.066$). In contrast, both shorter time to ROSC ($p < 0.001$) and lower lactate levels ($p < 0.001$) remained independent predictors of ED survival in the multivariate regression analysis.

**Conclusion:** Prehospital factors, such as timely CPR and EMS response times, significantly influence OHCA survival rates. While bystander CPR plays a critical role, optimizing EMS response time and reducing prehospital delays are essential for improving outcomes. Further studies are needed to refine EMS protocols and enhance survival prospects in OHCA patients.

**Keywords**: Out-of-hospital cardiac arrest, survival outcomes, emergency department, bystander CPR, prehospital factors

**ÖZ**

**Amaç:** Bu çalışmanın amacı, gelişen Acil Sağlık Hizmetleri (ASH) bağlamında hastane dışı kardiyak arrest hastalarının sağ kalım sonuçlarını etkileyen hastane öncesi ve hastane faktörlerini incelemektir.

**Gereç ve Yöntemler:** Bu retrospektif kohort çalışmasına 1 Ocak 2021 ile 31 Aralık 2024 tarihleri arasında Lokman Hekim Üniversitesi Ankara Hastanesi'nde yatan hastane dışı kardiyak arrest (HDKA) hastaları (≥18 yaş) dahil edildi. Hastalar sağ kalım durumlarına göre dört gruba ayrıldı; acil serviste sağ kalanlar (Grup I), acil serviste sağ kalamayanlar (Grup II), hastanede sağ kalanlar (Grup III) ve hastanede sağ kalamayanlar (Grup IV).

**Bulgular:** Toplam 644 hasta çalışmaya dahil edildi. Acil servisteki sağ kalım oranı %52,2 iken, genel sağ kalım oranı %6,4 idi. Acil servis (AS) sağ kalımının anlamlı tek değişkenli prediktörleri arasında spontan dolaşımın geri dönüşüne (SDGD) kadar geçen sürenin daha kısa olması, daha düşük başlangıç laktat düzeyleri, şok edilebilir ilk arrest ritmi, tanık olunan arrest ve arrestin gerçekleştiği yer aldı. Olay yerine tanık olan kişilerce yapılan kardiyopulmoner resüsistasyonda (KPR) tek değişkenli analizde AS sağ kalımı ile güçlü bir şekilde ilişkiliydi ($p<0,001$), ancak çok değişkenli modelde istatistiksel anlamlılığa ulaşmadı ($p = 0,066$). Buna karşılık, hem SDGD süresinin daha kısa olması ($p < 0,001$) hem de laktat düzeylerinin daha düşük olması ($p < 0,001$), çok değişkenli regresyon analizinde AS sağ kalımının bağımsız prediktörleri olarak kaldı.

**Sonuç:** Zamanında KPR ve ASH yanıt süreleri gibi hastane öncesi faktörler, HDKA hayatta kalma oranlarını önemli ölçüde etkiler. Olay yerindeki KPR kritik bir rol oynarken, ASH yanıt süresini optimize etmek ve hastane öncesi gecikmeleri azaltmak sonuçları iyileştirmek için önemlidir. ASH protokollerini iyileştirmek ve HDKA hastalarında hayatta kalma olasılıklarını artırmak için daha fazla çalışmaya ihtiyaç vardır.

**Anahtar Kelimeler:** Hastane dışı kardiyak arrest, hayatta kalma sonuçları, acil servis, tanık kardiyopulmoner resüsitasyonu, hastane öncesi faktörler

Received: 27 April 2025 Accepted: 18 August 2025

[1]Lokman Hekim University Faculty of Medicine, Department of Anesthesiology and Reanimation, Ankara, Türkiye

[2]Lokman Hekim University Faculty of Medicine, Department of Emergency Medicine, Ankara, Türkiye.

***Corresponding Author:*** Orhun Demir, Assistant Prof **Address:** Lokman Hekim Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilimdalı, Ankara, Türkiye. **Telephone:** +90 5334028125 **e-mail**: orhundemir@gmail.com.

***Atıf için/Cited as:*** Demir O, Türkmen Demir A. Out-of-Hospital Cardiac Arrest in Türkiye: A Four-Year Retrospective Analysis of Survival Determinants in an Evolving Emergency Medical Services System. Anatolian J Emerg Med 2025;8(4):150-157. https://doi.org/10.54996/anatolianjem.1684953.

## Introduction

Out-of-hospital cardiac arrest (OHCA) is a global health problem with high mortality rates and significant use of intensive care resources. It is estimated that approximately 55 OHCA cases occur per 100.000 person-years among adults worldwide (1).

In a 2020 meta-analysis including 141 studies, the overall hospital discharge rate following OHCA was 8.8%, with significant differences across continents, reflecting disparities between developed and developing countries (1).

In a prospective study of approximately 132.000 OHCA cases, the crude incidence was 95.7 per 100.000, survival at discharge was 1.2%, and 12-month survival was only 0.7% (2).

Cardiopulmonary resuscitation (CPR) is not only a life-saving intervention but also a critical step in clinical decision-making. Rapid assessment of consciousness, respiration, and circulation is essential for determining the need for resuscitation. The period before irreversible somatic death represents a vital window for initiating CPR (3). The timing and quality of resuscitative efforts have a direct impact on both survival and neurological outcomes (4).

Several factors influence the prognosis following OHCA. Early recognition of cardiac arrest, initiation of effective CPR, timely use of automated external defibrillators (AEDs), and rapid activation of emergency medical services (EMS) are all associated with improved survival and neurological outcomes (5–7). Mastery of Basic Life Support (BLS) techniques, including these key interventions, plays a pivotal role in enhancing patient outcomes. In addition to prehospital measures, the structure and performance of the EMS system are equally important. Factors such as EMS response time, the quality of care provided at the scene, patient assessment, and efficient transport to the hospital significantly contribute to survival (7–9). Another critical determinant of outcomes is the ability of EMS providers to promptly recognize and manage shockable and non-shockable rhythms. This highlights the importance of ongoing training and investment in modern equipment. In Türkiye, wider implementation of AEDs could offer significant benefits in improving survival rates, presenting a valuable area for further research. Countries with established EMS infrastructures tend to achieve better outcomes, underscoring the need to strengthen prehospital care systems in developing regions.

Furthermore, elevated lactate levels known to correlate with mortality in myocardial infarction have been proposed as a potential prognostic marker in OHCA patients. Although current evidence remains limited, this parameter warrants further investigation to clarify its predictive value in this context (2,10–14).

Therefore, additional evidence is needed to guide policy and improve national strategies, particularly in countries where EMS systems are newly established. This study aims to examine the impact of prehospital and hospital factors on survival outcomes in patients with out-of-hospital cardiac arrest.

## Material and Methods

We conducted a single-center retrospective cohort study using data from Lokman Hekim University Ankara Hospital in Türkiye, covering the period from January 1, 2021, to December 31, 2024. Patients who were 18 years of age or older and experienced OHCA were included in the study, while all cases of traumatic origin were excluded. Additionally, patients not transported by EMS, including those brought in by private vehicles or first responders, were excluded.

The Ethics Committee of the Lokman Hekim University approved the study protocol. (Date: 30/12/2024, No: 2024/13).

Data collected included patient age, gender, witness status, initial rhythm, defibrillation, timeline of events, bystander CPR, airway management, return of spontaneous circulation (ROSC), in-hospital resuscitation efforts, and mortality outcomes.

For this purpose, patients were categorized according to survival status. Initially, they were divided into two primary groups: survivors and non-survivors. For emergency department (ED) outcomes:

- Group I: ED survivors
- Group II: ED non-survivors

For overall in-hospital outcomes:

- Group III: Hospital survivors
- Group IV: Hospital non-survivors

This classification enabled a comparative analysis of clinical characteristics, interventions, and outcomes both within the ED and throughout the entire hospitalization period.

Data regarding OHCA patients were obtained from the database, encompassing details such as whether the arrest was witnessed, if bystander CPR was performed, whether an AED was used during bystander intervention, and information on advanced airway management or defibrillation administered before hospital arrival. Patient demographics, existing comorbidities, initial shockable rhythm, whether the arrest was witnessed, and the underlying cause of the arrest that considered as potential confounders influencing OHCA survival were included for explanatory analysis as well. The flow diagram of patient selection is shown in Figure 1.

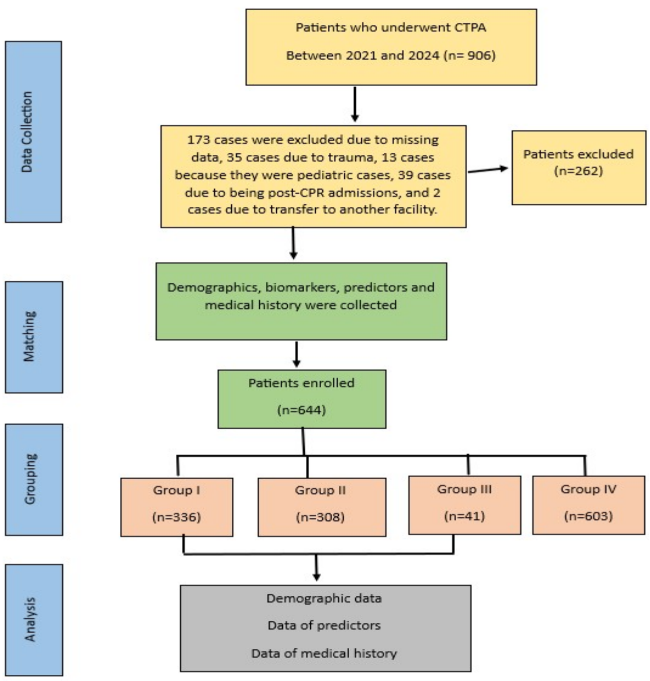


**Figure 1.** Flow diagram of patient selection.

*Statistical Analysis*

Statistical analysis was performed using IBM SPSS (IBM Corp., Armonk, NY, USA) version 27.0 program. The Shapiro-Wilk test, histogram, and skewness and kurtosis coefficients were used to assess the normal distribution of the data. For variables distributed non-normally, the Mann-Whitney U test was used to compare paired groups. To evaluate Multivariate cross-tabulations, the Chi-Square test was used. A p-value of <0.05 was considered statistically significant.

## Results

A total of 644 patients with OHCA were included, with a median age of 71 years (IQR: 61–80); 59.3% were male.

Patients who died in the emergency department (Group I) had significantly higher rates of comorbidities compared to survivors (Group II), including coronary artery disease (46.1% vs. 22.7%), heart failure (23.5% vs. 12.0%), diabetes mellitus (37.8% vs. 19.2%), hypertension (35.7% vs. 15.6%), renal disease (11.0% vs. 2.3%), respiratory disease (18.8% vs. 6.5%), dyslipidemia (11.0% vs. 3.6%), and stroke (4.8% vs. 2.3%) (all p < 0.001, Table 1).

Additionally, Group II showed significantly higher rates of shockable initial rhythm (17.9% vs. 4.2%, p < 0.001) and lower lactate levels at admission (4.7 [3.8–5.6] vs. 6.0 [4.4–10.0], p < 0.001, Table 2).

| **Patient Characteristics** | **All patients (n=644)** | **Group I (Survivors) (n=336)** | **Group II (Non-survivors) (n=308)** | **p** |
|---|---|---|---|---|
| Age, median, (IQR) | 71 (61-80) | 71 (60-80) | 72 (63-81) | 0.305 |
| Male, n (%) | 382 (59.3) | 211 (62.8) | 171 (55.5) | 0.060 |
| ***Comorbidity, n (%)*** | | | | |
| Coronary artery disease | 225 (34.9) | 155 (46.1) | 70 (22.7) | <0.001* |
| Heart failure | 116 (18.0) | 79 (23.5) | 37 (12.0) | <0.001* |
| Diabetes mellitus | 186 (28.9) | 127 (37.8) | 59 (19.2) | <0.001* |
| Cancer | 67 (10.4) | 45 (13.4) | 22 (7.1) | 0.009* |
| Hypertension | 168 (26.1) | 120 (35.7) | 48 (15.6) | <0.001* |
| Renal disease | 44 (6.8) | 37 (11.0) | 7 (2.3) | <0.001* |
| Respiratory disease | 83 (12.9) | 63 (18.8) | 20 (6.5) | <0.001* |
| Dyslipidemia | 48 (7.5) | 37 (11.0) | 11 (3.6) | <0.001* |
| Stroke | 23 (3.6) | 16 (4.8) | 7 (2.3) | <0.001* |
| ***Location type, n (%)*** | | | | |
| Home residence | 293 (45.5) | 155 (46.1) | 138 (44.8) | <0.001* |
| Street | 182 (28.3) | 122 (36.3) | 60 (19.5) | |
| Public/commercial building | 57 (8.1) | 32 (9.5) | 25 (8.1) | |
| Healthcare facility | 80 (12.4) | 20 (6.0) | 60 (19.5) | |
| Other | 32 (5.0) | 7 (2.1) | 25 (8.1) | |
| ***First arrest rhythm, n (%)*** | | | | |
| Shockable rhythm | 69 (10.7) | 14 (4.2) | 55 (17.9) | <0.001* |
| Unshockable rhythm | 575 (89.3) | 322 (95.8) | 253 (82.1) | |
| Initial lactate levels, median (IQR) | 5.9 (4.4-9.7) | 4.7 (3.8-5.6) | 6 (4.4-10.0) | <0.001* |
| ***Cause of arrest, n (%)*** | | | | |
| Presumed cardiac etiology | 293 (45.5) | 126 (37.5) | 167 (54.2) | <0.001* |
| Respiratory | 168 (26.1) | 117 (34.8) | 51 (16.6) | |
| Other | 183 (28.4) | 93 (27.7) | 90 (29.2) | |

*p <0.05, IQR: Interquartile Range

**Table 1.** Emergency department mortality according to patient characteristics

*:p <0.05.

| Patient characteristics | All patients (n=644) | Group I (Survivors) (n=336) | Group II (Non-survivors) (n=308) | p |
|---|---|---|---|---|
| Age, median, (IQR) | 71 (61-80) | 54 (40-86) | 72 (62-80) | 0.151 |
| Male, n (%) | 382 (59.3) | 24 (58.5) | 358 (59.4) | 0.916 |
| ***Comorbidity, n (%)*** | | | | |
| Coronary Artery Disease | 225 (34.9) | 13 (31.7) | 212 (35.2) | 0.654 |
| Heart failure | 116 (18.0) | 5 (12.2) | 111 (18.4) | 0.316 |
| Diabetes Mellitus | 186 (28.9) | 9 (22.0) | 177 (29.4) | 0.312 |
| Cancer | 67 (10.4) | 3 (7.3) | 64 (10.6) | 0.503 |
| Hypertension | 168 (26.1) | 8 (19.5) | 160 (26.5) | 0.322 |
| Renal disease | 44 (6.8) | 3 (7.3) | 41 (6.8) | 0.899 |
| Respiratory disease | 83 (12.9) | 6 (14.6) | 77 (12.8) | 0.730 |
| Dyslipidemia | 48 (7.5) | 1 (2.4) | 47 (7.8) | 0.206 |
| Stroke | 23 (3.6) | 0 (0.0) | 23 (3.8) | 0.203 |
| ***Location type, n (%)*** | | | | |
| Home Residence | 293 (45.5) | 16 (39.0) | 277 (45.9) | 0.492 |
| Street | 182 (28.3) | 14 (34.1) | 168 (27.9) | |
| Public/Commercial Building | 57 (8.1) | 6 (14.6) | 51 (8.5) | |
| Healthcare Facility | 80 (12.4) | 4 (9.8) | 76 (12.6) | |
| Other | 32 (5.0) | 1 (2.4) | 31 (5.1) | |
| ***First arrest rhythm, n (%)*** | | | | |
| Shockable rhythm | 69 (10.7) | 2 (4.9) | 67 (11.1) | 0.212 |
| Unshockable rhythm | 575 (89.3) | 39 (95.1) | 536 (88.9) | |
| Initial lactate level, median (IQR) | 5.9 (4.4-9.7) | 4.7 (3.8-5.6) | 6 (4.4-10.0) | <0.001* |
| Length of hospital stay, median (IQR) | | 4 (1-8) | 1 (1-3) | <0.001* |
| ***Cause of arrest, n (%)*** | | | | |
| Presumed Cardiac Etiology | 293 (45.5) | 16 (39.0) | 277 (45.9) | 0.286 |
| Respiratory | 168 (26.1) | 15 (36.6) | 153 (25.4) | |
| Other | 183 (28.4) | 10 (24.4) | 173 (28.7) | |

**Table 2.** Overall mortality according to patient characteristics
*: p<0.05, IQR: Interquartile range

Survival outcomes were also associated with whether the arrest was witnessed. Patients in the bystander-witnessed group had lower initial lactate levels (5.3 [3.8–6.0] vs. 5.95 [4.5–10.05], $p < 0.001$) and longer hospital stays (2 [1–6] days vs. 1 [1–3] days, $p < 0.001$) compared to unwitnessed cases. Survival to hospital discharge was significantly higher in those bystander-witnessed patients (12.1% vs. 6.2%, $p = 0.041$) (Table 3).
The multivariable logistic regression analysis identified shorter resuscitation time until ROSC (OR: 1.365; $p < 0.001$), lower initial lactate levels (OR: 2.611; $p < 0.001$), and arrest location as independent predictors of survival to ED discharge. Although bystander CPR was significantly associated with survival in the univariate analysis (OR: 0.162; $p < 0.001$), it did not reach statistical significance in the multivariate model (OR: 0.137; $p = 0.066$) (Table 4). Among patients who achieved ROSC in the ED, the survival rate was 52.2% (n = 336). The overall survival rate in the cohort was 6.4% (n = 41).
Kaplan–Meier survival analysis showed that patients with an initial shockable rhythm had significantly higher early survival rates compared to those with an unshockable rhythm, with a notable decline in survival within the first 10 days in both groups. Although the median survival time was 1 day in both groups, the mean survival time was longer in the unshockable group (4.22 ± 0.34 days) than in the shockable group (2.01 ± 0.38 days), likely due to some outliers surviving longer. The log-rank test confirmed a significant difference between the groups ($p < 0.05$), indicating that the initial arrest rhythm is an important predictor of in-hospital survival. (Figure 2).

| Patient characteristics | All patients (n=644) | Unwitnessed (n=324) | Bystander-witnessed (n=116) | p |
|---|---|---|---|---|
| Age, median, (IQR) | 71 (61-80) | 75 (65-83) | 73 (63-80) | 0.042* |
| Male, n (%) | 382 (59.3) | 62 (19.1) | 116 (100.0) | <0.001* |
| ***Comorbidity, n (%)*** | | | | |
| Coronary artery disease | 225 (34.9) | 94 (29) | 47 (40.5) | 0.023* |
| Heart failure | 116 (18.0) | 46 (14.2) | 28 (24.1) | 0.014* |
| Diabetes mellitus | 186 (28.9) | 107 (33) | 31 (26.7) | 0.209 |
| Cancer | 67 (10.4) | 39 (12) | 21 (18.1) | 0.102 |
| Hypertension | 168 (26.1) | 94 (29) | 35 (30.2) | 0.814 |
| Renal disease | 44 (6.8) | 19 (5.9) | 17 (14.7) | 0.003* |
| Respiratory disease | 83 (12.9) | 33 (10.2) | 29 (25.0) | <0.001* |
| Dyslipidemia | 48 (7.5) | 14 (4.3) | 14 (12.1) | 0.003* |
| Stroke | 23 (3.6) | 13 (4) | 8 (6.9) | 0.211 |
| ***Location type, n (%)*** | | | | |
| Home residence | 293 (45.5) | 124 (38.3) | 16 (13.8) | <0.001* |
| Street | 182 (28.3) | 102 (31.5) | 80 (69.0) | |
| Public/commercial building | 57 (8.9) | 44 (13.6) | 5 (4.3) | |
| Healthcare facility | 80 (12.4) | 25 (7.7) | 12 (10.3) | |
| Other | 32 (5.0) | 29 (9.0) | 3 (2.6) | |
| ***First arrest rhythm, n (%)*** | | | | |
| Shockable rhythm | 575 (89.3) | 303 (93.5) | 116 (100.0) | 0.005* |
| Unshockable rhythm | | 21 (6.5) | 0 (0.0) | |
| Initial lactate level, median (IQR) | 5.9 (4.4-9.7) | 5.95 (4.5-10.05) | 5.3 (3.8-6.0) | <0.001* |
| Length of hospital stay, median (IQR) | 1 (1-3) | 1 (1-3) | 2 (1-6) | <0.001* |
| ***Cause of arrest, n (%)*** | | | | |
| Presumed cardiac etiology | 293 (45.5) | 103 (31.8) | 12 (10.3) | <0.001* |
| Respiratory | 168 (26.1) | 72 (22.2) | 70 (60.3) | |
| Other | 183 (28.4) | 149 (46) | 34 (29.3) | |
| Bystander automated external defibrillator use | N/A | N/A | N/A | |
| Overall mortality (survivor) | 41 (6.4) | 20 (6.2) | 14 (12.1) | 0.041* |
| Mortality ED (survivor) | 336 (52.2) | 156 (41.8) | 97 (83.6) | <0.001* |

**Table 3.** Characteristics and Outcomes of OHCA Patients by Witnessed Status (Unwitnessed vs. Bystander-Witnessed)
*: p <0.05, IQR: Interquartile range, ED: Emergency department

| | Emergency Department Mortality | | | | | |
|---|---|---|---|---|---|---|
| | Univariate Regression Analysis | | | Multivariate Regression Analysis | | |
| *Predictors* | OR | 95% CI | p | OR | 95% CI | p |
| Bystander CPR | 0.162 | 0.096-0.273 | <0.001* | 0.137 | 0.016-1.144 | 0.066 |
| Witnessed cardiac arrest | 0.722 | 0.530-0.985 | 0.040* | | | 0.966 |
| Pre-hospital advanced airway management | 0.000 | 0.000 | 0.996 | | | |
| First arrest rhythm | 0.200 | 0.109-0.368 | <0.001* | | | 0.502 |
| Resuscitation time until ROSC (min) | 1.508 | 1.305-1.743 | <0.001* | 1.365 | 1.227-1.517 | <0.001* |
| Lactate | 2.287 | 1.985-2.634 | <0.001* | 2.611 | 1.722-3.960 | <0.001* |
| ***Cause of arrest*** | | | <0.001* | | | |
| (1) Presumed Cardiac Etiology | 1.370 | 0.945-1.984 | 0.096 | | | 0.604 |
| (2) Respiratory | 0.450 | 0.291-0.698 | <0.001* | | | 0.411 |
| ***Location type*** | | | <0.001* | | | |
| (1) Home Residence | 0.249 | 0.105-0.594 | 0.002* | | | 0.298 |
| (2) Street | 0.138 | 0.056-0.336 | <0.001* | | | 0.169 |
| (3) Public/Commercial Building | 0.219 | 0.081-0.588 | 0.003* | | | 0.156 |
| (4) Healthcare Facility | 0.840 | 0.316-2.236 | 0.727 | | | 0.761 |

**Table 4.** Multivariable Regression Analysis of Predictors for Survival to Discharge in OHCA Patients.
*: p <0.05, CPR: Cardiopulmonary Resuscitation, ROSC: Return of spontaneous circulation, OR: Odds Ratio, CI: Confidence interval

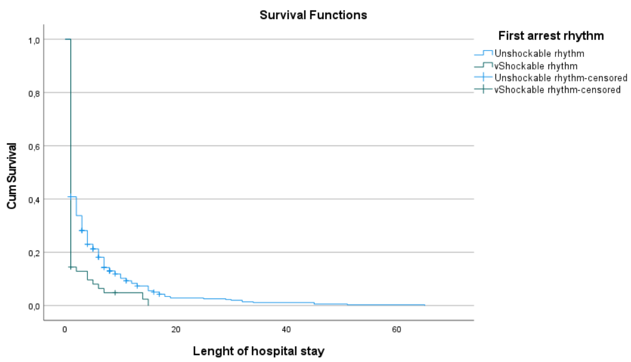


**Figure 2.** Kaplan–Meier survival analysis for initial shockable vs. non-shockable rhythm (P-log-rank: <0.001).

## Discussion

In this study, we evaluated the impact of external prehospital care and emergency response times on the survival of OHCA patients. The study provides important findings regarding OHCA and highlights the influence of prehospital factors on both treatment processes and subsequent hospital outcomes.

We found that both the etiology and the location of OHCA were associated with patient outcomes in our study. Cardiac-origin arrests were generally linked to poorer prognoses, whereas respiratory causes tended to result in more favorable survival outcomes. Similarly, the location of the arrest has emerged as a significant determinant. Patients who experienced cardiac arrest at home demonstrated relatively higher survival rates compared to those whose arrest occurred in public areas such as streets. This finding aligns with the results of the Turkish out-of-hospital cardiac arrest study (TROHCA), which reported that 61.3% of OHCA cases occurred at home and suggested that higher survival rates in this group might be attributed to faster EMS access and higher rates of witnessed arrests (10).

A more nuanced finding regarding arrest location was observed in the TROHCA study, where cardiac arrests that occurred at the hospital entrance, triage, or parking area classified as “hospital” localization were identified as a significant independent predictor of sustained ROSC. This highlights the potential benefit of rapid access to trained healthcare providers in borderline in-hospital scenarios (10). Supporting this observation, our dataset revealed a statistically significant association between location type and ED mortality ($p < 0.001$), where arrests in healthcare facilities demonstrated more favorable immediate outcomes compared to those occurring in public areas such as streets. Notably, patients who arrested in street environments had the lowest survival rates, likely due to delays in recognition and initiation of CPR. In contrast, arrests occurring in healthcare settings benefited from immediate intervention, possibly explaining the higher ROSC and survival outcomes.

Another noteworthy prognostic parameter in OHCA is serum lactate, a well-established biomarker of tissue hypoperfusion and adverse outcomes in critical conditions such as myocardial infarction and sepsis. In the TROHCA cohort, initial lactate levels were significantly elevated, with a median of 11.80 mmol/L in the ED and 9.85 mmol/L after ROSC, reflecting profound systemic hypoxia and impaired perfusion status (10). Although lactate was not identified as an independent predictor in TROHCA's multivariate analysis, its persistently high values in non-survivors suggest prognostic relevance.

Our study further strengthens the prognostic role of lactate, as observed in previous cohorts. Elevated initial lactate levels were found to be an independent predictor of ED mortality, with an odds ratio (OR) of 2.611 ($p < 0.001$). This effect remained robust even after adjusting for other significant predictors such as witnessed arrest, arrest location, cause of arrest, and resuscitation duration. The findings align with univariate analysis, where higher lactate was already associated with increased mortality risk (OR: 2.287; $p < 0.001$). These results emphasize that even modest elevations in lactate can indicate significant metabolic compromise and poor outcomes in OHCA patients.

Given its accessibility and cost-effectiveness, serum lactate may serve not only as a risk stratification tool but also as a candidate for inclusion in future prognostic scoring models. Moreover, its early measurement upon ED admission can support critical decisions regarding intensity of care, early intensive care units' triage, or consideration of extracorporeal support in selected patients. Our findings reinforce the role of lactate as a key biomarker in OHCA and support further prospective validation.

Beyond individual biomarkers, system-level variables also explain outcome disparities between regions. When comparing with international data, the European Registry of Cardiac Arrest (EuReCa) TWO study from Europe reported an 8% survival-to-discharge rate, whereas our study demonstrated a rate of only 4.4% (15). Similarly, a meta-analysis by Yan et al. reported a global average discharge survival rate of 8.8%, with Oceania presenting the highest rates (16.2%) and Asia the lowest (4.5%) (16). This suggests that outcomes in Türkiye are currently more comparable to those observed in Asian countries.

Initial rhythm and lactate levels were also determined to be important prognostic factors. Patients with shockable rhythms had higher survival rates than patients with non-shockable rhythms. However, our analysis showed that AEDs were not used in prehospital interventions, and therefore could not be analyzed. This is a critical gap in practice and highlights an area for improvement in the national EMS system. A study including 4188 witnessed adult OHCA cases analyzed whether prehospital defibrillation with an AED was a prognostic factor for survival to hospital discharge (17). The Dutch experience with public AED deployment should be cautiously examined and considered as a model for national implementation (11). Lower lactate levels indicate a better prognosis, suggesting that lactate levels are an important parameter reflecting the severity and response to treatment of OHCA patients during initial intervention (18–20).

In addition to AED use, bystander CPR remains a cornerstone of early intervention. In our study, early intervention was found to be a significant factor in reducing mortality in the ED. In particular, on-site CPR plays a critical role at the beginning of the emergency care process. In our multivariate analysis, the effect of bystander CPR on mortality was not statistically significant (OR: 0.137, $p = 0.066$). However, supporting evidence was observed in a large-scale meta-analysis (13). A study in Singapore found that the chance of survival was significantly increased by cardiac arrest occurring in a public place, the first shockable rhythm, a witnessed stop, CPR by bystanders, and defibrillation by bystanders (14).

Although prehospital airway management showed a significant univariate relationship with ED mortality, this association did not remain significant in multivariate regression analysis. This finding is consistent with a multinational study including data from 28 countries, which reported that CPR with ventilation by bystanders was associated with higher hospital discharge rates in compared to compression-only CPR (15).

Apart from CPR quality, the timeliness of EMS interventions is another crucial determinant of outcome. Our study found a strong association between time to resuscitation and ED mortality, highlighting the importance of rapid and effective EMS intervention on OHCA outcomes (1,7,13,14).

According to the results of our study, the rate of witnessed CPR events (49.7%) is close to the European average (47.8%) (12). To improve the low bystander CPR rates observed (18.0%), targeted BLSD training programs and incident response team mobilization strategies should be developed. Our current rates remain below the European average, and based on the experiences of countries with higher percentages of witnessed events, updated public training efforts are needed (11).

In our cohort, overall mortality was 6.4%. A random-effects meta-analysis estimated a global survival-to-admission rate of 22.0% among OHCA patients who received CPR. Regionally, the highest rate was in Oceania (33.5%), followed by Europe (25.7%), North America (20.5%), and Asia (15.6%) (13). This relatively low survival rate highlights the need for systemic improvements in prehospital care infrastructure.

**Conclusion**

The findings of this study suggest that external prehospital response and EMS processes notably impact survival rates for OHCA patients. Bystander CPR and defibrillation significantly reduce mortality rates. However, it becomes clear that EMS systems need to optimize response times, on-site time, and patient transport times. Additionally, further research is essential to find strategies for enhancing the effectiveness of EMS processes and improving outcomes in such cases.

These findings suggest that more comprehensive emergency response systems and training programs are needed to improve OHCA management.

This study has certain limitations, including its single-center and retrospective design, as well as the lack of AED data, which may affect the generalizability of the findings.

**Conflict of Interest:** The authors declare no conflict of interest.

**Financial Support:** This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

**Authors' Contribution: OD:** Conception and design of the work, supervision, data collection, analysis and interpretation of the data, literature review, writing and critical review of the work. **ATD:** Conception and design of the work, materials, data collection and processing, writing

of the work. All authors read and approved the final version of the manuscript.

**Ethical Approval:** The Ethics Committee of the Lokman Hekim University approved the study protocol. (Date: 30/12/2024, No: 2024/13).

## References

1. Yan S, Gan Y, Jiang N, et al. The global survival rate among adult out-of-hospital cardiac arrest patients who received cardiopulmonary resuscitation: a systematic review and meta-analysis. Crit Care. 2020 Dec 22;24(1):61.
2. Zheng J, Lv C, Zheng W, et al. Incidence, process of care, and outcomes of out-of-hospital cardiac arrest in China: a prospective study of the BASIC-OHCA registry. Lancet Public Health. 2023 Dec;8(12):e923–32.
3. Balci B, Keskin O, Karabag Y. Cardiopulmonary resuscitation. Kafkas Journal of Medical Sciences. 2011;1(1):41–6.
4. Araç S, Zengin Y, İçer M, et al. Acil Serviste Kardiyopulmoner Resüsitasyon Yapılan Hastaların Değerlendirilmesi; Retrospektif Çalışma. Abant Med J. April 2021;10(1):140-151. doi:10.47493/abantmedj.2021.44
5. 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 Dec 7;21(1):3.
6. Sasson C, Rogers MAM, Dahl J, Kellermann AL. Predictors of Survival From Out-of-Hospital Cardiac Arrest. Circ Cardiovasc Qual Outcomes. 2010 Jan;3(1):63–81.
7. Sirikul W, Piankusol C, Wittayachamnankul B, 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 Mar;9:100196.
8. Lee DW, Moon HJ, Heo NH. Association between ambulance response time and neurologic outcome in patients with cardiac arrest. Am J Emerg Med. 2019 Nov;37(11):1999–2003.
9. Merchant RM, Topjian AA, Panchal AR, et al. Part 1: Executive Summary: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020 Oct 20;142(16_suppl_2).
10. Şener A, Pekdemir M, İslam MM, et al. Prospective, multicenter, Turkish out-of-hospital cardiac arrest study: TROHCA. Turk J Emerg Med. 2024;24(3):133–44.
11. Zijlstra JA, Stieglis R, Riedijk F, Smeekes M, van der Worp WE, Koster RW. Local lay rescuers with AEDs, alerted by text messages, contribute to early defibrillation in a Dutch out-of-hospital cardiac arrest dispatch system. Resuscitation. 2014 Nov;85(11):1444–9.
12. Gräsner JT, Lefering R, Koster RW, et al. EuReCa ONE 27 Nations, ONE Europe, ONE Registry. Resuscitation. 2016 Aug;105:188–95.
13. Yan S, Gan Y, Jiang N, et al. The global survival rate among adult out-of-hospital cardiac arrest patients who received cardiopulmonary resuscitation: a systematic review and meta-analysis. Crit Care. 2020 Dec 22;24(1):61.
14. Lim SL, Smith K, Dyson K, et al. Incidence and Outcomes of Out-of-Hospital Cardiac Arrest in Singapore and Victoria: A Collaborative Study. J Am Heart Assoc. 2020 Nov 3;9(21).
15. Gräsner JT, Wnent J, Herlitz J, et al. Survival after out-of-hospital cardiac arrest in Europe - Results of the EuReCa TWO study. Resuscitation. 2020 Mar;148:218–26.
16. Yan S, Gan Y, Jiang N, et al. The global survival rate among adult out-of-hospital cardiac arrest patients who received cardiopulmonary resuscitation: a systematic review and meta-analysis. Crit Care. 2020 Dec 22;24(1):61.
17. 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 Dec 7;21(1):3.
18. Rusnak J, Schupp T, Weidner K, et al. Impact of Lactate on 30-Day All-Cause Mortality in Patients with and without Out-of-Hospital Cardiac Arrest Due to Cardiogenic Shock. J Clin Med. 2022 Dec 8;11(24):7295.
19. Dusik M, Rob D, Smalcova J, et al. Serum lactate in refractory out-of-hospital cardiac arrest: Post-hoc analysis of the Prague OHCA study. Resuscitation. 2023 Nov;192:109935.
20. Contenti J, Occelli C, Lemachatti A, Hamard F, Giolito D, Levraut J. Is the lactate value predictive of the return of spontaneous circulation during CPR in nontraumatic OHCA? Am J Emerg Med. 2024 May;79:75–8.