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ORIGINAL RESEARCH

Outcomes of arrest patients resuscitated in an emergency department: a prospective, observational study

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Abstract

In developing countries, a lack of knowledge about basic life support and overcrowded emergency departments (EDs) may cause problems related to the quality of cardiopulmonary resuscitation and postresuscitation care. We aimed to investigate which factors affect the return of spontaneous circulation (ROSC) and survival rates among out-of-hospital and in-hospital arrest patients in an upper-middle income country. The study was prospectively conducted from January 2018 to April 2019. All patients resuscitated in the ED, except trauma patients, were included. The out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA) groups were followed up for 30 days. The primary outcome was the 30-day-survival rate, while the secondary outcome was the ROSC rate. A total of 177 patients were included in the study (80 OHCA and 97 IHCA patients). Among the OHCA patients, ROSC was achieved at a rate of 58.8%, and a 30-day survival rate of 12.5% was observed. None of the OHCA patients underwent bystander CPR. One of the main factors affecting survival in this group was the time interval until the patient reached the ED. ROSC was achieved in 54.4% of IHCA patients, while 17.5% of them were alive at 30 days. Patients who survived 30 days were significantly younger than those who died within 30 days (56 (46–74) vs. 73 (64.2–83.7) years, respectively). In the IHCA group, patients with creatinine and potassium levels closer to normal survived for 30 days. Effective and rapid fluid-electrolyte treatments of patients with high lactate and potassium levels may improve the mortality rates of these patients. We think that a focus on improving the quality of the prehospital CPR practice in OHCA patients and increasing the rates of bystander CPR by educating the public can positively contribute to outcomes.

Keywords

Cardiac arrest; Emergency department; Out-of-hospital arrest; In-hospital arrest

1. Introduction

According to recent guidelines, one-tenth of out-of-hospital cardiac arrest (OHCA) and one-fourth of in-hospital cardiac arrest (IHCA) patients were noted to have survived [1]. However, basic life support (BLS) and the utilization of automated external defibrillators (AEDs) were clearly recommended on scene [2], and it has been reported that the survival rate of OHCA patients has not improved since 2012 [1]. Moreover, much of the research on cardiopulmonary resuscitation (CPR) quality is generally from developed countries. The major concern in the last term was the quality of CPR in low- and middle-income countries [3]. Although the proportion of people in high-income countries who know nothing about BLS is low [4], the proportion in developing countries is notable [5, 6]. This inadequate knowledge may lead to a delay in the initiation of CPR in developing countries. In addition, crowded emergency departments (EDs) and a lack of emergency medical systems (EMS) may hinder high-quality CPR in these developing populations [3].

There is insufficient information in the field about arrest patients who were resuscitated in the ED, especially from low- and middle-income countries.

We prospectively conducted this study to observe the cohort and to investigate the return of spontaneous circulation (ROSC) and survival rate of prehospital and in-emergency cardiac arrest patients, and we aimed to explore which factors affect the resuscitation process and survival rate of these patients.

2. Methods

2.1 Study setting

Our study was conducted in an ED of a tertiary-care, training and research hospital in Istanbul, Turkey, an upper-middle-

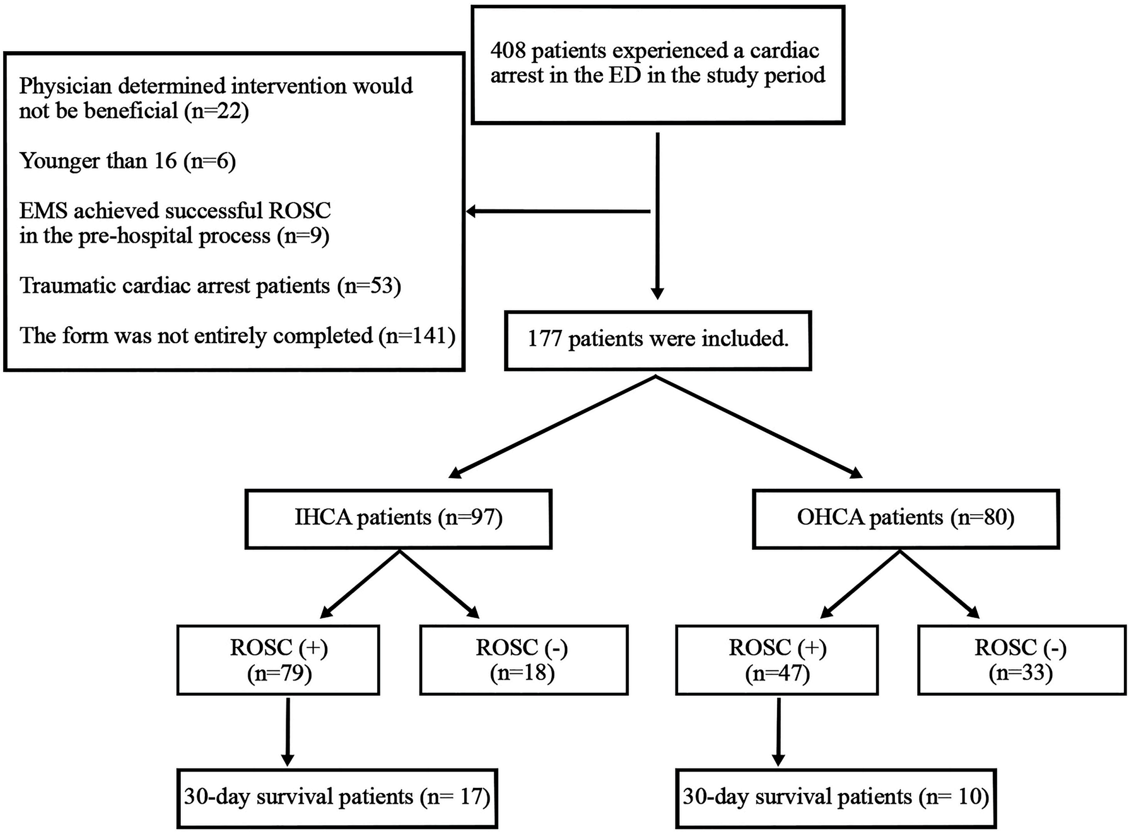

FIGURE 1. Patient flow chart. ED, Emergency Department; EMS, emergency medical services; IHCA, in-hospital cardiac arrest; OHCA, out-of-hospital cardiac arrest; CPR, cardiopulmonary resuscitation; ROSC, return of spontaneous circulation.

income country [7]. Approximately 35,000 patients are admitted to our ED per month. Furthermore, the average number of patients who are resuscitated in the ED per month is 25 to 30. The ED was in the highest category for overcrowding [8, 9].

2.2 Study design

The study was considered to define the differences in survival rates and prognoses among cardiac arrest patients who underwent CPR in our ED. The patients were evaluated in two cohort groups: prehospital cardiac arrest patients and in-emergency cardiac arrest patients. They were named as the OHCA and the IHCA groups. Specifically, "in-hospital" means "in the ED" in this study, and none of the other wards, general or coronary intensive care units (ICUs), were included. According to the rules of the Provincial Emergency Medical Services Coordination Commission, EMS never decides to terminate CPR at the scene in our country, and all patients are transferred to the nearest hospital as fast as possible.

2.3 Data collection

The study was conducted prospectively in a 17-month period from January 2018 to April 2019 after ethical approval (Ethical approval: 2017/394). Before starting the study, the researcher prepared case report forms according to the Utstein criteria [10]. We included all nontraumatic cardiac arrest patients for whom the form was fully completed. The form was completed for the first CPR of each patient. Information on the prehospital process for OHCA patients was acquired by EMS staff. CPR in the ED was administered in accordance with the guidance from the International Liaison Committee on Resuscitation (ILCOR) [2]. Clear pulse, blood pressure and improvement in the value of end-tidal carbon dioxide were accepted as the ROSC [11]. If the patient had an arrest again within 20 minutes following the ROSC, it was defined as "recurrent cardiac arrest". After the ROSC, whether patients were haemodynamically stable was marked on the form if systolic blood pressure was higher than 90 mmHg. Since the doctors worked in 24-hour shifts, the night shift was considered 11 PM–7 AM. For OHCA patients, the duration without CPR was defined as the time from the call to EMS to CPR initiation. Since bystander CPR was not reported in any of the OHCA patients, this information was not indicated in this study. Blood samples were tested within one hour after resuscitation.

Each patient was followed up by a researcher during their ED stay and postresuscitation process. The date of death or discharge was recorded. Survival was defined as living for more than 30 days. All patients in the 30-day survival group were discharged from the ICU. The cerebral performance category (CPC) scores of these patients were recorded at follow-up within one month after discharge.

2.4 Exclusion criteria

We excluded the following patients: cardiac arrest patients for whom the physicians determined that the intervention would not be beneficial (accepted as "dead on arrival"), patients who were younger than 16, patients who were resuscitated successfully during their prehospital process and had a clear pulse when they were transferred to the ED, and patients who had cardiac arrest due to traumatic reasons. In addition, patients whose exact information could not be provided, such as John Does, were not included in the study. Additionally, no pregnant patients were detected to undergo CPR in the time span of this study.

2.5 Outcome

We evaluated 30-day survival as the primary outcome and ROSC as the secondary outcome.

2.6 Data analysis

Statistical analysis was performed with SPSS 26 (IBM Corp., Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY, USA). The normality of continuous variables was determined with the Shapiro-Wilk test and histograms. Categorical outcomes are expressed as frequencies and percentages. Normally distributed variables are presented as the mean and the standard deviation, while non-normally distributed variables are presented as the median and 25th–75th percentiles. According to the normal distribution of continuous variables, Student's *t*-test or Mann-Whitney U test were used to compare the groups. A *p*-value < 0.05 was considered significant in the statistical analysis. A multivariate regression model was used to analyse the variables affecting the 30-day survival outcome. The multivariate regression model was composed of univariate analyses if the *p*-value was <0.05 for the OHCA and IHCA groups. The correlation between the variables included in the regression model was examined. If there was a high correlation between any two variables ($r > 0.7$), one of the variables was removed from the regression model. The goodness of fit of both models was confirmed by the Hosmer-Lemeshow test (*p*-values 0.822 and 0.984, respectively).

3. Results

A total of 408 patients underwent CPR in the time period of study in the ED. Ultimately, 177 patients were included in the study after exclusion (Fig. 1).

First, a total of 177 patients were investigated in two groups: the OHCA group (n = 80) and the IHCA group (n = 97). The general patient characteristics of these groups varied in some determinants (Table 1), and IHCA patients had a much higher ROSC rate than OHCA patients (81.4% and 58.8%, $p = 0.001$). In contrast to the ROSC, the 30-day survival rate was similar between the groups (12.5% for OHCA and 17.5% for IHCA, $p = 0.35$). The OHCA and IHCA groups with an ROSC had similar death rates in the first 24 hours, 46.8% and 54.4%, respectively ($p = 0.41$). The CPC score was evaluated as 1 for many of the patients (interquartile range (IQR) was 1–1.5 in both groups): CPC scores of 88.9% of OHCA patients and 94.1% of IHCA patients were 1 or 2.

Slightly more than one-third of OHCA patients were successfully intubated by EMS staff during the prehospital process, but the other 50 patients (62.5%) were intubated in the ED. The use of a laryngeal mask airway (LMA) was preferred by EMS for only one patient. Despite the similarity with the first shockable rhythm rate ($p = 0.60$), the use of amiodarone in the ED was doubled among the OHCA group compared with the IHCA group ($p = 0.02$). The IHCA patients had significantly higher rates of renal failure ($p = 0.016$), a primary focus of infection ($p = 0.006$) and a need for inotropic treatment after ROSC ($p = 0.001$).

We evaluated the ROSC separately for the OHCA and IHCA groups. In the ROSC comparison, among OHCA patients, 31.9% of those with successful ROSC had coronary artery thrombosis ($p = 0.016$). The association between the place of arrest of OHCA patients, such as in the ambulance, at home or in other places, and successful ROSC was found to be nonsignificant. Between the ROSC-achieved and the ROSC-not-achieved groups, the duration without CPR was similar (5 minutes (IQR: 0–10) and 5 minutes (IQR: 2–10), respectively, $p = 0.34$). In addition, the time interval until the patient reached the ED did not show a difference regardless of whether an ROSC was achieved (10 minutes (IQR: 5–15) for the ROSC achieved, 13 minutes (IQR: 5–20) for the ROSC not achieved, $p = 0.27$). In terms of all determinants, there was no significant difference between the successful and unsuccessful ROSC groups among IHCA patients.

After exclusion of unsuccessful ROSC patients, we evaluated the 30-day survival group separately for the OHCA and IHCA patients (Table 2). The time interval until the patient reached the ED among the survivor patients was approximately 5 minutes shorter ($p = 0.028$). The first rhythm was shockable for 60% of OHCA survivors, and similarly, 60% of OHCA patients had coronary artery thrombosis.

Notably, 52% of survivor IHCA patients initially had shockable rhythm, and 41.2% of IHCA patients had coronary artery thrombosis. Among IHCA patients, the survivor group was almost 20 years younger than the nonsurvivor group ($p = 0.002$). In addition, among IHCA patients, lactate in the nonsurvivor group (9.1 mmol/L (IQR: 5.9–12.3)) was more than double that in the survivor group (4.3 mmol/L (IQR: 2.3–5.5)) ($p < 0.001$). Creatinine in the nonsurvivor group (1.9 mg/dL (IQR: 1.2–3.5)) was twice as high as that in the survivor group (0.9 mg/dL (IQR: 0.8–1.2)) ($p < 0.001$). Potassium was one unit higher in the nonsurvivor group at 5.0 mmol/L ($p < 0.001$).

Neither the type nor the number of patient comorbidities patients had a significant association with the ROSC or survival in OHCA ($p = 0.60$) and IHCA ($p = 0.34$) patients. Years of experience of ED physicians were not associated with survival in either of the patient groups ($p = 0.85$ and $p = 0.16$ for the OHCA and IHCA groups). Similarly, experiencing cardiac arrest at the night shift did not determine survival ($p = 0.63$ for OHCA patients, $p = 0.16$ for IHCA patients). The median waiting time in the ED after resuscitation until transfer to an ICU was 3 hours (IQR: 0.8–5) and 2 hours (IQR: 1–4) in OHCA and IHCA patients, respectively, with no statistically significant difference between the groups ($p = 0.50$).

Moreover, according to multivariate logistic regression analyses (Table 3), a longer CPR duration among OHCA patients was seen to ease death at 30 days ($p = 0.048$, OR (Odds Ratio): 1.14 (95% CI (Confidence Interval): 1.00–1.30)).

TABLE 1. Patient characteristics in the out-of-hospital and in-hospital cardiac arrest groups.

Factors	OHCA patients (n = 80)	IHCA patients (n = 97)	*p*-value
Place of arrest: [c]			
Ambulance	31 (17.5)	NA	NA
Home	31 (17.5)		
Other (street, workplace, etc.)	18 (10.2)		
Time interval until the patient reached the ED (minutes)	10 (5–15) [b]		
CPR duration before reaching the ED (minutes)	5 (1–10) [b]		
Intubation by EMS staff	30 (37.5)		
Age, years [b]	68.5 (59–77.5)	72 (61–81)	0.23
Sex (male) [c]	52 (65)	67 (69.1)	0.57
Arrest time from 11 PM to 7 AM [c]	23 (28.7)	32 (33)	0.054
Duration without CPR (minutes) [b]	5 (1–10)	0 (0–0)	<0.001
ED physician (years of experience) [b]	5 (3–7)	6 (3–8)	0.04
Orotracheal intubation [d]	78 (97.5)	96 (99)	0.21
Initial rhythm [c]			
Shockable rhythm (VF/pulseless VT)	14 (17.5)	20 (20.6)	0.60
Peripheral cannulation	76 (95)	95 (97.9)	0.26 [d]
Extra central catheter required	17 (21.3)	16 (16.5)	0.42 [c]
Endotracheal drug therapy	2 (2.5)	0 (0)	0.20 [d]
Intraosseous cannulation	5 (6.3)	3 (3.1)	0.26 [d]
Medication given during CPR [c]			
Adrenaline	80 (100)	97 (100)	NA
Amiodarone	23 (28.7)	14 (14.4)	0.02
Bicarbonate	19 (23.8)	13 (13.4)	0.75
Ca-gluconate	12 (15)	16 (16.5)	0.79
Thrombolytic therapy	0 (0)	2 (2.1)	0.30 [d]
Naloxone	2 (2.5)	0 (0)	0.21 [d]
Main diagnosis [c]			
Cardiovascular aetiologies	26 (32.5)	23 (23.7)	0.19
Pulmonary aetiologies	27 (33.8)	36 (37.1)	0.64
Cerebrovascular aetiologies	2 (2.5)	5 (5.2)	0.31 [d]
Multiorgan failure/sepsis	5 (6.3)	9 (9.3)	0.46
Renal diseases	3 (3.8)	14 (14.4)	0.016
Other	17 (21.3)	10 (10.3)	0.044
Comorbidities [c]			
Congestive heart failure	15 (18.8)	16 (16.5)	0.69
Diabetes mellitus	17 (21.3)	25 (25.8)	0.48
Stroke	3 (3.8)	11 (11.3)	0.063
Active cancer	13 (16.3)	14 (14.4)	0.74
Alzheimer disease	6 (7.5)	9 (9.3)	0.67
Number of comorbidities ≥2 [c]	15 (18.8)	24 (24.7)	0.64
Reversible causes			
Hyperkalaemia	18 (22.5)	21 (21.6)	0.89
Coronary artery thrombosis	18 (22.5)	18 (18.6)	0.51
Active infection [c]	6 (7.5)	22 (22.7)	0.006
Inotropic therapy after ROSC [c]	27 (33.8)	38 (39.2)	0.001

TABLE 1. Continued.

Factors	OHCA patients (n = 80)	IHCA patients (n = 97)	*p*-value
Time interval until patients were transferred from the ED (hour)	3 (0.8–5)	2 (1–4)	0.50
Unit where patients were transferred [d]			
Coronary unit	13 (16.3)	17 (17.5)	0.11
Intensive care unit	20 (25.0)	43 (44.3)	0.14
pH [a]	7.03 ± 0.18	7.15 ± 0.18	<0.001
Lactate [b] (mmol/L)	11.5 (7.6–17)	7.9 (2.8–11.2)	<0.001
Haemoglobin [a] (g/dL)	11.9 ± 2.6	11.6 ± 2.6	0.28
Glucose [a] (mg/dL)	288 ± 134	274.8 ± 143.3	0.30
Creatinine [b] (mg/dL)	1.3 (1.1–2)	1.8 (1.1–2.9)	0.001
Estimated glomerular filtration rate [a]	51.8 (31.5–69.4)	37.8 (19.1–70.7)	0.051
Sodium [b] (mmol/L)	137 (133.3–140.5) [b]	137 (132–140.2) [b]	0.093
Potassium [b] (mmol/L)	4.4 (3.9–5.54) [b]	4.8 (4.1–5.4) [b]	0.53
Calcium (mg/dL)	8.8 ± 1.06 [a]	8.5 (8–9.3) [b]	0.19
Successful ROSC duration (minutes)	20 (10–30) [b]	10 (4–15)[b]	<0.001
Successful ROSC [c]	47 (58.8)	79 (81.4)	0.001
Recurrent arrest	6 (12.8)	7 (8.9)	0.55
24-hour survival after an ROSC [c]	22 (46.8)	43 (54.4)	0.41
24-hour survival rate in all patients	22 (27.5)	43 (44.3)	0.021
Survival more than 30 days after an ROSC [c]	10 (21.3)	17 (21.5)	0.97
Survival more than 30 days in all patients [c]	10 (12.5)	17 (17.5)	0.35
CPC [b]	1 (1–1.5)	1 (1–1.5)	0.65
CPC score 1 or 2 [d]	88.9	94.1	0.56

NA, not applicable; CPC, cerebral performance category. [a] mean ± standard deviation, independent t-test. [b] median (25th–75th percentile), Mann-Whitney U test. [c,d] n (%), [c] chi square test, [d] Fisher's exact test.

However, it could not be generalized to predict mortality due to the exclusion of patients with prehospital ROSC. Among IHCA patients, higher lactate and potassium levels were found to be associated with 30-day mortality (p = 0.04, OR: 1.27 (95% CI: 1.01–1.60) and p = 0.02, OR: 4.0 (95% CI: 1.26–13.06), respectively). The ROC curve of these parameters was significant (Fig. 2), and the cut-off value was 6.8 for lactate and 4.73 for potassium (Table 4).

4. Discussion

In our study, patients who underwent CPR in the ED were evaluated by grouping them according to the place of arrest. Interventional and medical treatments applied in the emergency room to OHCA and IHCA patients, the two study groups, were similar in most respects. However, the need for amiodarone was significantly lower in IHCA patients. Although the shockable rhythm observed when the patients were first monitored was similar in both groups, the clearly higher rate of renal failure and the presence of foci of infection in IHCA patients may have affected the CPR process.

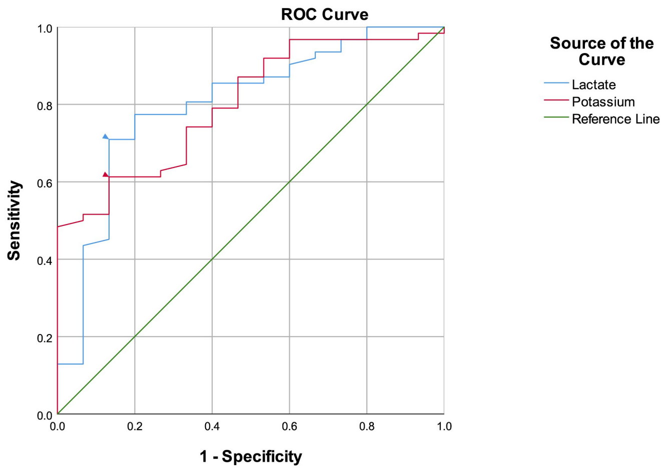

FIGURE 2. ROC curve of lactate and potassium among the non-30-day survival group despite ROSC in ED-arrest patients (the cut-off values for each parameter calculated according to the Youden index are shown with red and blue arrows).

TABLE 2. Comparison of 30-day survival in patients with successful ROSC in the OHCA and IHCA groups (n = 126).

	OHCA group (n = 47)			IHCA group (n = 79)		
	30-day nonsurvivors (n = 37)	30-day survivors (n = 10)	*p*-value	30-day nonsurvivors (n = 62)	30-day survivors (n = 17)	*p*-value
Age, years	70.5 ± 14.2	61.2 ± 15.6	0.078 [a]	73 (64.2–83.7)	56 (46–74)	0.002 [b]
Sex (male)	46 (65.7)	6 (60)	0.49 [d]	58 (72.5)	9 (52.9)	0.91 [c]
Duration without CPR (minutes) [b]	5 (0–10)	3 (0–10)	0.51	0 (0–0)	0 (0–0)	0.19
Time interval until patient reached the ED [b] (minutes)	10 (2–20)	5 (1–10)	0.028	NA		
Intubation by EMS staff	13 (37.1)	3 (30)	0.49	NA		
ED physician (years of experience) [b]	6 (3–7)	4.5 (3–7)	0.85	7 (3–11)	6 (2–6.2)	0.15
Arrest time from 11 PM to 7 AM	11 (29.7)	2 (30)	0.63 [d]	22 (35.5)	3 (17.6)	0.16 [c]
Main diagnosis [c]						
Cardiovascular aetiologies	13 (35.1)	5 (50)	0.31 [d]	10 (16.1)	10 (58.8)	0.001 [d]
Pulmonary aetiologies	9 (24.3)	2 (20)	0.57 [d]	25 (40.3)	5 (29.4)	0.41
Cerebrovascular aetiologies	2 (5.4)	0 (0)	0.61 [d]	4 (6.5)	1 (5.9)	0.71 [d]
Multiorgan failure/sepsis	2 (5.4)	0 (0)	0.61 [d]	8 (12.9)	0 (0)	0.13 [d]
Renal diseases	1 (2.7)	0 (0)	0.78 [d]	9 (14.5)	1 (5.9)	0.31 [d]
Other	10 (27)	3 (30)	0.56 [d]	6 (9.7)	0 (0)	0.22 [d]
Number of comorbidities ≥2 [c]	14 (26.9)	1 (20)	0.60 [d]	21 (31.8)	3 (21.4)	0.34
Reversible causes [c]						
Hyperkalaemia	11 (29.7)	0 (0)	0.088 [d]	14 (22.6)	1 (5.9)	0.11 [d]
Coronary artery thrombosis	9 (24.3)	6 (60)	0.042 [d]	9 (14.5)	7 (41.2)	0.023 [d]
Active infection	2 (5.4)	0 (0)	0.61 [d]	17 (27.4)	1 (5.9)	0.052 [d]
Initial rhythm [c]						
Shockable rhythm (VF/pulseless VT)	3 (8.1)	6 (60)	0.001 [d]	10 (16.1)	9 (52.9)	0.001 [d]
Time interval until patients were transferred from the ED (hour)	3 (1.1–5)	2 (0.5–4.2)	0.24	2 (0.5–4)	2 (1–7)	0.72
Unit where patients were transferred [d]						
Coronary unit	7 (30.4)	6 (60)	0.11	10 (23.3)	7 (41.2)	0.14
CPR duration (until successful ROSC) [b] (minutes)	23.5 ± 12.1	12.6 ± 5.3	<0.001	10 (5–15)	8 (3–16)	0.36
pH [a]	7.04 ± 0.19	7.11 ± 0.11	0.14	7.11 (6.9–7.3)	7.18 (7.1–7.3)	0.12
Lactate [a] (mmol/L)	12.3 ± 5.4	8.7 ± 3.5	0.053	9.1 (5.9–12.3)	4.3 (2.3–5.5)	<0.001

TABLE 2. Continued.

	OHCA group (n = 47)			IHCA group (n = 79)		
	30-day nonsurvivors (n = 37)	30-day survivors (n = 10)	*p*-value	30-day nonsurvivors (n = 62)	30-day survivors (n = 17)	*p*-value
Haemoglobin [a] (g/dL)	11.4 ± 2.5	13.5 ± 2.1	0.025	11.5 ± 2.7	12.3 ± 2.7	0.28
Glucose [a] (mg/dL)	293 ± 146.3	273 ± 83.5	0.85	265.6 ± 138.4	314.3 ± 162.4	0.13
Creatinine [b] (mg/dL)	1.3 (1.1–2.1)	1.3 (0.9–1.5)	0.56	1.9 (1.2–3.5)	0.90 (0.8–1.2)	<0.001
Estimated glomerular filtration rate [a]	50.5 ± 23.4	56.9 ± 14.8	0.48	38.3 ± 27.3	72.3 ± 28.6	<0.001
Sodium [b] (mmol/L)	138 (132–141)	136.5 (134.7–139)	0.60	137 (132.2–140–7)	136 (130.7–139.5)	0.34
Potassium [b] (mmol/L)	4.5 (4.1–5.6)	4.08 (3.6–5.2)	0.20	5.0 (4.2–5.5)	4.0 (3.4–4.7)	<0.001
Calcium (mg/dL)	8.9 ± 1.1 [a]	8.61 ± 0.6 [a]	0.28 [a]	8.6 (8–9.3) [b]	8.4 (7.9–9.2) [b]	0.46 [b]

NA, not applicable; ROSC, return of spontaneous circulation; OHCA, out-of-hospital cardiac arrest; IHCA, in-hospital cardiac arrest. [a] *mean ± standard deviation, independent t-test.* [b] *median (25th–75th percentile), Mann-Whitney U test.* [c,d] *n (%),* [c] *chi square test,* [d] *Fisher's exact test.*

TABLE 3. Multivariate logistic regression of significant factors for mortality within 30 days (HL >0.05).

Out-of-hospital cardiac arrest	Wald	*p*-value	OR	95% CI for OR	
				Lower	Upper
Time interval until patient reached the ED	0.790	0.374	1.102	0.889	1.366
Coronary artery thrombosis	0.001	0.981	1.033	0.074	14.364
Shockable rhythm (VF/pulseless VT)	1.356	0.244	0.113	0.003	4.435
CPR duration (until successful ROSC)	3.926	0.048	1.139	1.001	1.295
Haemoglobin	1.096	0.295	0.706	0.367	1.355
Constant	0.253	0.615	9.126		
In-Hospital Cardiac Arrest	Wald	*p*-value	OR	95% CI for OR	
				Lower	Upper
Age	3.587	0.058	1.044	0.999	1.091
Coronary artery thrombosis	0.180	0.671	1.617	0.176	14.873
Shockable rhythm (VF/pulseless VT)	4.130	0.042	0.125	0.017	0.929
Lactate	4.131	0.042	1.271	1.009	1.602
Creatinine	0.031	0.861	0.962	0.627	1.477
Potassium	5.275	0.022	4.001	1.225	13.061
Constant	9.041	0.003	0.000		

TABLE 4. Cut-off values of lactate and potassium related to death within 30 days after ROSC in the IHCA group.

	Cut-off	Specificity	Sensitivity	*p*-value	95% confidence interval	Area under the curve
Lactate (mmol/L)	6.8 [a]	87%	71%	<0.001	0.67–0.93	0.802
Potassium (mmol/L)	4.73 [a]	88%	61%	<0.001	0.69–0.91	0.814

[a] *calculated with Youden's index.*

When the OHCA patients included in our study were analysed according to their 30-day survival, the mean patient age, duration without CPR, and reversible causes were similar. However, the time interval until the patient reached the ED in the 30-day survivor group was significantly shorter than that in the nonsurvivor group. Furthermore, intubation at the scene improved neither the ROSC nor the survival rate. Although endotracheal intubation at the scene was not recommended in the study about airway management for OHCA patients [12], EMS used endotracheal intubation for 37.5% in our study. Instead of attempting intubation at the scene, it could be suggested that EMS should transfer OHCA patients to hospitals as soon as they start resuscitation, and they should focus on administering high-quality CPR with high-quality cardiac compression. However, a study investigating the association between resuscitation at the scene and transport to the hospital revealed that transport to the hospital may reduce the survival rate but result in better CPC scores among survivors [13]. This research was from Canada, a high-income country. The reason why these findings differ from ours is considered to be related to the EMS working system. In our country, it may be claimed that EMS is not capable of performing CPR at the scene. A lack of equipment or impolite attitudes of surrounding people may be problems for performing CPR at the scene. In addition, while this study [13] revealed that the rate of bystander CPR was 37.5%, none of the OHCA patients received bystander CPR in their prehospital process in our country. However, we need more research in prehospital settings to compare our country with low- and middle-income countries.

While we discovered the ROSC rate of OHCA patients in the ED at 58.8%, a review of OHCA patients reported an ROSC rate between 0 and 62%, with findings of 24 studies from low-resource countries. Our 24-hour survival rate in the OHCA group (27.5%) was compatible with these studies, 6.9 to 30% [3]. Among OHCA patients, the survival rate was 12.5%. The CPC score of 88.9% of the survivors was 1 or 2. In the latest guidelines, the survival rate in OHCA patients was reported to be 10.4%, and 8.2% of them had good cerebral performance [1]. A study of consecutive refractory OHCA patients reported ROSC, survival and better CPC score rates of 52%, 20%, and 86%, respectively, from a high-income country [14]. In that study [14], EMS transferred patients to an ED only after a period of ongoing CPR. The median time to reach an ED was 35 minutes for refractory OHCA patients, while this time span was 10 minutes in our study. In addition, 87% of patients in their research had a cardiovascular aetiology, while the value in our study was 32.5%. This difference is considered to indicate that we had a slightly higher ROSC rate but a lower survival rate. Reaching an ED may positively affect the initial circulation support. Regarding this, the initial rhythm is more important for survival [15]. While the association of the initial rhythm survival was not significant in patients with a cardiovascular aetiology, it was significant in patients who had coronary artery thrombosis. Additionally, the survival rate for patients with a shockable rhythm was greater than that of patients without a shockable rhythm, in accordance with the literature [16].

Moreover, the ROSC rate of IHCA patients was 81.4, and the 30-day survival rate was 17.5%, with a 94.1% improvement in CPC scores in our study. A study conducted in an ED from a lower-middle-income country revealed a rate of successful ROSC in the ED of 27.4% and a survival-to-discharge rate of 7.5% [17]. However, they did not categorize their patients according to the place of arrest as we did. In addition, their research [17] reported a CPC score less than 2 for 97% of patients. A study from Denmark, a high-income country that evaluated IHCA, found an ROSC rate of 53.8% and a survival rate of 27.8% [18]. The 30-day survival rate at a hospital in Sweden was 28.3%, and they found a CPC score of 1 or 2 for 93% of the evaluated patients [19]. These results from high-income countries are markedly better than ours, while the results from a lower-middle economy seem worse. On the other hand, CPC scores were similar in each economic situation. Perhaps hospitals in countries with poorer economies may not be able to keep their patients with complex conditions alive and help them recover. However, the results from studies in high-income countries were based on data from all hospital wards and ICUs. Therefore, the data from those studies are not equal to comparable with the data from our study. Due to the different wards and aetiologies evaluated in these studies, a comparison with data from only an ED, as in our study, would not be accurate. For instance, ED physicians may not diagnose a patient's aetiology while they resuscitate patients. In addition, ED patients have a much higher possibility of having a life-threatening condition.

More than half of IHCA patients who achieved an ROSC died in the 24-hour period following the first CPR. Therefore, death may be considered the concrete outcome even if ROSC has been achieved initially. The reason for having a higher death rate in the first 24 hours could be associated with a lower need for amiodarone, a significant difference in renal diseases among arrest aetiologies, the presence of a primary focus of infection and haemodynamic instability after the ROSC. While the cardiovascular aetiology had a better survival rate among IHCA patients, a significantly larger number of patients with higher creatinine levels and lower estimated glomerular filtration rates died within 30 days. In addition, lactate and potassium levels were significantly different between the survivor and nonsurvivor groups. In a study about mortality predictors after ROSC [20], lactate levels in nonsurvivor IHCA patients were revealed to be 2 units lower, with a value of 7.2 mmol/L (4.4–10.1), than that of the patient group in our study.

Our in-ED cardiac arrest patients were considered to have a life-threatening condition in advance. However, in our study, only a 30-day mortality analysis was performed, and the effect of the treatments received by the patients during this entire period on the outcome was not examined. Different treatments applied to the patients in their ICU process may have affected mortality.

5. Conclusions

We believe that the low bystander CPR rates determined in the study negatively affect the outcomes in OHCA patients, and we think that necessary studies should be performed and that public education should be offered to increase bystander CPR rates. Additionally, it should be emphasized that the focus should be on high-quality CPR rather than intubating the patient with ETT by EMS. Elevated lactate and potassium levels in IHCA patients are important predictors of mortality within 30 days. The earliest treatment of these patients can play a positive role in the prevention of arrest and their survival.

AUTHOR CONTRIBUTIONS

EY contributed to conceptualization, data curation, formal analysis, investigation, methodology, project administration, supervision, validation, visualization, writing — original draft, writing — review & editing. HD contributed to conceptualization, data curation, formal analysis, methodology, supervision, validation, visualization, writing — review & editing. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of Bakırköy Dr. Sadi Konuk Training and Research Hospital. All human participants' families were informed about the study and their consent was obtained. Ethical approval number was 2017/394.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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