original article

Survival after cardiopulmonary arrest in a tertiary care hospital in Turkey

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BACKGROUND: Despite significant improvements in the field of cardiopulmonary resuscitation (CPR) over the past 40 years, disparate survival rates are reported after in-hospital cardiac arrest (IHCA). Few studies have addressed the effect of comorbid conditions on survival after IHCA.

OBJECTIVE: Examine IHCAs over a two-year period, determine survival rates, and assess the effects of comorbid diseases on survival after IHCA.

DESIGN: Retrospective, cross-sectional study.

SETTINGS: Tertiary care hospital in Turkey.

PATIENTS AND METHODS: Patients who had an IHCA recorded in the data management system between 1 January 2016 and 31 December 2017 were evaluated using Utstein-style records for data collection. The Charlson Comorbidity Index (CCI) was scored retrospectively.

MAIN OUTCOME MEASURES: Return of spontaneous circulation (ROSC), survival in the first 24 hours, survival longer than 24 hours, and survival up to 6 months after discharge, CCI score, gender, age, location of IHCA, and first documented heart rhythm.

SAMPLE SIZE: 370 IHCA cases.

RESULTS: Of 502 patient, 370 met inclusion criteria. The presence of shockable rhythm was low (15.7%). The CCI was ≤3 in 10% (n=37) of all patients. A CPR duration of ≥20 minutes was the most important risk factor for ROSC. CCI ≥6 reduced ROSC-achieved cases by 2.8-fold (P=.036) and increased the mortality rate by 2.8 fold (P=.041). IHCA was most frequent in intensive care units (60.3%, n=223).

CONCLUSION: Assessing patients at risk in the hospital for comorbid conditions by CCI would be beneficial to prevent deaths related to IHCA. Close monitoring of patients with high CCI scores is advisable, as is making IHCA calls on time.

LIMITATIONS: Retrospective, small sample size, and no evaluation of the neurological condition of the discharged patients.

CONFLICT OF INTEREST: None.

Despite significant improvements in the field of cardiopulmonary resuscitation (CPR) over the past 40 years, disparate results have been reported in the literature on survival rates after in-hospital cardiac arrest (IHCA).[1-6] In addition to immediate CPR by trained personnel, the primary or comorbid diseases of the patient are important in long-term survival after IHCA.[7,8]

Many studies have shown that the use of resuscitation teams and the provision of basic life support (BLS) training to healthcare personnel have increased survival rates.[6,9] However, despite providing CPR to facilitate the return of spontaneous circulation (ROSC) after IHCA, reports of discharge survival rates are still between 0%-42%, often about 15%.[2,3,10,11] Few studies have addressed the effect of comorbid conditions on survival after IHCA. An increase in death rates is reported, but without using a systematic scoring method, such as the Charlson Comorbidity Index (CCI).[5,12] This particular index improves the evaluation of survival rates after IHCAs.

The Turkish population has an extended life expectancy as a result of improvements in income and health services in recent years. A parallel increase in the incidence of chronic diseases and IHCA would be expected. This study was aimed at examining the IHCAs in the two-year period in a tertiary hospital using Utstein's guide, determining survival rates, and assessing the effects of comorbid diseases on survival after IHCA by using the CCI, which is rarely used in reported studies.

PATIENTS AND METHODS

This study examined the IHCAs recorded at a tertiary hospital associated with the Aydın Adnan Menderes University School of Medicine in a 2-year period. The hospital is a university hospital with a total of 700 beds and 8 intensive care units (135 beds). The study was approved by the local ethics committee with approval number 2018/1334 and registered with clinicaltrial.gov (identifier: NCT03484559). IHCAs were catalogued in two periods: 1 January 2016 - 31 December 2016 and 1 January 2017 - 31 December 2017. All patients in the intensive care unit and angiography unit were under constant monitoring. All nurses and doctors were given resuscitation training at periodic intervals so that they could perform the necessary interventions during a cardiac arrest until the resuscitation team (RT) arrived. The RT consisted of an anaesthesiologist with at least one year of experience and at least one specially trained anaesthesiology nurse. The team was available 24 hours and was mobilized via calls at the phone number assigned for this task only. The RT responded to all communicated IHCAs. However, nurses did not have the authority to administer drugs without instructions from an anaesthesiologist in the hospital.

The study included patients who had IHCA (unresponsive with apnea, or agonal, gasping respiration and had undergone CPR and/or defibrillation) and who had been recorded in the on-line data management system (MIA-MED, MIA Technology, Turkey) between 1 January 2016 and 31 December 2017, who were 18 years or older, who were attended by the RT, and who were evaluated with Utstein-style records after the intervention.[13]

The Utstein style template is designed to collect data on hospital variables, patient variables, arrest variables, and outcome variables. It was developed to summarize IHCA data according to recommendations for reporting survival rates and outcomes.[13] Only one of repeated Code Blue calls for the same patient was evaluated. Patients under 18, patients not attended by the RT, and the calls from anaesthesia ICU and newborn or pediatric ICU were not included. In witnessed cardiac arrest (CA), the time to the arrival of the RT was considered as the arrival time. For witnessed cases who received cardiopulmonary resuscitation (CPR) before the arrival of the resuscitation team, the time to CPR was the time from the witnessed arrest time to the time of CPR initiation. All patients were followed up after CPR and for 6 months after discharge to assess survival. The results are reported as the return of spontaneous circulation (ROSC) within a maximum of 20 minutes after the non-pulse arrest (immediate), survival in the first 24 hours, survival longer than 24 hours, and survival up to 6 months after discharge (long-term).

The Charlson Comorbidity Index (CCI) is a weighted score of comorbidities based on the relative risk of one-year mortality. This index is widely used as a measure of the burden of comorbidities within research.[5] The CCI was scored retrospectively based on the hospital admissions data to assess IHCA comorbid conditions.[5] The patient data that were evaluated included gender, age, location of IHCA (intensive care unit, monitoring unit, non-monitoring unit), and first documented heart rhythm (ventricular tachycardia [VT]/ventricular fibrillation [VF] or pulseless electrical activity [PEA]/asystole). Electronic patient records were collected and classified based on the CCI as "low risk" (CCI ≤3), "moderate risk" (3< CCI ≤5), or "high risk" (CCI ≥6).

The Kolmogorov-Smirnov test was used to assess the normality of numerical variables. For numerical variables with normal distribution, the data are presented as mean and standard deviation and the comparison of groups was performed with independent samples *t* test. For data not normally distributed, the data are presented as median (25-75 percentiles) and the comparison of groups was performed with the Mann-Whitney U test. Descriptive statistics are presented as number and percentage and the chi-square test was used to analyse the categorical data. Logistic regression with a forward stepwise variable selection was used to predict the risk factors that affected ROSC and survival to discharge. A *P* value <.05 was considered statistically significant.

RESULTS

In the 2-year period, the RT received 502 IHCA calls. No intervention was performed in 132 cases as it was deemed inappropriate or the patient's condition had improved when the RT arrived at the scene (**Figure 1**). The remaining 370 patients (231 males, 139 females) and were included in the study. The incidence of IHCA was 3.5 and 2.7 per 1000 hospital admissions in 2016 and 2017, respectively. The frequency of cardiac arrests managed by the RT was 0.31% (370/118 005) of the patients admitted to the hospital and 0.089% (370/415 396) of the number of days of hospitalization. Of the patients included in the study, 65.9% (n=244) were older than 65 years of age. IHCA most frequently occurred in intensive care units (60.3%, n=223). Malignancies (32%, n=126) and cardiac diseases (23%, n=88) were the most common factors in the etiology (**Figure 2**). Whether the cardiac arrest was witnessed had no significant effect on the ROSC (*P*=.296). Respiratory insufficiency was the most common cause of cardiac arrest. The first initial rhythm recorded on the patient's monitor was PEA/asystole in 84.3% (n=312) of the cases. The presence of shockable rhythm was low (15.7%) among all IHCA cases. The arrival time of the CPR team in the ICU (median [interquartile range]: 2(2-3) minutes) was significantly shorter than in the non-monitored units (3[2-5]), and in the monitored units (5[2-5]) (*P*<.001).

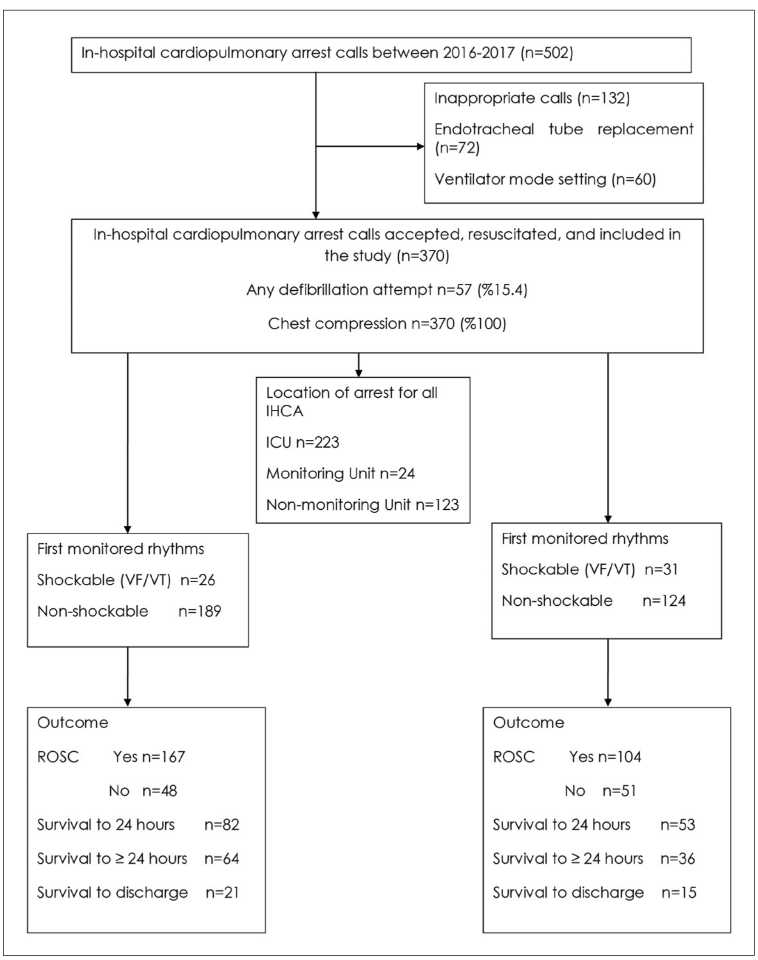

Figure 1. Flowchart of the study.

In the comparison of 2016 and 2017, the average age of patients, ratio of male patients and the ratio of those with PEA/asystole rhythm in 2016 were higher than in 2017 (*P*=.039, *P*=.019, and *P*=.026, respectively). However, the CPR duration was significantly shorter [25.0 (15) min vs. 29.0 (14) min] and the rate of ROSC-achieved patients was significantly higher (77.7% vs. 66.5%) in 2016 (*P*=.003 and *P*=.016, respectively). However, no significant difference was found between the two periods in terms of where arrest occurred, arrest time, witnessed cardiac arrest, arrival time of RT, CCI, and survival (ROSC) (**Table 1**). The CCI was ≥6 in 57.2% of all patients and ≤3 in 10% (n=37). In addition, the CCI was significantly lower in ROSC-achieved patients (median(IQR): 5.5[4-7]) than in ROSC-failed patients (median(IQR): 8 [6-10]) (**Table 2**).There was no change in the CCI through 2016-2017 (*P*=.841).

For the two-year period, ROSC (sustained ROSC lasting> 20 min) occurred in 73% (n=270) of patients and 50% (135/270) of these patients survived more than 24 hours (**Table 2**). Univariate analyses revealed a negative relationship between the ROSC and the duration of CPR and the CCI (r=-0.523, *P*=.001; r=-0.215, *P*=.001; respectively) (**Figure 3**). Thirty-six patients (9.7%) discharged alive had hospital readmission records within the period of 6 months. There was no difference between the genders in terms of ROSC and long-term survival (*P*=.557 and *P*=.396, respectively). The duration of CPR was <20 min in 41.8% of all cases. The CPR duration was <20 minutes in 40.7% of the ROSC-achieved cases and in 61.1% of the patients who were discharged and alive 6 months after discharge (*P*=.001, *P*=.001, respectively). A CPR duration of ≥20 minutes was the most important risk factor for ROSC, result-

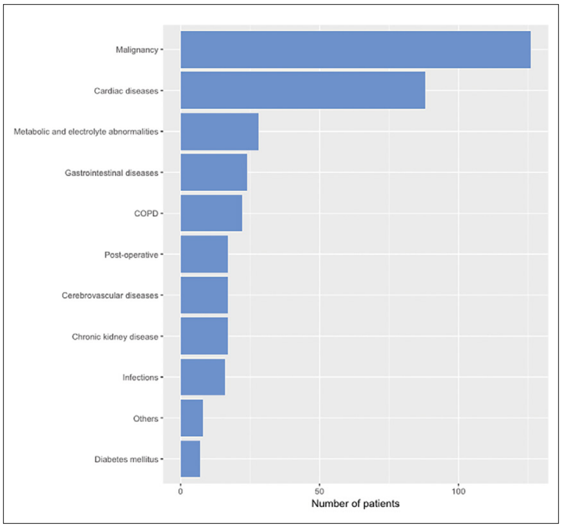

Figure 2. Comorbidities among cases of in-hospital cardiac arrest (n=370).

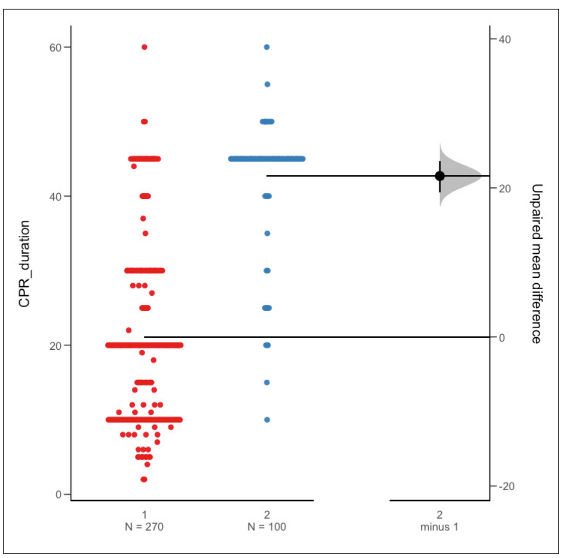

Figure 3. Estimation plot of CPR duration by ROSC achieved (n=270) or ROSC failed (n=100).[22]

ing in a 41.7-fold reduction in ROSC-achieved cases (*P*<.001, **Table 3**).

Among the 36 patients with long-term survival, 58.3% were male, mean age was 64.0 (16) years, 63.9% were in the ICU, 75% had an initial rhythm of PEA/asystole, and mean the mean arrival time was 2.9 (2.2) min (*P*=.593, *P*=.014, *P*=.721, *P*=.093, *P*=.566, respectively). In addition, CCI was ≤6 in 77.8% and mean duration of CPR was 16.6 (9.8) min in these patients (*P*=.001 and *P*=.001 respectively).

In the multivariate logistic regression, a CCI of ≥6 reduced ROSC-achieved cases by 2.8-fold and also reduced the 6-month survival rate by 2.7-fold (*P*<.036 and *P*=.041, respectively, **Table 3**). The analysis showed that a significantly lower rate of ROSC was achieved when CPR duration was >20 minutes, and CCI was ≥6. The rate of ROSC achieved was 2.2 times greater when cardiopulmonary arrest was in the ICU than in nonmonitored units (**Table 3**). In addition, 6-month survival rates were significantly lower with CPR duration of >20 minute, CCI of ≥6 and higher when cardiopulmonary arrest occurred in the ICU (**Table 3**).

DISCUSSION

Awareness of patient comorbidities is necessary for successful execution of CPR and patient survival after in-hospital cardiac arrest (IHCA). Pre-arrest comorbid diseases (e.g. cancer, cardiac diseases, and sepsis) have been shown to be associated with low survival.[11] In this report, we have shown that having a CPR duration of <20 minutes was the most important factor for successful return of spontaneous circulation (ROSC) after IHCA and long-term survival up to 6 months. In addition, this study is one of the few studies to use the Utstein style and CCI together to evaluate IHCA cases.

In our study, survival rate after cardiac arrest was evaluated in three periods: "immediate" (ROSC), "short term" (live discharge from hospital), and "long-term" (survival up to 6 months).[11] The rate of cases where patients had ROSC, an indicator of a successful CPR, was higher (73%) than some previous studies.[4,14] The 24-hour survival rate after ROSC was comparable (50%) to those in other studies in the literature (25-67%).[2,8,11] However, the long-term survival rate in our study (9.7%), although within the range reported in the literature (0-42%), was lower than the most frequently observed survival rates (15-20%).[4,8,11] We have found that the most important risk factor for long-term survival was having a CPR duration of <20 min. Another risk factor for long-term survival was having a CCI≤6 points. In addition, the frequency of CCI at "low risk" (CCI of ≤3 points) (10%) was similar to the long-term survival rate (9.7%). So, we think that comorbid diseases (cancer, cardiac disease, sepsis) and advanced age are significantly associated with poor survival. IHCA cases in newborn or pediatric intensive-care units (ICU) were not included in our study. In the literature, survival rates in those departments are similar to the rate of IHCA in other departments. However, our emergency physicians are the first attenders for cardiac arrest cases in the emergency ICU. Exclusion of these ICUs, which had higher survival rates in our hospital, might have contributed to the lower survival rate in our study.

Decreased survival rates after IHCA with increasing

Table 1. Demographic and clinical characteristics of each in-hospital cardiac arrest for each year.

	2015-2016 (n=215)	2016-2017 (n=155)	*P* value
Age (years)	70.6 (13)	67.6 (14.7)	**.039**
Male/Female	145/70	86/69	**.019**
Pre-existing conditions			---
Malignancy	70	56	
Cardiac diseases	50	38	
Gastrointestinal diseases	16	8	
Chronic obstructive pulmonary disease	14	8	
Chronic kidney disease	11	6	
Cerebrovascular disease	8	9	
Infections	12	4	
Metabolic and electrolyte abnormalities	14	14	
Postoperative	11	6	
Diabetes mellitus	5	2	
Others	4	4	
Initial heart rhythm			**.042**
Ventricular tachycardia/fibrillation	26 (12.1)	31 (20.6)	
Pulseless electrical activity/asystole	189 (87.9)	123 (79.4)	
Place of cardiopulmonary arrest			.806
Intensive care unit	131 (60.9)	92 (59.4)	
Monitoring unit	15 (7)	9 (5.8)	
Non-monitoring unit	69 (32.1)	54 (34.8)	
Arrest time			.177
8 a.m to 15:59 p.m	70 (32.6)	61 (39.4)	
16 p.m to 7:59 a.m	145 (67.4)	94 (60.6)	
Witnessed cardiac arrest			.079
Yes	98 (45.6)	85 (54.8)	
No	117 (54.4)	70 (45.2)	
Arrival time of the RT to CA site (median [IQR])	3 (2-5)	3 (2-4)	.098
Cardiopulmonary resuscitation time (minutes)	**25 (15)**	**29 (14)**	**.003**
Defibrillation attempted (Yes)	(26)	(32)	.277
Charlson comorbidity index			.841
0-3 points	20 (9.3)	17 (11)	
4-5 points	72 (33.5)	49 (31.6)	
≥6 points	123 (57.2)	89 (57.4)	
Return of spontaneous circulation			**.016**
Yes	167 (77.6)	104 (67)	
No	48 (22.4)	51 (33)	

Data are mean (standard deviation) or number (percentage) unless otherwise noted.

age have been reported in some studies.[6,14,15] This issue has been controversial.[11] In our study, most of the patients were older (65.9% were over 65 years), and age or gender alone had no effect on ROSC or 6-month survival. However, in the calculation of CCI, the patient's score increases for every 10-year period after the age of 50 and survival decreases. Therefore, it was thought that the CCI ≥6, which was identified as the important risk factor for long-term survival, indirectly reflected the effect of age. Primary or comorbid diseases are thought to be important factors affecting the ROSC and long-term survival. Most studies have emphasized that the primary etiology (cancer, sepsis, renal failure, etc.) was one of the main determinants of survival.[4,6,16-18] Malignancies (32%) and cardiac diseases (23%) were among the top primary etiologies in our study.

The rate of VF/VT rhythm, which is within the range of 20%-35% in IHCA cases, was slightly lower (15.7%) in our study. We think that the PEA/asystole rhythm was observed more often as secondary to hypoxia and hy-

Table 2. Demographic and clinical characteristics based on ROSC status.

Variables	ROSC-achieved (n=270)	ROSC-failure (n=100)	*P* value
Age (year)	69.2 (13)	69.6 (15)	.826
Male/Female	171/99	60/40	.557
Pre-existing conditions			
Malignancy	86	40	---
Cardiac diseases	70	18	
Gastrointestinal diseases	16	8	
Chronic obstructive pulmonary disease	19	3	
Chronic kidney disease	13	4	
Cerebrovascular disease	12	5	
Infections	14	2	
Metabolic and electrolyte abnormalities	18	10	
Postoperative	2	5	
Diabetes mellitus	5	2	
Others	5	3	
Initial heart rhythm			
Ventricular tachycardia/fibrillation	42 (15.6)	16 (16)	.917
Pulseless electrical activity/asystole	228 (84.4)	84 (84)	
Place of cardiopulmonary arrest			
Intensive care unit	158 (58.5)	65 (65)	.494
Monitoring unit	19 (7)	5 (5)	
Non-monitoring unit	93 (34.5)	30 (30)	
Arrest time			
8 a.m to 15:59 p.m	70 (34.8)	61 (37)	.696
16 p.m to 7:59 a.m	145 (65.2)	94 (63)	
Witnessed cardiac arrest			
Yes	138 (51)	45 (45)	.296
No	132 (49)	55 (55)	
Arrival time of the RT to CA site (median [IQR])	3 (2-4)	3 (2-5)	.324
Cardiopulmonary resuscitation time duration (minutes) (median, IQR)	**20 (10-30)**	**45 (45-45)**	**.001**
Defibrillation attempted (Yes/No)	41/229	16/84	.847
Charlson comorbidity index			
0-3 points	31 (11.5)	6 (6)	**.001**
4-5 points	104 (38.5)	17 (17)	
≥6 points	135 (50)	77 (77)	
Outcome			
Survival to 24 hours	135	0	---
Survival to ≥ 24 hours	99	0	
Survival to discharge	36	0	
Survival to 6 months	36	0	

Data are mean (standard deviation) or number (percentage) unless otherwise noted. ROSC: return of spontaneous circulation.

potension in cardiac arrest caused by respiratory problems in our study where older patients were in the majority. In the literature, better survival rates are reported for the shockable VF/VT rhythm (18-64%) than for PEA/asystole rhythm (1.2-14%).[1,4,11,19] In our study, however, survival rates in the VF/VT and PEA/asystole rhythms were not different. In our study, we observed that comorbid diseases and longer CPR duration were more important for survival.

In our study, 49.3% of the arrests were witnessed; however, we did not find a relationship between the immediate or long-term survival and the time of arrest or having a witnessed arrest. There are reports that patients in ICUs have lower survival rates since they have more serious illnesses, but other reports indicate the opposite.[8,11] In our study, we found that the majority of patients with better immediate and long-term survival were in the ICUs. We think that shorter arrival time for

Table 3. Multivariate logistic regression analysis for ROSC and survival to discharge long-term survival.

Dependent variable	Independent variable	Odds ratio	95% CI for odds ratio		*P*
			Lower	Upper	
Return of spontaneous circulation	Cardiopulmonary resuscitation duration ≥20 minute	41.767	9.918	175.885	**<.001**
	Charlson Comorbidity Index ≥6	2.861	1.069	7.657	**.036**
	Charlson Comorbidity Index 4-5	0.882	0.301	2.588	.819
	Place of cardiopulmonary arrest (intensive care unit)	2.198	1.259	3.837	**.006**
	Place of cardiopulmonary arrest (Monitoring unit)	1.084	0.348	3.379	.889
Long-term survival (6 months)	Cardiopulmonary resuscitation duration ≥20 minute	41.510	9.856	174.824	**<.001**
	Charlson Comorbidity Index ≥6	2.798	1.044	7.499	**.041**
	Charlson Comorbidity Index 4-5	0.885	0.301	2.559	.824
	Place of cardiopulmonary arrest (intensive care unit)	2.308	1.319	4.041	**.003**
	Place of cardiopulmonary arrest (monitoring unit)	1.133	0.363	3.532	.830

Reference variables are the non-monitored unit for place of cardiopulmonary arrest and CCI≤3 for Charlson Comormidity Index. Model Summary: Omnibus test 97.031, df=5, *P*<.001, -2 Log likelihood=334.779, Cox & Snell R Square=.231, Nagelkerke R Square=.335

the CPR team at the ICU in particular and early detection of arrest and immediate resuscitation of the patients monitored in the ICU increase the survival rates. However, we also found that long-term survival rates were low in patients with CCI of ≥6 and in patients with CPR duration of ≥20 min. Consequently, we think that the follow-up monitoring of patients who had ROSC might be a determining factor for their long-term survival. However, our study did not evaluate all post-CPR records.

The period between the time of arrest and the time of starting resuscitation is important to survival.[8,17,20] Various studies have reported different times of starting resuscitation and survival outcomes.[4] Herlitz recommended starting resuscitation within 1 minute after arrest and Pembeci et al recommended starting within 5 minutes after arrest for an increased survival rate at hospital discharge.[4] However, it has been shown that advanced life support (ALS) services might be delayed up to 6 minutes in large hospitals.[11] The commonly accepted view is that intervention within 3 minutes of cardiac arrest increases survival rates. In our study, 68.9% of the patients had been resuscitated within 3 minutes. In patients in the ICU in particular, CPR was started within 2 minutes of arrest. Since healthcare personnel other than physicians are not authorized to administer drugs or perform defibrillation in our hospital, the CPR success in our study depends on the arrival of the resuscitation team.

Although the ROSC and 24-hour survival rates in our study (70% and 50%, respectively) were higher than those reported by another study conducted in Turkey

13 years ago (49.3% and 28.5%, respectively), the discharge survival rate was lower in our study (9.7% vs. 13.4%).[4] However, discharge survival rates range between 0% and 42% in the literature, and large-scale studies have reported rates of approximately 20%.[7,8,21] We think that a higher proportion of patients over the age of 65 years, CCI scores of ≥6 associated with underlying chronic diseases, and CPR durations of >20 minutes might be important factors contributing to the lower discharge and long-term survival rates in our study.

The number of cases in this study, which retrospectively analysed the data over a 2-year period, was fewer than those in multicenter studies covering decades. In addition, our study evaluated neither the treatments applied during arrests nor the subsequent intensive care follow-up treatments for ROSC-achieved cases. Finally, the neurological condition of the discharged patients had not been evaluated in this study.

In conclusion, assessing patients at risk in the hospital for comorbid conditions by CCI would be beneficial in order to prevent mortalities related to IHCA. Also, close monitoring of those with high CCI scores is advisable, as is making IHCA calls on time to prevent deaths. In addition, periodic basic and advanced life support training should be provided to the healthcare personnel working in ICUs and off-hours in particular to improve survival rates.

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