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Evaluation of Patients Undergoing Cardiopulmonary Resuscitation in the Emergency Department: Descriptive Research

Acil Serviste Kardiyopulmoner Resusitasyon Uygulanan Hastaların Değerlendirilmesi: Tanımlayıcı Araştırma

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ABSTRACT Objective: In this study, we aimed to evaluate the datas about cardio pulmoner resusitation performed at Hatay Mustafa Kemal University hospital emergency department. by investigate of hospital data system and to make the most appropriate resuscitation planning. **Material and Methods:** 109 patients who underwent CPR at Hatay Mustafa Kemal University Emergency Department were retrospectively analysed. pH and lactate values of patients in blood samples taken on arrival of patients analysed. **Results:** In emergency department admissions 50 (45.9%) İHCA and 59 (54.1%) OHCA cases was observed. 26 (23.9%) of patients who underwent CPR in emergency department ROSC and admitted to intensive care following the CPR. 7(26.9%) patients in the intensive care unit were discharged and 10 (38.5%) patients exitus on the first day of hospitalisation. 102 patients (93,6%) were exitus. Mean lactate in OHCA patients (10.44±4.52 mmol/L) was significantly higher than the IHCA patients mean lactate (7.6±4.97 mmol/L) (p=0.002). In the ROC analysis, the AUC was 0.627 (0.514 0.740) (p=0.040). A lactate value above 10.65 mmol/L was determined as the cut-off point for mortality prediction. sensitivity 0.470 specificity of 0.808. Survival was not observed in traumatic cardiac arrests. **Conclusion:** While no significant difference was observed for survival in IHCA and OHCA, ROSC close to the literature was observed, but survival in traumatic cardiac arrest patients was far behind the literature. Resuscitation is a rescue chain that starts with 'bystander CPR' and consists of detection of the cause of arrest in emergency services, maintenance of CPR and post-CPR care. Survival rate can be increased by strengthening each link of this chain.

Keywords: Cardiopulmonary resuscitation;
in hospital cardiac arrest;
out of hospital cardiac arrest;
return of spontaneous circulation

ÖZET Amaç: Bu çalışmada, Hatay Mustafa Kemal Üniversitesi Tıp Fakültesi Acil Servisinde uygulanan kardiyopulmoner resusitasyonlarla (KPR) verileri incelenerek elde edilen bilgileri değerlendirmek ve en uygun resusitasyon planlamasını yapmak hedeflenmiştir. **Gereç ve Yöntemler:** Hatay Mustafa Kemal Üniversitesi Acil Servisinde KPR uygulanan 109 hasta retrospektif olarak incelendi. hastaların gelişinde alınan kan örneklerindeki pH ve laktat değerleri incelendi. **Bulgular:** Acil servise başvurularda 50 (%45,9) olguda HİKA, 59 (%54,1) olguda HDKA görüldü. Acil serviste KPR yapılan 26 (%23,9) olgunun KPR sonrası SDGD ve yoğun bakıma yatırıldığı gözlendi. Yoğun bakımdaki hastaların 7'sinin (%26,9) taburcu olduğu, 10'unun (%38,5) ise yoğun bakıma alındığı gün eks olduğu gözlenmiştir. Toplam 102 hastanın (%93,6) eks olduğu görüldü. HDKA hastaların laktat ortalaması (10,44±4,52 mmol/L) HİKA hastaların laktat ortalamasından (7,6±4,97 mmol/L) anlamlı düzeyde yüksek olduğu gözlendi (p=0,002). Yapılan ROC analizinde AUC 0,627 (0,514 0,740) olarak gözlendi (p=0,040). Laktat değerinin 10,65 mmol/L üzerinde olması mortalite tahmini için kesim noktası olarak tespit edildi. Sensitivite değeri 0,470 spesifisite 0,808 olarak gözlendi. Travmatik kardiyak arrestlerde sağkalım gözlenmedi. **Sonuç:** HİKA ve HDKA hastalarda sağkalım açısından anlamlı bir fark gözlenmezken literatüre yakın bir SDGD izlendi ancak travmatik kardiyak arrest hastalarda sağkalım literatürün çok gerisinde kaldı. Resusitasyon; "bystander KPR" ile başlayan, acil servislerde yapılan arrest sebebinin tespiti, KPR'nin sürdürülmesi ve KPR sonrası bakımdan oluşan bir kurtarma zinciridir. Bu zincirin her halkasının güçlendirilmesi ile sağkalım oranı artırılabilir.

Anahtar Kelimeler: Kardiyopulmoner resusitasyon;
hastane içi kardiyak arrest;
hastane dışı kardiyak arrest;
spontan dolaşıma geri dönüş

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Cardiopulmonary resuscitation (CPR) is a collection of life-saving practices that ensure continuous and reliable access to airways, effective artificial respiration with positive pressure, oxygen supplementation, administration of intravenous drugs and fluids, defibrillation in necessary cases, and proper treatment tailored to changing clinical and rhythm conditions during resuscitation. In summary, CPR combines many critical practices that are crucial in the chain of survival. These procedures and interventions are determined and published as guidelines by the International Collaboration Committee on Resuscitation, which was founded in 1992 and convenes regularly.[1]

The cessation of life, known as death, initiates with cardiac arrest. Although the primary goal of CPR is not to end every cardiac arrest with death, our goal today is continuity without neurologic sequelae.

Sudden cardiac death is defined as the unexpected death of a person due to cardiovascular causes, regardless of a known history of heart disease. There are 17 million deaths in the world annually and approximately 25.0% of these are sudden cardiac arrest.[2]

Cardiac arrests can be classified as in-hospital cardiac arrest (IHCA) and out-of-hospital cardiac arrest (OHCA) according to the location of occurrence. In the world, OHCA results in death more frequently. In Europe, approximately 275,000 cardiac arrests were treated in emergency departments annually and 19,000 (10.9%) survived and were discharged. In 2014, 7.9% of the 28,729 OHCA patients treated in emergency departments in the UK survived and were discharged. Reported OHCA survivors were 7.9% in Europe, 6.8% in North America, 3% in Asia and 9.7% in Australia.[3]

Survival in IHCAs varies between 15.0-20.0%. Although the outcome is better in ventricular fibrillation (VF) arrests, survival in IHCA has not changed significantly despite the widespread and systematic application of CPR in the last 30 years.[4]

Causes of non-cardiac arrest include non-traumatic bleeding, pulmonary thromboembolism, malignancy, intracranial pathologies, trauma, intoxications and drowning.[5]

The prognosis in OHCA is poor, with a survival rate of 3-7% despite effective CPR. 69% of these patients are male. In patients admitted to the emergency department, cardiopulmonary arrest is a condition with high mortality that can occur at any time. Arrest is highly likely to occur if the patient followed up in the emergency department has hypotension, tachycardia, tachypnea, mental status changes, decreased urine output and accompanying laboratory abnormalities (hypoxia, acidosis, hyponatremia, hyperkalemia, hyperkalemia, increased creatinine). In in-hospital arrests, extracardiac pathophysiologic processes continue and cardiac arrest develops as a result. Mortality is quite high in both out-of-hospital and in-hospital arrests even if timely and effective CPR is performed.[5]

Considering that 15-20% of all deaths occur as a result of sudden cardiac death, resuscitation procedures should be performed in the most accurate way by every physician and every healthcare personnel in order to use this precious time between life and death effectively. In addition, only 5-10% of OHCAs can be reversed and approximately 6% of these patients are discharged from the hospital with a neurological well-being.[6] Therefore, in order to define CPR application as “successful”, it is not enough for the patient’s circulation to be restored. The most important thing is that the patient’s neurologic status is restored in the best way.

In this study, we aimed to assess the efficacy of CPR as applied at Hatay Mustafa Kemal University Hospital, identifying factors that contribute to its success and determining modifiable elements.

MATERIAL AND METHODS

In our study, 109 patients from Hatay Mustafa Kemal University Faculty of Medicine Emergency Department were examined retrospectively after approval of the ethics committee (date: March 17, 2022 , no: 4). This study complies with the Declaration of Helsinki was performed. This retrospective analysis assessed arrest patients who underwent CPR at the Hatay Mustafa Kemal University Emergency Department between January 15, 2020, and January 15, 2023. A total of 109

patients who underwent CPR in the emergency department were evaluated in this study. Blood samples were collected from patients within 5 minutes of their arrival in the resuscitation area, and were analyzed at the Biochemistry laboratory of Hatay Mustafa Kemal University Hospital. The results were obtained from the Enlil HIS program in the hospital information system.

The normality of the variables was analyzed using the Shapiro-Wilk Test. Student's t-test was used to compare mean differences between two normally distributed groups and Mann-Whitney U test was used to compare non-normally distributed data. The χ^2 test or Fisher's exact test, where appropriate, was used to compare categorical variables between the groups Area under the curve (AUC) calculation was used to calculate the predictive value of the lactate parameter for mortality.

Receiver operating characteristic curve (ROC) curve was used to determine the optimal cut-off point. Two-sided $p<0.05$ was considered significant for all tests. Patient demographic information will be summarized using descriptive statistics (n, mean, SD, minimum, maximum, median, difference between percentiles) or frequency distribution (n and %) according to the data type. All statistical procedures were performed with SPSS 23.0 (IBM, Armonk, NY).

RESULTS

This study, which evaluated patients who underwent CPR in the emergency department, was conducted on 109 patients. 73 patients were male and 36 were female. The mean age of the patients was 64.69±19.36 years. The mean pH value of the patients was 7.06±0.21, lactate value was 9.14±4.92 mmol/L. The mean bicarbonate value was 13.42±6.65 mmol/L and the mean hemoglobin value was 11.36±2.45 g/dL. At admission to the emergency department, 50 (45.9%) patients had in-hospital arrest and 59 (54.1%) patients had out-of-hospital arrest. When the reasons for the emergency department admission were analyzed, it was found that 92 (84.4%) of the cases were non-traumatic and 17 (15.6%) were admitted to the emergency department with a history of trauma. It was observed that 26 (23.9%) patients who underwent CPR in the emergency department had return of spontaneous circulation (ROSC) after CPR and were hospitalized in the intensive care unit. It was observed that 7 (26.9%) of the patients followed up in the intensive care unit were discharged and 10 (38.5%) of them died on the day they were admitted to the intensive care unit. It was observed that 102 (93.6%) of all patients died (Table 1).

Socio-demographic and clinical characteristics of the patients were compared according to in-hospital and out-of-hospital arrest status. A statistically significant correlation was found between the pH and lactate levels of the patients and in-hospital and out-of-hospital arrest status. The mean pH of the patients with in-hospital arrest was 7.13±0.19, which was significantly higher than the mean pH of the patients with out-of-hospital arrest, which was 7.00±0.21 (p=0.001). However, the mean lactate of patients with out-of-hospital arrest (10.44±4.52 mmol/L) was significantly higher than

TABLE 1: General characteristics of the cases.

	n	%
Gender		
Male	73	67
Female	36	33
Age ($\bar{X}$±SD)	64.69±19.36	
Ph ($\bar{X}$±SD)	7.06±0.21	
Lactate ($\bar{X}$±SD)	9.14±4.92 mmol/L	
Base gap ($\bar{X}$±SD)	-13.44±9.37	
HCO_3 ($\bar{X}$±SD)	13.42±6.65 mmol/L	
Hb ($\bar{X}$±SD)	11.36±2.45 g/dL	
Trauma		
Non trauma	92	84.4
Trauma	17	15.6
Arrest		
In-hospital arrest	50	45.9
Out-hospital arrest	59	54.1
Returning	26	23.9
Hospital ex	83	76.1
Intensive care follow-up		
Discahrge	7	26.9
1 day ex	10	38.5
Day 2-7 ex	9	34.6
Living	7	6.4
Ex	102	93.6

n=109, SD: Standard deviation; Hb: Hemoglobin; Ex: Exitus.

the mean lactate of patients with in-hospital arrest (7.6±4.97 mmol/L) (p=0.002).

Among 50 patients with in-hospital arrest, 13 (26%) returned to spontaneous circulation after CPR and 37 (74%) died in the emergency department. It was observed that the rates of ROSC and exiting were similar in in-hospital and out-of-hospital arrest patients (p=0.628).

It was observed that 6 (12%) patients with in-hospital arrest died on Day 1, 4 (8%) patients died between Days 2 and 7, 3 (6%) patients were discharged with recovery after intensive care follow-up, while 4 (6.8%) of 59 patients with out-of-hospital arrest died on Day 1, 5 (8.5%) died between Days 2 and 7, and 4 (6.8%) patients were discharged with recovery after intensive care follow-up (Table 2). In addition, no significant correlation was found between in-hospital and out-of-hospital arrest status and mortality (p=0.869).

The relationship between the general characteristics of the patients and their mortality was analyzed in Table 3. Age and bicarbonate values were correlated with mortality. The bicarbonate values of the living patients (18.53±7.96 mmol/L) were significantly higher, while the mean age of the patients who died (66.05±18.91 years) was significantly higher (p<0.05). While high age was a factor that increased mortality, low bicarbonate levels were a factor that decreased mortality. Of the 109 patients who underwent CPR, 7 (100%) who were discharged with recovery were patients who came to the hospital for non-traumatic reasons.

TABLE 2: Comparison of the characteristics of in-hospital arrest and out-of-hospital arrest cases.

	Arrest	
	In-hospital arrest (n=50) n (%)/X̄±SD	Out-of-hospital arrest (n=59) n (%)/X̄±SD
Age (X̄±SD)	62.74±20.73	66.34±18.14
Ph (X̄±SD)	7.13±0.19	7±0.21
Lactate (X̄±SD)	7.6±4.97 mmol/L	10.44±4.52 mmol/L
Base gap (X̄±SD)	-11.94±9.27	-14.7±9.35
HCO (X̄±SD)	14.28±6.31 mmol/L	12.7±6.89 mmol/L
Hb (X̄±SD)	11.56±2.64 g/dL	11.19±2.3 g/dL
Male	35 (70)	38 (64.4)
Female	15 (30)	21 (35.6)
Non trauma	42 (84)	50 (84.7)
Trauma	8 (16)	9 (15.3)
Returning	13 (26)	13 (22)
Hospital ex	37 (74)	46 (78)
Discharge	3 (6)	4 (6.8)
In day 0. ex	37 (74)	46 (78)
1. day ex	6 (12)	4 (6.8)
2-7 days ex	4 (8)	5 (8.5)
Live	3 (6)	4 (6.8)
Ex	47 (94)	55 (93.2)

Hb: Hemoglobin; Ex: Exitus.

TABLE 3: Association of general and clinical characteristics of the patients with mortality.

	Live (n=7) n (%)/X̄±SD	Ex (n=102) n (%)/X̄±SD	p value
Age (X̄±SD)	44.86±15.36	66.05±18.91	0.005
Ph (X̄±SD)	7.12±0.19	7.05±0.21	0.420
Lactate (X̄±SD)	7.81±3.9 mmol/L	9.23±4.99 mmol/L	0.464
Base gap (X̄±SD)	-8±10.03	-13.81±9.26	0.113
HCO_3 (X̄±SD)	18.53±7.96 mmol/L	13.07±6.4 mmol/L	0.035
Hb (X̄±SD)	11.59±0.96 g/dL	11.35±2.53 g/dL	0.805
Male	5 (71.4)	68 (66.7)	0.796*
Female	2 (28.6)	34 (33.3)	
Non trauma	7 (100)	85 (83.3)	0.593*
Trauma	0 (0)	17 (16.7)	
In-hospital arrest	3 (42.9)	19 (18.6)	
Out-of-hospital arrest	4(57.1)	83 (81.4)	

*p value was obtained from pearson chi square test.
SD: Standard deviation; Hb: Hemoglobin; Ex: Exitus.

The relationship between the general characteristics of the patients, exiting after CPR and spontaneous circulation returned was analyzed. The mean age of patients who survived after CPR was significantly lower than that of patients who died. There was a significant correlation between older age and mortality. (p<0.05) Also it was observed that there was a significant correlation between low lactate value of the patients and ROSC after CPR. While the lactate value was found to be 9.67±5.04 mmol/L in the ex cases, the lactate value (7.46±4.18 mmol/L) was significantly lower in the spontaneous circulation returned cases (p<0.05). There was no significant correlation between the trauma or non-trauma status of the cases and Ex at the end of CPR or ROSC (p>0.05).

ROC analysis was performed on the lactate value of 26 patients whose spontaneous circulation returned after CPR performed in the emergency

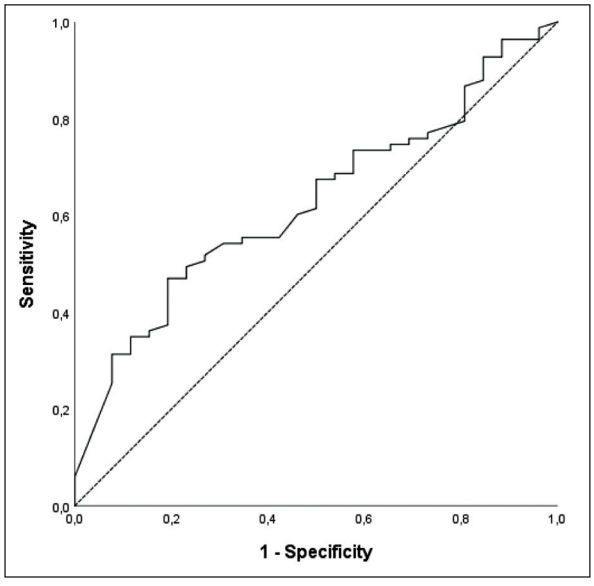

FIGURE 1: ROC curve of lactate values of patients who died as a result of cardiopulmonary resuscitations and spontaneous circulation returnedpatients.

department (Figure 1). In the ROC analysis, AUC was observed as 0.627 (0.514 0.740) (p=0.040). A lactate value above 10.65 was determined as the cut-off point for predicting the ex status and the sensitivity value of this value was 0.470 with a specificity of 0.808. A lactate value below 10.65 was observed to be a protective factor on mortality.

DISCUSSION

In this study, we aimed to compare the data of CPR performed in the emergency department with the literature.[7-13] The reported survival rate of OHCA patients is 7.9% in Europe, 6.8% in North America, 3% in Asia and 9.7% in Australia.[3] Survival of OHCA patients differs according to countries. In another study, Australia, where the survival of OHCA patients is higher than other countries, was evaluated in terms of CPR performed at the scene. In this study conducted in 2020, it was reported that survival was higher in Australia where bystander CPR was more common.[14] In our study, although there was no significant difference between IHCA and OHCA in terms of survival, lactate level was found to be higher in OHCA cases. Also we know higher lactate walue is result of ischemia and impaired circulation.

The correlation between lactate and critical illnesses has been established by earlier studies. Similar to sepsis and other critical illnesses, lactate elevation emerges after cardiopulmonary arrest caused by ischemic condition. This lactate elevation is associated with mortality. In prior research, a high lactate level and the requirement for vasopressors upon ROSC following CPR in out-of-hospital arrest cases have been identified as strongly predictive factors for mortality. However, the relationship between lactate level monitoring during CPR and spontaneous circulation returned or survival in in-hospital arrest cases is unclear.[15] Our study revealed that the lactate level of ROSC patients was significantly lower than that of ex patients. It remains to be determined whether lactate level monitoring during CPR can improve patient outcomes.

The findings of our study indicate that there is no statistically significant difference in survival rates between OHCA and IHCA. It is important to recognise that there are a number of factors that contribute to the effectiveness of CPR. The study conducted by Al et al. demonstrates that the efficacy of CPR is contingent upon a number of factors, including the duration of the arrest, the initial cardiac rhythm (VF/VT), the qualifications of the healthcare professionals who performed the CPR, the time taken to reach the hospital, the management of the airway, and the presence or absence of bystander CPR e.t.c.[16]

A limitation of our study is that the conditions preceding OHCA in the pre-hospital setting remain unclear.

In the course of our study, seventeen cases of traumatic cardiac arrest were observed, none of which resulted in ROSC. Previous research has indicated that survival rates following traumatic cardiac arrest are typically lower than those observed in cases of medical cardiac arrest. A review of Lewis and Perkins outcomes revealed that the rates of successful resuscitation from traumatic cardiac arrest remain unacceptably low. The review identified 36 studies involving 51,722 patients. The majority of studies originated from Europe and Asia and reported on outcomes following penetrating and blunt trauma. Survival rates exhibited variability contingent on whether

registries encompassed deaths that occurred in the prehospital setting. In studies that incorporated prehospital deaths, mortality was notably elevated at 97.2% (95% confidence interval 96.3-98.0).[17]

Despite the elevated mortality rate associated with traumatic cardiac arrest, our study did not observe any ROSC in cases of traumatic cardiac arrest. This highlights the necessity for a thorough examination of the CPR procedure in traumatic arrest scenarios. As demonstrated by a study conducted by Teeter and Haase, the utilisation of ultrasound in the initial assessment of trauma patients has been a mainstay for decades. It continues to be a valuable adjunct for the initial assessment of a trauma patient, both for the identification of reversible causes of arrest and the assessment of cardiac function when considering whether to withhold or terminate resuscitation efforts.[18]

Prior to January 2023, the use of ultrasonography (USG) was not a common practice in our clinic. Recently, there has been a notable increase in the number of USG users. It would be beneficial to compare the success of CPR for traumatic cardiac cases with previous results.

In addition, in our study, although a large proportion of spontaneous circulation returned patients returned to spontaneous circulation after CPR, they died in the first 7 days. According to a study conducted by Girotra et al., post-CPR care plays a crucial role in improving survival rates, since the high mortality rates in the post-resuscitation stage could result from the whole-body ischemia, reperfusion-mediated injury, and the cardiac arrest-induced pathological condition. It has been noted that implementing strategies like hypothermic resuscitation, early coronary angiography, and post-cardiac arrest care can improve survival rates.[19]

CONCLUSION

There is always a significant risk of death and disability as a result of cardiac arrest. The study revealed no statistically significant difference in survival rates between IHCA and OHCA cases. However, it should be noted that lactate levels, which are believed to be linked to mortality, were higher in OHCA patients. Furthermore, there was a negative correlation between high lactate levels and survival. Also The survival rates of ROSC patients admitted to intensive care following emergency services are not significantly different for IHCA and OHCA cases. An effective CPR to be applied to OHCA cases until they reach the emergency room will ensure that the patient reaches the emergency room with a lower lactate level and a higher pH value. Therefore, the survival rate in OHCA cases can be increased. Similarly, there is a need to enhance CPR procedures in order to achieve a higher success rate in the treatment of traumatic cardiac arrest patients at our clinic.

An effective CPR and aftercare will also increase survival and reduce the risk of disability. Resuscitation of the arrest patient is a rescue chain consisting of bystander CPR starting at the site of arrest, determination of the cause of arrest in emergency services and maintenance of CPR, return of the patient and post CPR care. The survival rate can be increased by strengthening each link of this chain.

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During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Ali Karakuş, Mustafa Polat;* ***Design:*** *Ali Karakuş, Mustafa Polat;* ***Control/Supervision:*** *Ali Karakuş, Mustafa Polat;* ***Data Collection and/or Processing:*** *Mehmet Karadağ, Alper Taşkın;* ***Analysis and/or Interpretation:*** *Mehmet Karadağ, Alper Taşkın, Mustafa Polat;* ***Literature Review:*** *Mustafa Polat, Mehmet Karadağ, Alper Taşkın, Ali Karakuş;* ***Writing the Article:*** *Mustafa Polat, Ali Karakuş;* ***Critical Review:*** *Alper Taşkın, Mehmet Karadağ;* ***References and Fundings:*** *Mustafa Polat;* ***Materials:*** *Mustafa Polat, Alper Taşkın.*

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