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Original Article

# Retrospective Analysis of Cardiac Arrest Cases Admitted to A General Intensive Care Unit

*Genel Yoğun Bakim Ünitesine Kabul Edilen Kardiyak Arrest Olgularinin Geriye Dönük Değerlendirilmesi*

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**Abstract**

**Background**: Cardiac arrest(CA) is the sudden loss of heart function and is one of the leading causes of death worldwide. After successful cardiopulmonary resuscitation (CPR), patients are monitored in the intensive care unit with a diagnosis of post-cardiac arrest syndrome. To date, many clinical and laboratory parameters have been used to predict outcomes. In this study, a retrospective analysis was performed by reviewing the clinical and laboratory parameters of patients admitted to the general intensive care unit within the last three years.

**Material and Methods:** Data from patients admitted to the intensive care unit between June 2016 and June 2019 due to CA were reviewed retrospectively. Independent effects were analyzed using linear and binary logistic regression.

**Results:** Increasing age and longer durations of CPR were associated with higher mortality rates, while mortality was lower among patients who received therapeutic hypothermia. Blood urea nitrogen (BUN) and creatinine levels were higher in patients who died. Higher mean arterial pressure (MAP) was associated with longer hospital stays. In patients with elevated lactate and creatinine levels and prolonged CPR duration, the length of hospital stay was shorter. No significant relationship was observed between blood gas parameters and mortality. None of the evaluated factors independently affected the length of hospital stay or mortality.

**Conclusions:** According to the data from our study, these factors alone were insufficient to predict patient prognosis.

**Keywords:** Cardiac arrest, cardiopulmonary resuscitation, post-cardiac arrest syndrome, hypothermia treatment, prognosis.

**ÖZ**

**Amaç:** Kardiyak arrest (KA), kalp fonksiyonunun ani kaybı olup dünya genelinde önde gelen ölüm nedenlerinden biridir. Kardiyopulmoner resüsitasyonun (KPR) başarılı bir şekilde uygulanmasının ardından hastalar, kardiyak arrest sonrası sendrom tanısıyla yoğun bakım ünitesinde izlenmektedir.
Bugüne kadar sonuçları tahmin etmek için birçok klinik ve laboratuvar parametresi kullanıldı.
Bu çalışmada son üç yıl içerisinde genel yoğun bakım ünitesine yatırılan hastaların klinik ve laboratuvar parametreleri incelenerek retrospektif bir analiz yapıldı.

**Gereç ve Yöntem:** Haziran 2016 ile Haziran 2019 tarihleri arasında KA nedeniyle yoğun bakım ünitesine kabul edilen hastaların verileri retrospektif olarak değerlendirilmiştir. Bağımsız etkenler linear ve binary lojistik regresyon kullanılarak analiz edildi.

**Bulgular:** Artan yaş ve uzayan kardiyopulmoner resüsitasyon süresi, daha yüksek mortalite oranları ile ilişkili bulunmuştur. Öte yandan, terapötik hipotermi uygulanan hastalarda mortalite oranı daha düşük saptanmıştır. Kan üre azotu (BUN) ve kreatinin düzeyleri, yaşamını kaybeden hastalarda daha yüksek bulunmuştur. Ortalama arteriyel basınç (OAB) değerindeki artış, hastanede kalış süresinin uzamasıyla ilişkili bulunmuştur. Laktat ve kreatinin düzeyleri yüksek olan ve KPR süresi uzun olan hastalarda ise hastanede kalış süresi daha kısa saptanmıştır. Kan gazı parametreleri ile mortalite arasında anlamlı bir ilişki gözlenmemiştir. Değerlendirilen faktörlerin hiçbiri hastanede kalış süresini veya mortaliteyi bağımsız olarak etkilemedi

**Sonuç:** Çalışmamızın verilerine göre bu faktörlerin tek başına hasta prognozunu öngörmede yeterli olmadığı görüldü.

**Anahtar kelimeler:** Kardiyak arrest, kardiyopulmoner resüsitasyon, post kardiyak arrest sendromu, hipotermi tedavisi, prognoz.

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**Highlights**

- Cardiac arrest remains one of the leading causes of death worldwide, and successfully resuscitated patients require intensive care monitoring.
- This study evaluated the impact of clinical findings on the prognosis of patients admitted after cardiac arrest.
- No single clinical or laboratory factor was sufficient to independently predict prognosis.

## Introduction

Cardiac arrest (CA) is defined as the abrupt cessation of effective cardiac activity. In the absence of immediate cardiopulmonary resuscitation (CPR), it invariably results in death. CPR involves the restoration of circulation through chest compressions and the maintenance of adequate oxygenation. Although CA may result from various etiologies, it most commonly arises from cardiac causes (1). The primary objective of CPR is to achieve return of spontaneous circulation (ROSC) and ultimately discharge patients without neurological impairment. Following successful CPR, patients are monitored in the intensive care unit under the diagnosis of post-cardiac arrest syndrome (2). Advances in science and technology have significantly improved CPR outcomes. The American Heart Association (AHA) regularly updates its basic and advanced life support algorithms, and these guidelines are implemented globally (3). Evidence suggests that the use of therapeutic hypothermia following CPR enhances survival rates and improves neurological outcomes (4). Enhancing the effectiveness of CPR requires prompt identification and management of the underlying causes of CA. Moreover, assessing patients' demographic characteristics, vital signs, and laboratory parameters is essential for optimizing CPR success.

To date, many clinical and laboratory parameters have been used to predict outcomes in patients with CA. In this study, a retrospective analysis was performed by reviewing the clinical and laboratory parameters of patients admitted to the general intensive care unit within the last three years.

## Material and Methods

### Study design

The data of patients admitted to the 3rd-level General Intensive Care Unit at Harran University Research and Application Hospital between June 2016 and June 2019 due to CA were retrospectively reviewed using the hospital information management system. The age, CPR duration, mean arterial pressure (MAP), Glasgow Coma Scale (GCS) score, fasting blood glucose, hemoglobin (Hgb) level, white blood cell (WBC), blood urea nitrogen (BUN), creatinine, pH, partial pressure of carbon dioxide ($PaCO_2$), arterial oxygen saturation ($SpO_2$), and lactate values were recorded and evaluated. All patients who underwent CPR and were admitted to the intensive care unit were included in the study. Patients younger than 18 years were excluded from the study.

### Statistical analysis

Data were analyzed using SPSS for Windows version 23.0. Descriptive statistics for continuous variables were presented as median ± standard deviation, categorical variables were expressed as numbers and percentages. The normal distribution of continuous variables was determined using the Kolmogorov-Smirnov test, skewness, and kurtosis tests. Student's t-test was used to compare continuous variables between groups with and without hypothermia therapy, as the data were normally distributed. The Mann-Whitney U test was used for comparing the means between mortality groups, as the data did not follow a normal distribution. Categorical variables were compared using the Chi-square test. The correlation between continuous variables was evaluated using Pearson's correlation coefficient (Rho). A $p<0.05$ was considered statistically significant. The independent effects of factors that could affect the duration of hospitalization and mortality were tested using linear and binary logistic regression analyses.

### Ethical Approval

This study approval was obtained from the Harran University Faculty of Medicine, Ethics Committee (number: 20.12.28. date: 29.06.2020. The data of both groups was retrospectively recorded and analyzed in the hospital automation system. This study was conducted retrospectively. Therefore, no consent form was obtained. All procedures were carried out in accordance with the Declaration of Helsinki.

**Results**

Of the 120 patients initially included in the study, 20 patients who experienced in-hospital CA and 4 patients referred to another facility whose outcomes could not be evaluated were excluded. Statistical analyses were therefore performed on 96 patients. The mean age of the patients was 60.5 years. The number of male and female patients was equal (48 each). The findings of the patients at the time of admission to the intensive care unit are presented in **Table 1**. The mean admission time was 7.6 minutes, GCS score was 3.9, MAP was 72.5 mmHg, CPR duration was 23.4 minutes, and the length of stay was 16.9 days **(Table 1).**

**Table 1. Admission findings of patients**

| Parameter | Mean | Standard Deviation |
|---|---|---|
| **Admission time* (minutes)** | 7.6 | 8 |
| **Glasgow Coma Scale score** | 3.9 | 1 |
| **Mean arterial pressure** | 72.5 | 21.3 |
| **CPR duration (minutes)** | 23.4 | 15.9 |
| **Length of stay (days)** | 16.9 | 24.9 |

**Abbreviations:** The time interval between cardiac arrest and cardiopulmonary resuscitation initiation

In patients who did not survive, the mean age was higher (p<0.001). Additionally, CPR duration was longer in patients who died (p=0.043). As MAP increased, the length of stay also increased. Patients with prolonged CPR had a shorter length of hospital stay **(Table 2).**

**Table 2. Comparison of age, admission time, GCS score, MAP, and other relevant parameters between survivors and non-survivors**

| Variables | Death none (n=11) | Death yes (n=85) | p |
|---|---|---|---|
| **Age (years)** | 31.4 ± 17.4 | 64.3 ± 16.9 | <0.001 |
| **Admission time (minutes)** | 6.3 ± 5.8 | 7.9 ± 8.4 | 0.765 |
| **GCS score** | 4.1 ± 0.8 | 3.8 ± 1.1 | 0.195 |
| **MAP** | 81.5 ± 11.2 | 71.4 ± 22.1 | 0.145 |
| **CPR duration (minutes)** | 15.9 ±11.8 | 24.4 ± 16.1 | 0.043 |
| **Length of stay (days)** | 17.2 ± 15.7 | 16.9 ± 25.9 | 0.138 |

**Abbreviations:** *Mann-Whitney-U test

No correlation was found between age, admission time, or GCS and the length of hospitalization. However, MAP showed a moderate positive correlation with length of hospital stay (p=0.002, r=0.311). As MAP values increased, the length of hospital stay also rose. Conversely, CPR duration exhibited a weak negative correlation with length of hospital stay (p=0.014, r=-0.252), indicating that longer CPR times were associated with shorter hospital stays. **(Table 3)**

**Table 3. Correlation Analysis of Length of Hospital Stay According to Patients' Age, Admission Time, GCS, MAP, CPR Duration, lactate and creatinine level.**

| Variables | r* | p |
|---|---|---|
| **Age (years)** | -0.076 | 0.464 |
| **Admission time (minutes)** | 0.120 | 0.375 |
| **GCS score** | 0.112 | 0.276 |
| **MAP** | 0.311 | 0.002 |
| **CPR duration (minutes)** | -0.252 | 0,014 |
| **Lactate (mg/dL)** | -0,214 | 0.039 |
| **Creatinine (mg/dL)** | -0,204 | 0.048 |

**Abbreviations:** *Pearson Rho Correlation; r=correlation coefficient

BUN and creatinine levels were higher in patients who died (p <0.001 and 0.007, respectively), respectively). As lactate and creatinine levels increased, the length of hospital stay decreased **(Table4).**

**Table 4. Comparison of survivors and non-survivors according to fasting blood glucose, Hgb, WBC, BUN, and creatinine values**

| Variables | Death None (n=11) | Death Yes (n=85) | p |
|---|---|---|---|
| Glucose (mg/dL) | 258.6±176.8 | 266.9±148.6 | 0.609 |
| Hgb (mg/dL) | 13.8±2.7 | 12.4±2.6 | 0.122 |
| WBC (x10^3/µL) | 24.4±9.2 | 20.1±10 | 0.106 |
| BUN (mg/dL) | 29.3±15 | 70±51.6 | <0.001 |
| Creatinine (mg/dL) | 1.01±0.44 | 1.99±1.94 | 0.007 |

**Abbreviations:** *Mann-Whitney-U test

**Table 5. Effect of Hypothermia on Mortality in Cardiac Arrest Patients**

| Variables | Death (None, %) | Died (Yes, %) | p |
|---|---|---|---|
| All patients | 11 (11.5) | 85 (88.5) | |
| Hypothermia<br>No | 1 (1.5) | 64 (98.5) | <0.001 |
| Yes | 10 (32.3) | 21 (67.7) | |

**Abbreviations:** *Chi-square test

Mortality rate was lower in patients who received hypothermia treatment (p<0.001) **(Table 5).**
When we look at the independent effects of the factors that may affect the mortality rate, no factor was found to have an independent effect. Similarly, no factor independently affected the length of hospital stay **(Table 6)**.

**Table 6. Independent effects of all factors on death**

| Variables | B | p | Exp(B) |
|---|---|---|---|
| Hypothermia | 5.119 | 1.000 | 167.167 |
| Age (years) | 0.92 | 0.998 | 2.509 |
| Admission time (minutes) | 3.101 | 0.998 | 22.211 |
| GCS | 7.245 | 1.000 | 1400.504 |
| MAP | -0.839 | 0.998 | 0.432 |
| CPR duration (min) | 1.872 | 0.997 | 6.502 |
| pH | -164.962 | 0.998 | 0 |
| SpO2 (%) | 3.873 | 0.996 | 48.092 |
| PaCO2 (mmHg) | -0.104 | 1.000 | 0.901 |
| Lactate (mg/dL) | -0.856 | 1.000 | 0.425 |
| Glucose (mg/dL) | 0.036 | 0.999 | 1.036 |
| Hgb (mg/dL) | -4.984 | 0.998 | 0.007 |
| WBC (x10^3/µL) | -1.854 | 0.998 | 0.157 |
| BUN (mg/dL) | 0.622 | 0.998 | 1.862 |
| Creatinine (mg/dL) | -7.967 | 0.999 | 0 |
| Length of stay (days) | 0.686 | 0.997 | 1.986 |
| Constant | 861.698 | 0.999 | . |

**Abbreviations:** Exp(B): estimated probability ratio, (B): coefficient

## Discussion

In this study, we conducted a retrospective analysis to evaluate the potential prognostic value of several clinical and laboratory parameters in patients who experienced CA. These parameters included age, duration of CPR, MAP, GCS score, fasting blood glucose, Hgb level, WBC count, BUN, creatinine, pH, $PaCO_2$, $SpO_2$, lactate levels, and the application of therapeutic hypothermia.
Our principal findings indicated that none of the evaluated variables demonstrated an independent effect on either the length of hospital stay or mortality when analyzed individually. Several factors may account for this outcome, including the limited sample size and the observation that patients who received therapeutic hypothermia tended to

be younger and exhibited lower BUN and creatinine levels. These imbalances may have introduced statistical confounding, limiting the ability to identify a singular factor responsible for improved survival outcomes.

In all studies, age has been shown to be the most important prognostic factor in patients in whom spontaneous circulation was achieved after CA. It is known that the mortality rate and the risk of permanent neurological damage after CPR are higher for older individuals. A meta-analysis examining studies on this topic found that the average age of CA patients ranged from 60 to 75 years (6). In our study, a total of 96 patients were included, of whom 48 were men and 48 were women, with an average age of 60.5 years. Of these patients, 85 died after treatment, and 11 were discharged. Consistent with previous studies, we found that the average age of patients who died was 64.3 years, while the average age of survivors was 31.4 years. Therefore, similar to the literature, we found that age was a significant prognostic factor in our cohort**.**

CPR duration is also known to significantly affect the prognosis of these patients. Studies have shown that early defibrillation is the most important factor for post-CA survival (7). As the duration of CPR increases, the chance of survival decreases. One study reported that each 1-minute delay in defibrillation decreases the survival rate by 10-12% (8). While some publications state that prolonged CPR does not make a significant difference in terms of anoxic brain damage (9), a 2022 study on 8,727 patients found that shorter CPR duration significantly improved 30-day and 1-year survival rates, and that shorter durations were associated with lower rates of anoxic brain injury (10). In our study, the average CPR duration was 15.9 minutes in discharged patients, compared to 24.4 minutes in those who died. Patients who died had longer CPR durations ($p=0.043$). Additionally, as CPR duration increased, the length of hospitalization decreased. These results were consistent with the literature.

Many studies have found that systolic blood pressure below 90 mmHg in patients who survived CA is associated with poor recovery and higher mortality (11). Another study found that patients with a MAP above 100 mmHg for 2 hours after ROSC were more likely to have better neurological recovery upon discharge (12). Although many studies have shown that MAP is important in post-CA care, some studies have not found definitive evidence of its benefit or the ideal threshold for maintaining MAP. Furthermore, the effects of medications such as adrenaline during CPR and sedation during follow-up make it difficult to draw definitive conclusions about blood pressure management. Current guidelines do not offer a recommendation on target blood pressure in CA resulting from acute myocardial infarction (13). In our study, although no statistically significant difference was found in terms of mortality, there was a moderate correlation between MAP and length of hospitalization ($p=0.002$, $r=0.311$). As MAP increased, the length of stay also increased. The average MAP was 81.5 mmHg in survivors and 71.4 mmHg in those who died.

Low GCS scores in patients examined after CA have been shown to negatively impact mortality (14). In a study by Schefold et al., patients with higher GCS scores who underwent hypothermia therapy after CA were discharged with better neurological outcomes (15). In our study, we examined the GCS scores of patients at the time of admission to the emergency department after CA. However, in our study, the average GCS scores for survivors and those who died were 4.1 and 3.8, respectively, which did not align with the literature. The GCS score was similar in both patient groups, and no significant effect on mortality or length of stay was observed.

Fasting blood glucose levels are a controversial parameter in this context. Some studies suggest that high blood glucose levels do not increase mortality after CA, while others have found an association between elevated blood glucose levels and more severe neurological dysfunction and mortality (16). In our study, the average glucose levels for survivors and those who died were 258.6 mg/dL and 266.9 mg/dL, respectively. We found no significant effect of glucose levels on mortality or length of stay.

Hgb levels were also examined in our study. The distribution of oxygen throughout the body depends on both cardiac output and arterial oxygen concentration, which is directly affected by Hgb concentration. Although it seems theoretically reasonable to increase the amount of oxygen reaching tissues by increasing Hgb levels, studies have shown that initial transfusions do not reduce mortality in patients who survived CA (17). Some studies have shown that low Hgb levels worsen the prognosis in post-CA patients (18). A study conducted in 2011 found that higher Hgb levels at the time of hospital admission were associated with better neurological outcomes (19). The number of WBC was another parameter we evaluated in the hemogram analysis. Although an increase in WBC is known to have a negative prognostic effect on cardiac diseases, its usefulness in predicting the prognosis of post-CA patients has not been clearly established (20). Although some studies have shown a relationship between WBC levels and mortality (21), others have found the opposite (22). There are studies indicating that an increase in WBC count is associated with increased infectious complications in post-cardiac arrest patients (23). Our study found that the average Hgb levels for survivors and those who died were 13.8 and 12.4 g/dL, respectively, while the average

WBC levels were 24.4 ×$10^3$/μL and 20.1 ×$10^3$/μL, respectively. Hgb and WBC levels did not have a significant effect on mortality or length of stay.

The level of BUN and kidney function are mentioned in many studies as factors that can be used to predict the prognosis of patients after CA (24). However, there are studies that suggest the relationship is unclear (25). Some studies have found a significant association between elevated BUN levels and increased mortality (26). Similarly, elevated creatinine levels have been shown to affect the prognosis of patients who survived CA (17). A study found that low creatinine levels reduced mortality (27). In a large cohort study conducted by Lemiale et al., elevated creatinine levels were found to increase mortality (28). In our study, the average BUN levels were 70 mg/dL in patients who died and 29.3 mg/dL in those who survived. Although no correlation was found between BUN levels and length of stay, creatinine levels showed a weak negative correlation with length of stay (p=0.048, r=-0.204). When mortality was evaluated, BUN and creatinine levels were higher in patients who died (p values <0.001 and 0.007).

Some studies suggest that certain parameters evaluated in arterial blood gas analyses can help predict the prognosis of patients after CA. pH levels are believed to be useful in prognosis prediction (29). A study found that low pH levels increased mortality (30). According to a study by Momiyama et al., higher pH levels in patients who survived CA were associated with better outcomes (31). PaCO2 is an important regulator of cerebral blood flow. Dysregulation of PaCO2 can alter cerebral blood flow, leading to worse clinical outcomes after cerebral injury (32). Some studies suggest that PaCO2 can be used to predict the prognosis of patients after CA (29). A review has shown that both hypocapnia and hypercapnia are indicators of poor prognosis in brain injury (32). $SpO_2$ is also considered a potential marker for this purpose. Studies suggest that low $SpO_2$ is associated with poor neurological outcomes (33). Not only hypoxia but also hyperoxia is harmful to the body. Research indicates that hyperoxia, by causing reperfusion injury, is linked to poor neurological outcomes. Therefore, it is recommended to avoid both hypoxia and hyperoxia in post-cardiac arrest patients (34). In a study investigating the prognosis of patients who experienced CA, higher mortality was observed in patients with low PO2 levels. However, when assessed alongside other criteria, it was found that PO2 alone is not a reliable marker for determining prognosis (30).

Another parameter evaluated in blood gas is lactate. An increase in lactate clearance is associated with reduced mortality in patients with trauma, sepsis, and burns. Effective early lactate clearance has also been found to be associated with reduced mortality in patients who survived CA (35). In another study, high lactate level was found to be associated with high mortality in patients examined after CA (30). A meta-analysis found that lower lactate levels were associated with lower mortality (27). However, some studies have shown that lactate levels are not helpful in prognosis prediction (36). In a study investigating the effects of elevated lactate levels on poor prognosis, it was suggested that higher lactate levels were associated with longer CPR times, and thus, longer hypoxic periods and more severe ischemia, leading to worse prognosis (30). The effect of blood gas values on mortality in our study was not consistent with the literature. The average pH in patients who died was 7.16, compared to 7.25 in survivors. The average $SpO_2$ values were 93% in patients who died and 95.5% in those who survived. The average PaCO2 values were 41.6 mmHg in patients who died and 37.4 mmHg in those who survived. The average lactate levels were 7.7 mg/dL in patients who died and 5.4 mg/dL in those who survived. Blood gas parameters were not found to be associated with mortality. However, lactate levels showed a weak negative correlation with the length of stay (p=0.039, r=-0.214). As lactate levels increased, the length of stay decreased.

Studies have shown that post-cardiac arrest mortality is lower in patients treated with hypothermia therapy (37). In a study conducted by Castrejón et al., hypothermia was found to improve the prognosis of anoxic encephalopathy (38). Although numerous studies demonstrate the benefits of hypothermia therapy, recent research has emphasized the need to focus on normothermia rather than hypothermia. A study conducted in 2021 involving 1,900 patients revealed no significant difference in six-month survival between hypothermia and normothermia (39). Similarly, a meta-analysis published by Shersta et al. in 2022 concluded that hypothermia therapy targeting 32–34 °C provided no additional benefit over normothermia in terms of mortality and neurological damage (40).

In our study, therapeutic hypothermia was applied to 31 patients. Of the 11 patients discharged, 10 had received hypothermia therapy. Although the length of hospital stay for patients receiving hypothermia therapy was similar (p=0.133), their mortality rate was significantly lower (p<0.001).

Numerous studies have proposed that various clinical and laboratory parameters may serve as predictors of prognosis in patients who are monitored following CA. We believe that early identification and evaluation of such criteria may contribute to the recognition of prognostic factors associated with mortality and morbidity. The parameters assessed in our study may provide clinical guidance in the management and follow-up of patients who achieve ROSC after CA. However, these variables do not offer definitive prognostic conclusions regarding long-term outcomes or overall patient well-being.

**Study limitations**

This study has several limitations. Primarily, it is a single-center and retrospective study, which inherently restricts the generalizability of the findings. Additionally, the relatively small sample size constitutes another limitation. Due to the retrospective design, some patient data were incomplete, resulting in the exclusion of certain cases from full evaluation.

**Conclusion**

In our study, when examining the independent effects of factors that could impact the length of hospital stay and mortality rate, it was found that no factor had an independent effect on either the length of stay or the mortality rate. Possible reasons for this include the insufficient number of patients and the fact that the patients who received therapeutic hypothermia were younger, with lower BUN and creatinine levels, which makes it statistically difficult to determine the exact factor that affects mortality. Additionally, due to the inadequacy of records, the time of patients' arrival at the emergency department and its impact on mortality could not be evaluated.

The post-ROSC management of CA patients in the intensive care unit represents a highly complex process, shaped by multiple interacting factors. To gain a clearer understanding of prognostic determinants and optimize patient outcomes, further large-scale, long-term, and multicenter studies are warranted.

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