

The Role of Eosinophil Count at Admission in Predicting Cardiac Arrest Prognosis

Kardiyak Arrestte Kabul Anındaki Eozinofil Sayısının Prognozadaki Rolü

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Abstract

Objective: Cardiac arrest, which is characterized by sudden cessation of circulation and cardiac activity, leads to irreversible fatal outcomes without resuscitative interventions. Although various biomarkers have been studied for the prognostic evaluation of cardiac arrest, data on the utility of eosinophil counts remain limited. The current study aimed to investigate the association between eosinophil count and emergency department (ED) mortality among patients experiencing cardiac arrest.

Methods: This retrospective study included patients with cardiac arrest who presented to the ED between 2022 and 2024. In total, 274 patients were analyzed. Data were retrospectively obtained from the hospital information system, including demographic characteristics (age, gender) and biochemical parameters (e.g., white blood cell count, eosinophil count). Outcomes such as ED mortality and hospital admission were also examined.

Results: The study was completed in 274 patients after applying the inclusion and exclusion criteria. The mean age of the patients was 68 years, and 65.3% of them experienced mortality in the ED. Among the blood parameters, eosinophil, lymphocyte, platelet, and albumin levels were significantly higher in patients who survived compared with those who did not ($p<0.001$, $p=0.001$, $p=0.006$, and $p=0.008$, respectively), while no significant differences were observed in other parameters ($p>0.05$). Multivariate logistic regression analysis revealed that a 0.1-unit decrease in eosinophil count increased the mortality rate by 1.482 times ($p=0.006$). The ROC analysis assessing the relationship between eosinophil count and mortality yielded an area under the curve of 0.629, with a cut-off value of 0.055 ($p<0.001$).

Conclusion: Our findings demonstrate that eosinophil levels are a significant biomarker of ED mortality in patients with cardiac arrest. The distinct response of eosinophils to post-cardiac arrest perfusion disturbances suggests their potential role as prognostic indicators in critical illness. Future large-scale, multicenter prospective studies are needed to further clarify the prognostic value of eosinophil levels and their broader clinical applications.

Keywords: Eosinophil, cardiac arrest, eosinopenia, prognosis, emergency department

Öz

Amaç: Kardiyak arrest dolaşımın ani bir şekilde durması ile olan kardiyak aktivitenin sonlandığı, resüsitatif müdahaleler yapılmadan dönüşü olmayan ölümcül durumlardır. Kardiyak arrest durumunda prognoz için çeşitli biyomarkerların kullanımına dair veriler olsa da eozonofil sayısının kullanımına dair veriler sınırlıdır. Biz de araştırmamızda eozonofil sayısının acil servis (ED) mortalitesi ile olan ilişkisini inceledik.



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Öz

Yöntem: Bu retrospektif çalışmada, 2022-2024 yılları arasında ED'ye başvuran kardiyak arrest hastaları incelenmiştir. Toplamda 274 hasta çalışmaya dahil edilmiştir. Veriler, hastane bilgi sistemi üzerinden geriye dönük olarak elde edilmiş ve yaş, cinsiyet, beyaz küre, eozinofil gibi biyokimyasal parametreler ile ED sonuçları (mortalite, hastane yatışı) analiz edilmiştir.

Bulgular: Çalışmamız dahil edilme ve dışlama kriterleri uygulandıktan sonra 274 hasta ile tamamlandı. Hastaların yaş ortalaması 68 olup, %65,3'ü ED'de mortalite ile sonuçlanmıştır. Hastaların kan parametreleri mortaliteye göre değerlendirildiğinde eozinofil, lenfosit, trombosit ve albümin değerleri mortalite görülmeyenlerde daha yüksek tespit edilirken (sırasıyla $p<0,001$, $p=0,001$, $p=0,006$ ve $p=0,008$) diğer kan parametrelerinde anlamlı bir fark tespit edilmemiştir ($p>0,05$). Multivariate lojistik regresyon analizinde eozinofil sayısındaki 0,1 birimlik azalışın mortalite oranını 1,482 kat artırdığı görüldü ($p=0,006$). Eozinofil sayısı ile mortalite arasındaki ROC analizi ile eğri altında kalan alan değerlendirildi. Buna göre eğri altında kalan 0,629 ve cut-off değeri 0,055 olarak bulundu ($p<0,001$).

Sonuç: Sonuç olarak, ED'de kardiyak arrest geçiren hastalarda eozinofil düzeylerinin ED mortalitesini öngörmeye anlamlı bir biyobelirteç olduğu çalışmamızda ortaya konmuştur. Eozinofillerin kardiyak arrest sonrası perfüzyon bozukluğuna yanıt veren diğer biyobelirteçlerden farklı bir mekanizma ile etkilenmesi, bu hücrelerin kritik hastalıklarda prognozun belirlenmesinde dikkate alınabilecek potansiyel bir gösterge olduğunu düşündürmektedir. Gelecekte yapılacak daha geniş, çok merkezli ve prospektif çalışmalarla eozinofil düzeylerinin prognostik değerinin daha iyi anlaşılacağı ve klinik uygulamalarda daha yaygın kullanılabileceği düşünülmektedir.

Anahtar Kelimeler: Eozinofil, kardiyak arrest, eozinopeni, prognoz, acil servis

Introduction

Cardiac arrest is a fatal condition in which cardiac activity is terminated with a sudden cessation of circulation and no return without resuscitative interventions⁽¹⁾. Resuscitation for cardiac arrest is performed in the emergency department (ED), except for hospitalized patients admitted to the hospital. Although mortality rates are high as a result of cardiac arrest, ED mortality rates are relatively low^(2,3). Therefore, follow-up of patients who present to the ED with or who have cardiac arrest in the ED is critical.

There are suggestions that various biomarkers (C-reactive protein, procalcitonin, lactate, etc.) can be used as prognostic indicators in intensive care units (ICU)⁽⁴⁾. However, the fact that some of these biomarkers are not available in every center and that the tests take a relatively longer time to complete is a limitation for EDs. Eosinopenia can be used as a prognostic marker in the exacerbation of chronic obstructive pulmonary disease, and eosinopenia can be used as a prognostic marker in areas such as acute infections, myocardial infarction, and sepsis⁽⁵⁻⁸⁾. Despite these findings, the pathophysiology related to inhibition of eosinophil release into the intravascular compartment has not been clearly defined. It is hypothesized that glucocorticoid discharge during acute stress blocks eosinophil release through multiple mechanisms, although the exact mechanisms warrant further elucidation⁽⁹⁾.

Although some studies in the literature have indicated that eosinopenia can be used in prognosis in critically ill patients, a limited number of studies have indicated that it can be used

as a prognostic marker in cardiac arrest^(4,10,11). The fact that some biomarkers used in cardiac arrest are not available in every center and the low specificity of the other markers obtained raises the possibility of using the eosinophil count, which is easily and rapidly obtained, as a biomarker. The present study aimed to investigate the relationship between eosinophil count –a simple and accessible marker that may serve as an indirect indicator of catecholamine discharge– and patient outcomes and prognosis in the context of cardiac arrest.

Materials and Methods

Study Design

This retrospective, observational, and descriptive study was designed. Patients who presented to the ED with cardiac arrest or experienced cardiac arrest within the ED between January 1, 2022, and January 1, 2024, were included in the study. The study complied with the Declaration of Helsinki, and approval was obtained from the Scientific and Ethical Committee for Medical Research at Ankara Bilkent City Hospital before starting the system search (approval number: TABED 2-24-411).

Data Collection

The study was conducted through a retrospective analysis of the data obtained from the hospital information system. Age, gender, white blood cell count, eosinophil count, lymphocyte count, monocyte count, neutrophil count, platelet count, albumin level, lactate dehydrogenase level,

blood pH, bicarbonate, base deficit, lactate, ED waiting time (in days), and ED outcome (hospitalization and mortality) were recorded. All data were collected using a standardized data collection form.

Inclusion Criteria

- Patients aged 18 years or older,
- Patients presenting to the ED due to out-of-hospital cardiac arrest,
- Patients experiencing cardiac arrest in the emergency department.

Exclusion Criteria

- Patients younger than 18 years,
- Cases without complete blood count or blood gas results,
- Patients with traumatic cardiac arrest,
- Patients on beta-blocker therapy,
- Patients administered epinephrine prior to hospital arrival,
- Patients with a history of steroid use or immunodeficiency.

Statistical Analysis

Descriptive analyses were presented as frequency and percentage (%) for categorical variables and as mean, standard error, median, first quartile, and third quartile for numerical variables (n). The normality of numerical data distributions was evaluated using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Non-normally distributed numerical data between two independent groups were analyzed using the Mann-Whitney U test. Correlation levels were assessed using Spearman’s correlation analysis. A p-value <0.05 was considered statistically significant within a 95% confidence interval for all tests.

Results

The study was completed in 274 patients after applying the inclusion and exclusion criteria. The socio-demographic characteristics of the patients revealed a median age of 68 years [interquartile range (IQR): 52-80], with females comprising 39.4% (n=108) of the cohort. The hospital admission rate was 32.1% (n=88), the median length of hospital stay was 0 days (IQR: 0-1), and the ED mortality rate was 65.3% (n=179) (Table 1).

The blood parameters of the patients are summarized in Table 2. The median eosinophil count was 0.05 (IQR: 0.01-0.14). Additionally, the median pH of the patients was 7.14 (IQR: 6.97-7.34).

When the blood parameters of the patients were evaluated in relation to mortality, eosinophil, lymphocyte, platelet, and albumin levels were found to be significantly higher in patients without mortality (p<0.001, p=0.001, p=0.006, and p=0.008, respectively), while no significant differences were observed in other blood parameters (p>0.05) (Table 3).

Patients were divided into two groups based on a median age of 68 years and a mean length of hospital stay of 2 days to assess eosinophil levels. Eosinophil levels were significantly higher in patients aged ≤68 years, those without comorbidities, those not admitted to the hospital, those hospitalized for ≤2 days, and those who did not experience mortality (p<0.001) (Table 3).

The correlation analysis of patient age and blood parameters is presented in Table 4. A negative correlation was observed between eosinophil count and age, neutrophil count, and pH (p<0.001, p<0.001, and p=0.043, respectively), while a positive correlation was identified between eosinophil count and lymphocyte count, albumin level, and lactate level (p<0.001, p=0.025, and p=0.008, respectively) (Table 5).

In the multivariate logistic regression analysis, a 0.1-unit decrease in eosinophil count was associated with a 1.482-fold increase in mortality risk (p=0.006) (Table 6).

Table 1. Socio-demographic characteristics		
	%	n
Age (years)	68 (52-80)	
Median (25-75%)		
Sex		
Female	39.4	108
Male	60.6	166
Hospitalization		
No	67.9	186
Yes	32.1	88
Length of stay in the emergency department (days)	0 (0-1)	
Median (25-75%)		
Mortality		
No	34.7	95
Yes	65.3	179
Total	100	274
(%): Frequency, 25-75%: 1 st and 3 rd quartiles		

The relationship between eosinophil count and mortality was further evaluated using receiver operating characteristic curve analysis. The area under the curve (AUC) was determined to be 0.629, with a cut-off value of 0.055 ($p < 0.001$) (Table 7).

Discussion

According to the results of our study, eosinophil counts were significantly lower in the mortality group, whereas no significant differences were observed in other biochemical parameters between patients who survived and those who did not in the ED. Biochemical parameters obtained from

blood gas analysis, such as pH, lactate, base deficit, and bicarbonate, are generally associated with the response to perfusion deficiencies. Almost all patients who experience cardiac arrest have perfusion abnormalities. Although the mechanism underlying changes in eosinophil count is not fully explained, our study demonstrated that eosinophil levels were significantly lower in the mortality group among patients with cardiac arrest.

Şener et al.⁽³⁾ conducted a multicenter study of out-of-hospital cardiac arrests and found that approximately 61% of the patients were male, with a mean age of 67 years. The

Table 2. Patients' blood parameters results

	Mean	Standard deviation	Median	25%	75%
White blood cell count ($10^3/\mu\text{L}$)	16.6	0.55	14.3	10.58	20.69
Eosinophils ($10^3/\mu\text{L}$)	0.13	0.02	0.05	0.01	0.14
Lymphocytes ($10^3/\mu\text{L}$)	3.76	0.37	2.89	1.29	5.14
Monocytes ($10^3/\mu\text{L}$)	0.95	0.05	0.80	0.51	1.13
Neutrophils ($10^3/\mu\text{L}$)	12.09	0.53	10.03	5.57	16.17
Platelets ($10^3/\mu\text{L}$)	215.3	8.56	192.5	116.0	282.0
Albumin (mg/dL)	24.28	1.29	24.4	16.4	32.2
LDH (mg/dL)	613.19	42.39	427	247.0	650.5
pH	7.13	0.02	7.14	6.97	7.34
Bicarbonate (mEq/L)	15.81	0.47	15.7	10.2	20.7
Base excess	-11.69	0.63	-11.3	-19.0	-4.4
Lactate (mmol/L)	12.81	4.28	7.69	3.16	12.74

(%): Frequency, 25-75%: 1st and 3rd quartile 25-75%: 1st and 3rd quartiles, LDH: Lactate dehydrogenase

Table 3. Evaluation of patients' blood parameters based on mortality

	Mortality (+)	Mortality (-)	
	Median (25-75%)	Median (25-75%)	p*
White blood cell count ($10^3/\mu\text{L}$)	13.9 (9.9-19.8)	15,6 (11-20.9)	0.181
Eosinophils ($10^3/\mu\text{L}$)	0.03 (0-0.1)	0,08 (0.01-0.21)	<0.001
Lymphocytes ($10^3/\mu\text{L}$)	2.44 (1.05-4.69)	3,84 (1.59-6.03)	0.001
Monocytes ($10^3/\mu\text{L}$)	0.77 (0.48-1.11)	0,84 (0.53-1.17)	0.278
Neutrophils ($10^3/\mu\text{L}$)	10.65 (5.55-15.64)	9,72 (6.27-17.84)	0.716
Platelets ($10^3/\mu\text{L}$)	183 (106-261)	238,5 (147-303)	0.006
Albumin (mg/dL)	22.1 (15.9-30.3)	28 (21.4-36.1)	0.008
LDH (mg/dL)	408 (275-658)	439 (270-619)	0.758
pH	7.13 (6.96-7.36)	7,15 (7.01-7.32)	0.843
Bicarbonate (mEq/L)	15.12 (9.6-20.6)	15,7 (10.8-20.9)	0.728
Base excess	-11.4 (-20,7- -4.6)	-11,15 (-17.30- -4.30)	0.726
Lactate (mmol/L)	7.62 (2.7-13.6)	7,75 (3.45-12.09)	0.909

(%): Frequency, 25-75%: 1st and 3rd quartiles, LDH: Lactate dehydrogenase 25-75%: 1st and 3rd quartiles

authors reported an ED mortality rate of 72%. In a Swedish cohort study investigating in-hospital cardiac arrests, the mean age was 67 years, approximately 65% of the patients were male, and 56% achieved return of spontaneous circulation (ROSC)⁽¹²⁾. In a study by Widestedt et al.⁽¹³⁾

analyzing in-hospital cardiac arrests, 59% of patients were male, with a mean age of 73 years, and 55% achieved ROSC. It is well established that approximately 10% of in-hospital cardiac arrests occur in EDs⁽¹⁴⁾, and outcomes are generally more favorable for witnessed in-hospital arrests. Given that these studies focused on witnessed cardiac arrests in EDs, their relatively lower mortality rates are unsurprising. A meta-analysis of approximately 4.5 million out-of-hospital cardiac arrests reported a ROSC rate of 29.7%, with the highest rate observed in Oceania (38.6%) and the lowest in Asia (22.1%)⁽¹⁵⁾. Additionally, the literature indicates a predominance of male patients, comprising approximately 60% of cases^(2,16). In another study examining in-hospital cardiac arrests, the mean age was 66 years, with a similar male predominance⁽¹⁷⁾. Compared with the literature, the age distribution and gender characteristics in our study were consistent. However, the mortality rate of ED was lower in our study than that reported in the literature. We attribute this difference to our study being conducted at one of the largest and most resource-rich centers in the region, which is supported by more experienced and skilled healthcare providers, which likely contributed to better outcomes.

To date, several biomarkers have been used to predict the prognosis of cardiac arrest and critically ill patients. Eosinophils primarily play a role in the pathogenesis of parasitic, allergic, and hematologic diseases. Studies have shown that eosinophil counts decrease during acute

Table 4. Evaluation of Socio-demographic characteristics based on eosinophil counts

	Eosinophil count			p*
	Median	25%	75%	
Age				
Under the age of 68 years	0.08	0.02	0.16	<0.001
Age >68 years	0.02	0	0.10	
Sex				
Female	0.04	0	0.11	0.061
Male	0.06	0.01	0.16	
Comorbidites				
No	0.06	0.01	0.16	<0.001
Yes	0.01	0	0.03	
Number of waiting days				
2 days	0.06	0.01	0.16	<0.001
More than 2 days	0.01	0	0.04	
Mortality				
No	0.08	0.01	0.21	<0.001
Yes	0.03	0	0.10	

(%): Frequency, 25-75%: 1st and 3rd quartiles, *: Mann-Whitney U test

Table 5. Correlation analysis of age and blood parameters

	Age	Eosinophils	Lymphocytes	Monocytes	Neutrophils	Albumin	pH	Lactate
Age	r 1 p .							
Eosinophils	r -0.238 p <0.001	1 .						
Lymphocytes	r -0.227 p <0.001	0.608 <0.001	1 .					
Monocytes	r 0.000 p 0.996	0.112 0.064	0.216 <0.001	1 .				
Neutrophils	r 0.135 p 0.026	-0.249 <0.001	-0.287 <0.001	0.468 <0.001	1 .			
Albumin	r -0.126 p 0.071	0.157 0.025	0.173 0.014	0.100 0.156	-0.101 0.150	1 .		
pH	r 0.105 p 0.100	-0.130 0.043	-0.377 <0.001	0.022 0.734	0.166 0.009	-0.144 0.053	1 .	
Lactate	r -0.100 p 0.115	0.168 0.008	0.494 <0.001	0.006 0.931	-0.147 0.020	0.104 0.160	-0.693 <0.001	1 .

P-values were determined using Spearman's correlation analysis

Table 6. Multivariate logistic regression analysis of eosinophil count and mortality

	B	SH	p*	OR (CR)
Mortality (No)				
Yes	-0.730	0.264	0.006	1.482 (1.287-1.809)

B: Regression coefficient; SE: Standard error, OR: Odds ratio, CI: Confidence interval, Cox-Snell R square: 0.027; Nagelkerke R square: 0.038. *: Multivariate Logistic Regression Analysis

Table 7. ROC analysis between eosinophil count and mortality and area under the curve

Risk factor	AUC (95%)	Cut-off	p*	Sensitivity	Specificity	PPV (%)	NPV (%)
Eosinophil count	0.629 (0.558-0.699)	0.055	<0.001	0.620	0.347	65.3	62.0

AUC: Area under the curve, *: ROC analysis, PPV: Positive predictive value, NPV: Negative predictive value

inflammation and return to normal levels during recovery⁽⁷⁾. Consequently, eosinophil counts have been employed as prognostic markers in various conditions^(4-8,10,11). However, our review of the literature revealed a lack of studies that investigated eosinophil counts as prognostic markers, specifically for ED outcomes in cardiac arrest cases.

Abidi et al.⁽⁴⁾ conducted a prospective study in the ICU to evaluate the prognostic value of eosinophil counts for mortality. Their results highlighted that eosinophil levels measured upon admission and during the first 7 days were significant predictors of mortality⁽⁴⁾. Conversely, Escobar-Valdivia et al.⁽¹¹⁾ reported that eosinophil levels at admission were not significant biomarkers for mortality but noted a marked increase in eosinophil counts among survivors over the first 7 days. Korkmaz et al.⁽¹⁰⁾ identified eosinophil counts at admission as independent predictors of mortality in intensive care patients who achieved ROSC, alongside other parameters, such as platelet count, bicarbonate levels, and pH. The study design differs from that of previous studies by specifically investigating eosinophil counts as prognostic indicators of ED outcomes in cardiac arrest cases. While Korkmaz et al.⁽¹⁰⁾ examined eosinophil counts as post-ROSC prognostic markers, our findings demonstrated a significant association between eosinophil levels and ED outcomes in cardiac arrest patients. In contrast, other commonly used parameters for critically ill patients did not show a significant association with ED outcomes.

The multivariate and receiver operating characteristic analyses in our study further underscore the significance of eosinopenia as a prognostic marker of mortality. Although Korkmaz et al.⁽¹⁰⁾ reported higher AUC and sensitivity values, their study focused on post-cardiac arrest intensive care patients, whereas our study examined all cardiac arrest cases occurring within the ED.

It is well established that cardiac arrest results in tissue perfusion cessation, which is expected to affect all perfusion-related biomarkers. However, eosinophil release into the intravascular compartment occurs through cytokine-mediated mechanisms involving granulocyte-macrophage colony-stimulating factor, interleukin-3, interleukin-5, and complement 5a, among others⁽¹⁸⁾. This unique regulatory mechanism may explain the relative preservation of eosinophil levels compared with other ischemia-associated biomarkers. Based on our findings, eosinophil levels can be considered a significant biomarker for predicting ED mortality in patients with cardiac arrest.

Study Limitations

The retrospective study design and the limited data available for patients who experienced mortality imposed certain constraints on our findings. Additionally, our inability to assess the impact of other chronic diseases on prognosis limits the generalizability of our results. Nevertheless, our rigorous exclusion criteria and focus on the mechanism of cardiac arrest mitigate potential biases arising from these limitations.

Conclusion

Our study demonstrated that eosinophil levels are significant biomarkers of ED mortality in patients with cardiac arrest. The distinct mechanisms by which eosinophils respond to perfusion abnormalities following cardiac arrest suggest that these cells may serve as potential prognostic indicators in critically ill patients. Larger, multicenter, and prospective studies are needed to further elucidate the prognostic value of eosinophil levels and facilitate their integration into clinical practice.

Ethics

Ethics Committee Approval: The study complied with the Declaration of Helsinki, and approval was obtained from the Scientific and Ethical Committee for Medical Research at Ankara Bilkent City Hospital before starting the system search (approval number: TABED 2-24-411).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Concept: N.İ.I., Design: N.İ.I., M.Ç., Data Collection or Processing: N.İ.I., M.Ç., Analysis or Interpretation: N.İ.I., M.Ç., Literature Search: N.İ.I., M.Ç., Writing: N.İ.I.

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