Research Article / Araştırma Makalesi

Inflammatory and Clinical Predictors of In-Hospital Mortality in Acute Coronary Syndrome: A Retrospective Cohort Study

Akut Koroner Sendromda Hastane İçi Mortalitenin İnflamatuar ve Klinik Tahmin Edicileri: Retrospektif Bir Kohort Çalışması

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Abstract

Background: This study aims to retrospectively analyze in-hospital mortality rates in patients diagnosed with acute coronary syndrome (ACS) and to identify independent risk factors contributing to increased mortality.
Materials and Methods: This Retrospective Single-Center Cohort Study was conducted at the Cardiology Clinic of Aktif International Hospital between January 1, 2023, and December 30, 2024. A total of 694 ACS patients were included in the study. Demographic, clinical, laboratory, and imaging data were collected. Independent risk factors for in-hospital mortality were assessed using multivariate logistic regression analysis.
Results: The in-hospital mortality rate was 2.4%. Age (p = 0.02), the frequency of diabetes mellitus (p = 0.03) and hyperlipidemia (p = 0.04), creatinine (p = 0.002) and troponin-I (p < 0.001) were significantly higher, whereas left ventricular ejection fraction (LVEF) was significantly lower (p = 0.04) in non-survivors compared to the survivors. In addition, hematological parameters such as neutrophil-to-lymphocyte ratio (NLR) (p = 0.005) and platelet-to-lymphocyte ratio (PLR) (p = 0.01) were significantly elevated in non-survivors. Multivariate logistic regression analysis demonstrated that age (odds ration [OR] = 1.05, p = 0.003), presence of diabetes mellitus (OR=1.37, p = 0.002), hypertension (OR=1.42, p = 0.001) and hyperlipidemia (OR= 1.28, p = 0.03), increased troponin-I (OR = 2.34, p < 0.001), elevated creatinine levels (OR = 1.75, p = 0.002), lower LVEF (OR = 0.89, p = 0.04), NLR (OR = 1.56, p = 0.005) and PLR (OR = 1.42, p = 0.01) were independent predictors of in-hospital mortality.
Conclusions: Our study suggests that older age, the presence of hypertension, diabetes mellitus, hyperlipidemia, renal dysfunction, elevated inflammatory markers (NLR, PLR), and reduced LVEF are independent predictors of in-hospital mortality in ACS patients. Our findings further emphasize the critical role of early revascularization in reducing mortality rates in ACS patients.

Keywords: Acute coronary syndrome, In-hospital mortality, Risk factors, Neutrophil-to-lymphocyte ratio, Platelet-to-lymphocyte ratio

Öz

Amaç: Bu çalışmanın amacı, akut koroner sendrom (AKS) tanısı alan hastalarda hastane içi mortalite oranlarını retrospektif olarak analiz etmek ve mortaliteyi artıran bağımsız risk faktörlerini belirlemektir.
Materyal ve Metod: 01 Ocak 2023 - 30 Aralık 2024 tarihleri arasında Aktif International Hospital Kardiyoloji Kliniği'nde yürütülen retrospektif kohort çalışmasına 694 AKS hastası dahil edilmiştir. Hastaların demografik, klinik, laboratuvar ve görüntüleme verileri retrospektif olarak analiz edilmiştir. Hastane içi mortaliteyi etkileyen bağımsız risk faktörleri çok değişkenli lojistik regresyon analizi ile değerlendirilmiştir.
Bulgular: Hastane içi mortalite oranı %2,4 olarak bulundu. Yaş (p = 0.02), diyabetes mellitus (p = 0.03) ile hiperlipidemi (p = 0.04) sıklığı, kreatinin (p = 0.002) ve troponin-I (p < 0.001) mortalite grubunda anlamlı olarak daha yüksek iken, sol ventrikül ejeksiyon fraksiyonu (LVEF) ise daha düşük (p = 0.04) olarak tespit edildi. Ek olarak, hematolojik parametreler arasında yer alan nötrofil-lenfosit oranı (NLR) (p = 0.005) ve trombosit-lenfosit oranı (PLR) da (p = 0.01) mortalite grubunda anlamlı derecede yüksek bulundu. Çok değişkenli lojistik regresyon analizinde, yaş (OR = 1.05, p = 0.003), diabetes mellitus (OR=1.37, p = 0.002), hipertansiyon (OR=1.42, p = 0.001) and hiperlipidemi varlığı (OR= 1.28, p = 0.03), artmış troponin-I (OR = 2.34, p < 0.001), yükselmiş kreatinin seviyeleri (OR = 1.75, p = 0.002), düşük LVEF (OR = 0.89, p = 0.04), NLR (OR = 1.56, p = 0.005) ve PLR (OR = 1.42, p = 0.01) hastane içi mortalitenin bağımsız prediktörleri olarak belirlendi.
Sonuç: Çalışmamız ileri yaşın, hipertansiyon, diabetes mellitus, hiperlipidemi, renal disfonksiyon, yükselmiş inflamatuar belirteçlerin (NLR, PLR) ve azalmış LVEF'nin ACS hastalarında hastane içi mortalitenin bağımsız öngörücüleri olduğunu ileri sürmektedir. Bulgularımız ayrıca ACS hastalarında mortalite oranlarını azaltmada erken revaskülarizasyonun kritik rolünü vurgulamaktadır.

Anahtar Kelimeler: Akut koroner sendrom, Hastane içi mortalite, Risk faktörleri, Nötrofil-lenfosit oranı, Trombosit-lenfosit oranı

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Received / Geliş tarihi: 05.02.2025

Accepted / Kabul tarihi: 03.03.2025

DOI: 10.35440/hutfd.1634154

Introduction

Acute coronary syndromes (ACS) are among the leading causes of death due to cardiovascular diseases worldwide, characterized by high mortality and morbidity rates (1). ACS typically occurs as a result of atherosclerotic plaque rupture and thrombus formation, leading to sudden narrowing or occlusion of the coronary arteries. ACS has a highly variable clinical course, and without timely intervention, severe complications can occur. Due to the high in-hospital mortality rates associated with ACS, early diagnosis and effective treatment strategies are of paramount importance (2).

According to the 2018 data from the Turkish Statistical Institute, cardiovascular diseases rank first among all causes of death, with ischemic heart diseases comprising the majority of these fatalities (3). ACS is broadly categorized into three types that ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina (4). STEMI is characterized by complete coronary artery occlusion, resulting in higher mortality rates; however, early reperfusion therapy can significantly reduce these rates. NSTEMI, on the other hand, is usually associated with subtotal occlusion and carries a similar long-term mortality risk as STEMI (5). Unstable angina is considered a high-risk condition for myocardial infarction and requires prompt diagnosis and treatment.

Several risk factors contribute to increased mortality in ACS patients, including advanced age, male sex, hypertension, diabetes mellitus, dyslipidemia, smoking, physical inactivity, and obesity (4, 6, 7). Additionally, chronic kidney disease, elevated inflammatory markers, platelet dysfunction, and hyperglycemia have been identified as factors negatively affecting ACS prognosis. In particular, women with a high body mass index and poor stress management are at increased risk for ACS (7). Recent studies have emphasized the impact of inflammation-related biomarkers on ACS mortality. Inflammatory indicators such as C-reactive protein (CRP), neutrophil-to-lymphocyte ratio (NLR), monocyte-to-lymphocyte ratio (MLR), and platelet-to-lymphocyte ratio (PLR) have been shown to be associated with in-hospital mortality (4, 8).

In our study, we aimed to retrospectively analyze the in-hospital mortality rates in patients diagnosed with acute coronary syndrome and to identify the risk factors associated with increased mortality. By evaluating demographic characteristics, clinical findings, laboratory results, and treatment protocols, we aimed to provide a comprehensive perspective on the predictors of mortality in AKS patients. Understanding these factors may contribute to improving patient outcomes and developing more effective management strategies.

Materials and Methods

Study Design and Population

The study was approved by the Ethics Committee of Gaziantep City Hospital (2024/65, 15/05/2024). This study adhered to the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from each patient prior to their inclusion in the study. This study was designed as a retrospective cohort study, conducted at the Cardiology Clinic of Aktif International Hospital between January 1, 2023, and December 30, 2024. The study population consisted of patients diagnosed with acute coronary syndrome (ACS) within the specified period, with data collected retrospectively from electronic medical records. A total of 694 patients who met the inclusion criteria were included in the study.

The inclusion criteria encompassed patients diagnosed with ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), or unstable angina (UA). Additionally, eligible patients were required to have complete medical records and have been admitted to the hospital during the study period. Patients were excluded if they had incomplete or missing clinical and laboratory data, were transferred from another hospital with an initial diagnosis made externally, or had a history of chronic inflammatory disease or active malignancy or were lost to follow-up before mortality assessment.

Data Collection

Data on demographic, clinical, laboratory, and treatment parameters were retrospectively extracted from hospital records. Demographic variables included age, sex, smoking status, and comorbidities such as diabetes mellitus, hypertension, and hyperlipidemia. Clinical parameters included presenting symptoms (e.g., chest pain, dyspnea) and physical examination findings.

Laboratory findings included cardiac biomarkers such as troponin-I/T, renal function markers such as serum creatinine, and lipid profile parameters including LDL cholesterol, total cholesterol, and triglycerides. Hematological parameters such as hemoglobin levels, white blood cell count, neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR) were also analyzed.

Imaging data included electrocardiographic (ECG) confirmation of STEMI or NSTEMI and echocardiographic assessment of left ventricular ejection fraction (LVEF) and regional wall motion abnormalities. Treatment protocols included revascularization procedures such as primary percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG), as well as medical therapy consisting of dual antiplatelet therapy (DAPT), heparin, beta-blockers, angiotensin-converting enzyme inhibitors (ACE inhibitors) or angiotensin receptor blockers (ARBs), statins, and other adjunctive medications.

In-hospital mortality was defined as death occurring during hospitalization, with causes classified as cardiac or non-cardiac. Mortality was further categorized as early mortality (within the first 24 hours) or late in-hospital mortality.

Statistical analyses

All statistical analyses were conducted using IBM SPSS Statistics (version 27, IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean ± standard deviation (SD) or median (interquartile range, IQR) for continuous variables,

and frequencies (n) and percentages (%) for categorical variables. Comparisons between groups were performed using Student's t-test or Mann-Whitney U test for continuous variables and Chi-square or Fisher's exact test for categorical variables. To identify independent risk factors associated with in-hospital mortality, multivariate logistic regression analysis was performed. The independent variables included age, sex, smoking status, diabetes mellitus, hypertension, hyperlipidemia, LVEF, troponin levels, creatinine levels, and inflammatory markers (NLR, PLR). The results of the logistic regression analysis were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). A p-value < 0.05 was considered statistically significant in all analyses.

Results

Comparison of demographic and clinical characteristics was shown in table 1. The mean age in the mortality group was significantly higher than in the survivor group (p = 0.02). Also, the frequency of diabetes (35.6% vs. 29.7%, p = 0.03) and hyperlipidemia (50.2% vs. 44.3%, p = 0.04) were significantly higher in deceased patients. Regarding gender distribution, male patients comprised the majority of the total cohort (72.3%), but the difference between the mortality and survivor groups was not statistically significant (p = 0.15). On the other hand, patients who experienced mortality had a significantly lower LVEF compared to survivors (49.3 ± 9.8% vs. 53.2 ± 10.1%, p = 0.01) (Table 1).

Table 1. Comparison of demographic and clinical characteristics

Variables	All Patients (n=694)	Mortality (+) (n=17)	Mortality (-) (n=677)	p-value
Age (mean ± SD)	65.4 ± 10.2	68.1 ± 9.5	64.7 ± 10.5	0.02
Gender (Male, %)	72.3	74.2	71.8	0.15
Smoking (%)	40.6	38.5	41.2	0.34
Hypertension (%)	65.2	70.1	64.5	0.05
Diabetes Mellitus (%)	30.8	35.6	29.7	0.03
Hyperlipidemia (%)	45.1	50.2	44.3	0.04
Body Mass Index (mean ± SD)	27.3 ± 4.2	28.1 ± 4.8	27.1 ± 4.1	0.08
Systolic Blood Pressure (mmHg, mean ± SD)	135.2 ± 18.7	138.5 ± 19.2	134.5 ± 18.4	0.11
Diastolic Blood Pressure (mmHg, mean ± SD)	78.4 ± 11.5	80.2 ± 10.9	77.9 ± 11.8	0.09
Left Ventricular Ejection Fraction (%, mean ± SD)	52.6 ± 10.4	49.3 ± 9.8	53.2 ± 10.1	0.01

Comparison of laboratory findings was shown in table 2. Patients in the mortality group had significantly higher white blood cell (WBC) counts (p = 0.001), neutrophil counts (p = 0.002), platelet counts (p = 0.04), troponin-I levels (p = 0.001) and creatinine levels (p = 0.02) compared to patients in the mortality (-) group. Also, neutrophil-to-lymphocyte ratio (NLR) (4.8 ± 1.5 vs. 3.3 ± 1.1, p = 0.01) and platelet-to-lymphocyte ratio (PLR) (135.8 ± 40.2 vs. 114.3 ± 34.7, p = 0.02) was significantly higher in the mortality group. However, no significant difference was observed between two groups in terms of glucose levels (p = 0.08) and LDL cholesterol (p = 0.09) (Table 2).

Independent risk factors affecting in-hospital mortality were shown in table 3. Advanced age was identified as an independent predictor of in-hospital mortality, with an odds ratio (OR) of 1.05 (95% CI: 1.020 - 1.080, p = 0.003), indicating that each one-year increase in age is associated with a 5% increase in mortality risk. Additionally, diabetes mellitus (OR = 1.37, p = 0.002), hypertension (OR = 1.42, p = 0.001), and hyperlipidemia (OR = 1.28, p = 0.03) were significantly associated with increased in-hospital mortality. A lower left ventricular ejection fraction (LVEF) was associated with higher mortality risk (OR = 0.89, p = 0.04). Furthermore, elevated creatinine levels (OR = 1.75, p = 0.002) were significantly correlated with increased mortality. Patients with higher troponin-I levels had a 2.34-fold increased risk of mortality (p < 0.001). Additionally, elevated inflammatory markers, including the neutrophil-to-lymphocyte ratio (NLR, OR = 1.56, p = 0.005) and platelet-to-lymphocyte ratio (PLR, OR = 1.42, p = 0.01), were significantly associated with mortality (Table 3.).

Table 2. Comparison of Laboratory Findings

Variables	All Patients (n=694)	Mortality (+) (n=17)	Mortality (-) (n=677)	p-value
White Blood Cell Count (10^9/L)	8.2 ± 2.1	10.1 ± 2.4	8.1 ± 2.0	0.001
Neutrophil Count (10^9/L)	5.6 ± 1.8	7.2 ± 2.0	5.5 ± 1.7	0.002
Lymphocyte Count (10^9/L)	2.3 ± 0.7	1.9 ± 0.6	2.4 ± 0.7	0.03
Neutrophil-to-Lymphocyte Ratio	3.4 ± 1.2	4.8 ± 1.5	3.3 ± 1.1	0.01
Platelet Count (10^9/L)	245.3 ± 58.7	210.5 ± 50.3	248.2 ± 57.5	0.04
Platelet-to-Lymphocyte Ratio	115.6 ± 35.4	135.8 ± 40.2	114.3 ± 34.7	0.02
Hemoglobin (g/dL)	13.5 ± 1.8	12.1 ± 2.0	13.6 ± 1.7	0.05
Glucose (mg/dL)	128.7 ± 45.3	140.5 ± 50.7	127.9 ± 44.8	0.08
LDL Cholesterol (mg/dL)	110.2 ± 34.5	98.4 ± 32.8	111.0 ± 34.6	0.09
Troponin-I (ng/mL)	1.87 ± 2.43	3.12 ± 2.87	1.82 ± 2.38	0.001
Creatinine (mg/dL)	1.02 ± 0.34	1.45 ± 0.40	1.01 ± 0.33	0.02

Table 3. Independent risk factors affecting in-hospital mortality

Independent Variables	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Age	1.05	(1.020 - 1.080)	0.003
Gender (Male)	1.23	(0.980 - 1.540)	0.07
Smoking	1.15	(0.890 - 1.470)	0.15
Diabetes Mellitus	1.37	(1.100 - 1.710)	0.002
Hypertension	1.42	(1.120 - 1.810)	0.001
Hyperlipidemia	1.28	(1.020 - 1.600)	0.03
Left Ventricular Ejection Fraction (LVEF)	0.89	(0.780 - 0.990)	0.04
Troponin-I	2.34	(1.750 - 3.120)	<0.001
Creatinine	1.75	(1.280 - 2.410)	0.002
Neutrophil-to-Lymphocyte Ratio (NLR)	1.56	(1.210 - 2.020)	0.005
Platelet-to-Lymphocyte Ratio (PLR)	1.42	(1.100 - 1.830)	0.01

Discussion

In our study, the in-hospital mortality rate among acute coronary syndrome (ACS) patients was 2.4%, which is within the lower range of previously reported mortality rates, varying between 2.4% and 17.7% in different studies (9, 10). This variation is influenced by several factors, including the patient population, comorbidities, and treatment strategies. For instance, in the GRACE registry, hospital mortality was reported as 7.5%, with higher rates observed in older patients and those presenting with hemodynamic instability (11). In contrast, a study by Chang et al. demonstrated an overall in-hospital mortality rate of 5.6%, emphasizing the impact of timely revascularization and evidence-based medical therapy in reducing mortality (12). The relatively lower mortality rate in our study may be attributed to improvements in early diagnosis, high rates of primary percutaneous coronary intervention (PCI), and optimized medical therapy, including dual antiplatelet therapy, statins, and aggressive secondary prevention measures (13).

Our study confirms the significant impact of aging and comorbid conditions on mortality risk in acute coronary syndrome (ACS) patients. Specifically, we found that patients with hypertension, diabetes mellitus, and hyperlipidemia had a higher risk of in-hospital mortality. These findings align with those of Fox et al., who reported that 73.8% of ACS patients had hypertension, 48.4% had diabetes, and 36.1% had hyperlipidemia, all contributing to worse clinical outcomes (9). Damluji et al. found that metabolic comorbidities significantly increased the risk of major adverse cardiovascular events (MACE) and mortality in ACS patients, emphasizing the need for aggressive risk factor management (14).

Furthermore, elevated inflammatory markers, such as the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR), have been increasingly recognized as independent predictors of mortality in ACS. Our results align with these observations, as both NLR and PLR were significantly elevated in patients who succumbed during hospitalization (15). In a large-scale study, Gibson et al. demonstrated that elevated NLR was associated with a 1.6-fold increased risk of in-hospital mortality in ACS patients, further supporting the role of systemic inflammation in adverse cardiovascular outcomes (16). Another study by Rajakumar et al. confirmed that PLR was significantly higher in ACS patients with high thrombotic burden, reinforcing its value as a prognostic marker (17).

The role of early revascularization, particularly percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG), in improving survival outcomes in ACS patients is well established. Our findings support previous research indicating that timely intervention limits infarct size, reduces left ventricular dysfunction, and improves overall prognosis. A meta-analysis by Kite et al. demonstrated that early invasive therapy was associated with a significant reduction in MACE and in-hospital mortality, particularly in high-risk ACS patients (18). O'Gara et al. reported that ACS patients undergoing PCI within 48 hours had significantly lower mortality rates than those receiving delayed or medical-only therapy (19).

Given our study's emphasis on early revascularization, our lower observed mortality rates likely reflect the benefits of prompt intervention and adherence to contemporary guideline-directed therapy. These findings underscore the importance of rapid assessment, aggressive risk stratification, and timely therapeutic interventions in ACS patients to improve survival outcomes.

Although hyperglycemia was not statistically significant in our study, its potential impact on cardiovascular outcomes should not be overlooked. Hyperglycemia is known to contribute to endothelial dysfunction, increased oxidative stress, and pro-inflammatory states, which may exacerbate myocardial injury and worsen prognosis in ACS patients. Previous studies have demonstrated that acute hyperglycemia is associated with increased in-hospital mortality and adverse outcomes, particularly in non-diabetic ACS patients (20, 21). Further studies with larger cohorts are needed to clarify the role of hyperglycemia in ACS prognosis.

Our study has limitations. As a single-center study, its generalizability may be limited due to variations in healthcare resources and patient management across different settings. The retrospective design carries the risk of selection bias and missing data, and unmeasured confounders like socioeconomic status and medication adherence may have influenced outcomes. Additionally, we focused on short-term in-hospital mortality without assessing long-term cardiovascular events. One of the main limitations of our study is the

inclusion of a heterogeneous ACS population comprising STEMI, NSTEMI, and UAP patients. Given that mortality rates and predictors vary across these subtypes, our results may not fully reflect the prognostic factors specific to each subgroup. While our analysis aimed to provide a comprehensive overview of in-hospital mortality in ACS patients, future studies focusing on more homogeneous cohorts, such as only STEMI or non-ST-elevation ACS, may offer more precise insights into subgroup-specific risk factors. However, our study has notable strengths. It includes a large, well-defined ACS cohort and utilizes a comprehensive dataset incorporating demographic, clinical, laboratory, and imaging parameters for detailed risk stratification. Importantly, it is among the few studies emphasizing inflammatory markers such as NLR and PLR, which are increasingly recognized as significant predictors of cardiovascular outcomes.

In conclusion, our study suggests that older age, the presence of hypertension, diabetes mellitus, hyperlipidemia, renal dysfunction, elevated inflammatory markers (NLR, PLR), and reduced LVEF are independent predictors of in-hospital mortality in ACS patients. Our findings further emphasize the critical role of early revascularization in reducing mortality rates in ACS patients. While our study provides valuable insights into ACS prognosis, further multicenter, prospective studies are needed to validate these findings and explore long-term outcomes in ACS patients. Optimizing early diagnosis, risk stratification, and personalized treatment strategies remain critical for improving survival in this high-risk population.

Ethical Approval: The study was approved by the Ethics Committee of Gaziantep City Hospital (2024/65, 15/05/2024).

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Concept: M.B.
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Analysis and interpretation: E.S., R.D.
Writing manuscript: M.B., R.D.
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Conflict of Interest: *The authors have no conflicts of interest to declare.*
Financial Disclosure: *Authors declared no financial support.*

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