



AHEAD Score and Prolonged Intensive Care Unit Stay Following Isolated Coronary Artery Bypass Grafting

İzole Koroner Arter Bypass Greftleme Sonrası AHEAD Skoru ile Uzamış Yoğun Bakım Ünitesi Yatışı Arasındaki İlişki

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ABSTRACT

Objective: Patients requiring longer postoperative intensive care unit (ICU) stay after coronary artery bypass grafting (CABG) are more likely to experience unfavorable clinical outcomes and increased healthcare resource utilization. The AHEAD score has been reported to predict adverse outcomes in several cardiovascular conditions. The present study sought to evaluate whether the AHEAD score could predict prolonged ICU stay in patients undergoing isolated CABG.

Methods: We analyzed data from 518 consecutive patients undergoing isolated CABG at two tertiary referral centers between January 2020 and September 2025. A postoperative ICU stay longer than 72 hours was considered prolonged. The AHEAD score, consisting of atrial fibrillation, low hemoglobin level, elderly age, abnormal renal function, and diabetes mellitus, was evaluated both as a continuous variable and according to predefined score categories (0, 1, 2, and ≥ 3 points).

Results: Of the 518 patients, 143 (27.6%) experienced prolonged ICU stay. These patients had significantly higher AHEAD scores than those without prolonged ICU stay [2 (1-3) vs. 1 (0-2), $p < 0.001$]. In multivariable analysis, increasing AHEAD score values were associated with a progressively

ÖZ

Amaç: Koroner arter bypass greftleme (KABG) sonrası uzamış yoğun bakım ünitesi (YBÜ) yatışı; olumsuz klinik sonuçlar ve artmış sağlık hizmeti maliyetleri ile ilişkilidir. AHEAD skorunun çeşitli kardiyovasküler hastalıklarda prognostik değeri gösterilmiştir. Bu çalışmada AHEAD skoru ile uzamış YBÜ yatışı arasındaki ilişkinin değerlendirilmesi amaçlandı.

Yöntemler: Bu retrospektif iki merkezli çalışmaya Ocak 2020-Eylül 2025 tarihleri arasında izole KABG uygulanan 518 hasta dahil edildi. Uzamış YBÜ yatışı, 72 saatin üzerindeki yatış süresi olarak tanımlandı. Atriyal fibrilasyon, düşük hemoglobin düzeyi, ileri yaş, anormal böbrek fonksiyonu ve diyabetes mellitus bileşenlerinden oluşan AHEAD skoru hem sürekli değişken olarak hem de önceden tanımlanmış skor kategorilerine (0, 1, 2 ve ≥ 3 puan) göre analiz edildi.

Bulgular: Toplam 518 hastanın 143'ünde (%27,6) uzamış YBÜ yatışı saptandı. Uzamış YBÜ yatışı olan hastalarda AHEAD skoru anlamlı olarak daha yüksekti [2 (1-3) vs. 1 (0-2), $p < 0,001$]. Çok değişkenli analizde AHEAD skorundaki her 1 puanlık artış, uzamış YBÜ yatışı ile bağımsız olarak ilişkili bulundu [olasılık oranı (OO): 1,620; %95 güven aralığı (GA): 1,317-1,993; $p < 0,001$]. Uzamış YBÜ yatışı sıklığı AHEAD skor kategorileri boyunca kademeli olarak arttı ve skor ≥ 3 olan

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Cite this article as: Güvendi Şengör B, Şengör M, Tiryaki MM, Akalin F, Biyıklı K, Ketten MF, et al. AHEAD score and prolonged intensive care unit stay following isolated coronary artery bypass grafting. Bezmialem Science. 2026;14(4):385-392

Received: 29.06.2026

Accepted: 24.07.2026

Published date: 26.10.2026



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ABSTRACT

greater likelihood of prolonged ICU stay [odds ratio (OR): 1.620, 95% confidence interval (CI): 1.317-1.993, $p<0.001$]. The frequency of prolonged ICU stays increased progressively across AHEAD score categories, from 16.3% in patients with a score of 0 to 61.2% in those with a score ≥ 3 . Compared with patients with an AHEAD score of 0, those with a score of 2 and ≥ 3 had significantly higher odds of prolonged ICU stay (OR: 2.060, 95% CI: 1.120-3.788, $p=0.020$ and OR: 8.121, 95% CI: 4.089-16.129, $p<0.001$, respectively).

Conclusion: The AHEAD score was independently associated with prolonged ICU stay following isolated CABG. Although it is straightforward to calculate using routinely available clinical variables, further studies are needed to establish its clinical role.

Keywords: Coronary artery bypass grafting, AHEAD score, intensive care unit

Öz

hastalarda %61,2'ye ulaştı. AHEAD skoru 0 olan hastalarla karşılaştırıldığında, skoru 2 ve ≥ 3 olan hastalarda uzamış YBÜ yatışı olasılığı anlamlı derecede daha yüksekti (sırasıyla OO: 2,060; %95 GA: 1,120-3,788; $p=0,020$ ve OO: 8,121; %95 GA: 4,089-16,129; $p<0,001$).

Sonuç: AHEAD skoru, izole KABG sonrası uzamış YBÜ yatışı ile bağımsız olarak ilişkilidir. Rutin olarak elde edilebilen klinik değişkenlere dayanan ve kolaylıkla hesaplanabilen bu skorun klinik rolünün belirlenebilmesi için ileri araştırmalara ihtiyaç vardır.

Anahtar Kelimeler: Koroner arter bypass greftleme, AHEAD skoru, yoğun bakım ünitesi

Introduction

Coronary artery bypass grafting (CABG) constitutes an established therapeutic option for patients with advanced coronary artery disease and remains widely performed across contemporary cardiac surgical procedures (1). In appropriately selected patients, CABG has been associated with improved survival, symptom relief, and better quality of life (2,3). Nevertheless, adverse postoperative outcomes continue to occur and contribute substantially to morbidity and mortality following surgery (4).

Several factors, including comorbidities, postoperative complications and prolonged intensive care unit (ICU) stay, have been associated with adverse outcomes after CABG (5,6). Among these factors, extended ICU stay is of particular importance due to increased healthcare resource utilization and worse postoperative outcomes (7). Therefore, reliable identification of individuals at increased risk before surgery may facilitate perioperative planning and optimize resource allocation. Although numerous risk models have been proposed for this purpose, there remains a need for simple and practical scoring systems that can be easily applied in routine clinical practice (8,9).

The AHEAD score is a straightforward clinical risk score derived from five readily available variables: atrial fibrillation (AF), anemia, advanced age, abnormal renal function and diabetes mellitus. Originally developed for patients hospitalized with acute heart failure, the score has subsequently shown prognostic relevance across several cardiovascular populations, including patients with coronary syndromes (10,11). However, its usefulness in the setting of CABG has not yet been explored. Accordingly, the present study aimed to evaluate the relationship between the AHEAD score and prolonged ICU stay following isolated CABG.

Methods

This study retrospectively reviewed 518 consecutive patients undergoing isolated CABG at two referral centers between January 2020 and September 2025. Patients undergoing urgent or emergent CABG, concomitant cardiac procedures, or redo cardiac surgery, as well as those with active infection or sepsis, malignancy, or end-stage kidney disease requiring dialysis, were excluded. Baseline clinical features, comorbidities, preoperative laboratory findings, operative variables, and postoperative outcomes were recorded. Relevant information was retrieved from electronic medical records and institutional databases maintained at both participating centers. Ethical approval was obtained from the University of Health Sciences Türkiye, Kartal Koşuyolu Education and Research Hospital Ethics (committee date: June 16, 2026; decision no: 2026/11/1506) and all study procedures complied with the principles outlined in the Declaration of Helsinki.

For each patient, the AHEAD score was preoperatively determined using five predefined clinical variables: AF, hemoglobin level <13 g/dL in men and <12 g/dL in women, elderly age (>70 years), abnormal renal function [serum creatinine >130 $\mu\text{mol/L}$ (approximately 1.47 mg/dL)], and diabetes mellitus. One point was awarded for each component, yielding a cumulative ranging from 0 to 5 (10). Intraoperative data regarding the number of distal anastomoses, cardiopulmonary bypass (CPB) time, and aortic cross-clamp (CC) time were recorded. Postoperative ICU stay and total hospital stay were also documented.

The study endpoint was prolonged ICU stay. Consistent with previous reports, patients requiring more than 72 hours of postoperative intensive care were classified as having prolonged ICU stay (6,9,12). For comparative analyses, the study population was divided into patients with ICU stays of ≤ 3 days and those requiring >3 days of

intensive care. Patients were also grouped according to predefined AHEAD score categories (0, 1, 2, and ≥ 3 points) to examine whether the likelihood of prolonged ICU stay increased across score levels. Furthermore, the relationship between the AHEAD score and the duration of intensive care utilization was evaluated.

Statistical Analysis

Statistical analyses were performed using Jamovi version 2.5.7.0 (The Jamovi project, Sydney, Australia). The normality of continuous variables was assessed using normality tests and distributional evaluation. Since most continuous variables were non-normally distributed, continuous variables were expressed as median (interquartile range). Categorical variables were presented as numbers and percentages. Comparisons between patients with ICU stay ≤ 3 days and >3 days were performed using the Mann-Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate.

The binomial logistic regression analysis was performed to evaluate the relationship between the AHEAD score and prolonged ICU stay. In the primary analysis, the AHEAD score was modeled as a continuous variable, with effect estimates reported per 1-point increase. Three regression models were constructed. Model 1 included only the AHEAD score. Model 2 was adjusted for clinically relevant non-AHEAD variables, including female sex, serum albumin level, left ventricular ejection fraction (LVEF), and log10-transformed troponin level. Model 3 additionally incorporated procedural variables, including CPB time and CC time. Individual components of the AHEAD score

were not included in multivariable models to avoid overadjustment. Troponin levels were logarithmically transformed because of their right-skewed distribution.

The AHEAD score was also analyzed according to score categories. Because sparse data and unstable estimates were observed in the highest individual score strata, patients with AHEAD scores ≥ 3 were combined into a single high-risk category. AHEAD score 0 was used as the reference category for categorical comparisons. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were calculated. In addition, because ICU stay duration was not normally distributed, the relationship between the AHEAD score and actual ICU stay duration was assessed using Spearman rank correlation analysis. A two-sided p-value <0.05 was considered statistically significant.

Results

The study cohort consisted of 518 patients (Figure 1). Among them, 375 (72.4%) patients had an ICU stay of ≤ 3 days, whereas 143 (27.6%) experienced prolonged ICU stay (>3 days). Baseline clinical characteristics according to prolonged ICU stay are presented in Table 1. Individuals in the prolonged ICU stay group were older [65 (57-71), $p=0.002$] and more frequently female (28.7%, $p=0.003$). In addition, diabetes mellitus, chronic kidney disease, and AF were also more prevalent among patients with prolonged ICU stay. Notably, the AHEAD score was significantly higher among patients with prolonged ICU stay than among those with ICU stay ≤ 3 days [2 (1-3) vs. 1 (0-2), $p<0.001$].

Laboratory and echocardiographic findings are summarized in Table 2. The prolonged-stay cohort exhibited lower

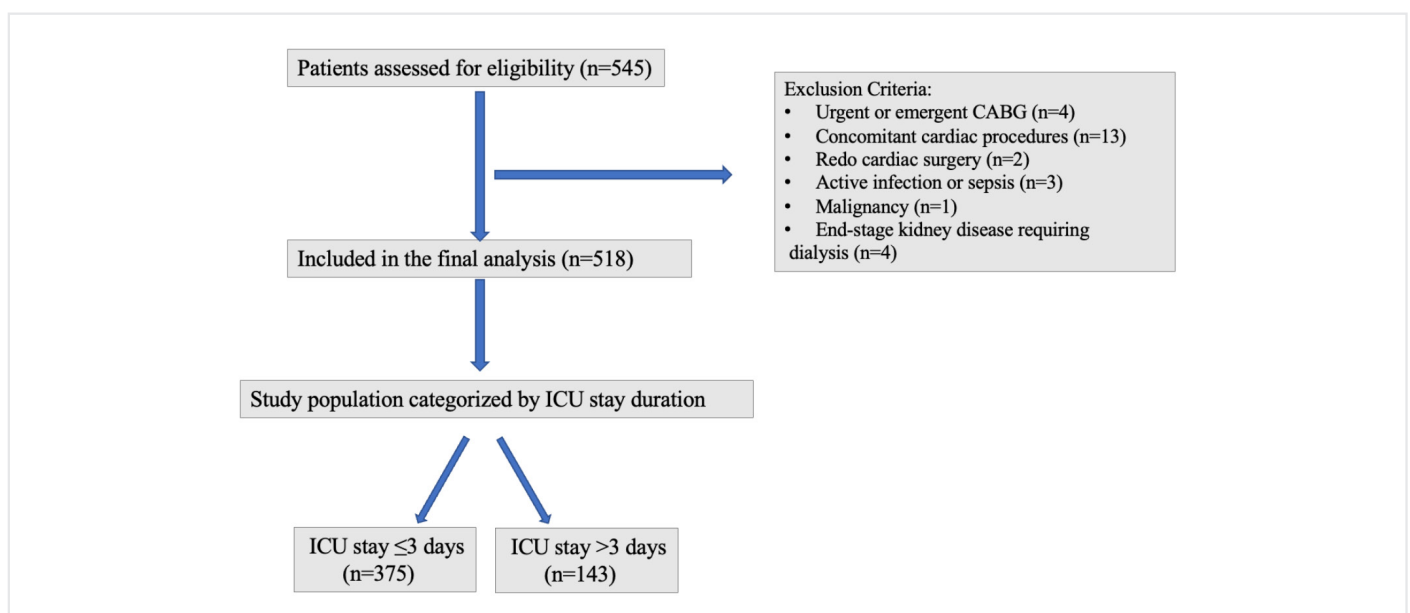


Figure 1. Study flow chart of patient selection and categorization

ICU: Intensive care unit, CABG: Coronary artery bypass grafting

hemoglobin and albumin levels [13.0 (11.5-14.4) vs. 13.6 (12.6-14.7) g/dL, $p<0.001$; 3.40 (3.10-3.95) vs. 3.80 (3.30-4.29), $p<0.001$; respectively]. In addition, neutrophil-to-lymphocyte ratio, creatinine, and troponin levels were

higher, whereas lymphocyte-to-monocyte ratio was lower, compared with patients with ICU stay ≤ 3 days [2.65 (1.83-3.57) vs. 2.21 (1.71-3.18), $p=0.022$; 0.96 (0.82-1.18) vs. 0.88 (0.80-1.05), $p=0.008$; 21.5 (3.30-1490) vs. 6.40 (0.72-122),

Table 1. Baseline clinical characteristics according to prolonged ICU stay

Variable	Overall	ICU stay ≤ 3 days n=375	ICU stay >3 days n=143	p-value
Age, years	62 [55-68]	61 [54-67]	65 [57-71]	0.002
Female sex	104 (20.1)	63 (16.8)	41 (28.7)	0.003
Height, cm	170 [165-175]	170 [165-175]	169 [160-173]	0.008
Weight, kg	80 [72-88]	80 [73-88]	78 [70.5-87]	0.219
BMI, kg/m ²	27.5 [25.3-30.2]	27.6 [25.4-30.1]	27.3 [25.2-30.9]	0.945
Obesity	115 (22.2)	75 (20)	40 (27.9)	0.289
Hypertension	373 (72.0)	266 (70.9)	107 (74.8)	0.378
Diabetes mellitus	271 (52.3)	178 (47.5)	93 (65.0)	<0.001
Recent myocardial infarction	170 (32.8)	121 (32.3)	49 (34.3)	0.665
Previous PCI	116 (22.4)	81 (21.6)	35 (24.5)	0.483
Chronic kidney disease	76 (14.7)	43 (11.5)	33 (23.1)	<0.001
Cerebrovascular disease	14 (2.7)	7 (1.9)	7 (4.9)	0.057
Hyperlipidemia	287 (55.4)	207 (55.2)	80 (55.9)	0.879
COPD	38 (7.3)	26 (6.9)	12 (8.4)	0.569
Atrial fibrillation	107 (20.7)	64 (17.1)	43 (30.1)	0.001
AHEAD score	1 [1-2]	1 [0-2]	2 [1-3]	<0.001

Values are presented as median [interquartile range] for continuous variables and n (%) for categorical variables
 BMI: Body mass index, PCI: Percutaneous coronary intervention, COPD: Chronic obstructive pulmonary disease, ICU: Intensive care unit

Table 2. Laboratory and echocardiographic findings according to prolonged ICU stay

Variable	Overall	ICU stay ≤ 3 days n=375	ICU stay >3 days n=143	p-value
WBC	8.36 [7.04-9.87]	8.28 [7.03-9.73]	8.58 [7.28-10.1]	0.153
Neutrophil count	5.13 [4.24-6.34]	5.10 [4.20-6.30]	5.43 [4.37-6.53]	0.148
Lymphocyte count	2.13 [1.60-2.68]	2.19 [1.70-2.66]	1.97 [1.46-2.75]	0.056
Monocyte count	0.63 [0.50-0.79]	0.63 [0.50-0.76]	0.64 [0.50-0.83]	0.584
Hemoglobin, g/dL	13.5 [12.2-14.6]	13.6 [12.6-14.7]	13.0 [11.5-14.4]	<0.001
Platelet count	227 [192-275]	227 [193-277]	220 [192-266]	0.325
NLR	2.30 [1.73-3.29]	2.21 [1.71-3.18]	2.65 [1.83-3.57]	0.022
LMR	3.58 [2.56-4.75]	3.64 [2.64-4.94]	3.25 [2.25-4.63]	0.045
Glucose	125 [100-173]	121 [99.3-167]	131 [101-192]	0.083
Creatinine	0.90 [0.81-1.07]	0.88 [0.80-1.05]	0.96 [0.82-1.18]	0.008
Urea	84.0 [66.0-94.0]	85.0 [70.0-95.0]	78.0 [57.0-91.0]	0.005
ALT	20.0 [14.0-29.0]	20.0 [14.0-29.0]	19.0 [13.0-28.5]	0.516
AST	20.0 [16.0-27.0]	20.0 [16.0-27.0]	20.0 [15.5-27.5]	0.928
Albumin	3.70 [3.30-4.20]	3.80 [3.30-4.29]	3.40 [3.10-3.95]	<0.001
Total cholesterol	194 [165-234]	199.5 [166-235]	189 [159-232.7]	0.198
LDL cholesterol	124 [95.8-156]	123 [95.9-156.2]	125 [94.9-155.7]	0.939
HbA1c	6.18 [5.61-7.68]	6.08 [5.59-7.40]	6.49 [5.73-7.78]	0.053
Troponin	8.60 [1.50-209]	6.40 [0.72-122]	21.5 [3.30-1490]	<0.001
LVEF, %	60 [50-60]	60 [50-60]	58 [49-60]	0.220

Values are presented as median [interquartile range]
 WBC: White blood cell count, NLR: Neutrophil-to-lymphocyte ratio, LMR: Lymphocyte-to-monocyte ratio, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, HbA1c: Glycated hemoglobin, LVEF: Left ventricular ejection fraction, ICU: Intensive care unit, LDL: Low-density lipoprotein

$p < 0.001$, and 3.25 (2.25-4.63) vs. 3.64 (2.64-4.94), $p = 0.045$; respectively]. LVEF was comparable between the two groups. Procedural and hospitalization variables are shown in Table 3. CPB time was greater among individuals requiring prolonged ICU care [130 (110.8-148) vs. 118 (95-144) min, $p < 0.001$]. CC time and the number of distal anastomoses were comparable between the two groups. As expected, the prolonged ICU stay group had a significantly longer total hospital stay [14 (11-19.8) vs. 8 (7-12) days, $p < 0.001$].

The association between the AHEAD score and prolonged ICU stay is presented in Table 4. In the univariable model, each 1-point increase in AHEAD score was associated with higher odds of prolonged ICU stay (OR: 1.831, 95% CI: 1.506-2.227; $p < 0.001$). This observed association persisted after adjustment for clinically relevant non-AHEAD variables (Model 2: OR: 1.648, 95% CI: 1.343-2.021; $p < 0.001$), and after further adjustment for procedural variables (Model 3: OR: 1.620, 95% CI: 1.317-1.993; $p < 0.001$). Among the

covariates included in the multivariable models, lower albumin levels were also independently associated with prolonged ICU stay.

The distribution of prolonged ICU stays according to AHEAD score categories is presented in Table 5. The frequency of prolonged ICU stays increased progressively across AHEAD score categories: rising from 16.3% in patients with an AHEAD score of 0 to 61.2% in those with a score of ≥ 3 (Figure 2). Compared with patients with an AHEAD score of 0, those with an AHEAD score of 1 showed a numerically higher but statistically non-significant odds of prolonged ICU stay (OR: 1.501, 95% CI: 0.836-2.693; $p = 0.174$). Patients with an AHEAD score of 2 had approximately two-fold higher odds of prolonged ICU stay, whereas patients with an AHEAD score of ≥ 3 had more than eight-fold higher odds (OR: 2.060, 95% CI: 1.120-3.788; $p = 0.020$ and OR: 8.121, 95% CI: 4.089-16.129; $p < 0.001$, respectively). In a secondary analysis, the AHEAD score showed a weak yet statistically

Table 3. Procedural and hospitalization variables according to prolonged ICU stay

Variable	Overall n=518	ICU stay ≤ 3 days n=375	ICU stay > 3 days n=143	p-value
Cardiopulmonary bypass time, min	120 [100-145]	118 [95-144]	130 [110.8-148]	< 0.001
Cross-clamp time, min	65 [52-80]	64 [52-80]	66.5 [56.8-78]	0.183
Distal anastomosis number	3 [3-4]	3 [3-4]	3 [3-4]	0.710
Beating-heart surgery	5 (1.0)	5 (1.3)	0 (0.0)	0.165
ICU stay, days	3 [2-4]	2 [2-3]	4 [4-6]	NA
Total hospital stays, days	10 [7-14]	8 [7-12]	14 [11-19.8]	< 0.001

Values are presented as median [interquartile range] for continuous variables and n (%) for categorical variables
ICU: Intensive care unit, NA: Not applicable

Table 4. Logistic regression models for prolonged ICU stay

Variable	Model 1 OR (95% CI)	p-value	Model 2 OR (95% CI)	p-value	Model 3 OR (95% CI)	p-value
AHEAD score	1.831 (1.506-2.227)	< 0.001	1.648 (1.343-2.021)	< 0.001	1.620 (1.317-1.993)	< 0.001
Female sex	—	—	1.481 (0.899-2.439)	0.123	1.496 (0.896-2.498)	0.123
Albumin	—	—	0.602 (0.409-0.885)	0.010	0.621 (0.420-0.917)	0.017
LVEF	—	—	0.995 (0.973-1.017)	0.654	0.996 (0.974-1.019)	0.725
Log10 troponin	—	—	1.119 (0.989-1.266)	0.074	1.117 (0.986-1.266)	0.083
Cardiopulmonary bypass time	—	—	—	—	1.002 (0.997-1.007)	0.501
Cross-clamp time	—	—	—	—	1.003 (0.991-1.016)	0.635
McFadden R ²	0.065		0.094		0.092	

Model 1 included only the AHEAD score. Model 2 was adjusted for clinically relevant non-AHEAD variables, including female sex, albumin, LVEF, and log10-transformed troponin. Model 3 additionally included procedural variables, including cardiopulmonary bypass time and cross-clamp time. Individual components of the AHEAD score were not included in the multivariable models to avoid overadjustment. Troponin was log10-transformed before inclusion in regression models because of its right-skewed distribution; therefore, the odds ratio for log10 troponin represents the change in odds per 10-fold increase in troponin level
OR: Odds ratio, CI: Confidence interval, LVEF: Left ventricular ejection fraction, ICU: Intensive care unit

significant positive correlation with postoperative ICU stay duration (Spearman’s rho: 0.283, $p<0.001$), indicating that higher AHEAD scores were associated with progressively longer ICU stays (Figure 3).

Discussion

In this multicenter cohort of patients undergoing isolated CABG, a higher AHEAD score was independently associated with an increased likelihood of prolonged ICU stay. The association remained significant after adjustment for relevant clinical, laboratory, and procedural variables. Moreover, the probability of prolonged ICU stay increased progressively across AHEAD score categories, indicating a clear risk gradient across increasing AHEAD score categories. Patients with an AHEAD score of 3 or greater represented a particularly vulnerable subgroup and experienced substantially higher rates of prolonged ICU stay than those with lower scores.

Prolonged ICU stay following CABG represents a clinically relevant outcome that reflects a more complicated postoperative course. Previous reports have demonstrated that patients requiring extended ICU stay are more likely to experience adverse events and consume greater healthcare

resources. Consequently, identifying patients at elevated risk before surgery may support individualized preoperative care and facilitate more efficient management of ICU care resources. Numerous prognostic models have been designed to facilitate outcome prediction after cardiac procedures (13-15). Dominici and colleagues constructed a nomogram including ten independent variables for the prediction of prolonged ICU stay (8). In the present study, increased age, female sex, diabetes mellitus, chronic kidney disease, and AF were more prevalent among patients with prolonged ICU stay.

The AHEAD score is a simple bedside tool based on five readily available clinical parameters: AF, anemia, advanced age, abnormal renal function, and diabetes mellitus. Although initially developed for patients hospitalized with acute heart failure, the AHEAD score has subsequently been investigated in several other cardiovascular settings, including patients with heart failure, coronary syndromes, and dementia (10,11,16,17). The present findings indicate that a higher AHEAD score was associated with prolonged ICU stay in patients undergoing CABG. The observed

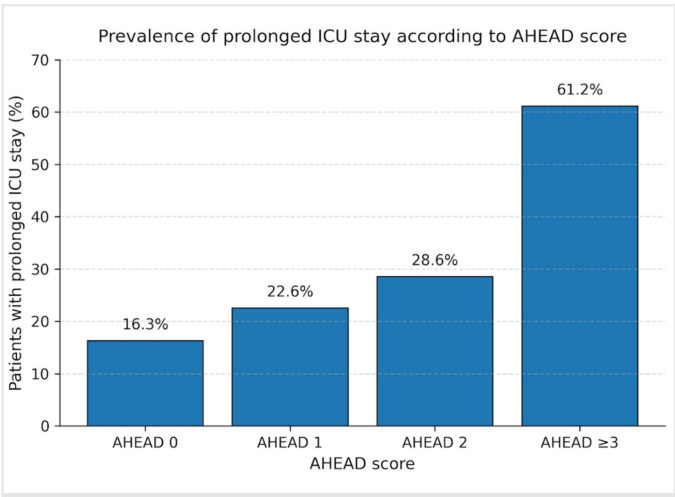


Figure 2. Prevalence of prolonged ICU stay according to AHEAD score categories
ICU: Intensive care unit

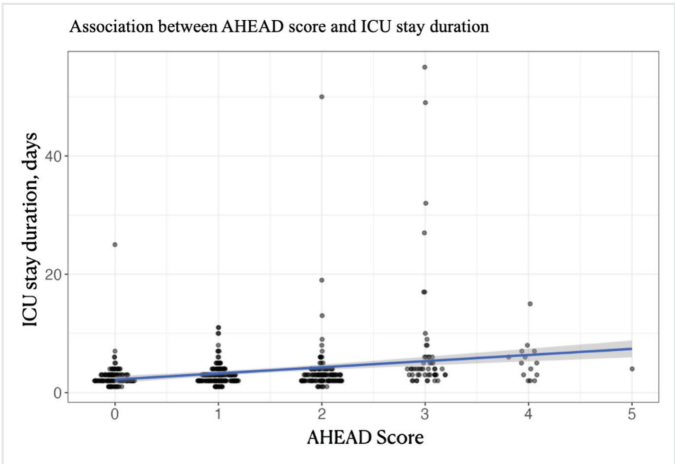


Figure 3. Association between AHEAD score and ICU stay duration. Scatter plot showing the relationship between AHEAD score and ICU stay duration. The solid blue line represents the fitted trend line with 95% confidence interval for visualization
ICU: Intensive care unit

Table 5. Prolonged ICU stay according to AHEAD score categories						
AHEAD score category	Overall n (%)	ICU stay ≤3 days n (%)	ICU stay >3 days n (%)	OR	95% CI	p-value
AHEAD 0	123 (23.7)	103 (83.7)	20 (16.3)	Reference	—	—
AHEAD 1	195 (37.6)	151 (77.4)	44 (22.6)	1.501	0.836-2.693	0.174
AHEAD 2	133 (25.7)	95 (71.4)	38 (28.6)	2.060	1.120-3.788	0.020
AHEAD ≥3	67 (12.9)	26 (38.8)	41 (61.2)	8.121	4.089-16.129	<0.001

Values are presented as n (%) unless otherwise indicated. Percentages for ICU stay ≤3 days and ICU stay >3 days are row percentages within each AHEAD score category. AHEAD 0 was used as the reference category for odds ratios. AHEAD scores ≥3 was combined into a single high-risk category because sparse data and unstable estimates were observed in the highest individual score strata
OR: Odds ratio, CI: Confidence interval, ICU: Intensive care unit

association between the AHEAD score and prolonged ICU stay is biologically plausible. Each component of the score has previously been linked to adverse postoperative outcomes following CABG. Age is an important parameter for postoperative recovery and advanced age is associated with reduced physiological reserve and increased susceptibility to postoperative complications (18,19). Diabetes mellitus is known to adversely affect postoperative recovery through impaired metabolic regulation and vulnerability to postoperative complications (20). Likewise, impaired renal function has consistently been linked to unfavorable outcomes after cardiac surgery, whereas preoperative anemia may compromise oxygen transport and increase perioperative transfusion requirements (21,22). In addition, AF often reflects a greater burden of cardiovascular disease and has been related to increased surgical risk and postoperative complications (23). The integration of these clinically relevant variables into a single score may account for the observed association between the AHEAD score and extended ICU utilization following CABG.

An additional finding of our study was the graded increase in prolonged ICU stay across AHEAD score categories. Patients with an AHEAD score ≥ 3 represented a particularly high-risk subgroup, with more than 60% experiencing prolonged ICU stay. This finding further supports the observed association between increasing AHEAD score categories and prolonged ICU stay. This graded relationship may be useful for future studies evaluating preoperative risk assessment in patients undergoing CABG.

Among the non-AHEAD variables included in the multivariable models, lower serum albumin levels were independently associated with prolonged ICU stay. Hypoalbuminemia is widely recognized as a marker of frailty, malnutrition, and systemic illness and has previously been linked to adverse outcomes after cardiac surgery (24,25). Our findings are consistent with these observations and further support the importance of preoperative nutritional and clinical status in determining postoperative recovery. While longer CC and CPB times have been linked to extended ICU utilization in previous reports, neither variable retained independent significance in our cohort (26,27). This discrepancy may be attributable to differences in patient characteristics between study populations as well as variations in perioperative management and ICU practices across centers. In contrast, the AHEAD score remained independently associated with prolonged ICU stay after multivariable adjustment.

Study Limitations

Several limitations merit consideration. First, the retrospective nature may have resulted in residual confounding despite multivariable adjustment. Second, because the study cohort was drawn from only two institutions, caution is warranted when extrapolating

these findings to other healthcare environments. Third, ICU discharge practices may vary between institutions and could influence ICU length of stay. Fourth, information regarding subsequent clinical events was unavailable, precluding assessment of the relationship between AHEAD score and outcomes beyond the immediate postoperative period. Finally, established surgical risk scores, including EuroSCORE II and ACEF, were not available in the retrospective dataset. Therefore, the present analysis could not adjust for these scores or compare the predictive performance of the AHEAD score with these established models. Further prospective studies are needed to determine whether the AHEAD score provides incremental prognostic information beyond established cardiac surgical risk scores.

Conclusion

A higher AHEAD score was independently associated with an increased likelihood of prolonged ICU stay after isolated CABG. Although the AHEAD score is simple to calculate using routinely available clinical variables, further prospective studies, including direct comparisons with established surgical risk models, are required to establish its clinical role.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the University of Health Sciences Türkiye, Kartal Koşuyolu Education and Research Hospital Ethics (committee date: June 16, 2026; decision no: 2026/11/1506) and all study procedures complied with the principles outlined in the Declaration of Helsinki.

Informed Consent: The ethics committee waived the requirement for obtaining individual informed consent due to the retrospective nature of this research.

Declaration on the Use of Artificial Intelligence (AI) AI-based tools were employed exclusively for language refinement and grammatical editing purposes

Footnotes

Authorship Contributions

Surgical and Medical Practices: B.G.Ş., M.Ş., F.A., Ü.A., Concept: B.G.Ş., Ü.A., R.Z., Design: B.G.Ş., M.M.T., Ü.A., R.Z., Data Collection or Processing: M.Ş., M.M.T., F.A., K.B., M.F.K., C.Y., Analysis or Interpretation: B.G.Ş., M.Ş., M.M.T., F.A., K.B., M.F.K., C.Y., Ü.A., R.Z., Literature Search: B.G.Ş., M.Ş., F.A., K.B., M.F.K., C.Y., Writing: B.G.Ş., M.M.T.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

Availability of Data and Material: The dataset analyzed during the current study can be obtained from the corresponding author upon reasonable request.

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