Original Article

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The impact of the Naples prognostic score on outcomes in patients undergoing coronary artery bypass grafting

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Abstract

Background: This study aimed to evaluate the prognostic value of the Naples prognostic score (NPS) in patients undergoing isolated coronary artery bypass grafting (CABG).

Methods: Patients undergoing isolated CABG were retrospectively analyzed. Patients were stratified into three groups based on preoperative NPS values. Thirty-day and one-year mortality, postoperative atrial fibrillation (AF), intensive care unit (ICU) and ward length of stay were recorded. Logistic regression analysis was used to assess the independent predictive value of NPS. Its contribution to the European System for Cardiac Operative Risk Evaluation II (EuroSCORE II) model was evaluated using ROC curves and Nagelkerke R^2.

Results: A total of 1.195 patients were included. Higher NPS was significantly associated with 30-day (odds ratio [OR] =1.838) and 1-year mortality (OR=1.620) ($p<0.001$). Postoperative AF was significantly more common in higher NPS groups ($p=0.010$). NPS was significantly associated with both ICU length of stay ($p<0.001$) and ward length of stay ($p=0.029$). The addition of NPS to EuroSCORE improved the predictive performance for both 30-day and 1-year mortality. Patients with higher NPS had significantly lower survival during follow-up.

Conclusion: The NPS is an independent and significant predictor of short- and long-term mortality in patients undergoing isolated CABG. As a simple, objective score reflecting both inflammatory and nutritional status, NPS enhances the predictive capacity of established risk models when integrated preoperatively.

Keywords: Coronary artery bypass, mortality, Naples prognostic score, EuroSCORE II.

Coronary artery disease (CAD) remains the leading cause of morbidity and mortality worldwide, despite major advances in medical therapy and percutaneous interventions.[1] Coronary artery bypass grafting (CABG) continues to be the preferred revascularization strategy for patients with complex multivessel disease or left main coronary artery involvement, owing to its demonstrated long-term survival benefits and reduced need for repeat revascularization.[2,3] However, postoperative morbidity and both short- and long-term mortality continue to pose significant challenges following CABG surgery.[4]

Preoperative risk stratification is critical for surgical planning, resource allocation, and patient counseling. Standardized scoring systems such as the European System for Cardiac Operative Risk Evaluation II (EuroSCORE II) are widely utilized to predict operative mortality; however, their discriminatory power remains suboptimal, particularly in heterogeneous clinical populations.[5,6] There is growing interest in incorporating biomarkers that reflect systemic inflammation and nutritional status into existing risk models, as these parameters have been shown to influence surgical outcomes independently.[7,8]

The Naples prognostic score (NPS) is a composite score based on four routinely measured laboratory parameters: Serum albumin, total cholesterol, neutrophil-to-lymphocyte ratio (NLR), and lymphocyte-to-monocyte ratio (LMR). By integrating markers of nutritional status and systemic inflammation, NPS offers a multidimensional assessment of physiological reserve and immune competence.[9] Although initially validated in patients with gastrointestinal malignancies,[9] recent studies have suggested that the NPS may also serve as a prognostic indicator in cardiovascular disease, including heart failure and acute coronary syndromes.[10,11] Nevertheless, its utility in predicting clinical outcomes after cardiac surgery, particularly in the context of isolated CABG, has not been sufficiently explored.

The aim of this study was to investigate the prognostic significance of the NPS in patients undergoing isolated CABG, with a particular focus on its association with short-term (30-day) and long-term (1-year) mortality. Additionally, we aimed to assess whether the integration of NPS into the EuroSCORE II model improves its predictive performance.

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Methods

Study Design and Population

This retrospective cohort study included patients who underwent isolated CABG at a tertiary cardiovascular surgery center between January 2020 and January 2025. A total of 1.426 patients were initially screened. Patients who underwent redo surgery, had concomitant cardiac procedures (e.g., valve surgery, aortic interventions), or were admitted for emergency CABG were excluded. Urgent cases were included in the analysis. Additionally, cases with incomplete preoperative laboratory data required for NPS calculation were omitted. After applying these exclusion criteria, 1.195 patients were included in the final analysis. All procedures were performed via median sternotomy under cardiopulmonary bypass by experienced cardiovascular surgeons. The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of Dokuz Eylül University (number: 10050-GOA, date: 23.07.2025). Due to the retrospective nature of the study and the use of anonymized patient data, the requirement for informed consent was waived by the institutional ethics committee.

Data Collection and Variable Definitions

Demographic, clinical, laboratory, and surgical data were extracted from institutional electronic health records. Preoperative variables included age, sex, and EuroSCORE II, which itself incorporates key clinical factors such as comorbidities (e.g., diabetes mellitus, hypertension) and left ventricular ejection fraction. Laboratory parameters used for NPS calculation were obtained from fasting blood samples collected within 24 hours before surgery. Postoperative outcomes such as 30-day and 1-year all-cause mortality, incidence of new-onset atrial fibrillation (AF), intensive care unit (ICU) length of stay, and hospital length of stay were recorded during the follow-up period. In addition to its continuous form, EuroSCORE II was also categorized into three risk groups: Low risk (<2%), intermediate risk (2-5%), and high risk (>5%), in accordance with prior literature.[12] These groupings were used in subgroup comparisons and interaction analyses.

Mortality data were verified through hospital records and national death registries. Postoperative AF was defined as any documented episode of AF lasting longer than 30 minutes or requiring medical/interventional therapy during hospitalization.

Calculation of the NPS

The NPS was calculated based on four parameters: Serum albumin, total cholesterol, NLR, and LMR, as previously described by Galizia et al.[9] One point was assigned for each of the following: Albumin <4.0 g/dL, total cholesterol <180 mg/dL, NLR ≥2.96, and LMR ≤4.44. The total score ranged from 0 to 4. Patients were stratified into three groups based on their NPS: Group 1 (score 0), group 2 (score 1-2), and group 3 (score 3-4).

Outcome Measures

The primary outcomes of interest were 30-day and 1-year all-cause mortality. Secondary outcomes included postoperative AF, ICU length of stay, and hospital length of stay. The relationship between NPS and each outcome variable was evaluated.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median with interquartile range (IQR), depending on distribution, and compared using One-Way ANOVA or Kruskal-Wallis test. Categorical variables were compared using chi-square or Fisher's exact test.

Univariate and multivariate logistic regression analyses were performed to identify independent predictors of 30-day and 1-year mortality. The predictive performance of NPS, both alone and in combination with EuroSCORE II, was assessed using receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC), Nagelkerke R^2, and -2 log-likelihood values were reported. Kaplan-Meier survival curves were generated for overall survival during the follow-up period, and differences between groups were evaluated using the log-rank test. A p-value <0.05 was considered statistically significant.

Results

Baseline Characteristics

A total of 1.195 patients who underwent isolated CABG were included in the final analysis. Patients were stratified into three groups based on their NPS: Group 1 (NPS =0, n=67), Group 2 (NPS =1-2, n=712), and Group 3 (NPS =3-4, n=416). The mean age of the overall cohort was 62.95±9.42 years. Patients in the high-NPS group were significantly older compared to the low- and medium-NPS groups (p<0.001). The proportion of male patients was similar across the groups (p=0.726).

The mean EuroSCORE II values were significantly higher in patients with higher NPS (Group 1: 1.17±0.90, Group 2: 1.79±1.73, Group 3: 3.28±3.33; p<0.001). A significant association was also observed between NPS category and EuroSCORE II risk classification (p<0.001). The proportion of high-risk patients (EuroSCORE II >5%) increased from 0% in Group 1 to 4.9% in Group 2 and 13.9% in Group 3 (Table 1).

Postoperative Outcomes

There was a statistically significant association between the NPS and both early and late postoperative outcomes in patients undergoing isolated CABG. Thirty-day mortality occurred in 6.3% of the overall cohort (75/1195), showing a stepwise increase across NPS groups: 0.0% in Group 1 (0/67), 3.7% in Group 2 (26/712), and 11.8% in Group 3 (49/416) (p<0.001). Similarly, 1-year mortality was 5.5% in the overall cohort (66/1195), with corresponding rates of 1.5% in Group 1 (1/67), 3.8% in Group 2 (27/712), and 9.1% in Group 3 (38/416) (p<0.001). These findings suggest that NPS effectively stratifies patients according to both short- and long-term mortality risk following CABG.

Postoperative AF was observed in 271 patients (22.7%). Its incidence increased significantly with higher NPS: 14.9% in Group 1, 20.6% in Group 2, and 27.4% in Group 3 (p=0.010). This result underscores the potential role of systemic inflammation and nutritional status as captured by the NPS in predisposing patients to postoperative arrhythmias.

A significant difference in ICU length of stay was also identified across NPS groups. The median ICU length of stay was 2 days (IQR 2-3) in Group 1, 3 days (IQR 2-4) in Group 2, and 3 days (IQR 3-5) in Group 3 (p<0.001).

Pairwise comparisons revealed that patients in the high-risk group (NPS =3) stayed significantly longer in the ICU compared to both low- and intermediate-risk groups (Group 1 *vs.* 3 and Group 2 *vs.* 3, p<0.001), while no significant difference was observed between Groups 1 and 2 (p=0.202).

The median hospital length of stay increased progressively with higher NPS (8 [IQR 5-11] days in Group 1, 9 [IQR 7-11] days in Group 2, and 10 [IQR 8-12] days in Group 3), with a statistically significant difference among groups (p=0.029). This suggests that patients with elevated NPS, reflecting higher inflammatory and nutritional burden, require more prolonged perioperative care (Table 2).

Binary logistic regression analysis showed that the NPS was an independent predictor of both 30-day and 1-year mortality. When added to a model containing EuroSCORE II, the inclusion of NPS improved the model's explanatory power. For 30-day mortality, Nagelkerke R^2 increased from 0.106 to 0.154, and for 1-year mortality from 0.078 to 0.109. In both models, the NPS retained statistical significance (p<0.001). The odds ratios for mortality per unit increase in NPS were 1.838 for 30-day and 1.620 for 1-year mortality (Table 3).

ROC analysis for the NPS yielded an AUC of 0.693 for predicting 30-day mortality, indicating moderate discriminative ability.

Kaplan-Meier survival analysis demonstrated significantly lower overall survival across increasing NPS groups during the entire follow-up period (log-rank p<0.001) (Figure 1). These findings suggest that the NPS may serve not only as a predictor of mortality but also as a valuable tool for perioperative risk stratification and postoperative resource planning in patients undergoing CABG.

Discussion

Nutritional and inflammatory status has emerged as a pivotal determinant of postoperative outcomes in cardiovascular surgery. Patients undergoing CABG often exhibit varying degrees of systemic inflammation and malnutrition, both of which have been independently

Table 1. Baseline characteristics of patients according to NPS groups

Variable	Group-1 (low NPS)	Group-2 (medium NPS)	Group-3 (high NPS)	Overall population	p-value
	(n=67, 5.6%)	(n=712, 59.6%)	(n=416, 34.8%)	(n=1195)	
Age, years (median [IQR])	59.18±9.22	62.17±9.30	64.88±9.30	62.95±9.417	<0.001
Male sex, n (%)	55 (82.1%)	560 (78.7%)	333 (80%)	948 (79.3%)	0.726
EuroSCORE II, mean (%)	1.17±0.90	1.79±1.73	3.28±3.33		<0.001
EuroSCORE II category, n (%)					<0.001
- Low (<2%)	55 (82.1%)	493 (69.24%)	240 (57.7%)		
- Intermediate (2-5%)	12 (17.9%)	184 (25.84%)	118 (28.4%)		
- High (>5%)	0 (0.0%)	35 (4.92%)	58 (13.9%)		

NPS: Naples prognostic score; IQR: Interquartile range; EuroSCORE II: European System for Cardiac Operative Risk Evaluation II.

Table 2. Summary of postoperative outcomes by NPS categories

Outcome	Group-1 (low NPS) (n=67)	Group-2 (medium NPS) (n=712)	Group-3 (high NPS) (n=416)	p-value
30-day mortality, n (%)	0 (0.0%)	26 (3.7%)	49 (11.8%)	<0.001
1-year mortality, n (%)	1 (1.5%)	27 (3.8%)	38 (9.1%)	<0.001
Postoperative AF, n (%)	10 (14.9%)	147 (20.6%)	114 (27.4%)	0.010
ICU LOS, median (IQR), days	2 (2-3)	3 (2-4)	3 (3-5)	<0.001
Hospital LOS, median (IQR), days	8 (5-11)	9 (7-11)	10 (8-12)	0.029

AF: Atrial fibrillation; NPS: Naples prognostic score; ICU: Intensive care unit; IQR: Interquartile range; LOS: Length of stay.

Table 3. Logistic regression analysis for 30-day and 1-year mortality

Outcome	Model	Predictor	B	SE	Wald	p-value	OR (95% CI)	Nagelkerke R^2	-2 Log Likelihood
30-day mortality	EuroSCORE II only	EuroSCORE II	1.121	0.158	50.130	<0.001	3.07 (2.25-4.19)	0.106	512.287
30-day mortality	EuroSCORE II + NPS	EuroSCORE II	0.961	0.161	35.500	<0.001	2.62 (1.91-3.59)		
		NPS	0.609	0.132	21.280	<0.001	1.84 (1.42-2.38)	0.154	489.362
1-year mortality	EuroSCORE II only	EuroSCORE II	0.985	0.167	34.921	<0.001	2.68 (1.93-3.71)	0.078	477.808
1-year mortality	EuroSCORE II + NPS	EuroSCORE II	0.848	0.170	24.974	<0.001	2.33 (1.67-3.25)		
		NPS	0.483	0.135	12.805	<0.001	1.62 (1.24-2.11)	0.109	464.375

NPS: Naples prognostic score; EuroSCORE II: European System for Cardiac Operative Risk Evaluation II; CI: Confidence interval; OR: Odds ratio; SE: Standard error.

associated with increased morbidity and mortality.[10,11] Traditional risk scoring systems such as EuroSCORE II, while effective in stratifying baseline surgical risk, do not directly incorporate inflammatory or nutritional biomarkers into their models. In this context, the NPS a composite index integrating serum albumin, total cholesterol, NLR, and LMR has garnered attention as a multidimensional marker reflecting both physiologic reserves and inflammatory burden.[9] The principal differences between NPS and EuroSCORE II are summarized in Table 4, underscoring that these models should be regarded as complementay rather than interchangeable tools.

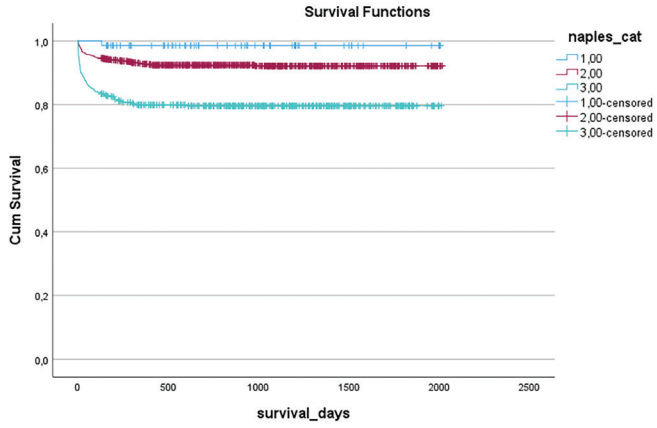


Figure 1. Kaplan-Meier survival analysis between three groups.

The present study demonstrated that higher NPS values were significantly associated with increased 30-day and 1-year mortality following isolated CABG. In addition, elevated NPS was linked to a higher incidence of postoperative AF and longer ICU length of stay, supporting the hypothesis that malnutrition and systemic inflammation may adversely affect recovery and survival. These findings are consistent with previous studies reporting that preoperative nutritional and inflammatory markers are predictive of adverse cardiovascular outcomes.[10,11] Notably, the incidence of new-onset AF, a common complication after CABG, increased significantly across ascending NPS categories. This observation aligns with literature indicating that systemic inflammation contributes to the pathogenesis of AF in surgical populations.[13,14]

Furthermore, patients in the highest NPS group exhibited significantly prolonged ICU length of stay. This suggests that elevated NPS may be linked to early postoperative instability requiring prolonged critical care. In linear regression analysis, each 1-point increase in NPS was associated with an additional 1.1 days of ICU stay (B=1.088, p<0.001), further supporting its clinical relevance.

Importantly, the addition of NPS to EuroSCORE II significantly improved the prediction of both short- and long-term mortality. This suggests that integrating inflammatory and nutritional assessment with established surgical risk models can provide a more comprehensive evaluation of perioperative risk. The predictive utility of NPS, while statistically moderate (AUC: 0.693), remains clinically meaningful due to its simplicity, objectivity, and reliance on routine laboratory data.

Table 4. Key differences between the NPS and EuroSCORE II

Characteristic	NPS	EuroSCORE II
Underlying construct	Composite index of systemic inflammation and nutritional status	Multivariable perioperative surgical risk model for cardiac surgery
Type of variables	Simple laboratory parameters from routine blood tests	Demographic, clinical, echocardiographic and procedural variables
Main components	Serum albumin, total cholesterol, NLR and LMR, combined into a 0-4 score	Age, sex, renal function, LVEF, NYHA class, extracardiac arteriopathy, pulmonary hypertension, previous cardiac surgery, urgency, critical preoperative state, recent MI, CCS class, diabetes on insulin, active endocarditis, poor mobility, procedure type, etc.
Scoring range & direction	Ordinal score usually from 0 to 4, with higher values indicating a worse inflammatory/nutritional profile and poorer prognosis	Continuous predicted risk of in-hospital/30-day mortality (%); higher percentage indicates higher estimated operative risk
Pathophysiological focus	Reflects chronic inflammation, immune status and malnutrition, which may impair healing and increase postoperative complications	Captures global operative risk related to patient comorbidities, cardiac function and procedural complexity
Timing of assessment	Preoperative blood sampling, typically within days before surgery	Preoperative clinical evaluation, echocardiographic assessment and procedural planning, before surgery
Primary outcome inoriginal validation	Short-term and long-term mortality and major adverse events in various cardiovascular and oncologic cohorts	Early postoperative mortality after cardiac surgery (mainly CABG and valve procedures)
Original target population	Patients with cardiovascular and oncologic diseases; subsequently applied to surgical cohorts including CABG	Adult patients undergoing cardiac surgery (CABG, valve, combined procedures)
Main strengths	Requires only routine laboratory tests; inexpensive, easily reproducible; highlights modifiable factors such as nutrition and inflammation	Extensively validated; procedure-specific; integrates many clinical variables; recommended by guidelines for risk estimation
Main limitations	Not procedure-specific; cut-off values may vary between studies; does not directly account for surgical complexity	Focused on early mortality; less sensitive to nutritional/inflammatory status; some variables may be missing or subject to inter-observer variability

CABG: Coronary artery bypass grafting; NLR: Neutrophil-to-lymphocyte ratio; LMR: Lymphocyte-to-monocyte ratio; NPS: Naples prognostic score; EuroSCORE II: European System for Cardiac Operative Risk Evaluation II; LVEF: Left ventricular ejection fraction; NYHA: New York Heart Association.

From a practical perspective, NPS offers an accessible adjunct for preoperative assessment, especially in resource-limited settings. Its application may support decision-making regarding postoperative planning, including ICU resource allocation and nutritional optimization. However, it is not intended to replace traditional models or guide surgical eligibility but to supplement existing tools for more individualized care planning.

This study's retrospective design and single-center nature represent its main limitations. Additionally, dynamic changes in laboratory values were not assessed, and comparisons with other nutritional or inflammatory indices were not performed. The findings were not externally validated, which restricts their applicability across different clinical settings. Moreover, although NPS appeared to be an independent predictor in multivariable analysis, comprehensive adjustment for clinical confounders was not possible, as individual variables such as ejection fraction, diabetes mellitus, and hypertension were not accessible due to limitations in the hospital registry. EuroSCORE II was retrieved as a composite score, without access to its individual components, restricting the scope of adjustment. Future prospective and multicenter studies are needed to validate these findings and determine whether NPS-guided strategies can improve outcomes in cardiac surgery.

In summary, the NPS is independently associated with adverse outcomes after CABG and may enhance current risk stratification methods by incorporating systemic inflammation and nutritional status into perioperative evaluation. Its routine use may contribute to more personalized perioperative care.

The NPS was independently associated with mortality, AF, and ICU stay in patients undergoing CABG. While not a substitute for existing models, its integration with EuroSCORE II improved risk prediction. Given its simplicity and clinical relevance, NPS may serve as a valuable adjunct for perioperative risk assessment.

Ethics

Ethics Committee Approval: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of Dokuz Eylül University (number: 10050-GOA, date: 23.07.2025).

Informed Consent: Due to the retrospective nature of the study and the use of anonymized patient data, the requirement for informed consent was waived by the institutional ethics committee.

Footnotes

Authorship Contributions

Concept: C.S., T.G., S.B.; Design: C.S., T.G.; Data Collection or Processing: O.B.D., E.N.E.; Analysis or Interpretation: C.S.; Literature Search: C.S., E.N.E.; Writing: C.S., O.B.D.

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

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