Original Article

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Effects of Prognostic Nutrition Index, Neutrophil/ Lymphocyte Ratio, and C-reactive Protein/Albumin Ratio on Prognosis Undergoing Open Heart Surgery

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Abstract

Aim: Deficiencies in preoperative nutritional status increase the incidence of negative postoperative events. In this study, we aimed to investigate the effect of the prognostic nutrition index (PNI), neutrophil-to-lymphocyte (N/L) ratio, and C-reactive protein (CRP)-to-albumin (CRP/Alb) ratio on postoperative prognosis in patients undergoing open-heart surgery.

Methods: Patients undergoing primary open-heart surgery in our hospital from December 2021 to August 2023 were screened for PNI, N/L ratio, and CRP/Alb ratios, along with durations in intensive care, total hospitalization, and 30-day mortality rates. Binary logistic regression and robust regression analyses were used for the statistical analysis of this cross-sectional study.

Results: The study included a total of 437 cases. All patients had a mean PNI of 49.35±7.70. A one-unit increase in PNI value reduced intensive care duration by 0.495 units (p=0.049), while it reduced discharge duration by 0.101 units (p<0.001). A one-unit reduction in PNI value increased mortality by 1.07 times (p=0.002). The other variables showed no significant effects on intensive care duration, total hospitalization, and 30-day mortality rates.

Conclusion: PNI, a marker of inflammatory and immune processes, may be a beneficial variable for estimating postoperative prognosis among patients undergoing open heart surgery.

Keywords: PNI, N/L ratio, CRP/Alb ratio, open-heart surgery, prognosis

Introduction

Coronary artery bypass graft surgery (CABG), valve surgery, and aortic graft surgery are the most common open-heart surgeries performed in adults. Despite new surgical techniques and technological advances, the risk of complications after cardiac surgery remains high (1). The postoperative period is of critical importance for all open-heart surgeries, and patient-related correctable factors, especially during the postoperative period, may favorably affect all outcomes, including postoperative mortality.

In general, low albumin levels are a strong marker of mortality in patients with poor prognosis, chronic inflammation, and associated cardiovascular disease. Lymphocytes are important peripheral blood elements that indicate immune function in patients and may be indicative of prognosis in critical diseases. They are used to predict poor prognosis in clinical situations such as coronary artery disease (CAD) and heart failure (2). The prognostic nutrition index (PNI), calculated using serum albumin and peripheral total lymphocyte counts, is a relatively new score that has been included in clinical practice. While the PNI was initially used to assess preoperative nutritional conditions and surgical complications in patients with malignancies, it is now used to assess the prognosis of patients with autoimmune diseases, other surgical diseases, and a variety of different clinical conditions (3,4).

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The aim of this study, which was performed with open-heart surgery patients, a patient group known to have high surgical and anesthesia risks, was to determine whether predicting factors with the potential to impact postoperative prognosis in the preoperative period would be beneficial or not. We hypothesized that the effects of the PNI, neutrophil/lymphocyte (N/L) ratio, and C-reactive protein (CRP)-to-albumin (CRP/Alb) ratio, which were simply calculated preoperatively, on the duration of intensive care unit duration (ICU duration), total hospitalization (discharge duration), and 30-day mortality rates in the postoperative period.

Materials and Methods

Ethical Approval and Study Design

Permission for this retrospective study was obtained from the Ordu University Clinical Research Ethics Committee (approval no.: 2023/224, date: 01.09.2023). The study included all adults undergoing primary open-heart surgery, including CABG, valve surgeries, and aorta surgeries with median sternotomy and cardiopulmonary bypass from December 1, 2021, to August 31, 2023. Patients younger than 18 years, repeat cases, emergency cases, surgeries without cardiopulmonary bypass, and exitus patients within 24 hours postoperatively were excluded from the study.

Anesthesia Management

All patients received general anesthesia using the same medications and methods routinely used in cardiovascular anesthesia administration: IV induction with 0.1 mg/kg midazolam, 3-5 mcg/kg fentanyl, and 1-2 mg/kg propofol (until loss of eyelash reflex) and 0.6-0.8 mg/kg rocuronium, followed by endotracheal intubation. After this, anesthesia was maintained in volume control mode with 2% sevoflurane + 50% oxygen and a 50% dry air mixture to ensure ETCO2 was 35-40 mm Hg. When cardiopulmonary bypass began, inhalation anesthesia was discontinued. During cardiopulmonary bypass, 0.05 mg/kg midazolam, 1 mcg/kg fentanyl, and 0.2 mg/kg rocuronium at 30-minute intervals were administered for anesthesia maintenance. After the end of cardiopulmonary bypass, maintenance continued with 2% sevoflurane + 50% oxygen and 50% dry air mixture titrated according to the hemodynamic situation and arterial gas oxygenation to ensure ETCO2 was 35-40 mmHg until transfer to the ICU.

Cardiopulmonary Bypass Process

Anticoagulation was provided by 300 U/kg heparin, as routine for CPB. During surgery, the pump blood flow rate was BSAx2.4 L/min for isothermic patients and BSAx2.2 L/min for patients with mild hypothermia, and the mean blood pressure was kept at 50-80 mmHg. On exiting the pump, heparin was antagonized with a 1:1 ratio of protamine sulfate. At the end of surgery, patients were transferred to the cardiovascular surgery ICU unit with or without vasopressor/inotrope support according to the hemodynamic requirements.

Data Collection

Patient age, sex, ASA, comorbid diseases, type of operation, surgical duration, postoperative ICU duration, discharge duration, and 30-day mortality outcomes were recorded. PNI, N/L ratio, CRP/Alb ratio, and other routine laboratory values were recorded from peripheral venous blood samples taken routinely during the preoperative period.

Statistical Analysis

Data were analyzed using IBM SPSS V23 and the R program. Continuous variables were presented as mean (± standard deviation) and median (mininum-maximum), whereas categorical variables were presented as counts (n) and percentages. The fit to the normal distribution was investigated using the Kolmogorov-Smirnov test. Investigation of risk factors affecting mortality using binary logistic regression analysis. The factors affecting discharge duration were investigated without normal distribution using robust regression analysis. The significance level was taken as p<0.050.

Results

For this study, data from a total of 461 patients were screened. Twenty-four patients with missing data were excluded from the study. The study included 437 patients. The mean age of patients included in the study was 63.63±10.37 years. The most common diagnosis was CABG surgery (76%). The mean surgical duration was calculated as 225.46±60.94 minutes. The mean ICU duration was 61.37±75.13 hours and the mean discharge duration was 6.15±3.72 days. Additionally, the 30-day mortality rate was 7.8%. According to laboratory values, the mean white blood count was 8.83±4.97, the mean hematocrit (Htc) was 45.55±127.20, the mean neutrophil count was 6.00±4.39, and the mean lymphocyte count was 1.93±0.78. The mean CRP was 17.27±34.21 and the mean albumin was 39.97±5.68. The mean PNI value was found to be 49.35±7.70, with a mean N/L ratio of 4.16±5.23 and a mean CRP/Alb ratio of 0.50±1.07 (Table 1).

As a result of an investigation of factors affecting ICU duration with robust regression analysis, the regression model was found to be statistically significant (F=3.992, p<0.00). A one-unit increase in the PNI value reduced

ICU duration by 0.495 (p=0.049). At the same time, for patients with mortality, the ICU duration was 12.8 days longer than that for patients without mortality (p=0.048). Other variables were not found to have statistically significant effects (Table 2).

Table 1. Descriptive statistics of the variables		
	Mean±SD/n	**Median (Min.-Max.)/%**
Age†	63.63±10.37	65.00 (29.00-87.00)
Gender‡		
Female	134	30.4
Male	307	69.6
Diagnosis‡		
CABG	335	76
Valve surgery	97	22
Aort surgery	41	9,3
Number of comorbidities†	1.63±0.93	2.00 (0.00-6.00)
Comorbidities‡		
CAD	184	41.7
DM	78	17.7
HT	289	65.5
COPD/Asthma	51	11.6
CHF	55	12.5
Renal disease	19	4.3
Tyroid disease	9	2
Neurological disease	34	7.7
Surgery duration†	225.46±60.94	215.00 (50.00-660.00)
ICU duration	61.37±75.13	48.00 (5.00-1200.00)
Discharge duration*	6.15±3.72	5.00 (1.00-50.00)
Thirty day mortality‡		
None	403	92.2
Present	34	7.8
WBC *	8.83±4.97	8.11 (3.22-90.40)
Htc†	45.55±127.20	40.40 (23.70-2708.00)
Neutrophil*	6.00±4.39	5.09 (1.64-72.80)
Lymphocyte*	1.93±0.78	1.85 (0.37-5.49)
CRP*	17.27±34.21	4.17 (0.02-248.45)
Alb*	39.97±5.68	40.70 (18.00-52.80)
ALT*	24.26±41.24	17.00 (2.00-728.00)
AST*	27.81±39.25	19.00 (0.29-575.00)
PNI†	49.35±7.70	50.00 (13.60-71.10)
N/L ratio†	4.16±5.23	2.62 (0.56-64.43)
CRP/Alb ratio†	0.50±1.07	0.10 (0.00-9.20)

*Indicates normal distribution, †indicates non-normal distribution and ‡indicates categorical variables.
CABG: Coronary artery bypass graft surgery, CAD: Coronary artery disease, CHF: Congestive heart failure, WBC: White blood cell, Htc: Hematocrit, CRP: C-reactive protein, Alb: Albumin, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, PNI: Prognostic nutritional index, N/L ratio: Neutrophil/lymphocyte ratio, CRP/Alb ratio: C-reactive protein/albumin ratio, Min.-Max.: Minimum-maximum

The regression model created as a result of robust regression analysis for factors affecting discharge duration was found to be statistically significant (F=11.287, p<0.001). A one-unit increase in PNI reduced discharge duration by 0.101 (p<0.001). An increase in the number of comorbid diseases increased the discharge duration by 0.181 units (p=0.021). A one-unit increase in the surgical duration increased the discharge duration by 0.003 units (p=0.004). The other variables did not have statistically significant effects (Table 3).

Risk factors affecting mortality were investigated using binary logistic regression analysis in univariate and multivariate models. According to the univariate model, as age increased, mortality increased by 1.057 times (p=0.004). A reduction in the Htc value was observed to increase the mortality risk (Odds ratio=0.92; p=0.006). According to the analysis, a one-unit reduction in PNI values increased the mortality risk by 1.07 times (1/0.935) (p=0.002). An increase in ICU duration increased the mortality risk by 1.005 times (p=0.013). Investigation of the multivariate model results revealed that an increase in age increased the mortality risk by 1.058 times (p=0.009). Other variables were not found to have statistically significant effects (Table 4).

Discussion

This study revealed significant correlations between low PNI values and adverse postoperative events after cardiac surgery, defined as prolonged ICU time, prolonged discharge time, and increased 30-day mortality rate. Open-heart surgery is a process that may stimulate oxidative stress and inflammation, which are significant for postoperative complications. PNI was first reported to have potential prognostic value in patients undergoing gastrointestinal surgery (6,7). Severity of cardiac pathology, comorbid diseases, age, and other similar factors significantly affect postoperative morbidity and mortality (1).

Variations in leukocyte subtypes examined in the preoperative period, particularly the N/L ratio, may provide significant prognostic information for the postoperative period (8). Recent studies have proposed that an increase in the perioperative N/L ratio is associated with poor outcomes in adult heart surgery cases (9,10). In this study, there was no significant correlation between N/L ratios and postoperative ICU duration, discharge time, and 30-day mortality rates. This result may be explained by the fact that the patients included in the study had no additional pathologies other than cardiac pathologies that could cause abnormalities in peripheral blood values, and emergency patients with poor general condition were excluded from the study. Surgical stress suppresses cellular immunity as a result of inflammatory responses in all patients who undergo surgery. In addition to damaging the host's defense mechanism, this suppression can cause the overproduction of inflammatory mediators. Serum CRP, an acute-phase protein, is released by the liver in response to inflammation and is associated with poor prognosis after CABG in patients with CAD. Reduced levels of the negative acute phase protein of albumin increase blood viscosity and platelet activation, worsen endothelial function, and are associated with negative cardiovascular events. The inflammatory parameter of the CRP/Alb ratio is superior to CRP or albumin alone for determining the inflammatory status in a variety of cardiovascular diseases (7). In our study, the mean CRP/Alb ratio was 0.50±1.07 in all patients, and this ratio was not significantly correlated with postoperative ICU duration, discharge time, and 30-day mortality rates. Although our patients were in the critically ill group, we believe that the prognosis may not have been affected by changes in the CRP/Alb ratio because they were operated on under relatively elective conditions.

Table 2. Investigation of factors affecting ICU duration

	β1 (95% CI)	S. data	β2	t	p	VIF
Constant	44,745 (4,835-84,656)	20,303		2,204	0.**028**	
Age	0.248 (-0.042-0.538)	0.148	0.080	1,679	0.094	1,108
Htc	0.016 (-0,007-0,040)	0.012	0.067	1,362	0.174	1,163
PNI	-0,495 (-0.987- -0.002)	0.251	-0.112	-1,974	**0.049**	1,563
N/L ratio	0.000 (-0.665-0.665)	0.338	0.000	0.001	1,000	1,398
CRP/Alb ratio	3,741 (-0.164-7,645)	1,986	0.113	1,883	0.060	1,744
Number of comorbidities	0.480 (-2,757-3,717)	1,647	0.014	0.291	0.771	1,096
Surgery duration	-0.001 (-0.052-0.050)	0.026	-0.002	-0.038	0.969	1,117
Mortality (Reference: none)	12,834 (0.127-25,542)	6,465	0.094	1,985	**0.048**	1,084

Robust regression analysis. F=3,992, $p<0.001$, R^2=%14,82, β1: Unstandardized beta coefficient, β2: Standardized beta coefficient
ICU: Intensive care unit, CI: Confidence interval, Htc: Hematocrit, PNI: Prognostic nutrition index, N/L: Neutrophil-to-lymphocyte, CRP/Alb: C-reactive protein-to-albumin

Table 3. Robust regression analysis of factors affecting discharge time (Survivors)

	β1 (95% CI)	S. data	β2	t	p	VIF
Constant	9,382 (7.57-11,194)	0.922		10,180	0.000	
Age	0 (-0.013-0.014)	0.007	0.002	0.040	0.968	1,083
PNI	-0.101 (-0.125- -0.077)	0.012	-0.442	-8,226	**<0.001**	1,475
N/L ratio	0.006 (-0.025-0.037)	0.016	0.019	0.379	0.705	1,244
CRP/Alb ratio	0.126 (-0.034-0.285)	0.081	0.075	1,552	0.122	1,197
Number of comorbidities	0.181 (0.028-0.334)	0.078	0.105	2,321	**0.021**	1,046
Surgery duration	0.003 (0.001-0.006)	0.001	0.135	2,923	**0.004**	1,097

Robust regression analysis. F=11,287, $p<0.001$, R^2=%24,3, β1: Unstandardized beta coefficient, β2: Standardized beta coefficient
CI: Confidence interval, PNI: Prognostic nutrition index, N/L: Neutrophil-to-lymphocyte, CRP/Alb: C-reactive protein-to-albumin

Table 4. Logistic regression analysis of mortality risk factors

	Mortality		**Univariate**		**Multiple**	
	No	**Yes**	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
Age	63.26±10.34	68.65±9.49	1,057 (1,018-1,097)	**0.004**	1,058 (1,014-1,104)	**0.009**
Htc	46.30±133.04	36.80±6.47	0.92 (0.867-0.976)	**0.006**	0.979 (0.897-1,068)	0.631
PNI	49.66±7.38	45.37±10.18	0.935 (0.896-0.976)	**0.002**	0.955 (0.888-1,027)	0.215
N/L ratio	4.02±5.16	5.64±5.79	1,038 (0.992-1,087)	0.107	0.987 (0.91-1.07)	0.749
CRP/Alb ratio	0.48±1.07	0.68±1.15	1,141 (0.882-1,476)	0.315	0.888 (0.597-1,323)	0.561
Number of comorbidities	1.62±0.92	1.71±1.12	1,098 (0.76-1,587)	0.617	1,273 (0.817-1,984)	0.286
Surgery duration	225.32±60.71	228.18±67.36	1,001 (0.995-1,006)	0.796	1 (0.994-1,007)	0.899
ICU duration	57.34±68.47	112.68±122.86	1,005 (1,001-1,009)	**0.013**	1,003 (1-1,006)	0.077

Binary logistic regression analysis
ICU: Intensive care unit, CI: Confidence interval, Htc: Hematocrit, PNI: Prognostic nutrition index, N/L: Neutrophil-to-lymphocyte, CRP/Alb: C-reactive protein-to-albumin

Deficiencies in preoperative nutritional status increase the incidence of adverse postoperative events, such as increased risk of infection, prolonged mechanical ventilator support, and prolonged hospital stay. In patients with cardiac pathology, malnutrition is associated with fluid retention, inflammation, and neurohormonal activation, leading to poor prognosis in cardiac patients (11). In such cases, the preoperative nutritional index is a valuable marker of postoperative prognosis. Many nutritional indices are used in clinical practice; however, most of these indices use multiple parameters and are relatively difficult to calculate. Onodera's PNI score, however, is a simple index that can be derived using only absolute albumin and absolute lymphocyte counts, requires less time to calculate, and can be used routinely (12,13). One potential mechanism underlying the prognostic impact of PNI is that low PNI reflects hypoalbuminemia. Serum albumin was used to assess disease severity, progression, and prognosis. Another important factor is the important role of lymphocytes in the immunity of patients (14). PNI was initially proposed to assess the perioperative immunologic status and surgical risk in patients undergoing gastrointestinal surgery; however, it is currently used to assess prognosis in many clinical situations (14,15).

Currently, PNI is used for critical illnesses such as heart failure and malignancies (16,17). Recent studies have shown a significant association between decreased PNI levels and increased mortality rates in patients with cardiovascular conditions who undergo CABG surgery and that PNI is an important predictor of mortality in this group of patients (18).

Among other factors affecting surgical outcomes, preoperative nutritional status has the potential to influence outcomes. Despite its proven prognostic value for abdominal and gastrointestinal surgery, studies investigating the impact of PNI in cardiac surgery are still not very extensive. Impaired preoperative nutritional status is associated with increased morbidity and mortality rates after cardiac surgery, prolonged hospital stay, and decreased postoperative quality of life (1). Malnutrition in the preoperative period is a risk factor for poor outcomes after orthopedic, percutaneous coronary, and cardiovascular surgeries; therefore, measuring and screening for malnutrition in surgical patients are necessary. In fact, many patients are malnourished during the preoperative preparation period, but this condition is often not recognized. Although there are different nutritional assessment tools in clinical practice, the PNI is very easy to calculate and apply in the preoperative period. A variety of studies in the literature have reported different threshold values for PNI in different diseases (2,19,20). The mean PNI value for patients included in our research was 49.35±7.70, and it was identified that increases or reductions in PNI values were effective for prognostic factors. Research defined PNI<45 as moderate or severe nutritional deficiency, and the cutoff value may be 45. It has been reported that low PNI increases the risk of adverse events by 2-fold. Koyuncu and Koyun (21) investigated the effect of preoperative PNI levels on postoperative 1-month mortality in patients undergoing CABG surgery and reported that the mortality risk increased in patients with PNI values below 39.1. Similarly, in their study on patients undergoing hip arthroplasty, Tuncez et al. (22) found that the postoperative period and total hospital stay were longer in patients with low PNI levels (≤38.4) than in patients with high PNI levels and reported that the PNI value is a modifiable risk factor affecting the survival of patients. However, despite these recommendations, the optimal threshold value of PNI for predicting long-term outcomes remains unclear (14). The increase in postoperative morbidity and mortality after low PNI may be explained by functional changes in the immunologic system due to surgical stress, which is associated with physiologic homeostatic changes related to proinflammatory cytokines. Several recent studies have reported that lower PNI levels are significantly associated with higher mortality and morbidity in patients with cardiovascular disease, including coronary artery disease (23,24). According to the results of our research, a one-unit increase in the PNI value increased mortality risk by 1.07 times. Arai et al. (25) analyzed 146 patients undergoing elective cardiovascular surgery and found that patients with good preoperative nutritional status had better postoperative cardiac rehabilitation, and this group of patients had shorter lengths of hospitalization. In a study conducted by Lin et al. (26) on aortic dissection cases, it was found that patients with low PNI had higher in-hospital mortality, longer duration of stay on mechanical ventilators, and longer duration of stay in the ICU. For these patients, PNI≤41.6 was significantly and strongly associated with postoperative in-hospital mortality in cases of aortic dissection, even after adjustment for other risk factors (26). Similarly, studies on pediatric open-heart surgery patients have reported that hypoalbuminemia (<3 g/dL) and lymphocytopenia (<3000 mL) are important markers for poor prognosis criteria, such as prolonged mechanical ventilator support, infections, and high morbidity and mortality. In a study, Wakita et al. (13) identified a PNI cutoff value of 55 as a reliable marker and that infants with PNI<55 were included in the postoperative risk group.

PNI has become a promising prognostic biomarker for several diseases because it reflects the inflammatory status on one hand and the nutritional status on the other (3). For PNI, predicted to show poor postoperative outcomes, including few parameters, is an important advantage (4,12). Available evidence suggests that a low PNI value may be a predictive marker for overall prognosis and postoperative complications after a surgical procedure, and the investigation of nutritional and immunologic status through PNI may be a useful clinical approach (4,27). A retrospective study by Cadwell et al. (28) found that the preoperative PNI value in patients with geriatric cancer aged >75 years could independently predict six-month postoperative mortality regardless of age, frailty, American Society of Anesthesiologists Performance Scale (ASA-PS), and metastasis. The role of PNI in predicting prognosis has received considerable attention in the last decade. A study of 453 patients undergoing cardiovascular surgery showed that low PNI significantly increased the risk of postoperative complications and shorter survival. In this study, the investigators set the cutoff value for PNI as 48 and showed that PNI values above this limit were statistically associated with shorter stays in the ICU and shorter intubation times (29). In our study, a one-unit increase in the PNI value reduced the ICU stay by 0.495. Similarly, Lee et al. (30) reported that a low PNI value alone can predict early mortality and morbidity in adult patients undergoing primary cardiac surgery. The authors stated that a low PNI value was also associated with a longer duration of mechanical ventilation and longer ICU duration. According to the results of this study, PNI values were found to be significantly lower in non-survivors (30). A study by Kim et al. (31) involving 132 lung transplant recipients reported that the preoperative PNI score was a useful prognostic marker for identifying high-risk lung transplant recipients. In this study, the survival of the group with a higher PNI value was found to be higher, and they stated that useful information could be obtained to reduce postoperative morbidity and mortality with preoperative nutritional evaluation using PNI (31). The relationship between malnutrition and poor prognosis in critically ill and ICU patients has long been known. In a study conducted by Kosovali et al. (19) on patients with COVID-19, albumin and lymphocyte levels were found to be significantly lower in mortal patients, and the PNI value was ≤42 in these patients. In the period after cardiovascular interventions, patients at nutritional risk are more likely to have chronic obstructive pulmonary disease and impaired renal function than those who are not at risk of malnutrition (32,33). In our research, a one-unit reduction in PNI increased mortality by 1.07-fold. Considering the increase in the number of high-risk patients undergoing elective heart surgery, nutritional management practices are recommended, like serum albumin and nutrient supplementation, for cases with preoperative low albumin levels in postoperative enhanced recovery and postoperative rehabilitation protocols (ERAS protocols). The study by Gucu et al. (34) mentioned the importance of the PNI score for optimal care to help predict surgical outcomes and select the right strategies in the preoperative period. They recommended preoperative intervention by a cardiometabolic team consisting of a cardiologist, internist, dietician, cardiovascular surgeon, and clinicians from other provinces for patients with low PNI scores (34).

In a cohort of elderly patients admitted for acute decompensated heart failure, a significant increase in both short- and long-term mortality was reported with low PNI (11,26). A study conducted by Keskin et al. (35) on 644 patients with CABG found that patients with low PNI had a 12-fold higher long-term mortality rate than those with high PNI. They reported that PNI was an independent prognostic factor for mortality among patients undergoing CABG (35). When the literature is reviewed, low PNI values were independently associated with 30-day mortality, 1-year mortality, and overall mortality after cardiac surgery, as reported in a study by Tóth et al. (36). In their study on pediatric open-heart surgery cases, Wakita et al. (13) found that intensive care bed prices were higher than normal ward bed prices and that even a one-day reduction in intensive care time reduced overall hospital costs. In this study, the authors concluded that improving the PNI score after determining a low PNI score for patients would be beneficial both medically and in terms of cost. In our study, as the PNI value decreased, ICU duration and discharge times were prolonged. Although our study design did not include the issue of cost, evaluation of ICU durations and discharge times in a detailed cost analysis based on PNI in our study may be instructive for such studies. One of the most basic studies in the literature on PNI is Onodera's study, in which a PNI value of 40 was associated with an increased incidence of postoperative complications (5). In our study, when postoperative adverse events were characterized, prolonged ICU time, prolonged discharge time, and 30-day mortality rates were all significantly correlated with low PNI. Our study is consistent with the literature in that it reveals this correlation with low PNI.

Study Limitations

Our study has some limitations. First, the inherent limitations of this single-center retrospective observational study should not be ignored. Another related limitation is the small sample size; however, this may be explained by the fact that our hospital has recently opened a cardiovascular surgery unit, and the date range for data screening was narrow. Finally, due to the retrospective study design, we could not predict whether prognosis-related outcomes would have changed after correction of low PNI values in patients who received appropriate medical treatment.

Conclusion

In this study, it was determined that changes in PNI values examined preoperatively in cardiac surgery patients were associated with prolonged postoperative intensive care period, prolonged discharge time, and increased 30-day mortality rates. Identifying patients with poor immunity and nutrition with preoperative PNI value seems to be useful in terms of reducing morbidity and mortality on a patient basis and optimizing intensive care and general hospital services in terms of hospital services. PNI is a simple systemic prognostic marker that can be calculated with objective quantitative data, and we believe that it will be more accepted in the future for many clinical situations, such as our cardiac surgery patients.

Ethics

Ethics Committee Approval: Permission for this retrospective study was obtained from the Ordu University Clinical Research Ethics Committee (approval no.: 2023/224, date: 01.09.2023).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.K., M.U., E.C., Concept: A.K., N.T., M.U., E.C., I.C., Design: A.K., N.T., E.C., Data Collection or Processing: N.T., M.U., M.E.D., Analysis or Interpretation: A.K., E.C., I.C., Literature Search: A.K., N.T., I.C., M.E.D., Writing: A.K., N.T., M.U., E.C., I.C., M.E.D.

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