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Effect of prognostic nutritional index on hospital stay in patients undergoing metallic prosthetic mitral valve surgery

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ABSTRACT

Objectives: Preoperative malnutrition has been associated with higher rates of morbidity and death, longer hospital admissions, and a worse quality of life after surgery. This study aimed to examine the association between the Prognostic Nutritional Index (PNI) and the duration of hospitalization, in-hospital, and 1-year all-cause mortality among patients having surgery on metallic prosthetic mitral valves.

Methods: The study retrospectively included 90 consecutive patients with metallic prosthetic mitral valve surgery at Dicle University Hospital between January 2021 and December 2023. Patients were split into two groups based on the median length of stay in the hospital (14 days). Those who stayed ≥14 days were included in the longer in-hospital stay group (53 patients), and those who stayed <14 days were included in the shorter in-hospital stay group (37 patients).

Results: The study included patients aged 52.3±15.2 years, 48.9% (n=44) female. Patients with longer hospital stays had wider left atrial diameters, lower albumin levels, and lower PNI values (34.7±6.1 vs. 38±4, P=0.002). Inotropic support was more frequent in this group (18.9% vs. 2.7%, P=0.021). ROC analysis identified PNI <37.2 as predictive of prolonged stays (AUC=0.653, P=0.014). Logistic regression analysis revealed significant associations between prolonged stays and inotropic support, left atrial diameter, albumin, CRP, and PNI values. PNI also predicted in-hospital and 1-year all-cause mortality.

Conclusions: PNI was associated with hospital stay duration, in-hospital, and 1-year all-cause mortality in patients undergoing metallic prosthetic mitral valve surgery. Incorporating PNI into routine preoperative evaluation may enhance perioperative management and outcomes.

Keywords: Prognostic nutritional index, length of hospital stay, prosthetic mitral valve surgery

Patients having cardiac surgery still face a comparatively high risk of mortality and morbidity, even with new surgical procedures and recent technology improvements [1]. Preoperative anemia, advanced age, coronary artery diameter, socioeconomic status, and left ventricular dysfunction are among the variables that affect mortality and morbidity rates [2-6]. To maximize patient outcomes, preop-

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erative examination is frequently carried out before elective surgery. In addition to determining a patient's functional ability, a comprehensive assessment often consists of a history and physical examination with an emphasis on risk factors for infectious, pulmonary, and cardiac problems. However, this preoperative evaluation frequently leaves out the patient's nutritional status.

It's also crucial to evaluate the dietary state of people having surgery. Preoperative malnutrition has been associated with higher rates of morbidity and death, longer hospital admissions, and a worse quality of life after surgery [7-9]. It negatively impacts several body systems, including the immunological, gastrointestinal, cardiovascular, and endocrine systems.

As a result, nutritional evaluation is rarely routinely included in preoperative screening, and there are currently no established methods for assessing the nutritional condition of patients having cardiac surgery. A simple prognosis tool, the prognostic nutritional index (PNI), was first created by Buzby *et al*. [10] and then revised by Onodera *et al*. [11]. In recent years, it has been associated with adverse outcomes in cardiovascular diseases [12-14].

The purpose of this study was to examine the association between PNI and the duration of hospitalization, in-hospital mortality, and 1-year all-cause mortality among patients having surgery on metallic prosthetic mitral valves.

METHODS

Our analysis retrospectively included 154 consecutive patients who had isolated prosthetic mitral valve surgery at Dicle University Faculty of Medicine Hospital between January 2021 and December 2023. Ninety patients in all were included in the analysis when the exclusion criteria were met. Fig. 1 displays the flowchart for patient enrollment. Based on the population's median hospital stay (14 days), patients were split into two groups. The longer in-hospital stay group (≥14 days) consisted of 53 patients, and the shorter in-hospital stay group (<14 days) consisted of 37 patients. Demographic, clinical, and laboratory characteristics of the patients were obtained from hospital records. An estimated glomerular filtration rate (eGFR) of less than 60 mL/min/1.73 m^2 for a minimum of three months [15] was considered chronic kidney disease (CKD). The 10th Revision Codes of the International Classification of Diseases were used to classify heart failure (HF), atrial fibrillation (AF), coronary artery diseases (CAD), type 2 diabetes (DM), and hypertension (HT).

To reduce the risk of thromboembolism, anticoagulant medication was carefully controlled before surgery, shifting patients from warfarin to low-molecular-weight or unfractionated heparin. Valve function was assessed by transthoracic or trans-

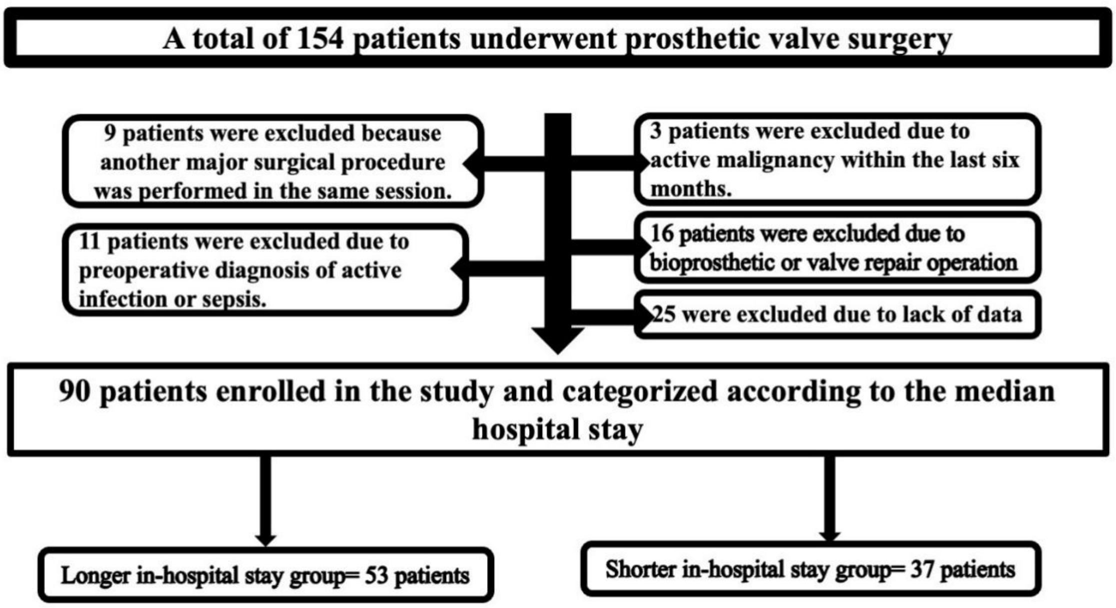

Fig. 1. Patient enrollment flowchart.

esophageal echocardiography, and perioperative stability was ensured by optimizing comorbidities.

Perioperative Anesthesia Management

After the patients were taken to the operating room, standard monitoring was performed (Electrocardiogram (ECG), pulse oximetry (SpO_2), and noninvasive blood pressure). Additionally, all patients received noninvasive brain function monitoring, regional oximetry, and hemodynamic monitoring (Masimo® Sedline®, Masimo Corporation, Irvine, California, USA).

Preoperative sedoanalgesia was provided with midazolam 1-2 mg IV (Zolamid®, Vem İlaç Sanayi ve Tic. A.Ş. Ankara, Turkey) or midazolam (1-2 mg IV) and fentanyl 1-2 µg/kg IV (Talinat®, Vem İlaç Sanayi ve Tic. A.Ş. Ankara, Turkey) according to the clinical status and vital signs. Radial artery cannulation was done for invasive arterial blood pressure measurement following sedoanalgesia. When radial artery cannulation fails, cannulation is performed from the femoral artery. For anesthesia induction, propofol 1-3 mg/kg IV (Propofol® 2% Fresenius®, Fresenius Kabi, Bad Hamburg, Germany) was used as general anesthetic, fentanyl (1-2 µg/kg IV) was used as analgesic, and rocuronium 0.6-0.9 mg/kg IV (Curon®, Mustafa Nevzat İlaç Sanayi A.Ş., Istanbul, Turkey) was used as neuromuscular blocker. In critically ill patients with low ejection fraction (EF), induction was performed with midazolam (0.1 mg/kg IV) and fentanyl (5 µg/kg IV) instead of propofol. The patients were intubated and connected to mechanical ventilators. The right jugular vein was used for central venous catheterization. To maintain anesthesia, 2% sevoflurane (1 MAC, 50% O_2, and 50% air mixture) was used. All interventions during cardiopulmonary bypass were performed by the joint decision of the surgeon, anesthesiologist, and perfusion specialist. All surgery procedures applied in the entire region were managed according to the clinical protocol, and training was provided in a standard manner. Valve surgeries were performed by two different surgeons with similar skills and experience. The anesthesiologists working on the table where the cases were taken were two anesthesiologists with similar skills and experience.

Prioritizing hemodynamic management during surgery involves reducing myocardial depression. Transesophageal echocardiography, central venous access, and invasive arterial pressure were also monitored. Intravenous heparin was used to establish anticoagulation during cardiopulmonary bypass, with an ACT over 480 seconds. This was carefully reversed after the bypass to balance the hazards of thrombosis and hemorrhage. To preserve valve performance and avoid problems, anticoagulation was quickly begun after surgery while being closely monitored. Early mobilization and recovery were supported by customized pain management.

Assessing Nutritional Status

Using the PNI and the following formula, the patient's pre-surgery nutritional status was ascertained:

10 × serum albumin (g/Dl) + 0.005 × total lymphocyte count (/mm^3)

While scores of 35–38 and <35 suggest moderate and severe malnutrition, a score of >38 is regarded as normal. For PNI, there is no "mild" category.

Statistical Analysis

The Statistical Package for Social Science for Windows (SPSS) 27 package tool was used to analyze the data. The Shapiro-Wilks test and histogram were used to confirm the data's normal distribution. Depending on the distribution, continuous parameters have been shown as median, interquartile range (IQR), or mean±SD. The chi-square test was used to compare groups of categorical variables, and categorical results were presented as percentages. The Mann-Whitney U test or Student t-test was used when comparing continuous variables. To determine the factors that contribute to longer hospital stays, univariable logistic regression analyses were conducted. The findings of the univariable logistic regression study were also displayed using a Forest-Plot graph. Receiver operating characteristic (ROC) curve analysis was used to assess the connection between PNI and length of hospital stay. The statistical significance level of the gathered data was ascertained using the P-value. At $P<0.05$, statistics were considered significant.

RESULTS

The mean age of our patients was 52.3±15.2 years, and the female-male ratios were similar. The female-patient ratio was 48.9% (n=44). In the longer in-hospital

Table 1. Baseline characteristics of the total population

Parameters	Longer in-hospital stay (n=53)	Shorter in-hospital stay (n=37)	Total population (n=90)	P value
Age (years)	54.1±15	49.6±15.2	52.3±15.2	0.165
Female gender, n (%)	28 (52.8)	16 (43.2)	44 (48.9)	0.371
LVEF (%)	56.8±7.4	58.9±5.4	57.6±6.7	0.147
Mean pulmonary arterial pressure (mmHg)	46±15.8	50±15.2	47.5±15.6	0.301
GFR (ml/dk/1.73 mm^2)	82.6±35.2	90.6±27.4	85.8±32.3	0.255
Left atrial diameter (cm)	5.1±1.1	4.5±1	4.8±1.1	**0.027**
Hypertension, n (%)	26 (49.1)	15 (40.5)	41 (45.6)	0.425
Diabetes mellitus, n (%)	8 (15.1)	5 (13.5)	13 (14.4)	0.834
Coronary artery disease, n (%)	11 (20.8)	5 (13.5)	16 (17.8)	0.377
Cerebrovascular disease, n (%)	4 (7.5)	0 (0)	4 (4.4)	0.087
Re-do operation, n (%)	0 (0)	1 (2.7)	1 (1.1)	0.229
Heart failure, n (%)	10 (18.9)	7 (18.9)	17 (18.9)	0.995
Pulmonary artery disease, n (%)	9 (17.3)	4 (10.8)	13 (14.6)	0.392
Smoker, n (%)	10 (18.9)	5 (13.5)	15 (16.7)	0.502
Inotropic support, n (%)	10 (18.9)	1 (2.7)	11 (12.2)	**0.021**
Atrial fibrillation, n (%)	9 (17)	5 (13.5)	14 (15.6)	0.655
In-hospital mortality, n (%)	6 (11.3)	5 (13.5)	11 (12.2)	0.755
One-year mortality, n (%)	12 (22.6)	7 (18.9)	19 (21.1)	0.670
Laboratory parameters				
Hemoglobin (g/dL)	13.4±1.1	13.3±1.2	13.3±1.2	0.839
Albumin (mg/dL)	3.5±0.6	3.8±0.4	3.6±0.6	**0.002**
Neutrophile (×10^3/µL)	5.4±1.7	5.4±2.1	5.4±1.9	0.978
Lymphocyte (×10^3/µL)	2.4±0.9	2.2±0.7	2.2±0.8	0.786
White blood cell (×10^3/µL)	8.7±2	8.5±2.4	8.6±2.2	0.634
Platelet (×10^3/µL)	232±76	245±78	237±76	0.464
CRP (mg/dL)	0.6 (2.1)	1 (1.1)	0.54 (1.2)	**0.041**
Total cholesterol (mg/dL)	171±49	179±41	174±45	0.426
PNI	34.7±6.1	38±4	36±5.5	**0.002**
Medications, n (%)				
Acetyl salicylic acid	22 (41.5)	11 (29.7)	33 (36.7)	0.254
Beta-blocker	30 (56.6)	19 (51.4)	49 (54.4)	0.623
Statin, n (%)	6 (11.3)	1 (2.7)	7 (7.8)	0.133
ACE-I or ARB	20 (37.7)	10 (27)	30 (33.3)	0.484
Calcium channel blocker	7 (13.2)	7 (18.9)	14 (15.6)	0.462
Vitamin K antagonist	11 (20.8)	6 (16.2)	17 (18.9)	0.588
Non-vitamin K oral anticoagulant	3 (5.7)	1 (2.7)	4 (4.4)	0.503

Data are shown as mean±standard deviation or n (%).

ACE-I=Angiotensin converting enzyme inhibitor, ARB=Aldosterone receptor blocker, GFR=Glomerular filtration rate, LVEF=Left ventricular ejection fraction, PNI=Prognostic nutritional index,

Table 2. Pearson correlation analysis of length of in-hospital stay and other parameters

Parameters	Correlation coefficient	P value
PNI	-0.388	**0.002**
Age	0.176	0.172
Left ventricular ejection fraction	-0.215	0.093
Mean pulmonary artery pressure	-0.005	0.967
Left atrial diameter	0.070	0.588
Lymphocyte	0.002	0.991
Monocyte	0.152	0.239
Glomerular filtration rate	0.056	0.666
Albumin	-0.388	**0.002**

PNI=Prognostic nutritional index

stay group, left atrial diameter (5.1±1.1 cm vs. 4.5±1 cm, P=0.027) was wider, albumin values were lower (3.5±0.6 mg/dL vs. 3.8±0.4 mg/dL, P=0.002), and PNI values were lower (34.7±6.1 vs. 38±4, P=.002) as expected. Inotropic support was more common in the longer in-hospital stay group (10 [18.9] vs. 1 [2.7], P=0.021). Although left ventricular ejection fraction (LVEF), mean pulmonary arterial blood pressure, and GFR values were lower in the longer in-hospital stay group, this was not statistically significant. There was no noticeable distinction in the medication utilized by the groups. Table 1 shows the comparison of baseline characteristics, laboratory parameters, and medication use of the total population between groups.

Pearson correlation analyses were performed between the parameters discussed in the literature for their effects on the length of hospital stay. In these comparisons, the strongest relationship between the length of hospital stay and PNI was observed (r=-0.388, P=0.002). Correlation analyses are shown in Table 2.

ROC curve analysis was performed to show the

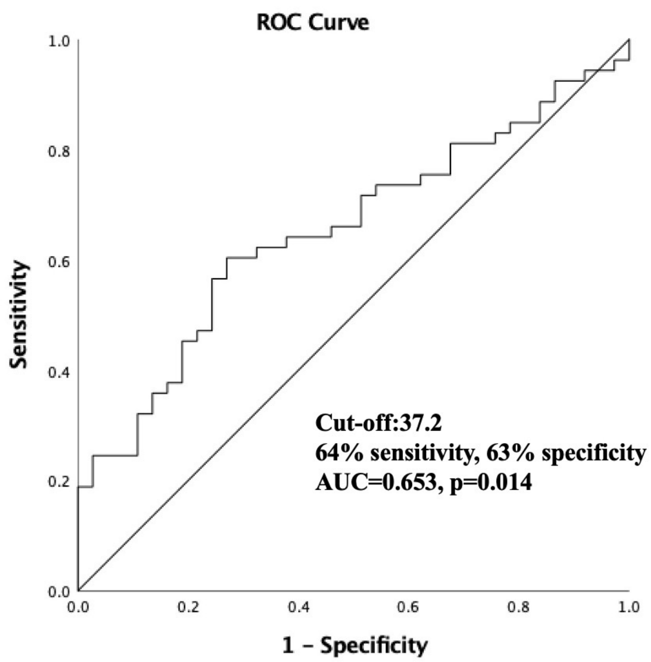

Fig. 2. ROC curve analysis.

Table 3. Logistic regression analysis for predictors of longer in-hospital stay

Parameters	OR (95% CI)	P value
Age	1.020 (0.992-1.050)	0.165
Inotropic support	8.372 (1.022-68.558)	**0.048**
LVEF	0.949 (0.882-1.020)	0.154
Left atrial diameter	1.713 (1.043-2.814)	**0.033**
Albumin	0.288 (0.116-0.715)	**0.007**
Lymphocyte	0.632 (0.351-1.140)	0.128
PNI	0.883 (0.806-0.967)	**0.007**
CRP	1.227 (1.044-1.442)	**0.013**
Regression analyses of the associations of PNI with mortality		
In-hospital mortality	0.875 (0.781-0.981)	**0.022**
1-year all-cause mortality	0.870 (0.789-0.959)	**0.005**

CI=Confidence interval, CRP=C-reactive protein, LVEF=Left ventricular ejection fraction, OR= Odds ratio, PNI=Prognostic nutritional index

relationship between PNI and longer in-hospital stay groups. In ROC analysis, the cut-off value of PNI 37.2 was statistically significant for longer in-hospital stays with 64% sensitivity and 63% specificity (Area under curve: 0.653, P=0.014). (fig. 2).

In univariable logistic regression analysis, statistically significant associations were found between inotropic support (OR=8.372, 95% CI:1.022-68.558, P=0.048), left atrial diameter (OR=1.713, 95% CI:1.043-2.814, P=0.033), albumin (OR=0.288, 95% CI:0.116-0.715, P=0.007), CRP (OR=1.227, 95% CI:1.044-1.442, P=0.013), and PNI (OR=0.883, 95% CI:0.806-0.967, P=0.007) and longer in-hospital stay. In addition, the relationship between PNI and in-hospital (logistic regression) and 1-year all-cause mortality (Cox regression) was investigated by regression analyses. PNI was found to be a predictor of both in-hospital (OR=0.875, 95% CI:0.781- 0.981, P=0.022) and 1-year all-cause mortality (OR=0.870, 95% CI:0.789- 0.959, P=0.005). Logistic regression analyses are shown in Table 3.

DISCUSSION

In this study, we investigated the effect of PNI on longer in-hospital stay in patients who underwent metallic prosthetic heart valve surgery. As a result of the study, we found that PNI had a statistically significant effect on longer in-hospital stay in both logistic regression analysis and correlation analysis. We also found that PNI was associated with postoperative in-hospital and 1-year all-cause mortality.

The results of our study are compatible with the studies in the literature. According to a study by Tasbulak *et al*. [16], patients undergoing isolated coronary artery bypass graft (CABG) procedures had greater mortality rates and long-term adverse cardiac and cerebrovascular events when compared to the control group when nutritional indicators such as PNI, controlling nutritional status score (CONUT), and geriatric nutritional risk index (GNRI) were present [22]. Recent investigations on cardiovascular illness have also demonstrated a clear correlation between lower PNI levels and greater rates of morbidity and death [17-19]. According to Lee *et al*. [20], decreased PNI was linked to prolonged hospital and intensive care unit stays and may serve as an independent predictor of early morbidity and death. The results of Hayashi *et al*. [21] showed a high correlation between a poor prognostic nutrition index and surgical complications and survival. Almohammadi *et al*.'s study [22], which was comparable to ours, showed that lower PNI levels were linked to greater rates of mortality and morbidity as well as longer hospital stays. These studies show how PNI and other nutritional indicators may be useful in determining risk and forecasting results for patients undergoing heart surgery.

Our study also shows that serum albumin and CRP levels, left atrial diameter, and intraoperative inotropic support are associated with longer in-hospital stay. Inflammatory indicators, including the level of serum albumin and CRP concentrations, can have a major impact on a patient's likelihood of staying in the hospital for an extended period after having a prosthetic valve operation. Studies show that patients with infective endocarditis had higher long-term death rates when their CRP and albumin levels were raised, indicating that these biomarkers may be predictive of unfavorable outcomes [23, 24]. CRP and albumin levels are considered to be part of the nutritional status and immune response system [25, 26]. It seems to be in line with the literature that they are predictors of poor outcomes in patients undergoing valve surgery, as in many cardiovascular diseases.

We believe that the most important result of our study that distinguishes it from the literature is the lack of a relationship between LVEF and the duration of hospital stay. One study, like previous studies, has shown that low LVEF is a predictor of prolonged hospital stay [27]. In our study, although LVEF was not associated, left atrial diameter, another indicator of ventricular geometry, was associated with prolonged hospital stay. In a study by Augustin P *et al*., it was shown that the length of hospital stay was not related to mortality. The results of our study were also consistent with this study [28].

The European Society of Parenteral and Enteral Nutrition advises that nutritional optimization for 7-14 days before elective heart valve surgery should be performed on patients with severe malnutrition [29]. Before surgery, nutritional supplements taken orally are believed to improve the outcomes of patients and lessen problems associated with malnutrition by maximizing daily vitamin intake and avoiding excessive fluid and salt [30, 31]. According to these results, nutritional assessment should be performed at the time of admission for every patient, irrespective of age, having heart valve surgery. Perioperative evaluations and multidisciplinary treatment plans should include nutritional screening and nutritional therapy optimization.

Limitations

As in other studies, our study has many limitations. Three primary limitations of our study are its retrospective design, small patient population, and single-center design. In addition, many parameters that are likely to affect hospitalization were not available in our data. Hospital-acquired infections, operator experience, illnesses that coexist (like chronic obstructive pulmonary disease), and some laboratory parameters could not be included in the statistical analysis. Due to the retrospective design, bias could not be completely eliminated. Inotropic support was available in only 1 patient in the shorter in-hospital stay group, and this low number also raises doubts about the reliability of the results. Finally, our data regarding patients who underwent intraoperative blood transfusion were not included in the analysis because of the doubts.

CONCLUSION

According to the results of our study, PNI was associated with the length of hospital stay, in-hospital, and 1-year all-cause mortality in patients undergoing metallic prosthetic mitral valve surgery. Adding PNI, which is not routinely used in preoperative evaluation, to routine evaluation may provide useful information to clinicians in improving perioperative patient management and outcomes.

Ethical Statement

This study was approved by the University of Health Sciences Gazi Yaşargil Training and Research Hospital Clinical Research Ethics Committee (Decision no.: 322, date: 17.01.2025).

Authors' Contribution

Study Conception: HTS, MEE; Study Design: HTS, SS; Supervision: HTS, MÖ; Funding: N/A; Materials: HTS, MÖ; Data Collection and/or Processing: HTS, MÖ; Statistical Analysis and/or Data Interpretation: HTS, SS; Literature Review: HTS, SS; Manuscript Preparation: HTS, SS and Critical Review: HTS, MEE.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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Editor's note

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