Obvious but Always Ignored: Nutritional Status Affects Cardiac Surgery Mortality

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Abstract

Background: The nutritional status of the patient is an important parameter in patients undergoing surgery. This study aims to determine of prognostic nutritional index value that predicts hospital mortality and morbidity in on-pump cardiac surgery. **Methods:** In this study, we scanned the medical data of 1003 patients who underwent on-pump cardiac surgery. Patients' divided into two groups according to in-hospital mortality. 934 patients without in-hospital mortality were defined as Group I, and 69 patients who died in the hospital were defined as Group II. Their preoperative nutritional status was determined using the prognostic nutritional index classification. **Results:** In our series, age is statistically higher in Group II rather than Group I (62.5 ± 0.3 vs. 67.4 ± 1.2 ; $p=0.001$). There was a significantly different a higher tendency of hospital-acquired infection in Group II (151; 16.2% vs. 44; 63.8%; $p=0.001$). Postoperative stroke significantly higher in Group II (35; 3.7% vs. 62; 89.9%; $p=0.001$). Multivariate analysis revealed that cross clamp time, cardiopulmonary bypass time, intraaortic balloon pump usage and intensive care unit stay significantly higher in Group II ($p<0.05$, respectively). The prognostic nutritional index value was found statistically low in Group II (48.34 ± 6.71 vs. 44.76 ± 7.63 ; $p=0.001$). Multivariate analysis revealed that male gender, age, and the prognostic nutritional index were independently associated with postoperative survival. **Conclusion:** In on-pump cardiac surgery, postoperative mortality and morbidity are significantly associated with preoperative low prognostic nutritional index, and the prognostic nutritional index can be a useful and suitable parameter for preoperative risk evaluation.

INTRODUCTION

Despite recent advance in technology and surgical techniques, the perioperative and in-hospital mortality and morbidity rates of patients undergoing cardiac surgery remain high¹⁻³. There are many factors that can cause this increase in risk. Left ventricular dysfunction, preoperative anemia, chronic renal failure, coronary artery diameter and advanced age are the most common causes⁴⁻⁸. Currently, various risk estimation algorithms are used to evaluate the surgical risk of patients planned for cardiac surgery. The most commonly used of these are the Society of Thoracic Surgeons (STS) score and the Euroscore^{9,10}. While both scores take into account many variables belonging to the patient, they ignore the clinical nutritional status of the patient. On the other hand, the patient's clinical nutritional status is an indirect indicator of the patient's resistance and reservoir. This relationship has been demonstrated especially in patients undergoing gastrointestinal system and malignancy surgery^{11,12}. Several different methods, including Mini Nutritional Assessment, Malnutrition Universal Screening Tool, Subjective Global Assessment, and Short Nutritional Assessment Questionnaire have been developed for the nutritional status of patients who undergo malignancy surgery. The prognostic nutritional index (PNI) is one of them, and it's the most widely used method. The PNI, which was first designed by Buzby et al.¹¹ in 1980 and simplified by Onodera et al.¹³, was calculated based on the serum albumin concentration and lymphocyte count of peripheral blood. On the other hand, there are very limited studies in the literature regarding this evaluation in patients undergoing cardiac surgery¹⁴. Thus the aim of this study was to assess the value of PNI as a predictor of in hospital mortality and morbidity in patients

undergoing cardiac surgery.

MATERIALS AND METHODS

This retrospective study included a total of 1003 patients who underwent on-pump cardiac surgery in our institute between January 2016 and January 2020. The patients' demographic characteristics, medical records, laboratory study findings, and clinical outcomes were retrospectively collected by searching the institutional clinical database. Surgical procedures included coronary artery bypass grafting (CABG), aortic valve replacement (AVR), mitral valve replacement (MVR), and combined procedures (Table1). Peripheral blood samples taken on the first day of hospitalization for all patients were noted. The whole blood cell count analysis were performed using Beckmann Coulter LH780 Hematology Analyzer device and Biochemical measurements were performed using Roche diagnostic Cobas 8000 (Manheim).

Other data, body mass index (BMI), preoperative left ventricular ejection fraction (LVEF), cross clamp (X-clamp) time, cardiopulmonary bypass (CPB) time, intraaortic balloon pump (IABP) usage, intensive care unit (ICU) stays, postoperative hospital-acquired infection and stroke were noted. We defined six types of infections after cardiac surgery as hospital-acquired infections Based on O'Keefe et al.¹⁵. These included urinary tract infection, pneumonia, harvest site infections, superficial sternal wound infection, deep sternal wound infection, and sepsis. We also noted that stroke events after surgery. The most commonly used definitions were stroke observed 'on waking' or 'after extubation' for early stroke after a symptom-free interval for delayed stroke. We used both to describe postoperative stroke.

The preoperative nutritional status of the patients was assessed using the PNI classification. PNI was calculated according to the formula: $10 \times \text{serum Albumin} + 0.005 \times \text{total lymphocyte count}$ (as previously described)¹³.

The study protocol was approved by the Bursa Yuksek Ihtisas Training and Research Hospital Ethics Committee (2011-KAEK-25 2020/03-11). The informed consent requirement was renounced due to the retrospective nature of the study.

Statistical Analysis

Continuous study data were presented as the mean $\pm$ Standard deviation. Categorical variables were presented as the number and percentage. To compare the severity of each symptom between the groups with respect to continuous variables was tested with Student's t-test or Mann-Whitney U test, with the former being used for normally distributed variables and the latter for non-normally distributed ones. The difference with regard to categorical variables was tested using the chi-squared test. To determine potential risk factors for preoperative mortality, multivariable logistic regression analysis was performed. All statistical analyses were performed using SPSS package for Windows version 21 (SPSS Inc., Chicago, IL, USA). For all statistical analyses, p-value of <0.05 was considered statistically significant.

RESULT

The overall study consisted of 1003 patients; a mean age of 62.9 ± 10.8 years, of whom 755 (75.3%) were male and 248 (24.7%) were female. Hypertension was the most identified risk factor in 452 patients (45.1%), and 279 of all patients (27.8%) had diabetes mellitus. In-hospital mortality occurred in 69 patients (6.87%).

Patients were divided into two groups according to in-hospital mortality. 934 patients without in-hospital mortality were defined as Group I, and 69 patients who died in the hospital were defined as Group II. Compared to Group I, Group II patients were significantly older (62.5 ± 10.8 vs. 67.45 ± 10.1 , $p=0.001$). Comparisons of the groups with respect to the laboratory data revealed that Group II had significantly lower hemoglobin levels, albumin levels, ($p=0.001$). Preoperative serum creatinine levels were significant differences between Group I and Group II (1.0 ± 0.02 vs. 1.3 ± 0.1 ; $p=0.01$, respectively). Compared to Group I, PNI level was significantly lower in the Group II (48.34 ± 6.71 vs. 44.76 ± 7.63 , respectively, $p=0.001$). The mean BMI was similar between the groups (26.70 ± 2.87 vs. 26.54 ± 2.60 $p=0.66$). Preoperative LVEF was statistically lower in the Group II rather than the Group I (51.6 ± 0.3 vs. 44.5 ± 1.2 ; $P=0.001$). Since the

infection was broadly categorized in our study, we compared hospital-acquired infection between groups. There was a significantly different a higher tendency of hospital-acquired infection in the Group II (151; 16.2% vs. 44; 63.8%; $p=0.001$). Postoperative stroke significantly higher in the Group II (35; 3.7% vs. 62; 89.9%; $p=0.001$). Multivariate analysis revealed that X-clamp time ($p<0.005$), CPB time ($p=0.001$), IABP usage ($p=0.001$), and ICU stay ($p=0.001$) significantly higher in the Group II.

The demographic, clinical, echocardiographic, biochemical data of the two groups were shown in Tables 2 and 3.

In the receiver-operating characteristic analysis, PNI lower than 42.6 predicted in-hospital mortality with 82% sensitivity and 42.6 % specificity [area under the curve 0.64, 95% confidence interval 0.572 - 0.714; $p=0.001$] (Figure1). Multivariate analysis revealed that male sex (95% confidence interval 1.29 - 11.91, $p=0.016$), age (95% confidence interval 1.11 - 10.15, $p=0.032$), and the PNI (95% confidence interval 0.18 - 0.90, $p=0.026$) were independently associated with postoperative survival.

CONCLUSION

The European Society for Clinical Nutrition and Metabolism defined malnutrition as a condition resulting from a lack of nutrition or intake that leads to changes in body composition (reduction of lean mass) and body cell mass, resulting in reduced physical and mental function and impaired clinical outcomes from the disease. Additionally, cardiac cachexia triggers impaired neuroendocrine and immunological function, and it is considered an indicator of poor prognosis regardless of age and disease severity^{16,17}.

Malnutrition is generally associated with humoral and cellular immune dysfunction, inflammatory response change, and the wound healing process delay or failure. It is well known that malnutrition is closely related to the incidence of postoperative complications, length of hospital stay, quality of life, and increased mortality of malignant tumors¹⁸. Besides, the negative impact of long-term calorie and protein deficiencies on critically ill surgical patients' outcomes has recently been demonstrated¹⁹. The decreased response of albumin and lymphocytes to acute disease indicates low immunonutritional status. The PNI was calculated based on the serum albumin concentration and lymphocyte count of peripheral blood. Therefore, the PNI score should be considered a clinical element and indicator of disease severity in patients undergoing cardiac surgery. Some studies recently reported that a lower PNI level was significantly associated with higher mortality in patients with cardiovascular diseases²⁰⁻²³. One of the most beneficial aspects of PNI is not time-consuming, and no special equipment is required. Therefore, it can be easily integrated into routine clinical practice. Although the prognostic significance of the PNI has been reported previously in several types of abdominal or gastrointestinal surgery, its relevance in cardiovascular surgery has not been proven. The surgery's success depends not only on technical surgical skills but also on the preoperative nutritional status.

Keskin et al.²⁴ showed a significant relationship between PNI level and mortality (in-hospital and long-term) in coronary artery disease patients undergoing CABG. In addition, Hyashi et al.²⁵ retrospective study showed that a high PNI value was found to decrease mechanical ventilation duration, ICU stays, and infection rates. In the multivariate analysis, in addition to age and female gender, a low PNI value was determined as an independent predictor for mortality. Recent published Lee et al.²⁶ study is the first to assess the usefulness of the PNI in adult cardiac surgery using only CPB and showed that a lower PNI was an independent predictor of early morbidity and mortality, and was also related to prolonged mechanical ventilation support and ICU stays.

In cardiac surgery, an increasing number of older people are accepted for elective surgery. When low pre-operative PNI is detected in elderly patients, postoperative nutritional management such as serum albumin supplementation, dietary maintenance, or nutritional supplementation should be considered to improve patients' nutritional status²⁷.

Our research demonstrated that the PNI value was statistically low in the mortality group. There was significantly different a higher tendency for postoperative hospital-acquired infection and stroke in the mortality group. PNI may be used to predict patients' outcomes before cardiac surgery and select an adequate surgical

strategy. In that case, it must be useful for choosing the biological or mechanical materials for valvular surgery and determining graft materials in coronary surgery. In the case of patients with a low PNI, less invasive surgery may be suitable if possible.

Our study does not include the effects of preoperative nutritional support on postoperative mortality and morbidity in patients with low PNI values. Further studies are needed to show the results of preoperative nutritional support in elective cases.

Preoperative low PNI level was evaluated as an independent predictor of long-term cardiovascular outcomes. Also, it was statistically significantly associated with postoperative mortality and morbidity in cardiac surgery. According to the results we obtained in our study, we firmly believe that PNI is a useful and suitable parameter for preoperative assessment of nutritional status and should be regarded in managing the indication and strategy in on-pump cardiac surgery.

Authors' contributions The authors' responsibilities were as follows: AG, OAO and SAS conceived the study and designed the search strategy; AG and OAO conducted the study selection; SAS and NK conducted data extraction; AG, NK and DD evaluated the risk of bias of included studies; AG, OAO and SAS conducted the data analysis and interpretation of results; AG, OAO and IBS wrote the first draft of the manuscript; AG and OAO revised the manuscript; all authors read and approved the final version of the manuscript.

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Table 1. The type of the surgical procedures according to groups

Type of the surgical procedure						
CABG (n, %)	CABG+AVR (n, %)	CABG+MVR (n, %)	CABG+AVR+MVR (n, %)	AVR (n, %)	MVR (n, %)	AVR+MVR

CABG: Coronary artery bypass grafting, AVR: Aortic valve replacement, MVR: Mitral valve replacement

Table 2. Comparison of basic blood values of patients in groups

Basic Blood Values							
Hemoglobin (gr/dL)	WBC ($\times 10^3$)	Neu ($\times 10^3$)	Lym ($\times 10^3$)	Platelets ($\times 10^3$)	CRP (mg/dL)	Cre (mg/dL)	Total Protein (g/dL)

WBC: White blood cell, Cre: Creatinine, Neu: Neutrophil, Lym: Lymphocyte, Crp: C-reactive protein

*the mean difference is significant at the 0.05 level

Table 3. Comparison of Characteristics and Basic Findings of patients in groups

Characteristics and Basic Findings							
Male (n,%)	Age (year)	Preoperative LVEF (%)	BMI (m^2/kg)	X-clamp time (min)	CPB time (min)	IABP usage (n,%)	ICU

LVEF: Left ventricular ejection fraction, X- clamp: Cross clamp, CPB: Cardiopulmonary bypass, IABP: Intraaortic balloon pump, ICU: Intensive care unit

*the mean difference is significant at the 0.05 level

Figure1. Data figure of the area under the curve (AUC), confidence interval (CI), and cut-off values in receiver-operating characteristic (ROC) curve analysis for prognostic nutritional index.

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FIGURE 1.pdf available at <https://authorea.com/users/392914/articles/506660-obvious-but-always-ignored-nutritional-status-affects-cardiac-surgery-mortality>