

Investigation of The Effects of Pre- and Postoperative Nutritional Status on Complication Development, Intensive Care Unit and Hospital Stay in Elective Cardiac Surgery Patients: A Cross-Sectional Study

Aylin DURMAZ EDEER¹
Eda Ayten KANKAYA²
Özlem BİLİK³



¹Department of Surgical Nursing, Dokuz Eylül University Nursing Faculty, İzmir, Türkiye

² Department of Surgical Nursing, Dokuz Eylül University Nursing Faculty, İzmir, Türkiye

³ Department of Surgical Nursing, Dokuz Eylül University Nursing Faculty, İzmir, Türkiye



ABSTRACT

Objective: The study aimed to examine the effects of nutritional status on complications, the intensive care unit, and hospital stay.

Methods: This descriptive, prospective, and correlational study was conducted with 180 patients who underwent elective open-heart surgery. Data were collected using the Malnutrition Universal Screening Tool and Sociodemographic Clinical Characteristics Form.

Results: The risk of malnutrition was found to be medium to high in 27.2% of preoperative patients and moderate to high in 50.0% of postoperative patients. There was a statistically significant difference between the pre- and postoperative body weight, albumin, and total protein values of the patients. We found a moderate correlation between preoperative MUST values and the status of complications. It was determined that the patients' preoperative malnutrition scores ($\beta=.186$; $P=.024$, the presence of infection ($\beta=.200$; $P=.005$), the time of mechanical ventilation ($\beta=.265$; $P<.001$), and complication status ($\beta=.262$; $P=.012$) significantly predicted the time of stay in the hospital. It was determined that these variables explained 24% of the total variance.

Conclusion: Evaluation of the malnutrition status before the surgery, the initiation of early postoperative nutrition and evaluation of nutritional needs are important in the postoperative recovery.

Keywords: Coronary artery bypass, inpatient, malnutrition, risk

INTRODUCTION

Patients undergoing open-heart surgery (OHS) experience a systemic inflammatory response. Inflammation depletes the reserves of the organs and a negative nitrogen balance occurs. Negative nitrogen balance leads to nutritional deficiencies and contributes to the reduction in defense mechanisms and metabolic reserves in patients. Malnourished patients are more susceptible to surgical trauma, ischemia and reperfusion injury, anesthesia-related complications, hemodilution, and inflammation.^{1,2}

Malnutrition is a common condition among patients undergoing cardiac surgery. Studies report that approximately 3.9–78.2% of patients scheduled for cardiac surgery are at risk of malnutrition.³⁻¹² Preoperative malnutrition has been shown to be strongly associated with postoperative complications, prolonged hospital stay, and increased 30-day and one-year mortality following cardiac surgery.^{3,9,11,13-16} However, some studies have reported no such relationship.^{6,7,10} In the meta-analysis by Luo et al., preoperative malnutrition was associated with both early and late mortality; however, its relationship with postoperative wound complications and overall infections could not be established due to publication bias and limited sample size.¹⁷ To our knowledge, no studies have evaluated both preoperative and postoperative malnutrition status in Turkish patients undergoing cardiac surgery, nor its effects on postoperative complications, intensive care unit length of stay, and overall hospitalization. In this study, we investigated the effects of preoperative and postoperative

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Corresponding author:

Eda Ayten KANKAYA

E-mail: edayten@gmail.com

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nutritional status on the development of postoperative complications, as well as on ICU and hospital length of stay.

AIM

The aim of this study was to examine the preoperative and postoperative nutritional status of patients undergoing open-heart surgery and to evaluate the effects of nutritional status on postoperative complications, signs of infection, intensive care unit length of stay, and hospital length of stay.

Research questions

- What are the preoperative and postoperative nutritional status levels of patients undergoing open-heart surgery?
- Does nutritional status affect postoperative complications and signs of infection?
- Does nutritional status affect intensive care unit and hospital length of stay?
- Which variables predict hospital length of stay in patients undergoing open-heart surgery?

METHODS

Study Design

The study was descriptive, prospective, and correlational.

Study Settings

Research data were collected from March 2019 to March 2021. The research was conducted on patients hospitalized in the cardiovascular surgery clinic of a university hospital in Turkey.

Study Sample

The study population consisted of patients scheduled for their first elective open-heart surgery. Patients awaiting open-heart surgery would undergo coronary artery bypass grafting (CABG) or valve replacement surgery. Patients over the age of 18, who planned for OHS (coronary, heart valve, etc.) with on-pump, who could communicate verbally and could read and write, were included in the sample. Patients who underwent emergency surgery in the hospital underwent revision surgery, had active preoperative infection (wound infection, pneumonia, etc.), had a previously diagnosed nutritional disorder (anorexia nervosa, bulimia, etc.), had minimally invasive surgery and off-pump OHS and did not accept the study were excluded from the study. The sample size for the study was determined using the G*Power 3.1.9.4 program. Based on Cohen's correlation coefficients, a power analysis assuming a medium effect size ($r = .30$) and a power level of 0.95 indicated that a minimum of 138 participants was required.¹⁸ Two hundred fifty patients who underwent elective cardiac surgery in the hospital constituted the

research population. Seventy patients were excluded due to a history of previous cardiac surgery, and declined participation in the study. The study was conducted with 180 patients who had sample characteristics and agreed to participate in the study.

Variables of the Study The dependent variables of the study were postoperative complications, presence of infection, length of stay in the intensive care unit, and total hospital stay. The independent variables included preoperative and postoperative MUST scores and selected clinical characteristics (e.g., duration of mechanical ventilation).

Data Collection

Data were collected using the Sociodemographic Clinical Characteristics Form and the Malnutrition Universal Screening Tool (MUST). Preoperative data were obtained within 24 hours before surgery. Postoperative clinical data (complications, infection, ICU stay, and hospital stay) were recorded from the day of surgery until discharge. Nutritional status was reassessed on the fifth postoperative day, as patients are typically discharged within 5–6 days and longer stays are usually associated with complications.

Sociodemographic Clinical Characteristics Form: It was used to determine the sociodemographic and clinical characteristics of the patients.³⁻⁵ Age, gender, type of surgery, existing high-risk diseases (congestive heart failure, hypertension, diabetes), and nutritional support in the ICU. There were 16 questions about the condition of taking the medicine, the time of fasting after the operation, and the development of complications after the surgery.

The descriptions of complications: Dysrhythmias were irregularities in the heartbeat (too fast or too slow), which appeared after surgery. Acute pulmonary failure was defined as a partial oxygen pressure of less than 60mmHg and peripheral oxygen saturation of less than 90%. Low cardiac output syndrome was a systolic arterial pressure of less than 90 mmHg and clinical signs of hypoperfusion (cold periphery, clammy skin, confusion, oliguria, increased lactate levels), and infection was determined to be fever above 38.5°C, white blood cells above 106, and blood and urine culture positive. Patients for whom the clinician and consultant physicians reported developing infections and complications were accepted as having developed infections and complications.

Malnutrition Universal Screening Tool (MUST): This tool was developed in 2003 by the Malnutrition Working Group and the British Society for the Enteral Parenteral Nutrition Working Group.¹⁹ It is designed to evaluate the nutritional risk of malnourished or obese people who carry a nutritional risk. The MUST incorporates three variables:

BMI, unintended weight loss over 3 to 6 months, and the expected duration of absence of nutritional intake for 5 days. If the total score is 0, the risk of malnutrition is low; if it is 1, the risk of malnutrition is medium; and if it is 2 and above, the risk of malnutrition is high.²⁰ Lomivorotov et al.¹⁴ have suggested the MUST in a study evaluating nutritional screening tools for patients scheduled for cardiac surgery. There is only expert consensus regarding the best screening tool available for nutritional risk assessment. MUST is one of the screening tools recommended by the European Society of Clinical Nutrition and Metabolism (ESPEN) expert group for perioperative nutrition.²¹ The MUST was preferred in this study.

Data Collection

First, the purpose and procedure of the study were explained to the patients in the preoperative period. The Sociodemographic Clinical Characteristics form and MUST were completed by conducting face-to-face interviews with patients. Data such as albumin and total protein levels were obtained from patients' files. The nutritional status was evaluated with MUST in the preoperative period and on the fifth postoperative day (Figure 1).

Ethical Consideration

Ethical approval for the study was obtained from the Dokuz Eylul University Non-Interventional Clinical Research Ethics Committee (Date: March 15, 2018; 2018/07-39). Additionally, institutional permission was secured from the cardiovascular surgery clinic of a university hospital, where the study was conducted.

Statistical Analysis

The research data was analyzed in the Statistical Package for the Social Sciences (IBM SPSS Corp., Armonk, NY, USA) Statistics 24.0 statistics program. Sociodemographic and clinical characteristics were analyzed by number and percentage. The dependent samples t-test was used in paired group comparisons. A Spearman correlation analysis was used to determine the relationship between pre/postoperative MUST values and complication status, presence of infection, time of stay in the ICU and hospital. The correlation coefficient cutoff points are used < .39 "weak," < .69 "moderate," and < .89 "strong" relationships in our research.²² Linear regression estimates the relationship between a continuous dependent variable and one or more independent variables. In this study, the variables included in the model were selected from among those considered literature-based and clinically significant, taking into account potential confounding effects, and were evaluated for multicollinearity. Linear regression analysis was performed to examine the association between postoperative hospital stay and independent

variables, including preoperative MUST scores, postoperative MUST scores, complication status, presence of infection, and length of ICU stay. A *P*-value of < .05 was considered statistically significant.

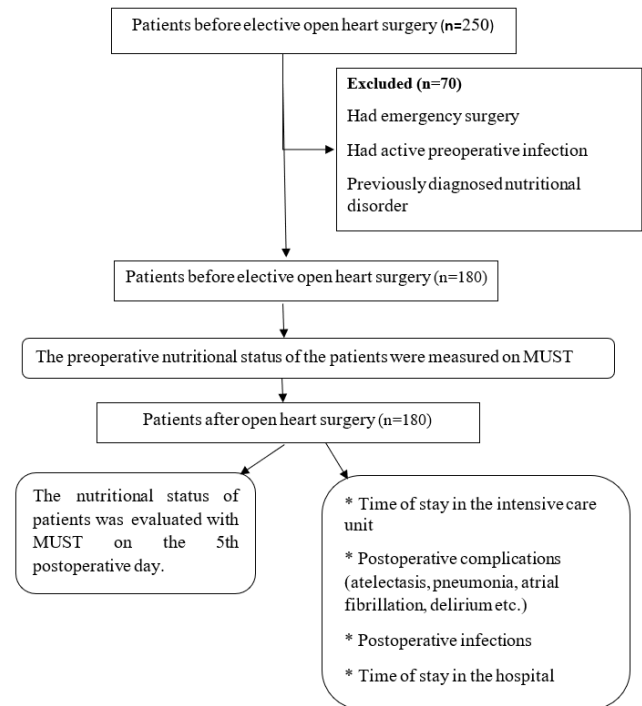


Figure 1: Research plan

RESULTS

The mean age of the patients was 61.82±10.41 years, 65.6% (n=18) were male, and 76.1% (n=137) had chronic disease. The most common diseases were hypertension 36.1% (n=65). The mean preoperative BMI of the patients was 27.79±4.24. The preoperative hospitalization period of the patients was 127.02±109.13 hours, and the preoperative fasting was 10.31±3.30 hours (Table 1).

The duration of mechanical ventilation was 14.92±12.93 h after surgery. 60.0% of patients were weaned off mechanical ventilation 12 hours after the surgery. Patients started feeding 25.75±18.27 hours after surgery. None of the patients received nutritional support during their stay in the ICU, and only about 4% of them began oral nutrition within the first 24 hours. The mean length of stay in the hospital for patients was 10.26±5.25 days. There was an infection in 28.9% (n=52) of patients. Postoperative complications developed in 35% (n=63) of patients. The most common complications were acute pulmonary failure (n=15; 8.3%), low cardiac output syndrome (n=15; 8.3%), and dysrhythmia (n=12; 6.7%). 12.2% of patients were again hospitalized due to complications after surgery (Table2).

Table 1. Preoperative Sociodemographic and Clinical Characteristics of the Patients (n=180)

	n (%)
Gender	
Female	62 (34.4)
Male	118 (65.6)
Presence of comorbid disease	
Yes	137 (76.1)
No	43 (23.9)
Comorbid diseases*	
Hypertension	65 (36.1)
Diabetes Mellitus	64 (35.6)
Coronary Artery Disease	47 (26.1)
Obesity (BMI≥30)	49 (27.3)
Dysrhythmia	7 (3.9)
Hyperlipidemia	6 (3.3)
Other**	16 (8.9)
Type of surgery	
Coronary artery bypass graft (CABG)	100 (55.6)
Valve replacement surgery (VRS)	52 (28.9)
CABG and VRS	17 (9.4)
Aneurysm repair (ascending aorta)	11 (6.1)
Preoperative BMI categories	
18.5–24.9	51 (28.3)
25–29.9	80 (44.4)
30–34.9	42 (23.3)
over 35	7 (4.0)
Preoperative MUST scores	
Low risk	131 (72.8)
Medium risk	21 (11.7)
High risk	28 (15.5)
	$\bar{X} \pm SD(\text{Min.}-\text{Max.})$
Age (years)	61.82±10.41 (21–82)
Preoperative BMI	27.79±4.24 (19.64–41.90)
Length of hospital stay before surgery (hours)	127.02±109.13(7.00–648.00)
Preoperative fasting time (hours)	10.31±3.30 (8.00–36.00)

*The number n reflects more than one option; **Other: Stroke, Chronic obstructive pulmonary disease, Asthma, Gout, Rheumatoid arthritis, Parkinson's disease, Ulcerative colitis, Chronic kidney disease, Cancer; BMI, Body Mass Index; Min-Max., Minimum-maximum; MUST, Malnutrition Universal Screening Tool; SD, Standard Deviation; $\bar{X}$, Mean

We found the risk of malnutrition to be low in 72.8% (n=131) of the preoperative patients and medium to high in 27.2% (n=49) of the patients (Table 1). We found a moderate to high risk of malnutrition in 50.0% (n = 90) of postoperative patients (Table 2). There was a statistically significant difference between the mean pre- and postoperative MUST scores (0.42 ± 0.74 ; 0.84 ± 0.90) ($t = 7.489$; $P < .001$).

We found a statistically significant difference between the preoperative and postoperative body weight, albumin, and total protein values of the patients ($P < .001$) (Table 3). Postoperative body weight, albumin, and total protein values of the patients were low. A weak but significant positive correlation was found between preoperative MUST scores and ICU length of stay ($r = .251$; $P < .05$), total hospital stay ($r = .255$; $P < .05$), and the presence of infection

Table 2. Postoperative clinical characteristics of the patients (n=180)

	$\bar{X} \pm SD$ (Min-Max)
Length of stay in intensive care (hours)	64.63±42.61 (12.00–334.00)
The duration of mechanical ventilation (hours)	14.92±12.93 (4.00–117.00)
Time to start feeding after surgery (hour)	25.75±18.27 (10.00–170.00)
Postoperative hospital stay (days)	10.26±5.25 (4.00–45.00)
	n (%)
Postoperative MUST scores	
Low risk	90 (50.0)
Medium risk	28 (15.6)
High risk	62 (34.4)
Infection	
Yes	52 (28.9)
No	128 (71.1)
Complication	
Yes	63 (35.0)
No	117 (65.0)
Re-admission to hospital	
Yes	24 (13.3)
No	156 (86.7)

MUST, Malnutrition Universal Screening Tool; SD, Standard Deviation, $\bar{X}$, Mean

Table 3. Preoperative and postoperative weight, albumin, and total protein values of the patients (n=180)

Variables	Preoperative $\bar{X} \pm SD$	Postoperative $\bar{X} \pm SD$	t	P
Body weight	77.74±13.12	75.76±12.90	8.28	<.001
Albumin	3.92±0.45	3.15±0.42	25.33	<.001
Total Protein	6.69±0.67	5.85±0.55	16.18	<.001

SD, Standard Deviation; $\bar{X}$, Mean

($r = .193$; $P < .05$). Additionally, we found a significant, positive, and moderate correlation between preoperative MUST scores and the occurrence of complications ($r = .485$; $P < .05$). Postoperatively, MUST scores showed a significant, positive, and weak correlation with ICU length of stay ($r = .355$; $P < .05$), hospital stay ($r = .202$; $P < .05$), and presence of infection ($r = .285$; $P < .05$). A significant, positive, and strong correlation was also identified between postoperative MUST scores and complication status ($r = .742$; $P < .05$) (Table 4).

Linear regression analysis showed that preoperative MUST scores alone explained 6% of the variance in postoperative hospital stay ($P < .001$; $\beta = .256$; DW=1.682). Multiple regression results for the five potential predictors of postoperative hospital stay are presented in Table 5. The overall model was statistically significant ($P < .001$), with all

Table 4. The relationship between the MUST scores of the patients before and after the surgery and time of stay in the intensive care unit, the time of hospital stay, the complications status, and the presence of infection (n=180)

Variables	Preoperative MUST		Postoperative MUST	
	r	P	r	P
Time of stay in the intensive care unit	.251	.001*	.355	<.001
Time of hospital stay	.256	<.001	.202	.006
The Complication status	.485	<.001	.742	<.001
Presence of infection	.193	.009*	.285	<.001

*P< .05, MUST, Malnutrition Universal Screening Tool; r, Correlation coefficient

included variables together explaining 24% of the variance. Among these predictors, preoperative MUST scores ($\beta = .186$; $P = .024$), presence of infection ($\beta = .200$; $P = .005$), duration of mechanical ventilation ($\beta = .265$; $P < .001$), and complication status ($\beta = .262$; $P = .012$) were significant positive predictors of hospital stay. Specifically, each one-unit increase in preoperative MUST scores was associated with an approximately 1.3-day increase in hospital stay; the presence of infection increased hospital stay by about 2.3 days; and each one-unit increase in complication status increased hospital stay by approximately 2.8 days. Postoperative MUST scores were not a significant independent predictor of hospital stay in the model ($P > .05$; Table 5).

Table 5. Predictive status of variables affecting the hospital stay of the patients

Variables	B	SE	Model		P	95% CI	
			β	t		Lower	Upper
Constant	7.34	.60		12.22	<.001	6.16	8.53
Preoperative MUST value	1.30	.57	.186	2.27	.024*	.17	2.43
Postoperative MUST value	-1.12	.61	-.196	-1.83	.068	-2.32	.08
Presence of infection	2.31	.81	.200	2.83	.005*	.70	3.92
Time of stay on mechanical ventilation	.10	.02	.265	3.90	<.001	.05	.16
Complication status	2.88	1.12	.262	2.55	.012*	.652	5.10
R	0.495						
R ²	0.245						
F	11.28						
P	<.001						
DW (1.5–2.5)	1.58						

*P< .05; B, Unstandardized regression coefficient; CI, Confidence Interval; DW, Durbin-Watson; MUST, Malnutrition Universal Screening Tool; SE, Standard Error; t, t statistic; β , Standardized regression coefficient (Beta)

DISCUSSION

Malnutrition contributes to inflammation due to reduced defense mechanisms and depleted metabolic reserves in the patient. Malnourished patients are more susceptible to surgical trauma, ischemia-and-reperfusion injury, anesthesia-related complications, and inflammation.¹ Therefore, malnutrition causes delays in the healing process, and prolonged hospital stays in patients.^{13,23}

We determined that 27.2% of the patients had a moderate to high risk of malnutrition in the preoperative period. Previous studies examining the preoperative nutritional status of patients undergoing cardiac surgery have reported malnutrition risk rates ranging from 3.9% to 51%.^{3-5,7-11} This finding indicates that approximately one in four patients is at risk of malnutrition before surgery. It is considered that the presence of comorbidities and inadequate nutritional intake during the preoperative period may have contributed to the malnutrition status observed in our study.

We defined that 50.0% of patients had a moderate to high risk of malnutrition after OHS. In the study conducted by Passantino et al., the risk of malnutrition was found in 37.2% of patients two months after cardiac surgery.²⁴ One research study stated that patients often experienced reduced appetite after surgery and had been eating only small portions at mealtimes, expressing that they skipped meals several times due to a lack of appetite.²⁵ Patients may have a higher risk of malnutrition due to their decreased appetite and reduced calorie intake after surgery. Delayed postoperative initiation of oral feeding may have been associated with an increased risk of malnutrition in the patient. In addition, the lack of postoperative nutritional support may have contributed to the development of this condition.

Our study found that 4% of the patients started oral nutrition within the first 24 hours. Critically ill people are at increased risk of malnutrition. Acute and chronic illness, trauma and inflammation induce stress-related catabolism,

and drug-induced adverse effects may reduce appetite or increase nausea and vomiting. In addition, patient management in the intensive care unit (ICU) may also interrupt feeding routines.²⁶ Additionally, vasopressor or inotrope therapy was frequently used in intensive care patients after OHS because of inflammatory response syndrome, vasoplegia, or myocardial stunning, and postoperative low output syndrome. In this study, low cardiac output syndrome was seen in 15 patients, and inotropic agents were started in the ICU. The need for vasopressor therapy leads to marked changes in energy expenditure and intolerance to oral feeding, leading to significant energy/protein deficiencies.^{1,27,28} Moreover, catabolism continues for the first 7 days after surgery. During the catabolism process, the energy requirements of the patients increased.²⁷ Malnutrition can be caused by the long fasting period before the surgery, the lack of oral carbohydrate loading, the delayed initiation of postoperative nutritional support, and inadequate protein and energy supplementation.¹ For these reasons, the risk of malnutrition might have been higher in post-operative patients.

A statistically significant difference was found between the patients' pre- and postoperative body weight, albumin, and total protein values ($P < .001$). Postoperative values decreased. One study found that the postoperative body weights of patients decreased compared to preoperative values.²⁹ In the study by Koyuncu et al. conducted with 174 patients who had undergone cross-sectional open heart surgery, it was found that postoperative albumin levels of patients decreased compared with preoperative levels.²⁹ On-pump cardiopulmonary bypass surgery during the operation might cause the formation of proinflammatory markers, reactive oxygen species, and the development of organ dysfunction.^{30,31} Postoperative weight and protein loss might have been due to the inflammation experienced by the patients after surgery, the catabolism process, the reluctance to take oral intake, the lack of nutritional supplementation, and late started oral nutrition in the ICU. Moreover, the patients were hypoalbuminemia postoperatively. The level of albumin decreases with a stress response. Hypoalbuminemia may predict an increased risk of morbidity, particularly regarding infections, organ dysfunction, and mortality after cardiac surgery.^{31,32} Albumin should be evaluated before and after cardiac surgery.

We found a significant, positive, weak correlation between the pre-/post-operative MUST values of the patients and time of stay in the ICU and the hospital and the presence of infection. We determined a significant, positive, and moderate correlation between preoperative MUST values

and complication status. We found a significant, positive, and strong correlation between postoperative MUST values and complication status. Other studies found that the risk of malnutrition correlated with early postoperative adverse outcomes¹⁵, postoperative cardiac and gastrointestinal complications³, as well as increased hospital length of stay and intensive care unit length of stay.^{4,15} Dietary deficiencies decreased defense mechanisms, and depleted metabolic reserves in the patient contribute to the pathomechanisms of inflammation.¹ For these reasons, a significant and intense relationship may have been found between post-operative malnutrition status and the development of complications.

Our study determined that the patients' preoperative MUST scores, presence of infection, time of mechanical ventilation, and complication status significantly predicted the time of stay in the hospital. It was determined that these variables explained 24% of the total variance (Table 5). These variables explained 24% of the patients' time of stay in the hospital during the postoperative period. In patients who will undergo OHS, the presence of preoperative malnutrition was associated with more than two days in the ICU, more extended hospital stays, and postoperative complications.^{3,4,13-15} Malnutrition of patients increases due to postoperative catabolism. The prolongation of the duration of mechanical ventilation is the reason for the late initiation of feeding. These factors negatively affect the patient's recovery process and prolong the hospital stay. Therefore, it is essential to optimize nutritional status, correct deficiencies, and strengthen immune defense mechanisms before surgery in the preoperative period.^{27,28,30}

Limitations

This study has some limitations. It was conducted at a single center and was non-randomized. Postoperative nutritional status was evaluated only on the fifth day. Malnutrition was not shown to affect 30-day, 1-year, and long-term mortality and survival in our research—this study has not used EUROSCORE II values. In the study data, repeated hospitalization within 30 days after surgery was evaluated.

In conclusion, OHS patients are still at risk of malnutrition during the perioperative process. There was a loss of weight, albumin, and total protein in the postoperative period. Preoperative malnutrition risks affect the time of stay in the hospital. Evaluation of malnutrition status before and after surgery is important for postoperative recovery. There is a need for randomized controlled studies to examine the effect of starting perioperative nutrition therapy on patient outcomes.

Ethics Committee Approval: The researchers obtained permission from the hospital where the study was conducted and the Ethics Committee of Dokuz Eylul University Ethics Committee for Noninvasive Clinical Studies (decision number of 2018/07-39 on March 15, 2018). The aim of the study was explained to the patients.

Informed Consent: Written and verbal informed consent was obtained from the patients. Study data and notes taken were kept by the researchers.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – ADE, EAK, ÖB ; Design - ADE, EAK ; Supervision -ADE, EAK, ÖB Resources -EAK; Materials - ADE, EAK; Data Collection and/or Processing - EAK; Analysis and/or Interpretation - ADE, EAK; Literature Search -ADE, EAK, ÖB ; Writing Manuscript - ADE, EAK, ÖB; Critical Review - ADE, EAK, ÖB; Other –None .

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REFERENCES

- Hill A, Nesterova E, Lomivorotov V, et al. Current Evidence about Nutrition Support in Cardiac Surgery Patients-What Do We Know?. *Nutrients*. 2018;10(5):597. <https://doi.org/10.3390/nu10050597>
- Vinck EE, van Ierland KM, Rendón JC, et al. Peri-operative nutrition in cardiovascular surgery: current pitfalls and future directions. *Acta Chir Belg*. 2022;122(2):77-84. <https://doi.org/10.1080/00015458.2021.2020009>
- Mubashir T, Balogh J, Breland E, et al. Risk Factors and Outcomes of Protein-Calorie Malnutrition in Chronic Heart Failure Patients Undergoing Elective Cardiac Surgery. *Cureus*. 2022;14(10):e30378. <https://doi.org/10.7759/cureus.30378>
- Goldfarb M, Lauck S, Webb JG, et al. Malnutrition and Mortality in Frail and Non-Frail Older Adults Undergoing Aortic Valve Replacement. *Circulation*. 2018;138(20):2202-2211. <https://doi.org/10.1161/CIRCULATIONAHA.118.033887>
- Ringaitiene D, Gineityte D, Vicka V, et al. Concordance of the new ESPEN criteria with low phase angle in defining early stages of malnutrition in cardiac surgery. *Clin Nutr*. 2018;37(5):1596-1601. <https://doi.org/10.1016/j.clnu.2017.08.007>
- Efremov SM, Ionova TI, Nikitina TP, et al. Effects of malnutrition on long-term survival in adult patients after elective cardiac surgery. *Nutrition*. 2021;83:111057. <https://doi.org/10.1016/j.nut.2020.111057>
- Gonçalves LB, de Jesus NMT, Gonçalves MB, Dias LC, Deiró TC. Preoperative Nutritional Status and Clinical Complications in the Postoperative Period of Cardiac Surgeries. *Braz J Cardiovasc Surg*. 2016;31(5):371-380. <https://doi.org/10.5935/1678-9741.20160077>
- Youssef Elshamy NFA, Abdelaziz SH, Gado AS, et al. The preoperative nutritional and psychosocial health status among patients undergoing open heart surgery: a cross-sectional correlational study. *Int J Nurs Sci*. 2016;6(2):48-57. <http://article.sapub.org/10.5923.j.nursing.20160602.03.html>
- Cho JS, Shim JK, Kim KS, Lee S, Kwak YL. Impact of preoperative nutritional scores on 1-year postoperative mortality in patients undergoing valvular heart surgery. *J Thorac Cardiovasc Surg*. 2022;164(4):1140-1149.e3. <https://doi.org/10.1016/j.jtcvs.2020.12.099>
- Patricio MD, Lagos BTA, Tan ADA, et al. Nutrition and frailty status of patients undergoing cardiovascular surgery and its association with postoperative outcomes. *Philipp J Cardiol*. 2021;49(2):18-25. <https://doi.org/10.1093/eurheartj/ehab724.2255>
- Arai Y, Kimura T, Takahashi Y, Hashimoto T, Arakawa M, Okamura H. Preoperative nutritional status is associated with progression of postoperative cardiac rehabilitation in patients undergoing cardiovascular surgery. *Gen Thorac Cardiovasc Surg*. 2018;66(11):632-640. <https://doi.org/10.1007/s11748-018-0961-7>
- Oshima T, Tsutsumi R. The Malnutrition Universal Screening Tool (MUST) Predicts Postoperative Declines in Activities of Daily Living (ADL) in Patients Undergoing Cardiovascular Open-Heart Surgery. *Nutrients*. 2025;17(7):1120. <https://doi.org/10.3390/nu17071120>
- Unosawa S, Taoka M, Osaka S, et al. Is malnutrition associated with postoperative complications after cardiac surgery?. *J Card Surg*. 2019;34(10):908-912. <https://doi.org/10.1111/jocs.14155>
- Lomivorotov VV, Efremov SM, Boboshko VA, et al. Evaluation of nutritional screening tools for patients scheduled for cardiac surgery. *Nutrition*. 2013;29(2):436-442. <https://doi.org/10.1016/j.nut.2012.08.006>
- Jiang X, Xiang J, Yang M, et al. Predictive Role of Preoperative Nutritional Status on Early Postoperative Outcomes in Different-Aged Patients Undergoing Heart Valve Surgery. *J Cardiothorac Vasc Anesth*. 2024;38(5):1169-1180. <https://doi.org/10.1053/j.jvca.2024.01.037>
- Chung J, Bae J, Park S, et al. Performance of the comprehensive nutrition screening index in predicting mortality after cardiac surgery. *Sci Rep*. 2024;14(1):28507. <https://doi.org/10.1038/s41598-024-78114-x>
- Luo P, Shi K, Luo Y, Ren HB. Prognostic value of the Geriatric Nutritional Risk Index in patients undergoing cardiac surgery: a systematic review and meta-analysis. *Front Nutr*. 2025;12:1628671. <https://doi.org/10.3389/fnut.2025.1628671>
- Gignac GE, Szodorai ET. Effect size guidelines for individual differences researchers. *Pers Individ Dif*. 2016;102:74-78. <https://doi.org/10.1016/j.paid.2016.06.069>
- Elia M. The "MUST" report. Nutritional screening for adults: a multidisciplinary responsibility. Development and use of the "Malnutrition Universal Screening Tool" (MUST) for adults. Redditch: British Association for Parenteral and Enteral Nutrition (BAPEN); 2003. Available from. <https://www.bapen.org.uk/pdfs/must/must-report.pdf>

20. Stratton RJ, Hackston A, Longmore D, et al. Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the 'malnutrition universal screening tool' ('MUST') for adults. *Br J Nutr.* 2004;92(5):799-808. <https://doi.org/10.1079/bjn20041258>
21. Lobo DN, Gianotti L, Adiamah A, et al. Perioperative nutrition: Recommendations from the ESPEN expert group. *Clin Nutr.* 2020;39(11):3211-3227. <https://doi.org/10.1016/j.clnu.2020.03.038>
22. Schober P, Schober P, Mascha EJ, Vetter TR. Statistics From A (Agreement) to Z (z Score): A Guide to Interpreting Common Measures of Association, Agreement, Diagnostic Accuracy, Effect Size, Heterogeneity, and Reliability in Medical Research. *Anesth Analg.* 2021;133(6):1633-1641. <https://doi.org/10.1213/ANE.0000000000005773>.
23. Hill A, Elke G, Weimann A. Nutrition in the Intensive Care Unit-A Narrative Review. *Nutrients.* 2021;13(8):2851. <https://doi.org/10.3390/nu13082851>.
24. Passantino A, Guida P, Rizzo C, Carbonara R, Ruggieri R, Scrutinio D. Malnutrition in patients admitted to in-hospital cardiac rehabilitation: Clinical correlates and association with mortality. *Monaldi Arch Chest Dis.* 2021;92(2). <https://doi.org/10.4081/monaldi.2021.1960>
25. Elbrønd P, Højskov IE, Missel M, Borregaard B. Food and heart-the nutritional jungle: Patients' experiences of dietary habits and nutritional counselling after coronary artery bypass grafting. *J Clin Nurs.* 2020;29(1-2):85-93. <https://doi.org/10.1111/jocn.15061>
26. Lewis SR, Schofield-Robinson OJ, Alderson P, Smith AF. Enteral versus parenteral nutrition and enteral versus a combination of enteral and parenteral nutrition for adults in the intensive care unit. *Cochrane Database Syst Rev.* 2018;6(6):CD012276. <https://doi.org/10.1002/14651858.CD012276.pub2>
27. Singer P, Blaser AR, Berger MM, et al. ESPEN guideline on clinical nutrition in the intensive care unit. *Clin Nutr.* 2019;38(1):48-79. <https://doi.org/10.1016/j.clnu.2018.08.037>
28. Stoppe C, Goetzenich A, Whitman G, et al. Role of nutrition support in adult cardiac surgery: a consensus statement from an International Multidisciplinary Expert Group on Nutrition in Cardiac Surgery. *Crit Care.* 2017;21(1):131. <https://doi.org/10.1186/s13054-017-1690-5>
29. Koyuncu A, Yava A, Eti Aslan F. Determination of food intake and the factors affecting food intake in perioperative period in patients who undergo open heart surgery. *Turk Gogus Kalp Damar Cerrahisi Derg.* 2018;26(2):214-222. <https://doi.org/10.5606/tgkdc.dergisi.2018.15787>
30. Squicciarro E, Stasi A, Lorusso R, Paparella D. Narrative review of the systemic inflammatory reaction to cardiac surgery and cardiopulmonary bypass. *Artif Organs.* 2022;46(4):568-577. <https://doi.org/10.1111/aor.14171>
31. Lopez-Delgado JC, Muñoz-Del Río G, Flordelis-Lasierra JL, Putzu A. Nutrition in Adult Cardiac Surgery: Preoperative Evaluation, Management in the Postoperative Period, and Clinical Implications for Outcomes. *J Cardiothorac Vasc Anesth.* 2019;33(11):3143-3162. <https://doi.org/10.1053/j.jvca.2019.04.002>
32. Zaffar M, Afreen A, Waseem M, Ahmed Z. Effect of nutritional status on wound healing after coronary artery bypass graft (CABG) surgery. *J Pak Med Assoc.* 2022;72(5):860-865. <https://doi.org/10.47391/jpma.1890>