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Araştırma/*Research Article*

Morbidity and Mortality Markers in Elderly Patients with Cardiovascular Surgery

Kardiyovasküler Cerrahi Geçiren Yaşlı Hastalarda Morbidite ve Mortalite Belirteçleri

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ABSTRACT

Objective: *In recent years, as a result of increased average longevity, the number of hospitalized elderly patients has been increasing. Today, although many parameters are used to determine the prognosis of hospitalized patients, more specific information about elderly patients is required. This study aims to investigate the effect of preoperative and postoperative parameters on postoperative complications and mortality among patients aged 65 and over who underwent cardiovascular surgery.*
Methods: *Demographic data, preoperative and postoperative hemoglobin, neutrophil/lymphocyte ratio, mean platelet volume, erythrocyte distribution width, platelet, glucose, urea, creatinine, albumin values and postoperative data were recorded.*
Results: *When the preoperative risk factors for postoperative complications and mortality were evaluated, low preoperative hemoglobin and albumin values and high blood urea and glucose levels were statistically significant (p <0.005). Low postoperative hemoglobin, albumin values, platelet counts, and and high glucose, urea and creatinine values were found to be significant markers of postoperative complications (p <0.005). When preoperative risk factors were evaluated in terms of postoperative 30-day mortality, preoperatively decreased hemoglobin and albumin, increased urea , decreased postoperative hemoglobin, albumin levels, platelet counts, and increased glucose, urea and creatinine values were statistically significant (p <0.005).*
Conclusion: *We believe that closely monitoring the nutritional status of elderly patients, providing them with dietary supplementation for deficient parameters, and keeping blood glucose, urea, and creatinine at optimum levels could help us to decrease hospital stay, mortality-morbidity, and total economic cost.*

Keywords: *Cardiovascular surgery, postoperative complications, mortality, anemia, hypoalbuminemia, hyperglycemia, geriatrics*

ÖZ

Amaç: *Son yıllarda ortalama yaşam süresinin artması sonucunda hastaneye yatırılan yaşlı hasta sayısı artmaktadır. Günümüzde hastanede yatan hastaların prognozunu belirlemek için birçok parametre kullanılsa da yaşlı hastalar hakkında daha spesifik bilgilere gereksinim duyulmaktadır. Bu çalışma, 65 yaş ve üzeri kardiyovasküler cerrahi geçiren hastalarda ameliyat öncesi ve sonrası parametrelerin ameliyat sonrası komplikasyonlar ve mortalite üzerine etkisini araştırmayı amaçlamaktadır.*
Yöntem: *Demografik veriler, ameliyat öncesi ve sonrası hemoglobin, nötrofil/lenfosit oranı, ortalama trombosit hacmi, eritrosit dağılım genişliği, trombosit, glukoz, üre, kreatinin, albümin değerleri ve ameliyat sonrası veriler kaydedildi.*
Bulgular: *Postoperatif komplikasyonlar ve mortalite için preoperatif risk faktörleri değerlendirildiğinde, preoperatif düşük hemoglobin ve albümin değerleri ile yüksek kan üre ve glukoz seviyeleri istatistiksel olarak anlamlıydı (p<0,005). Düşük postoperatif hemoglobin, trombosit ve albümin değerleri ile yüksek glukoz, üre ve kreatinin değerleri postoperatif komplikasyonların önemli belirteçleri olarak bulundu (p<0.005). Postoperatif 30 günlük mortalite açısından preoperatif risk faktörleri değerlendirildiğinde, preoperatif düşük hemoglobin ve albümin, yüksek üre değeri, düşük postoperatif hemoglobin, trombosit ve albümin seviyeleri ve yüksek glukoz, üre ve kreatinin değerleri istatistiksel olarak anlamlı bulundu (p<0.005).*
Sonuç: *Yaşlı hastaların beslenme durumlarının yakından izlenmesi, eksik parametreler için diyet takviyesi yapılması ve kan şekeri, üre ve kreatinin optimum seviyelerde tutulmasının hastanede kalış süresini, mortalite-morbiditeyi ve toplam ekonomik maliyeti düşürmemize yardımcı olabileceğine inanıyoruz.*

Anahtar kelimeler: *kardiyovasküler cerrahi, postoperatif komplikasyon, mortalite, anemi, hipoalbuminemi, hiperglisemi, geriatri*

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INTRODUCTION

In recent years, an increase in the average longevity and the overall aging of the population have brought about a dramatic rise in the number of hospitalized elderly patients. Cardiovascular surgery has also had its share. It is stated in the literature that from 1990 to 2007, the average age of cardiac surgery patients in Germany increased from 55.8 to 68.8, and the proportion of the patients aged 80 and over was 9.8% [1]. In the USA, it has been reported that approximately 25% of the population develop cardiovascular diseases at the age of 75 and over, and the number of potential elderly candidates for surgery has increased in more than half of candidates for all cardiac procedures applied to this age group [2]. Therefore, the perioperative evaluation and care for elderly patients are becoming more important day by day. This group of patients is affected by certain aging-related conditions such as the presence of comorbid diseases, weakening cognitive functions, poor nutrition, increased physical dependence rate, and multiple drug use, the severity of the diseases requiring intervention, atypical responses to inflammation, and failing kidney functions [3].

Today, the perioperative management of elderly patients is mostly based on data from the adult population. Prognostic factors that may affect the evaluation of elderly patients are still being investigated [3,4]. In particular, it is noteworthy that cardiovascular diseases increase dramatically with age, and the majority of the deaths associated with cardiovascular diseases are seen in the elderly population. In fact, cardiovascular diseases are the most common cause of death among patients over 65 years of age and cause severe morbidity [5].

In this context, this study aims to determine preoperative and postoperative risk factors which cause postoperative complications and mortality in elderly patients undergoing cardiovascular surgery.

MATERIAL and METHODS

Patients aged 65 and over who underwent cardiovascular surgery in our clinic between April 2015 and March 2017 were included in the study after receiving the approval of the ethics committee of our hospital (No: 43,19.07.2018). In our retrospective cross-sectional study, the preoperative and postoperative data of the patients were obtained from the electronic database of our hospital. Patients under 65 years of age, emergency cases, and cases that had undergone re-do surgeries were excluded from the study.

All patients received a balanced anesthesia using our routine clinical protocols. Standard CPB was established and antegrade cold blood cardioplegia was used for myocardial protection. Hemoglobin concentrations were kept above 7.5 g dl^{-1} during CPB and above 8.5 g dl^{-1} after CPB. All patients were transferred to the ICU after surgery.

Patients' demographic data, comorbidities, preoperative variables (hemoglobin, neutrophil/lymphocyte ratio (NLR), mean platelet volume (MPV), erythrocyte distribution width (RDW), platelet, glucose, urea, creatinine, albumin), postoperative variables (hemoglobin, NLR, MPV, RDW, platelet, glucose, urea, creatinine, albumin), type of surgery, intensive care unit and hospital stay, postoperative morbidity and mortality information were recorded.

Statistical analyses were performed using IBM SPSS for Windows (IBM Corp., version 22.0, Armonk, NY, USA). Descriptive statistics outline the basic features of the data. According to the distribution of data, Mann-Whitney U or two-sample t-test was used to compare independent groups. Additionally, regression analysis was performed to analyze risk factors in complications and mortality. A *p*-value <0.05 from two-sided tests was considered statistically significant.

RESULTS

Baseline demographics, preoperative variables, and surgery types for 346 patients are presented in Table 1. Postoperative variables and complications are presented in Table 2. The postoperative complication rate was 28.3%. The most common complications were reported to be bleeding (8.9%), arrhythmias (5.2%), and neurological complications (3.5%). Hospital mortality was 9.5%, and 30-day mortality was 2%.

Table 1: Patients' demographic data, preoperative laboratory values and types of surgery

n (%) or mean ± SD	N:346
Age, year	70.7±4.4
Male, gender	246(70.1)
BMI	29.9±2.1
Hemoglobin, g/dl	13.1±1.9
MPV, fL	9.1±1.1
RDW	14.5±1.8
Platelet,10^3/fL	233.1±71.3
Glucose, mg/dl	132.6±62.4
Urea, mg/dl	45.2±20.1
Creatinine, mg/dl	1.2±2.6
Albumin, g/dl	3.8±0.6
Anemia, n	133(38.4)
Comorbidity	
None	158(45.7)
Hypertension	91(26.4)
Chronic obstructive pulmonary disease	20(5.8)
Goitre	3(0.9)
Renal failure	5(1.5)
Diabetes mellitus	10(2.9)
Cerebrovascular accident	1(0.3)
Hyperlipidemia	63(18.2)
Surgery type	
CABG	218(63)
AVR/MVR	13/12(3.8/3.5)
CABG+valve replacement, carotid endarterectomy	26(7.5)
Ascending / descending aorta grafting	14(4)
Femoropopliteal bypass	20(5.8)
Thoracoabdominal aortic aneurysms	16(4.6)
TAVI, EVAR, TEVAR	20(5.8)
AVR+Ascending aortic grafting / MVR	4(1.2)
LVAD	1(0.3)
ASD	2(0.6)
Total	346 (100)

Values are expressed as n (%) or mean ± SD, BMI: body mass index, MPV: mean platelet volume, RDW: red cell distribution width, CABG: coronary artery bypass grafting, AVR: aortic valve replacement, MVR: mitral valve replacement, TAVI: Transcatheter aortic valve implantation, EVAR: Endovascular aneurysm repair, TEVAR: Thoracic endovascular aortic repair, LVAD: left ventricular assist device, ASD: atrial septal defects

Table 2: Postoperative data

n (%) or mean ± SD	N: 346
Anemia	35 (10.1)
Hemoglobin, g/dl	15.3±9.3
MPV, fL	15.6±9.4
RDW	14.8±1.6
Platelet count,10^3/fL	155.4±61.0
Glucose, mg/dl	174.1±56.4
Urea, mg/dl	46.8±20.1
Creatinine, mg/dl	1.2±0.6
Albumin, g/dl	2.9±0.5
Postoperative complications	
None	248(71.7)
Pleural effusion	8(2.3)
Renal failure	3(0.9)
Bleeding	31(8.9)
Arrhythmia	18(5.2)
Infection (pneumonia, wound infection)	10(2.9)
Major advance cardiac events	4(1.2)
Neurological complications	12(3.5)
Mortality	
None	306 (88.4)
≤30 days	33 (9.5)
>30 days	7 (2.0)
Duration of ICU stay (day)	3.07±6.3
Hospital stay (day)	8.4±7.5

Values are expressed as n (%) or mean ± SD, MPV: mean platelet volume, RDW: red cell distribution width, ICU: intensive care unit

When preoperative risk factors were evaluated in terms of postoperative complications, low preoperative hemoglobin and albumin and high blood urea and glucose levels were statistically significant predictors ($p<0.005$). When postoperative risk factors were examined, decreased postoperative hemoglobin, albumin values, platelet counts and high glucose, urea, and creatinine values could predict postoperative complications at a statistical significance level of $p<0.005$ (Table 3). In the evaluation of postoperative 30-day mortality, low preoperative hemoglobin and albumin, high urea, low postoperative hemoglobin, albumin levels, and platelet counts and, increased glucose, urea, and creatinine values were found as significant predictors and risk factors ($p<0.005$) (Table 4). A multivariate risk analysis was performed to determine preoperative and postoperative risk factors. Low albumin level was both a preoperative and

Table 3: Preoperative and postoperative risk factors for postoperative complications; univariate analysis

	Complication (-)	Complication (+)	p value
Age, year	70.5±4.3	71.1±4.6	0.242
BMI	30.1±2.8	29.9±2.1	0
Preoperative variables			
Hemoglobin, g/dl	13.2±1.8	12.6±2.0	0.004*
MPV, fL	9.1±1.1	9.2±1.1	0.304
RDW	14.5±1.8	14.5±1.5	0.904
Neutrophil/Lymphocyte ratio	3.5±3.6	3.5±3.0	0.874
Platelet, 10^3/fL	236.6±67.9	224.3±79.2	0.150
Glucose, mg/dl	128.2± 57.6	143.7±72.3	0.039*
Urea, mg/dl	43.6±18.1	49.4±24.3	0,017*
Creatinine, mg/dl	1.0±0.5	1.6±4.8	0.078
Albumin, g/dl	3.8±0.5	3.5±0.7	0.000*
Postoperative variables			
Hemoglobin, g/dl	9.5±1.5	9.0±1.2	0.004*
MPV, fL	9.3±1.2	9.4±1.2	0.770
RDW	14.8±1.6	14.9±1.5	0.310
Neutrophil/Lymphocyte ratio	17.5±14.9	16.9±10.6	0.727
Platelet,10^3/fL	162.5±57.9	137.5±65.3	0.001*
Glucose, mg/dl	165.3± 44.4	197.0±75.1	0.000*
Urea, mg/dl	43.3±14.4	55.4±28.3	0,000*
Creatinine, mg/dl	1.2±0.6	1.4±0.7	0,000*
Albumin, g/dl	3.1±0.5	2.7±0.5	0,000*

Values are expressed as mean ± SD, BMI: body mass index, MPV: mean platelet volume, RDW: red cell distribution width

Table 4: Preoperative and postoperative risk factors for postoperative 30-day mortality; univariate analysis (mean±SD)

	Mortalite (-)	Mortalite (+)	P value
Preoperative variables			
Hemoglobin, g/dl	13.1±1.8	12.4±2.4	0.045*
MPV, fL	9.1±1.1	9.0±1.2	0.651
RDW	14.5±1.7	14.9±2.3	0.216
Neutrophil/Lymphocyte	3.6±3.5	2.8±1.6	0.208
Platelet,10^3/UL	232.8±68.2	236.0±97.6	0.804
Glucose, mg/dl	133.3±64.0	127.6±44.9	0.527
Urea, mg/dl	44.0±18.1	56.6±34.4	0.001*
Creatinine, mg/dl	1.2±2.7	1.2±0.4	0.921
Albumin, g/dl	3.8±0.6	3.5±0.6	0.003*
Postoperative variables			
Hemoglobin, g/dl	9.4±1.4	8.5±0.9	0.000*
MPV, fL	9.4±1.2	9.3±1.3	0.944
RDW	14.8±1.6	14.9±1.0	0.660
Neutrophil/Lymphocyte	16.8±13.4	23.1±16.5	0.015
Platelet,10^3/UL	159.6±59.5	115.4±61.9	0.001*
Glucose, mg/dl	169.2±46.3	223.4±106.1	0.000*
Urea, mg/dl	44.9±17.0	64.8±33.8	0.000*
Creatinine, mg/dl	1.2±0.6	1.6±0.6	0.001*
Albumin, g/dl	3.0±0.5	2.6±0.3	0.000*

Values are expressed as mean ± SD, MPV: mean platelet volume, RDW: red cell distribution width

postoperative risk factor. High glucose and urea levels were considered as postoperative risk factors. Albumin was also a preoperative and postoperative risk factor as for postoperative 30-day-mortality. Higher postoperative glucose and urea levels were evaluated as postoperative risk factors (Table 5).

DISCUSSION

In this study, we investigated the effects of perioperative laboratory parameters on postoperative complications and mortality in patients aged 65 and over who underwent cardiovascular surgery. We found that among preoperative factors, low hemoglobin and albumin, and high glucose and urea levels were associated with postoperative complications. We also determined that preoperative low hemoglobin and albumin and high urea levels were significantly associated with 30-day mortality.

When the postoperative laboratory data were evaluated, postoperative low hemoglobin, platelet, and albumin and high glucose, urea, and creatinine scores were observed to be associated with postoperative complications. Furthermore, postoperative low hemoglobin, thrombocyte, and albumin and high glucose, urea, and creatinine scores were found to be significantly associated with 30-day mortality.

Although there are many prognostic markers being used to evaluate surgical patients in the literature, these markers are still being investigated for elderly patients. Today, there are studies evaluating the effects of easily observable laboratory parameters on postoperative morbidity and mortality, as well as markers such as age, BMI, accompanying comorbidities, and Euroscore which are widely used in the middle age group [4,6-9]. It has been emphasized that the presence of preoperative anemia (<13g / dl regardless of gender) is a very strong indicator of mortality in surgical patients [10-12]. It has been reported that 16-54% of patients undergoing cardiac surgery suffer anemia [13], and most cases have resulted from iron deficiency [10,14]. In elderly patients,

Table 5: Multivariate regression analysis of pre-, and post-operative risk factors

Preoperative variables for postoperative complications	OR	95% CI	p value
Hemoglobin, g/dl	0.983	0.8-1.1	0.822
Glucose, mg/dl	1.002	0.9-1.0	0.212
Urea, mg/dl	1.008	0.9-1.0	0.240
Albumin, g/dl	0.474	0.3-0.8	0.003*
Postoperative variables for postoperative complications			
Hemoglobin, g/dl	1.029	0.8-1.3	0.824
Platelet,10^3/uL	0.996	0.9-1.0	0.187
Glucose, mg / dl	1.008	1.00-1.01	0.009*
Urea, mg/dl	1.032	1.01-1.05	0.001*
Creatinine, mg/dl	1.068	0.6-1.7	0.815
Albumin, g/dl	0.287	0.1-0.5	0.000*
Preoperative variables for postoperative 30- day mortality			
Hemoglobin, g/dl	1.038	0.8-1.3	0.738
Urea, mg/dl	1.015	1.00-1.03	0.054
Albumin, g/dl	0.497	0.3-0.9	0.036*
Postperative variables for postoperative 30- day mortality			
Hemoglobin, g/dl	0,606	0.4-1.0	0.087
Platelete,10^3/uL	0,088	0.9-1.0	0.088
Glucose, mg/dl	0.015	1.00-1.02	0.015*
Urea, mg/dl	0.002	1.02-1.07	0.002*
Creatinine, mg/dl	0.210	0.2-1.4	0.210
Albumin, g/dl	0.034	0.1-0.9	0.034*
Neutrophil/Lymphocyte ratio	0.061	0.9-1.0	0.061

preoperative anemia may develop mostly due to malnutrition, malabsorption, bone marrow dysfunction , or chronic blood loss. In many studies, it is stated that anemia impairs the quality of life in the elderly and causes cognitive dysfunction, depression, and congestive heart failure. It is also stated that it causes an increase in mortality, length of hospital stays, and cost [15,16]. In a study by Spahn et al. [10], it was observed that simply administering intravenous iron treatment to elderly patients with iron deficiency anemia the day before surgery had a positive impact on postoperative results. Elective surgeries are recommended to be postponed for 2-3 weeks in elderly patients with iron deficiency meanwhile filling iron stores with intravenous iron preparations since adequate absorption cannot be achieved with oral supplements during this period [7,10]. In our study, the presence of preoperative and postoperative anemia was found to be associated with postoperative complications and 30-day mortality. Due to age-related physiological changes and the effect of anemia, these patients may be more susceptible to hypoxia. Preoperative low albumin was reported to be a risk factor for the development of postoperative atrial fibrillation in elderly patients with off-pump cardiac surgery [17]. Another study suggested that low hemoglobin and albumin scores were not associated with postoperative atrial fibrillation, ventricular fibrillation, or asystole [11]. In our study, the most frequent postoperative complications were bleeding (8.9%), cardiac arrhythmias (5.2%), and neurological complications (3.5%). The data we obtained in this study show that elderly patients with anemia must receive treatment in the preoperative period. As oral iron replacement might be ineffective due to possible nutritional disorders or malabsorption, intravenous iron preparations may be considered.

In elderly patients, blood albumin levels may change due to malnutrition, or malabsorption. To this aim, the geriatric nutritional risk index (GNRI) evaluating nutritional risk factors according to height, weight, and serum albumin levels has been developed [8]. In the literature, a comprehensive geriatric assessment (CGA) and related frailty rates have been defined for each negative indicator, including accompanying malnutrition, anemia, and low albumin levels, and these scales have been reported to reduce morbidity [3,18]. A recent report has recommended avoiding surgery in patients with preoperative albumin levels <3 mg/dl, as the condition is associated with malnutrition and adverse postoperative outcomes [9]. In a study evaluating 4551 patients who had undergone total knee surgery, patients with albumin levels <3.5 mg/dl had a higher incidence of postoperative pneumonia, surgical site and urinary tract infections, sepsis, intraoperative and postoperative blood transfusions, prolonged mechanical ventilation periods, and acute renal failure [19]. In a different study comparing different albumin levels after cardiac surgery, as hypoalbuminemia deteriorated, patients with albumin <3 mg/dl were found to be more vulnerable to septic and bleeding-related complications, and even long-term survival rates were affected [9]. In our study, we have found that low albumin levels are both preoperative and postoperative independent risk factors. Postoperative bleeding, arrhythmias, infections, and neurological complications were observed more frequently in patients with albumin levels <3.5 ± 0.7 mg/dl in the preoperative period and <2.7 ± 0.5 mg/dl in the postoperative period. It is essential to plan how to improve the total quality of nutrition to mitigate or eliminate the postoperative impacts of this important predictor. It is possible to cooperate with the surgeon and dietician to ensure that the patients are optimally prepared for the surgery.

Hyperglycemia is an important cause of morbidity and mortality in elderly patients [20,21]. Even in non-diabetic patients, blood sugar levels may increase by various mechanisms (physiological stress response, deterioration of nutrition, etc.). These conditions also increase the risk of infection. In the literature, it has been stated that uncontrolled hyperglycemia is associated with poor postoperative clinical results and that although there is no consensus on an appropriate blood glucose level, a fasting blood glucose level above 126 mg/dl raises postoperative mortality [22]. Another study stated that blood glucose levels should be <200 mg/dl to prevent postoperative infections [23]. In our study, we found that preoperatively increased glucose levels (143.7 ± 72.3 mg/dL) were significantly associated with early postoperative complications. Postoperative glucose elevation (197.0 ± 75.1) was another independent

risk factor that can lead to postoperative complications and mortality.

Elderly patients are more likely to get dehydrated than middle-aged patients. Along with aging, kidney functions may be limited or impaired due to conditions such as loss of nephrons, decreased feeling of thirst, forgetfulness. In addition, the catabolic processes and nutritional status affect blood urea-creatinine levels [24,25]. In patients undergoing cardiovascular surgery, cardiac dysfunction, accompanying comorbidities (especially diabetes and hypertension), multiple drug use, cardiopulmonary bypass, renal ischemia-reperfusion, increased intraabdominal pressure, and inflammatory, immunological, and neurohumoral factors may increase the susceptibility to acute kidney injury (AKI) [25,26]. In a study comparing the incidence of AKI development in patients aged 18-69, and older who underwent cardiac surgery was found to be 3.1% and 10.5%, respectively [27]. It was reported that preoperative creatinine > 1.5 mg/dl increased postoperative mortality by 5-30% [28]. It is estimated that kidney mass and blood flow decrease by > 10% in each decade of life [25]. With the reduced sense of thirst and poor nutrition in elderly patients, blood urea and creatinine levels might be at the top limit or exceed it at the time of admission to the hospital. In our study, we found that postoperative elevation of creatinine was also a significant marker of postoperative complications and mortality. Postoperative elevation of blood was an independent variable in postoperative complications and mortality. We regard that the preoperative evaluation of elderly patients is of particular importance. We believe that negative postoperative conditions can be minimized with the appropriate measures to be taken on time.

Inflammatory mediators, which are present in the circulation in high quantities, have been reported to be one of the possible causes of cardiovascular disease [29]. Similarly, it is stated that the increase in hematological mediators such as MPV, RDW, and NLR could be a negative prognostic factor in acute coronary syndrome [30,31]. Although the primary pathophysiological mechanism that triggers the increase of RDW levels in the blood is unknown, it has been mostly associated with inflammation and nutritional disorder. Zalyesov et al. [32] found that the role of RDW in predicting mortality is closely related to advanced age. A different study suggested that the predictive power of double or triple combinations of MPV, RDW, and NLR parameters derived from the hemogram was higher than the predictive value of a single parameter [30]. Contrary to the literature, no significant effect of MPV, RDW, and NLR parameters on postoperative morbidity and mortality was found in our study. We consider that this might result from atypical inflammatory responses in elderly patients.

Elderly patients who will undergo cardiovascular surgery are at a high risk of coagulopathy and bleeding because of provoking factors as suppressed hematopoietic system, general anesthesia, medications used, prolonged CPB , and hypothermia. In addition, iron deficiency anemia, infections, mechanical heart valves, and disorders triggered by surgical trauma can lead to thrombocytosis/thrombocytopenia [33]. To have a more accurate postoperative prognosis, evaluating the number of platelets may offer significant data. In our study, we found that postoperatively decreased platelet counts (115.4±61.9 10^3/fL) were associated with postoperative complications and 30-day mortality.

The retrospective nature of data collection and differences in surgical procedures applied may be some limitations in our study which aimed to evaluate the mortality markers for elderly patients undergoing cardiovascular surgery. Another limitation of this study was that we did not calculate the geriatric nutrition risk index, which has been presented as an important marker in recent studies.

In conclusion, both preoperative and postoperative low hemoglobin and albumin, high glucose and urea levels were found to be risk factors for postoperative complications and mortality in elderly patients who underwent cardiovascular surgery. Postoperative low platelet counts and high creatinine levels were found to be associated with postoperative complications. Also, preoperative low hemoglobin, albumin levels and platelet counts, high glucose, urea, and creatinine levels were found to be significantly associated with 30-day mortality. We are of the opinion that closely monitoring the nutritional status of elderly patients, providing them

with dietary supplementation for deficient parameters, and keeping blood glucose, urea, and creatinine at optimum levels could help us to decrease hospital stay, mortality, morbidity, and total economic cost.

REFERENCES

1. Friedrich I, Simm A, Kötting J, Thölen F, Fischer B, Silber RE. Cardiac surgery in the elderly patient. Dtsch Arztebl Int 2009;106(25):416-2. https://doi.org/10.3238/arztebl.2009.0416
2. Yaffee DW, Williams MR. Cardiovascular Surgery in the Elderly. Semin Thorac Cardiovasc Surg 2016;28(4):741-7. https://doi.org/10.1053/j.semtcvs.2016.08.007
3. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol SciMed Sci 2001;56.(3):146-56. https://doi.org/10.1093/gerona/56.3.M146
4. Machado AN, Sitta MC, Filho WJ, Garcez-Leme LE. Prognostic factors for mortality among patients above the 6th decade undergoing non-cardiac surgery: cares-clinical assessment and research in elderly surgical patients. Clinicss 2008;63(2):151-6. https://doi.org/10.1590/S1807-59322008000200001
5. Yılmaz MB, Korkmaz Ş. Cardiovascular disease in the elderly. Turkiye Klinikleri J Cardiol 2002;15(6):406-15.
6. Warwick R, Mediratta N, Shaw M, McShane J, Pullan M, Chalmers J, et al. Red cell distribution width and coronary artery bypass surgery. Eur J Cardio-thoracic Surg 2013;43(6):1165-9. https://doi.org/10.1093/ejcts/ezs609
7. Rössler J, Schoenrath F, Seifert B, Kaserer A, Spahn GH, Falk V, et al. Iron deficiency is associated with higher mortality in patients undergoing cardiac surgery: a prospective study. Br J Anaesth 2020;124(1):25-34. https://doi.org/10.1016/j.bja.2019.09.016
8. Sasaki M, Miyoshi N., Fujino S, Ogino T, Takahashi H, Uemura M, et al. The Geriatric Nutritional Risk Index predicts postoperative complications and prognosis in elderly patients with colorectal cancer after curative surgery. Sci Rep 2020;10(1):1-9. https://doi.org/10.1038/s41598-020-67285-y
9. Berbel-Franco D, Lopez-Delgado JC, Putzu A, Esteve F, Torrado H, Farrero E, et al. The influence of postoperative albumin levels on the outcome of cardiac surgery. J Cardiothorac Surg 2020;15:1-13. https://doi.org/10.1186/s13019-020-01133-y
10. Rubinger DA, Cahill C, Ngo A, Gloff M, Refaai MA. Preoperative Anemia Management: What's New in 2020? Curr Anesthesiol Rep 2020;10:166-75. https://doi.org/10.1007/s40140-020-00385-7
11. TauriainenT, Koski-Vahala J, Kinnunen EM, Biancari F. The Effect of Preoperative Anemia on the Outcome After Coronary Surgery. World J Surg 2017;41(7):1910-18. https://doi.org/10.1007/s00268-017-3911-0
12. Ranucci M, DiDedda U, Castelvecchio S, Menicanti L, Frigiola A, Pelissero G. Surgical and Clinical Outcome Research (SCORE) Group. Impact of preoperative anemia on outcomes in adult cardiac surgery: a propensity-matched analysis. Ann Thorac Surg 2012;94:1134-42. https://doi.org/10.1016/j.athoracsur.2012.04.042
13. Padmanabhan H, Siau K, Curtis J, Alex Ng, Menon S, Luckraz H, et al. Preoperative anemia and outcomes in cardiovascular surgery: systematic review and meta-analysis. The Ann Thorac Surg 2019;108(6):1840-48. https://doi.org/10.1016/j.athoracsur.2019.04.108
14. Spahn DR, Schoenrath F, Spahn GH, Seifert B, Stein P, Theusinger OM, et al. Effect of ultra-short-term treatment of patients with iron deficiency or anaemia undergoing cardiac surgery: a prospective randomised trial. Lancet 2019;393(10187):2201-12. https://doi.org/10.1016/S0140-6736(18)32555-8
15. Smith DL. Anemia in the elderly. Am Fam Physician 2000;62:1565-72.
16. Patel KV, Guralnik JM. Prognostic implications of anemia in older adults. Haematologica 2009;94:1-2. https://doi.org/10.3324/haematol.2008.001289
17. Akgül E, Parlar Aİ, Alptekin Erkul GS, Erkul S, Cekirdekci A. Investigation of the Effect of Preoperative Hypoalbuminemia, Blood Urea Nitrogen and Creatinine Levels on Postoperative Atrial Fibrillation on Off-Pump Coronary Bypass Surgery Patients. HSF 2020;23(5):641-6. https://doi.org/10.1532/hsf.3163
18. Osterweil D. Comprehensive geriatric assessment: lessons in progress. Isr Med Assoc J 2003;5:371-4.
19. Kamath Af, Nelson C, Elkassabany N, Guo Z, Liu J. Low Albumin Is a Risk Factor for Complications after Revision Total Knee Arthroplasty. J Knee Surg 2017; 30(03):269-75. https://doi.org/10.1055/s-0036-1584575
20. Doenst T, Wijeysundera D, Karkouti K, Zechner C, Maganti M, Rao V, et al. Hyperglycemia during cardiopulmonary bypass is an independent risk factor for mortality in patients undergoing cardiac surgery. J Thorac Cardiovasc Surg 2005;130(4):1144. https://doi.org/10.1016/j.jtcvs.2005.05.049
21. Galindo RJ, Fayfman M, Umpierrez GE. Perioperative Management of Hyperglycemia and Diabetes in Cardiac Surgery Patients. Endocrinol Metab Clin North Am 2019;47(1),203-22. https://doi.org/10.1016/j.ecl.2017.10.005
22. Van den Berghe G, Wouters P, Weekers F, Verwaest C. Intensive insulin therapy in critically ill patients. N Engl J Med 2001;345:125-39. https://doi.org/10.1056/NEJMoa011300
23. McGory ML, Kao KK, Shekelle PG, et al. Developing quality indicators for elderly surgical patients. Ann Surg 2009;250:338-47. https://doi.org/10.1097/SLA.0b013e3181ae575a
24. Rosner MH. Acute Kidney Injury in the Elderly. Clin Geriatr Med. 2019;29(3):565-78. https://doi.org/10.1016/j.cger.2013.05.001
25. Infante B, Franzin R, Madio, D, Calvaruso M, Maiorano A, Sangregorio F, et al. Molecular Mechanisms of AKI in the Elderly: From Animal Models to Therapeutic Intervention. J Clin Med. 2020;9(8):2574. https://doi.org/10.3390/jcm9082574
26. Grieshaber P, Möller S, Arneth B, Roth P, Niemann B, Renz H, et al. Predicting Cardiac Surgery-Associated Acute Kidney Injury Using a Combination of Clinical Risk Scores and Urinary Biomarkers. Thorac Cardiovasc Surg. 2020;68(5):389-400. https://doi.org/10.1055/s-0039-1678565

27. Ried M, Puehler T, Haneya A, Schmid C, Diez C. Acute kidney injury in septua- and octogenarians after cardiac surgery. BMC Cardiovasc Disord 2011;11(1):52. https://doi.org/10.1186/1471-2261-11-52
28. Machado MN, Nakazone MA, Maia LN. Acute kidney injury based on KDIGO (Kidney Disease Improving Global Outcomes) criteria in patients with elevated baseline serum creatinine undergoing cardiac surgery. Rev Bras Cir Cardiovasc 2014;29(3):299-307. https://doi.org/10.5935/1678-9741.20140049
29. Park BJ, Shim JY, Lee HR, Jung DH, Lee JH, Lee YJ. The relationship of platelet count, mean platelet volume with metabolic syndrome according to the criteria of the American Association of Clinical Endocrinologists: A focus on gender differences. Platelets. 2012;23:45-50. https://doi.org/10.3109/09537104.2011.589014
30. Aydınlı B, Demir A, Güçlü ÇY, Bölükbaşı D, Ünal EU, Koçulu R, et al. Hematological predictors and clinical outcomes in cardiac surgery. J Anesth 2016;30:770-8. https://doi.org/10.1007/s00540-016-2197-y
31. Muhmmed Suliman MAR, Bahnacy Juma AA, Ali Almadhani AA, Pathare AV, Alkindi SSA, Uwe Werner F. Predictive Value of Neutrophil to Lymphocyte Ratio in Outcomes of Patients with Acute Coronary Syndrome. Arch Med. Res 2010;41(8):618-22. https://doi.org/10.1016/j.arcmed.2010.11.006
32. Zalyesov E, Shugaev I, Prokopov Y, Shahory R, Chirmicci S, Aizen E. Red Cell Distribution Width as a Predictor of Functional Outcome in Rehabilitation of Older Stroke Patients. Ann Geriatr Med. Res 2020;24(3):211-7. https://doi.org/10.4235/agmr.20.0042
33. Hermann W, Risch L, Grebhardt C, Nydegger UE, Sakem B, Imperiali M, et al. Reference Intervals for Platelet Counts in the Elderly: Results from the Prospective SENIORLAB Study. J Clin Med. 2020;9(9):2856. https://doi.org/10.3390/jcm9092856