To cite this article: Yesiler Fİ, Kosovali BD, Sendur UG,Yuksekyayla O. Is prognostic nutritional ındex mortality predictor in patients with acute stroke in the ıntensive care unit?. Turk J Clin Lab 2022; 3: 416-423.

Original Article

Is prognostic nutritional index mortality predictor in patients with acute stroke in the intensive care unit?

Yoğun bakım ünitesinde akut strok hastalarında prognostik nütrisyonel indeks mortalite belirleyicisi mi?

Fatma Irem Yesiler*[1], Behiye Deniz Kosovalı[2], Umit Gokhan Sendur[3], Osman Yuksekyayla[4]

[1]Department of Anesthesiology and Critical Care Unit, Baskent University Faculty of Medicine, Ankara, Turkey
[2]Department of Intensive Care Unit, Ankara City Hospital, Ankara, Turkey
[3]Department of Internal Medicine, Alanya Alaaddin Keykubat University Alanya Education and Research Hospital, Antalya, Turkey
[4]Department of Internal Medicine, Şanlıurfa Training and Research Hospital, Şanlıurfa, Turkey

Abstract

Aim: The prognostic nutritional index (PNI) is a simple and useful score for predicting the prognosis in various diseases such as cancers, ischemic heart disease, and pulmonary embolism.The aim of our study is to investigate the association between PNI level and mortality rates of patients with ischemic or hemorrhagic acute stroke (AS) admitted to the intensive care unit (ICU).

Material and Methods: We retrospectively analyzed records for 102 patients with ischemic and hemorrhagic AS admitted to the ICU between January 2017, and January, 2018.

Results: During the period,83.3% of 102 patients with ischemic AS, 45.1% were male.The patients were divided into two groups according to the cut-off PNI value (47.8). Patients in the low PNI group (PNI≤47.8) were older than high PNI group (PNI>47.8). Atrial fibrillation (p=0.02) and renal diseases (p=0.049) were observed more frequently in the low PNI group. APACHE II and SOFA scores were higher in the low PNI group. The length of mechanical ventilation, ICU and hospital stay were longer in the low PNI group (p<0.05). The ICU and hospital mortality rates were higher in the low PNI group (p<0.001). Presence of atrial fibrillation, high APACHE II and SOFA scores, low GCS and diastolic blood pressure, high neutrophil lymphocyte ratio and low PNI were determined as independent risk factors for mortality.

Conclusion: This study presented that low PNI level was closely associated with mortality in patients with AS. Thus, PNI may be considered as a new indicator in determining the prognosis in patients with AS.

Keywords: Acute stroke, mortality, prognostic nutritional index, intensive care unit

Corresponding author*: Fatma İrem Yesiler, Department of Anesthesiology and Critical Care, Başkent University Faculty of Medicine, Ankara, Turkey
Fevzi Çakmak Road,10th Street, Apt45 Bahçelievler
E-mail: fatmairem84@hotmail.com
ORCİD: 0000-0002-0612-8481
Doi: 10.18663/tjcl.1151391
Recevied: 31.07.2022 accepted: 19.08.2022

TJCL Volume 13 Number 3 p: 416-423

Öz

Amaç: Prognostik nutrisyonel indeks (PNI), kanser, iskemik kalp hastalığı ve pulmoner emboli gibi çeşitli hastalıklarda prognozu tahmin etmek için kullanılan basit ve kullanışlı bir skordur. Çalışmamızın amacı, yoğun bakım ünitesine (YBÜ) kabul edilen iskemik veya hemorajik akut strok (AS) hastalarının PNI düzeyi ile mortalite oranları arasındaki ilişkiyi araştırmaktır.

Gereç ve Yöntemler: Ocak 2017 ile Ocak 2018 arasında yoğun bakım ünitesine kabul edilen 102 iskemik ve hemorajik AS hastasının kayıtları retrospektif olarak analiz edildi.

Bulgular: Çalışma dönemindeki 102 hastanın %83,3'ü iskemik akut strok hastasıydı ve %45,1'i erkekti. Hastalar cut-off PNI (47,8) değerine göre iki gruba ayrıldı. Düşük PNI (PNI≤47,8) grubundaki hastalar, yüksek PNI (PNI>47,8) grubundan daha yaşlıydı. Atriyal fibrilasyon (p=0,02) ve renal hastalıklar (p=0,049) düşük PNI grubunda daha sık gözlendi. APACHE II ve SOFA skorları düşük PNI grubunda daha yüksekti. Mekanik ventilasyon, YBÜ ve hastane kalış süresi düşük PNI grubunda daha uzundu (p<0,05). YBÜ ve hastane mortalite oranları düşük PNI grubunda daha yüksekti (p<0,001). Atriyal fibrilasyon varlığı, yüksek APACHE II ve SOFA skorları, düşük GKS ve diyastolik kan basıncı, yüksek nötrofil lenfosit oranı ve düşük PNI mortalite için bağımsız risk faktörleri olarak belirlendi.

Sonuç: Bu çalışma, akut strok hastalarında düşük PNI düzeyinin mortalite ile yakından ilişkili olduğunu ortaya koymuştur. Bu nedenle akut strok hastalarında prognozu belirlemede PNI yeni bir gösterge olarak düşünülebilir.

Anahtar Kelimeler: Akut strok, mortalite, prognostik nütrisyonel indeks, yoğun bakım ünitesi

Introduction

Acute stroke (AS) is a central nervous system (CNS) disease characterized by acute neurological deficits caused by cerebral ischemic and/or hemorrhagic causes [1]. Stroke is the first leading cause of disability. According to the World Health Organization data, stroke is the second most common cause of death after ischemic heart diseases. Worldwide, it is responsible for approximately 11% of total deaths [2]. Because of the high mortality and morbidity rates associated with AS, the patients with AS are followed in intensive care unit (ICU) [3,4].

In recent years, some studies have been carried out with clinical findings, scoring systems, biochemical markers and imaging methods in order to predict the mortality of ischemic heart diseases, pulmonary embolism, acute kidney injury, cancers and strokes, which are diseases with high mortality [5,6,7,8,9,10]. The prognostic nutritional index (PNI) is a combined score used to evaluate the prognosis of diseases. It can be accepted as an indicator of nutritional and immune status of patients, which can be easily measured by serum albumin value and lymphocyte count. PNI has been associated with different inflammatory processes in previous studies [11,12,13]. Clinical trials have shown that lower PNI was related with poor survival in cancer cases following surgery [3,6,8]. There is a lack of studies and data about the relationship between the prognostic role of PNI and outcomes in patients with AS.

The aim of our study is to investigate the effect of PNI level on mortality of patients with ischemic or hemorrhagic AS admitted to Şanlıurfa Training and Research Hospital ICU between January 2017 and January 2018.

Material and Methods

The medical records of patients aged 18 years or more with ischemic and/or hemorrhagic acute stroke between January 2017 and January 2018 were retrospectively analyzed in our ICU. Patients younger than 18 years, who had acute infection and whose data were not available were excluded from the study. The patients were divided into 2 groups with the cut-off PNI value; those with a PNI ≤ 47.8 were included in the low PNI group, and those with a PNI>47.8 in the high PNI group

The primary outcome of the study was to investigate the effect of PNI level on ICU and hospital mortality of patients with AS. The secondary outcome was to determine the demographic characteristics, the need for mechanical ventilation, length of ICU and hospital stay of the patients with AS.

The following data were obtained from electronic medical and nursing records: patient age; sex; comorbidities (hypertension, diabetes mellitus, hypercholesterolemia, renal disease, malignancy, chronic obstrucitve pulmonary disease and smoking); stroke type and number of stroke attack; Acute Physiology and Chronic Health Evaluation System (APACHE II) score; Sequential Organ Failure Assessment (SOFA) score;

Glasgow Coma Score (GCS); blood pressure at ICU admission; need for intubation and mechanical ventilation (MV) (noninvasive or invasive); carotid – vertebral artery doppler ultrasonography (USG) examination; nutritional support type (oral, enteral, parenteral); treatments; complications (pneumonia, bleeding, acute renal failure); length of ICU-hospital stay and ICU-hospital mortality.

Hemoglobin, lymphocyte, arterial blood gas (lactate), glucose, albumin, CRP, prognostic nutritional index, TSH, Free T4, Vitamin B12, folate, HbA1c, total cholesterol (TC), triglyceride, high-density lipoprotein cholesterol (HDL-C), and Low-density lipoprotein cholesterol (LDL-C) were assessed within first 24 h of ICU admission

Acute stroke is defined as the acute onset of focal neurological findings in a vascular territory as a result of underlying cerebrovascular disease. The primary end points were the incidence of ICU or hospital mortality. Hospital mortality was defined 30-day mortality as death from any cause after discharge.

PNI was calculated by using following formula: "Serum albumin levels (g/dl) x 10 + total lymphocyte count in peripheral blood (per mm3) x 0.005" for each patient [3,11,13]. PNI was calculated on ICU admission.

Statistical analysis

The statistical analysis was performed using The Statistical Package for Social Sciences 25.0 (version 25.0; SPSS Inc., Chicago, IL, USA). Frequencies were expressed as numbers (n) and percentages (%). Variables are expressed as mean values ± standard deviation. Categorical variables between the two groups were analyzed with the chi-square test. The non-parametric continuous variables between two groups were compared by Mann-Whitney test or Student-t test. Logistic regression (univariate and multivariate) was used to assess the independent relationship between PNI and ICU/hospital mortality. The receiver operating characteristic (ROC) curve was carried out to determine the optimal cut-off value of PNI. Factors affecting mortality were determined by univariate and multivariate logistic regression analyses. A value of $p<0.05$ was considered statistically significant.

This study was approved by the Harran University Clinical Research and Ethics Committee (project no: HRU/20.11.11) in accordance with the principles of the Declaration of Helsinki.

Results

During the period, 102 patients with AS, 46 (45.1%) were male and 56 (54.9%) were female. The mean age of the study cohort was 66.8±12.7 years (between 31 and 93 years). The patients in the low PNI group were older than those in the high PNI group (70.1±13.6 vs. 65.0±11.9, p=0.025). Eighty-five patients (83.3%) had ischemic and 17 patients (16.7%) had hemorrhagic AS. Hypertension (81.4%) was the most common comorbidity. Atrial fibrillation (34.2% vs. 14.1%, p=0.02) and renal diseases (7.9% vs.0%, p=0.049) were observed more frequently in the low PNI group than the high PNI group. Table 1 presented the demographic and clinical characteristics of the low PNI group and high PNI group.

Table 1. Demographic and Clinical Characteristics of Patients with Different PNI

Characteristics	Total (n=102)	High PNI (n=64)	Low PNI (n=38)	P value
Age (year,mean±SD)	66.8±12.7	65.0±11.9	70.1±13.6	0.025
Frequency (n) / Percentage (%)				
Sex				1.0
Male	46 (45.1)	29 (45.3)	17 (44.7)	
Female	56 (54.9)	35 (54.7)	21 (55.3)	
Etiology				0.4
Ischemic	85 (83.3)	55 (85.9)	30 (78.9)	
Hemorrhagic	17 (16.7)	9 (14.1)	8 (21.1)	
Number of Previous CVD				0.8
One	22 (21.6)	14 (21.9)	8 (21.1)	
Two	3 (2.9)	1 (1.6)	2 (5.3)	
Three	2 (2.0)	2 (3.1)	0 (0.0)	
Comorbidities				
Hypertension	83 (81.4)	56 (87.5)	27 (71.1)	0.06
Diabetes Mellitus	26 (25.5)	18 (28.1)	8 (21.1)	0.4
Coronary Artery Disease	18 (17.6)	12 (18.8)	6 (15.8)	0.7
Congestive Heart Failure	11 (10.8)	6 (9.4)	5 (13.2)	0.7
Atrial Fibrillation	22 (21.6)	9 (14.1)	13 (34.2)	0.02
Hyperlipidemia	21 (20.6)	15 (23.4)	6 (15.8)	0.4
Renal diseases	3 (2.9)	0 (0.0)	3 (7.9)	0.049
Malignancy	5 (4.9)	2 (3.1)	3 (7.9)	0.3
COPD	8 (7.8)	4 (6.3)	4 (10.5)	0.4

PNI: Prognostic Nutrition Index, SD: Standard Deviation, CVD: Cerebrovascular Diseases, COPD: Chronic Obstructive Pulmonary Disease, , p<0.05 was considered statistically significant.

The mean APACHE II score was 15.5 ± 6.7, SOFA score was 2.8 ± 2.5, GCS was 11.8 ± 3.5 and on ICU admission of all patients. APACHE II and SOFA scores were higher and GCS (on ICU admission or discharge) and diastolic blood pressure were lower in the low PNI group than the high PNI group (Table 2).

Twenty-four patients (23.5%) required endotracheal intubation and invasive mechanical ventilation (IMV). Non-invasive mechanical ventilation (NIMV) was used in 2 patients (2%). IMV was used more in the low PNI group than the high PNI group (50% vs. 7.8%, p<0.001). Thirty-five patients (34.3%) had carotid stenosis, 17 patients <%50, 18 patients ≥ 50% of stenosis. Vertebral artery stenosis was seen in 7 patients (6.9%) (Table 2).

Table 2. Severity Scores and Features on ICU Admission of Patients with Different PNI

	Mean±SD			
Features	Total (n=102)	High PNI (n=64)	Low PNI (n=38)	P value
APACHE-II score	15.5±6.7	12.6±4.2	20.5±7.3	<0.001
SOFA score	2.8±2.5	1.7±1.5	4.8±2.6	<0.001
GCS (on ICU admission)	11.8±3.5	13.3±2.5	9.3±3.5	<0.001
GCS (on ICU discharge)	11.4±4.9	13.3±3.5	8.2±5.2	<0.001
SBP (mmHg)	165.0±31.4	168.6±30.0	159.1±33.3	0.3
DBP (mmHg)	94.6±19.8	98.7±19.2	87.7±19.1	0.005
MAP (mmHg)	116.1±23.4	119.3±22.3	110.8±24.4	0.1
Lactate (mmol/L)	2.1±1.0	2.0±0.8	2.4±1.2	0.1
Duration of MV (day)	2.8±9.4	0.3±1.5	6.9±14.5	<0.001
Length of ICU stay (day)	8.7±11.9	5.7±7.7	13.7±15.5	<0.001
Length of Hospital stay (day)	13.2±13.0	10.4±8.9	18.0±17.1	0.049
	Frequency (n) / Percentage (%)			
Need of MV				<0.001
NIMV	2 (2.0)	1 (1.6)	1 (2.6)	
IMV	24 (23.5)	5 (7.8)	19 (50.0)	
Carotid Stenosis				0.3
Stenosis <50%	17 (16.7)	9 (14.1)	8 (21.1)	
Stenosis ≥50%	18 (17.6)	11 (17.2)	7 (18.4)	
Presence of vertebral artery stenosis	7 (6.9)	5 (7.8)	2 (5.3)	1.0
Using Antiaggregant drugs	81 (79.4)	53 (82.8)	28 (73.7)	0.3
Using Anticoagulant drugs	84 (82.4)	55 (85.9)	29 (76.3)	0.3
Nutrition				<0.001
Oral	65 (63.7)	52 (81.3)	13 (34.2)	
Enteral	37 (36.3)	12 (18.8)	25 (65.8)	
Complications				0.005
Pulmonary Infections	20 (19.6)	9 (14.1)	11 (28.9)	
Gastrointestinal bleeding	3 (4.9)	0	3 (7.9)	
Others	16 (15.7)	7 (10.9)	9 (23.7)	
ICU Mortality	23 (22.5)	6 (9.4)	17 (44.7)	<0.001
Hospital Mortality	25 (24.5)	7(10.9)	18 (47.4)	<0.001

SD: Standart Deviation, PNI: Prognostic Nutrition Index, APACHE: Acute Physiology and Chronic Health Evaluation, SOFA: Sepsis-Related Organ Failure Assessment, GCS: Glasgow Coma Scale, ICU: Intensive Care Unit, SAP: Systolic Blood Pressure, DAP: Diastolic Blood Pressure, MAP: Mean Arterial Pressure, MV: Mechanical Ventilation, NIMV: Noninvasive Mechanical Ventilation, IMV: Invasive Mechanical Ventilation, p<0.05 was considered statistically significant.

Sixty-five patients (63.7%) had oral nutrition and 37 patients (36.3%) had enteral nutrition support. None of the patients received parenteral nutrition. While more enteral nutrition was used in the low PNI group (65.8% vs. 18.8%, p<0.001), the majority of the high PNI group had oral nutrition (81.3% vs. 34.2%, p<0.001). The most common complication was pulmonary infections (19.6%). The frequency of complications as pulmonary infections was higher in the low PNI group than the high PNI group (28.9% vs. 14.1%, p=0.005) (Table 2).

The mean length of stay in mechanical ventilation, ICU and hospital were 2.8±9.4, 8.7±11.9 and 13.2±13.0 days. The length of mechanical ventilation, ICU and hospital stay were longer in the low PNI group than the high PNI group (6.9±14.5 vs. 0.3±1.5, p<0.001, 13.7±15.5 vs. 5.7±7.7, p<0.001, 18.0±17.1 vs. 10.4±8.9, p=0.049) (Table 2).

Laboratory data including total cholesterol, LDL-C, folate, lymphocyte, albumin, CRP-albumin ration were lower; troponin, CRP, NLR and PLR were higher in the low PNI group compared to the high PNI group (Table 3).

The ROC curve analysis of PNI for predicting an AUC of 0.776 (95% CI:0.660–0.891; p<0.001). The optimal cut-off value of the PNI was 47.8 (sensitivity: 72%, specificity: 26%; Figure 1).

Table 3. Laboratory Values of Patients with Different PNI				
Parameters (mean±SD)	Total (n=102)	High PNI (n=64)	Low PNI (n=38)	P value
Glucose (mg /dl)	147.0±66.4	149.0±72.9	143.6±54.5	0.8
Total Cholesterol (mg/dl)	174.5±47.8	181.4±44.2	160.9±52.3	0.035
Triglyceride (mg/dl)	169.7±137.3	183.6±154.0	142.5±92.8	0.1
LDL-C (mg/dl)	106.4±37.1	110.7±33.0	98.4±43.1	0.049
HDL-C (mg/dl)	36.6±11.6	37.2±10.7	35.3±13.3	0.7
TSH (mIU/l)	3.3±7.9	4.1±9.6	1.6±1.2	0.2
Folate (ng/ml)	7.2±3.7	7.9±3.6	5.8±3.6	0.001
Vitamin B12 (pg/ml)	332.8±402.2	308.0±368.7	383.3±465.9	0.2
Hemoglobin A1c (%)	6.5±1.8	6.8±2.0	5.9±1.4	0.1
Troponin (ng/ml)	22.3±29.5	15.2±21.1	34.4±37.1	<0.001
Lymphocyte (103/µl)	1.9±1.0	2.3±1.0	1.2±0.6	<0.001
Albumin (g/dl)	4.0±0.5	4.2±0.4	3.6±0.5	<0.001
CRP (mg/dl)	20.5±50.5	11.3±19.0	36.2±77.0	0.046
PNI (%)	50.2±9.9	54.9±9.1	42.3±4.8	<0.001
NLR (%)	7.6±10.9	3.9±3.4	13.8±15.5	<0.001
PLR (%)	169.2±137.2	124.6±60.9	244.4±189.3	<0.001
CRP-Albumin Ratio	16.0±101.7	18.7±127.0	11.5±27.0	0.027

ICU: Intensive Care Unit, PNI: Prognostic Nutrition Index, SD: Standart Deviation, LDL-C: Low-Density Lipoprotein Cholesterol, HDL-C: High-Density Lipoprotein Cholesterol, TSH: Thyroid-Stimulating Hormone, CRP: C-Reactive Protein, NLR: Neutrophil Lymphocyte Ratio, PLR: Platelet Lymphocyte Ratio

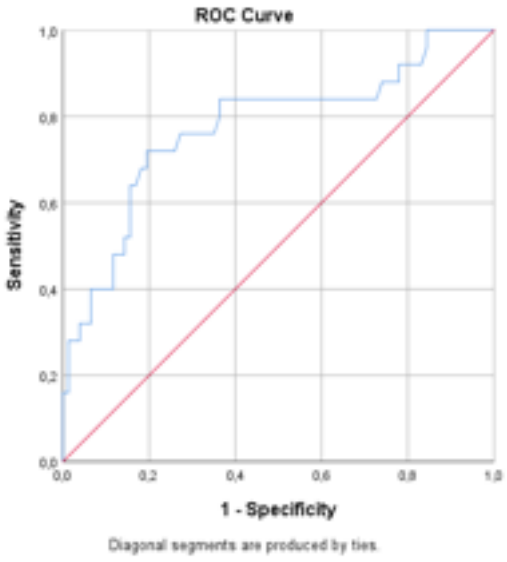

Figure 1. The Receiver Operating Characteristic curve analysis of PNI. The cut-off point of the PNI was 47.8, predicting an AUC of 0.776, sensitivity: 72%, specificity: 26%.

According to univariate logistic regression analysis; presence of atrial fibrillation (OR: 0.472, CI 95%: 0.170-1.310, p=0.047), high APACHE II and SOFA scores (OR: 0.723, CI 95%: 0.631-0.829, p<0.001, OR:0.435, CI 95%: 0.314-0.602, p<0.001), low GCS and DBP (OR: 1.594, CI 95% 1.331-1.908, p<0.001, OR:1.031, CI 95%: 1.004-1.058, p=0.02), high NLR (OR: 0.897, CI 95%:0.835-0.964, p=0.003) and low PNI (OR: 7.329, CI 95%: 2.667-20.137, p<0.001) were determined as independent risk factors for mortality (Table 4).

Table 4. Univariate Logistic Regression Analysis of Independent Predictors of Mortality in Patients with Acute Stroke			
Risk Factors	Odds ratio	%95 CI (Lower-Upper)	P value
Age	0.964	0.927-1.002	0.06
Sex	1.317	0.527-3.295	0.5
Atrial Fibrillation	0.472	0.170-1.310	0.047
APACHE-II	0.723	0.631-0.829	<0.001
SOFA	0.435	0.314-0.602	<0.001
GCS	1.594	1.331-1.908	<0.001
Diastolic Blood Pressure	1.031	1.004-1.058	0.02
Neutrophil Lymphocyte Ratio	0.897	0.835-0.964	0.003
PNI	1.177	1.084-1.279	<0.001
Low PNI	7.329	2.667-20.137	<0.001

APACHE: Acute Physiology and Chronic Health Evaluation, SOFA: Sepsis-Related Organ Failure Assessment, GCS: Glasgow Coma Scale, PNI: Prognostic Nutrition Index,

The ICU mortality rate was 22.5% and hospital mortality rate was 24.5%. The ICU and hospital mortality rates were statistically significantly higher in the low PNI group compared to the high PNI group (44.7% vs. 9.4% p<0.001, 47.4% vs. 10.9%, p<0.001, respectively) (Table 2).

Discussion

In our cohort study, the patients in the low PNI group were older than the high PNI group. Atrial fibrillation and renal

diseases were higher in the low PNI group than the high PNI group. APACHE II and SOFA scores were higher and GCS (on ICU admission or discharge) and DBP were lower in the low PNI group than the high PNI group. Need of IMV, enteral nutrition and the frequency of complications were higher in the low PNI group than the high PNI group. Total cholesterol, LDL-C, folate, lymphocyte, albumin, CRP-albumin ration were lower; troponin, CRP, NLR and PLR were higher in the low PNI group compared to the high PNI group. The length of MV, ICU and hospital stay were longer and the ICU and hospital mortality rates were higher in the low PNI group compared to the high PNI group. Presence of atrial fibrillation, high APACHE II and SOFA scores, low GCS and DBP, high NLR and low PNI were independent risk factors for mortality.

Malnutrition is a common clinical condition in AS patients. In these patients, prevalence of malnutrition at admission is around 33% [9,14,15]. International guidelines recommend nutritional assessment in patients with ischemic AS. Many tools are available for nutritional assessment, but their routine usage is not easy. Therefore, as an easily obtainable nutritional marker, PNI is more feasible in patients with ischemic AS. It is calculated based on peripheral lymphocytes counts and the serum albumin. Thus, PNI may cause awareness in the clinician about the nutritional status of patients with AS [9].

In our study, the patients in the low PNI group were older than the high PNI group. Elderly patient may have low oral intake and low albumin levels. Albumin is a negative acute phase reactant in inflammatory events. In inflammatory conditions such as acute stroke, albumin levels are often low [5,6,9,12,16,17,18]. These can be explained by the low PNI observed in elderly patients.

Although there are data on the relationship between malnutrition and arrhythmias, there is no clear explanation for the underlying pathophysiology [17,19,21]. This relationship can be explained by two possible mechanisms. Malnutrition is associated with chronic inflammation. Some studies have reported that chronic inflammation is associated with arrhythmias [3,17,20]. The other mechanism is electrolyte imbalance, trace element and vitamin deficiency that can be seen in the presence of malnutrition causing arrhythmia [17,19]. Therefore, in our cohort, atrial fibrillation was higher in patients with poor nutritional status. Presence of atrial fibrillation was an independent risk factor for mortality.

Renal diseases were higher in the low PNI group than the high PNI group of our cohort. Hypoalbuminemia is a comprehensive result of inflammation and insufcient intake of protein and calories in patients with chronic diseases. Malnutrition has been reported to be closely related to inflammation in patients with end-stage renal diseases. We think that low PNI may also be associated with chronic renal diseases [21].

PNI is associated with poor prognosis in many diseases involving the inflammatory process [4,5,6,9]. APACHE and SOFA are also severity scores used to predict prognosis in patients admitted to the ICU [22,23]. It is expected that patients with low PNI will have higher severity scores. GCS is the clinical scale that shows the state of consciousness in patients with cerebrovascular diseases. High GCS score is associated with a good prognosis. In our study, APACHE II and SOFA scores were higher and GCS was lower in the low PNI group than the high PNI group similar previous studies [3,23]. In addition, high APACHE II, SOFA and low GCS scores were independent risk factors for mortality.

In inflammation, albumin escapes into the interstitial space due to increased capillary permeability. Low albumin in the intravascular space can cause low oncotic pressure and decreased blood pressure [21,24]. Hypoalbuminemia in malnutrition may also cause hypotension with a similar mechanism [16,24]. For these reasons, DBP was lover in the low PNI group in our patient cohort, and low DBP was a predictor of mortality.

Nutritional status is considered an indicator of general health status, including immune adequacy, protein turnover, and physical condition. Malnutrition is an important health problem often associated with a poor prognosis. A reduced immune system function may cause respiratory dysfunction, delayed wound healing, edema and cachexia. There are clinial trials reporting that PNI predicts adverse clinical outcomes in cerebrovascular disease [3,9,25]. In the low PNI group, the need for IMV may be higher due to respiratory muscle weakness and dysfunction [9,14]. Oral intake may also reduce due to decreased swallowing function [9,15]. Therefore, the risk of pneumonia may increase due to both decreased respiratory muscle function and reduced swallowing function. In our cohort, need of IMV, enteral nutrition and pneumonia were higher in the low PNI group than the high PNI group.

Malnutrition is a common clinical condition in AS patients. In these patients, the prevalence of malnutrition at admission is around 33% [9,14,15]. Malnutrition can cause loss of muscle strength and sarcopenia in critically ill patients [26,27]. The need for invasive mechanical ventilation may increase due to atrophy of the respiratory muscles [27]. The length of MV, ICU and hospital stay may be prolonged due to sarcopenia [3,25,26]. In our cohort, the length of MV, ICU and hospital stay were longer in the low PNI group than the high PNI group.

Malnutrition is an independent prognostic index of incidence and mortality in patients with various cancers, myocardial infarction, undergoing cardiovascular surgery and acute kidney injury [3,5,9,10,11,12]. The PNI is a score that reflects

the nutritional and immunological status based on serum albumin level and lymphocyte count. Several studies have reported that PNI is associated with poor prognosis and increased mortality [3,6,7,9]. Low PNI value is associated with mortality in AS patients [3,4,9,23]. So, the ICU and hospital mortality rates were higher in the low PNI group compared to the high PNI group In our cohort, And low PNI was an independent risk factor for mortality

NLR is a ratio easily calculated by dividing the peripheral blood neutrophil count by the lymphocyte count. NLR is increased in many clinical statuses that have inflammation. High NLR is a risk factor associated with mortality [28,29]. In our study, we reported that high NLR was an independent risk factor for mortality similar to the literature,

In our study, we found the PNI cut-off value to be 47.8. It was similar to previous studies of patients with stroke and cerebral sinus vein thrombosis [3,9,25]. While PNI was lower in patients with pulmonary embolism [7], and infective endocarditis [30], it was similar in patients with colorectal cancer and undergoing cardiovascular surgery [12,18] and higher in patients with lung cancer [6] compared to our study. Therefore, it is difficult to determine a fixed prognostic PNI value. PNI value may be variable according to disease types and age groups. It should be evaluated within each clinical trial.

This study has some limitations. It was a retrospective study. It was conducted at a single center, which limits the generalizability of the results. The data were collected from the digital patient records.

Conclusion

Our study reported that low PNI was associated with poor prognosis and an independent prognostic factor for survival of patients with AS. Nutritional, inflammatory and immunological conditions are very important for long-term outcomes in patients with AS. PNI is an easy and cost-effective nutritional marker as it is obtained using only blood parameters. Therefore, it can be a useful tool for nutritional assessment in clinical trials.

Ethics approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All persons included in the study signed the informed consent form.

Declaration of conflict of interest

The authors have no conflicts of interest to declare. The authors received no funding for this work.

References

1. Powers WJ, Rabinstein AA, Ackerson T, et al. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke. 2019 Dec; 50(12): e344-e418.
2. GBD 2015 Neurological Disorders Collaborator Group. Global, regional, and national burden of neurological disorders during 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet Neurol. 2017; 16: 877–97.
3. Liu Y, Yang X, Kadasah S, Peng C. Clinical Value of the Prognostic Nutrition Index in the Assessment of Prognosis in Critically Ill Patients with Stroke: A Retrospective Analysis. Comput Math Methods Med. 2022 May 9; 2022: 4889920.
4. T-Bolayır A. Can the prognostic nutritional index be used as an indicator of mortality in patients with acute ischemic stroke? Cumhuriyet Medical Journal, 2020; 42(4): 484-490.
5. Wada H, Dohi T, Miyauchi K, et al. Relationship between the prognostic nutritional index and long-term clinical outcomes in patients with stable coronary artery disease. J Cardiol. 2018 Aug;7 2(2): 155-161.
6. Li D, Yuan X, Liu J, Li C, Li W. Prognostic value of prognostic nutritional index in lung cancer: a meta-analysis. J Thorac Dis. 2018 Sep;10(9): 5298-5307.
7. Hayıroğlu Mİ, Keskin M, Keskin T, et al. A Novel Independent Survival Predictor in Pulmonary Embolism: Prognostic Nutritional Index. Clin Appl Thromb Hemost. 2018 May; 24(4): 633-639.
8. Kang, M, Chang CT, Sung HH, et al. Prognostic Significance of Pre- to Postoperative Dynamics of the Prognostic Nutritional Index for Patients with Renal Cell Carcinoma Who Underwent Radical Nephrectomy. Ann Surg Oncol 2017; 24: 4067–4075.
9. Xiang W, Chen X, Ye W, Li J, Zhang X, Xie D. Prognostic Nutritional Index for Predicting 3-Month Outcomes in Ischemic Stroke Patients Undergoing Thrombolysis. Front Neurol. 2020 Jun 26; 11: 599.
10. Hu Y, Cao Q, Wang H, et al. Prognostic nutritional index predicts acute kidney injury and mortality of patients in the coronary care unit. Exp Ther Med. 2021 Feb; 21(2):123.
11. Tokunaga R, Sakamoto Y, Nakagawa S et al. Prognostic Nutritional Index Predicts Severe Complications, Recurrence and Poor Prognosis in Patients With Colorectal Cancer Undergoing Primary Tumor Resection. Dis Colon Rectum 2015; 58: 1048-57.
12. Hayashi J, Uchida T, Ri S, et al. Clinical significance of the prognostic nutritional index in patients undergoing cardiovascular surgery. Gen Thorac Cardiovasc Surg. 2020 Aug; 68(8): 774-779.

13. Kos M, Titiz H, Onec B, et al. Association of "Controlling Nutritional Status Index" and "Prognostic Nutritional Index" with intensive care unit survival in elderly patients, European Geriatric Medicine 2016; 7: 13-17.
14. Unosson M, Ek AC, Bjurulf P, von Schenck H, Larsson J. Feeding dependence and nutritional status after acute stroke. Stroke 1994; 25: 366– 71.
15. Mann G, Hankey GJ, Cameron D. Swallowing function after stroke: prognosis and prognostic factors at 6 months. Stroke 1999; 30: 744– 8.
16. Wu LH, Chiou KR, Pan IJ, Hsiao SH. Malnutrition Affects the Outcomes of Patients with Low-Output Heart Failure and Congestion. Acta Cardiol Sin. 2021 May; 37(3): 269-277.
17. Kurmus Ferik O, Akbuga K, Tolunay H, et al. Poor nutritional status is associated with arrhythmic events on 24 hour holter recording. Med Princ Pract. 2022 Apr 8 (doi: 10.1159/000524396).
18. Tominaga T, Nonaka T, Hisanaga M, et al. Prognostic value of the preoperative prognostic nutritional index in oldest-old patients with colorectal cancer. Surg Today. 2020 May; 50(5): 449-459.
19. Anaszewicz M, Budzyński J. Clinical significance of nutritional status in patients with atrial fibrillation: an overview of current evidence. J Cardiol. 2017; 69: 719–30.
20. Guo Y, Lip GY, Apostolakis S. Inflammation in atrial fibrillation. J Am Coll Cardiol. 2012; 60: 2263–70.
21. Iseki K, Miyasato F, Tokuyama K, et al. Low diastolic blood pressure, hypoalbuminemia, and risk of death in a cohort of chronic hemodialysis patients. Kidney Int. 1997; 51(4): 1212-7.
22. Keegan MT, Gajic O, Afessa B. Severity of illness scoring systems in the intensive care unit. Crit Care Med. 2011; 39(1): 163-9.
23. Zhang B, Zhu Q, Lu Z. Prognostic nutrition index predicts outcomes in critically ill stroke patients: a database-based cohort study, European Heart Journal, Volume 42, Issue Supplement_1, October 2021,
24. Vincent JL, Russell JA, Jacob M, et al. Albumin administration in the acutely ill: what is new and where next? Crit Care. 2014; 18(4):231.
25. Zhao J, Liu K, Li S, et al. Prognostic nutritional index predicts clinical outcomes in patients with cerebral venous sinus thrombosis. BMC Neurol. 2021; 21(1): 404.
26. Zhang XM, Chen D, Xie XH, Zhang JE, Zeng Y, Cheng AS. Sarcopenia as a predictor of mortality among the critically ill in an intensive care unit: a systematic review and meta-analysis. BMC Geriatr. 2021 Jun 2; 21(1): 339.
27. Arsava EM, Aydoğdu İ, Güngör L, Işıkay CT, Yaka E. Nutritional Approach and Treatment in Patients with Stroke, An Expert Opinion for Turkey. Turk J Neurol. 2018; 24(3): 226-242.
28. Guthrie GJ, Charles KA, Roxburgh CS, Horgan PG, McMillan DC, Clarke SJ. The systemic inflammation-based neutrophil-lymphocyte ratio: experience in patients with cancer. Crit Rev Oncol Hematol. 2013 Oct; 88(1): 218-30.
29. Ha YJ, Hur J, Go DJ, et al. Baseline peripheral blood neutrophil-to-lymphocyte ratio could predict survival in patients with adult polymyositis and dermatomyositis: A retrospective observational study. PLoS One. 2018 Jan 2;13(1): e0190411.
30. Kahraman S, Zencirkıran Aguş H, Kalkan AK, et al. Prognostic nutritional index predicts mortality in infective endocarditis. Turk Kardiyol Dern Ars. 2020; 48(4): 392-402.