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The Prognostic Nutritional Index as a predictor of in-hospital mortality in geriatric intensive care patients

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ABSTRACT

Aims: This study aimed to evaluate the prognostic value of the Prognostic Nutritional Index (PNI) in predicting in-hospital mortality among geriatric patients admitted to the intensive care unit (ICU).

Methods: This single-center, retrospective cohort study included 337 patients aged ≥65 years who were admitted to the ICU between June and December 2024. Patients were divided into two groups based on clinical outcomes: survivors and non-survivors. Demographic data, comorbidities, clinical outcomes, and laboratory values including serum albumin and lymphocyte count were analyzed. PNI was calculated as: PNI=[10×serum albumin (g/dl)]+[0.005×total lymphocyte count (/mm^3)]. Statistical analyses included univariate and multivariate logistic regression and receiver operating characteristic (ROC) curve analysis.

Results: Among 337 patients, 195 (57.9%) died during ICU stay. PNI scores were significantly lower in non-survivors (p=0.001), with an optimal cut-off value of ≤29.8 (sensitivity: 43.1%, specificity: 90.1%). The area under the ROC curve for PNI was 0.661, indicating limited discriminatory power. Multivariate analysis identified prolonged ICU stay (OR=1.052), elevated WBC (OR=1.044), hypoalbuminemia (OR=2.283), increased urea (OR=1.006), lactate (OR=1.144), sepsis (OR=2.362), and stroke (OR=2.746) as independent predictors of mortality (p<0.05).

Conclusion: Low PNI scores are associated with in-hospital mortality in geriatric ICU patients. However, given its low sensitivity and moderate AUC, PNI should not be used as a standalone predictor. Instead, as a simple and cost-effective biomarker, it may serve as a supportive tool alongside other clinical parameters for early risk stratification in geriatric intensive care settings.

Keywords: Prognostic Nutritional Index, malnutrition, geriatric patients, intensive care unit, mortality, albumin, lymphocyte count

INTRODUCTION

With people around the world living longer than ever before, the global population is aging rapidly. Geriatric individuals are at high risk for nutritional deficiencies and malnutrition due to factors such as reduced functional capacity, multiple comorbidities, and polypharmacy.[1] Malnutrition has been associated with increased risk of complications, prolonged hospital stays, greater need for intensive care, and higher rates of infection, ultimately leading to both in-hospital and post-discharge mortality.[2,3] While adequate nutritional status can accelerate recovery, reduce the risk of infection, and improve the prognosis of critically ill patients, malnutrition adversely affects this process by increasing the rate of complications and delaying recovery.[4]

The Prognostic Nutritional Index (PNI) is a scoring system that reflects an individual's immunological, inflammatory, and nutritional status based on serum albumin levels and total lymphocyte count.[5] Both parameters are key indicators of overall health and have been recognized as prognostic factors in various clinical conditions. Total lymphocyte count serves as a valuable marker of immune function, and low levels may indicate immunodeficiency. Previous studies have demonstrated that low lymphocyte counts and hypoalbuminemia are associated with increased mortality in many chronic diseases.[6,7] In critically ill patients, hypoalbuminemia may arise due to inadequate nutritional intake, liver dysfunction, protein loss, and systemic inflammatory responses.[8] PNI has been shown to be an important prognostic indicator for predicting outcomes and mortality in various clinical settings, including malignancies, infections, and cardiovascular diseases.[9-11]

However, although the PNI is a practical, easily calculable, and low-cost assessment tool, its adequacy in predicting in-hospital mortality as a standalone marker in geriatric ICU patients remains debatable. A recent study among geriatric ICU patients demonstrated that lower PNI scores were significantly associated with increased mortality, yet emphasized that despite its clinical practicality, the prognostic power of PNI may be limited.[12] In contrast, another study

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involving patients with acute respiratory failure reported that the modified nutrition risk in critically ill (mNUTRIC) score provided greater sensitivity and stronger prognostic accuracy compared to both PNI and NRS-2002.[13] Nevertheless, the ability of PNI to be calculated using routinely available biochemical parameters, along with its speed and ease of use, continues to offer a considerable advantage, particularly in healthcare settings with limited resources.

Therefore, the aim of this study was to evaluate the prognostic value of PNI in predicting in-hospital mortality among geriatric ICU patients. We hypothesized that lower PNI scores would be associated with increased mortality, reflecting the combined impact of inflammation and malnutrition in this vulnerable patient population.

METHODS

Study Design

This study was designed as a single-center, retrospective cohort analysis. The study protocol was approved by the Kartal Koşuyolu High Specialization Training and Research Hospital Clinical Researches Ethics Committee (Date: 07.01.2025, Decision No: 2025/01/999). The study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Study Population

The medical records of patients aged 65 years and older who were admitted to the ICU of Tuzla State Hospital between June 2024 and December 2024 were retrospectively reviewed.

Inclusion criteria: Age ≥65 years, admission to the ICU, and availability of serum albumin and total lymphocyte count measurements taken within the first 24 hours of ICU admission.

Exclusion criteria: Absence of albumin or lymphocyte values at ICU admission, missing data in medical records, admission due to trauma or postoperative reasons, and patients with hematological disorders or receiving immunosuppressive therapy.

Study Protocol

Patients were categorized into two groups: those who were discharged and those who died in the ICU (exitus). All data were compared and analyzed between these two groups. The included patients were evaluated based on the following parameters:

- **Baseline demographic data:** Age, sex, and comorbidities
- **Clinical data:** Length of ICU stay, sepsis, and mortality
- **Laboratory parameters at ICU admission:** White blood cell, hemoglobin, neutrophil, lymphocyte, monocyte, eosinophil, platelet, mean platelet volume, red cell distribution width, C-reactive protein, albumin, calcium, sodium, chloride, magnesium, potassium, urea, creatinine, and lactate

The PNI was calculated using serum albumin levels and total lymphocyte counts.

The formula for PNI calculation was as follows;

PNI=[10×serum albumin (g/dl)]+[0.005×total lymphocyte count (/mm^3)]

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 22. The Kolmogorov-Smirnov test was used to assess the normality of distribution for continuous variables. Descriptive statistical methods were applied to summarize the data, including minimum, maximum, mean, standard deviation, median, interquartile range (IQR), and frequency.

For the comparison of quantitative variables, the student's T test was used when the data followed a normal distribution, while the Mann-Whitney U test was applied for non-normally distributed variables. For the analysis of categorical variables, the Chi-square test, Fisher's exact Chi-square test, and continuity correction (Yates' correction) were utilized as appropriate.

To identify independent predictors, a multivariate logistic regression analysis was performed. The optimal cut-off point was determined based on receiver operating characteristic (ROC) curve analysis. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 337 geriatric patients (aged 65-98) were included. Of these, 195 (57.9%) died during ICU stay (exitus), and 142 (42.1%) were discharged.

No significant differences were observed between groups in age or gender (p>0.05). However, ICU stay duration, and the incidence of sepsis (76.4%), pneumonia (45.6%), and stroke (27.2%) were significantly higher among exitus group (p<0.05). No significant association was found between mortality and other comorbidities (p>0.05) (**Table 1**).

Laboratory parameters including white blood cell count, neutrophils, mean platelet volume, red cell distribution width, C-reactive protein, procalcitonin, urea, creatinine, and lactate were significantly higher in the exitus group compared to the discharged (p<0.05). Conversely, levels of hemoglobin, lymphocyte, eosinophil, albumin, and calcium were significantly lower in the exitus group (p<0.05) (**Table 2**).

PNI scores were significantly lower in the exitus group (p=0.001) (**Figure 1**).

ROC analysis for PNI revealed an AUC of 0.661 (SE: 0.029; 95% CI: 0.608-0.711; p=0.001). The optimal PNI cut-off was ≤29.8, yielding 43.1% sensitivity and 90.1% specificity (**Figure 2**).

In the regression model (Nagelkerke R^2=0.347; accuracy=76.9%), significant predictors of mortality included ICU stay (OR=1.052), elevated white blood cell (OR=1.044), low albumin (OR=2.283), high urea (OR=1.006), elevated lactate (OR=1.144), sepsis (OR=2.362), and stroke (OR=2.746) (p<0.05) (**Table 3**).

Table 1. Comparative analysis based on mortality outcomes			
	Discharged (n=142)	Exitus (n=195)	p
Age (year)	79.99±8.67	81.49±7.91	[1]0.106
Duration of ICU (days)	5.5 (3-11.25)	12 (5-25)	[2]0.001*
Gender, n (%)			
Male	61 (43%)	93 (47.7%)	[3]0.389
Female	81 (57%)	102 (52.3%)	
Sepsis	72 (50.7%)	149 (76.4%)	[3]0.001*
Mechanical ventilation	62 (43.6%)	101(51.8%)	[3]0.172
Comorbidity, n (%)			
Pneumonia	49 (34.5%)	89 (45.6%)	[3]0.040*
Hypertension	56 (39.4%)	76 (39%)	[3]0.932
Stroke	21 (14.8%)	53 (27.2%)	[3]0.007*
Alzheimer	27 (19%)	43 (22.1%)	[3]0.497
Diabetes mellitus	26 (18.3%)	39 (20%)	[3]0.698
COPD	34 (23.9%)	28 (14.4%)	[3]0.025*
Congestive heart failure	20 (14.1%)	36 (18.5%)	[3]0.286
Coronary artery disease	14 (9.9%)	12 (6.2%)	[4]0.293
Chronic renal failure	7 (4.9%)	10 (5.1%)	[4]1.000
Malignancy	6 (4.2%)	7 (3.6%)	[4]0.990
Acute renal failure	4 (2.8%)	7 (3.6%)	[5]0.766
Parkinson	4 (2.8%)	6 (3.1%)	[5]1.000
Epilepsy	4 (2.8%)	5 (2.6%)	[5]1.000
Atrial fibrillation	4 (2.8%)	5 (2.6%)	[5]1.000
Pulmonery odema	6 (4.2%)	3 (1.5%)	[5]0.175
Pulmonary embolism	1 (0.7%)	3 (1.5%)	[5]0.641

Normally distributed variables are presented as mean±standard deviation (SD), while non-normally distributed variables are expressed as median (interquartile range), [1]Student T test, [2]Mann-Whitney U test, [3]Chi-square test, [4]Continuity (yates) correction, [5]Fisher's exact test, *p<0.05, ICU: Intensive care unit, COPD: Chronic obstructive pulmonary disease

Table 2. Comparison of biochemical parameters between groups			
	Discharged median (IQR)	Exitus median (IQR)	p
White blood cell (10^3/mm^3)	10.76 (7.9-14)	13.03 (9.7-18)	0.001*
Hemoglobin (g/dl)	10.9 (8.9-12.3)	9.9 (8.6-11.5)	0.008*
Neutrophil (10^3/mm^3)	8.96 (6-11.7)	11.14 (7.6-15.7)	0.001*
Lymphocyte (10^3/mm^3)	975 (587.5-1425)	810 (510-1210)	0.024*
Monocyte (10^3/mm^3)	0.5 (0.3-0.7)	0.5 (0.3-0.7)	0.836
Eosinophil (10^3/mm^3)	0.04 (0-0.1)	0.01 (0-0.1)	0.001*
Platelet (10^3/mm^3)	225.5 (153.3-287)	210 (136-299)	0.432
Mean platelet volume (fL)	11 (10-12)	11.5 (10.4-12.4)	0.010*
RDW (%)	50 (46.8-54.5)	51.9 (48-58.3)	0.007*
CRP (mg/L)	86.3 (23.4-138)	138.44 (66.2-211)	0.001*
Procalcitonin (ng/ml)	0.38 (0.1-1.3)	1.36 (0.3-7.7)	0.001*
Albumin (g/dl)	3 (2.7-3.3)	2.6 (2.2-3)	0.001*
Calcium (mg/dl)	8.26 (7.8-8.6)	7.91 (7.4-8.5)	0.001*
Sodium (mmol/L)	140 (137-144)	141 (137-146)	0.543
Chloride (mmol/L)	102 (98-108)	104 (98-109)	0.288
Magnesium (mg/dl)	1.94 (1.7-2.2)	1.97 (1.8-2.2)	0.070
Potassium (mmol/L)	4.05 (3.6-4.5)	3.98 (3.5-4.7)	0.870
Urea (mg/dl)	60 (38-92.3)	85.2 (56.6-127.6)	0.001*
Creatinine (mg/dl)	0.98 (0.7-1.4)	1.28 (0.8-2)	0.002*
Lactate (mmol/L)	1.9 (1.3-2.9)	2.5 (1.7-4.2)	0.001*
PNI	34.9 (31.8-38.5)	31.9 (26-37)	0.001*

Mann-Whitney U test, *p<0.05, IQR: Interquartile range, RDW: Red cell distribution width, CRP: C-reactive protein, PNI: Prognostic Nutritional Index

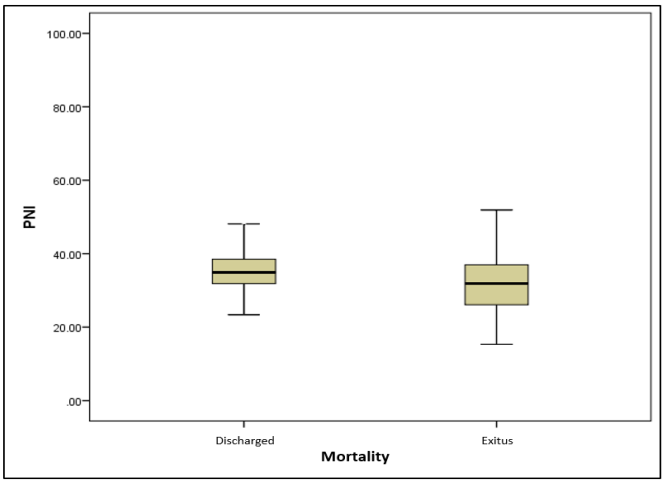

Figure 1. Box plot of PNI values according to mortality status
PNI: Prognostic Nutritional Index

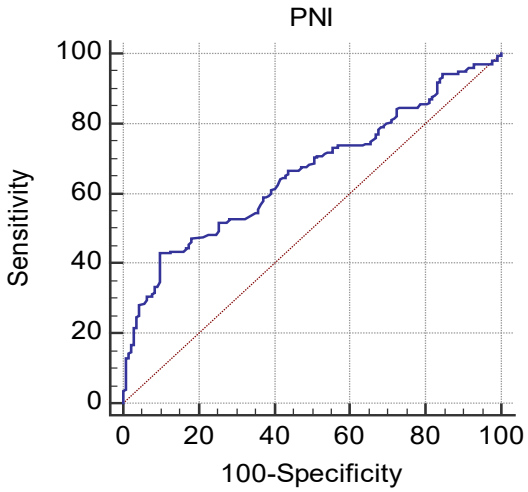

Figure 2. ROC curve of PNI for predicting in-hospital mortality
ROC: Receiver operating characteristic, PNI: Prognostic Nutritional Index

Table 3. Logistic regression analysis of independent predictors of in-hospital mortality				
		95% CI		
Step 13	**OR**	**Lower**	**Upper**	**p**
Duration of ICU	1.052	1.031	1.074	0.001*
White blood cell	1.044	1.000	1.090	0.048*
Albumin	2.283	1.385	3.774	0.001*
Urea	1.006	1.001	1.011	0.018*
Lactate	1.144	1.004	1.303	0.044*
Sepsis	2.362	1.337	4.173	0.003*
Stroke	2.746	1.41	5.349	0.003*

CI: Confidence interval, OR: Odds ratio, ICU: Intensive care unit

DISCUSSION

In this study, we investigated the prognostic value of the PNI in predicting in-hospital mortality among geriatric patients admitted to the ICU. Our findings demonstrated that patients who died had significantly lower PNI scores, with a determined cut-off value of 29.8. These results suggest that PNI may serve as a valuable prognostic biomarker in critically ill elderly patients. However, the relatively low sensitivity (43.1%)

and moderate AUC value (0.661) indicate that PNI may have limited discriminatory power when used alone and should be interpreted in conjunction with other clinical indicators.

Geriatric patients in the ICU experience high mortality rates due to multiple comorbidities, reduced physiological reserves, and increased vulnerability. Although commonly used scoring systems such as SOFA and APACHE II are comprehensive and reliable in mortality prediction, their complexity and reliance on numerous variables may limit their routine application in clinical practice.[14,15] In contrast, PNI relies solely on two laboratory parameters (serum albumin and total lymphocyte count) making it a simple and practical tool. Malnutrition and immunosuppression, which are prevalent in the elderly population, further enhance the clinical relevance of PNI.

PNI was initially developed to assess surgical risk and perioperative immunonutritional status in patients undergoing gastrointestinal surgery.[16] Since then, it has been shown to be associated with prognosis in a wide range of clinical conditions, including cardiovascular diseases, various cancers, and infections.[5,17] The literature contains similar findings in different patient populations. Keskin et al.[18] reported that PNI was an independent predictor of mortality in patients undergoing coronary artery bypass surgery. Hayashi et al.[17] found that higher PNI scores were associated with shorter durations of mechanical ventilation, shorter ICU stays, and lower rates of infection. In oncology, Ofluoglu et al.[19] demonstrated that PNI was a valuable biomarker for predicting surgical complications in patients with locally advanced rectal cancer and that preoperative nutritional optimization could improve treatment outcomes. In our study, the association between low PNI values and mortality can be interpreted as a reflection of both malnutrition and immunosuppression. Particularly, hypoalbuminemia is a strong indicator of nutritional deficiency and systemic inflammation,[20,21] while a reduced lymphocyte count suggests compromised immune function and a suppressed inflammatory response.[22] Consistent with these findings, our regression analysis revealed that low albumin levels increased the risk of mortality by 2.28 times.

The prognostic value of PNI has also been highlighted in geriatric orthopedic surgery patients. Taşkın et al.[23] reported significantly lower preoperative PNI scores in patients with femoral fractures who died postoperatively, with a cut-off value of 29 and a six-month mortality rate of 22.4%. Arslan et al.[24] also found lower PNI levels in the mortality group, although it was not identified as an independent predictor. These findings underscore the relationship between PNI, nutritional status, and immune function in elderly patients. Similarly, our study found that PNI scores were significantly lower in the exitus group.

Recent literature supports the role of PNI as a robust nutritional indicator in elderly ICU patients. Akgün et al.[12] reported that among elderly individuals with acute decompensated heart failure in the coronary ICU, low PNI scores were associated with increased mortality, longer ICU stay, and higher 12-month rehospitalization rates. Moreover, in a 2025 study by Küçük et al.,[13] mNUTRIC and NRS-2002 were compared in ICU patients admitted for respiratory failure. The mNUTRIC score, which incorporates disease severity and length of prior hospitalization, showed stronger predictive capacity for both short- and long-term mortality compared to traditional tools like NRS-2002. The authors emphasized that combining mNUTRIC with clinical markers could enhance risk stratification. Although our study did not compare mNUTRIC and PNI directly, our findings underscore the importance of multimodal nutritional risk assessment in ICU patients. Given the relatively low sensitivity and AUC of PNI, it is advisable to use it as a supportive measure alongside more comprehensive tools such as mNUTRIC.

The cut-off value for PNI identified in our study (29.8) was lower than those reported in some previous studies. This difference may be attributed to the characteristics of our patient population, which consisted of very elderly individuals with multiple comorbidities and more severe clinical conditions requiring intensive care. These findings suggest that PNI thresholds may vary depending on the clinical setting and patient demographics.

Additionally, among other key findings, rates of sepsis (56.1%), pneumonia (50.3%), and stroke (45.9%) were markedly higher in patients who died. Logistic regression analysis identified sepsis and stroke as independent risk factors for mortality, increasing the risk by 2.36 and 2.74 times, respectively. These results highlight the significant impact of infectious and neurological complications on mortality, particularly in the geriatric population.

Limitations

This study has several limitations. First, the retrospective and single-center design may limit generalizability. Second, we evaluated only in-hospital mortality; long-term outcomes such as functional recovery or quality of life were not assessed. Third, we did not conduct a direct comparison between PNI and other tools such as mNUTRIC in this dataset. Nevertheless, our findings contribute to the growing body of evidence supporting the role of nutritional indices in ICU prognostication and emphasize the clinical utility of PNI as part of a comprehensive, multimodal assessment strategy for elderly critically ill patients.

CONCLUSION

In conclusion, this study demonstrated that low PNI values are significantly associated with in-hospital mortality in geriatric intensive care patients. As a simple and cost-effective parameter, PNI may be utilized to support early risk stratification in elderly patients admitted to the ICU. However, given its high specificity but limited sensitivity, PNI should not be used as a standalone prognostic tool. Instead, it may serve as a useful adjunct to clinical assessment or more comprehensive scoring systems to improve the accuracy of mortality prediction and to guide timely and individualized treatment strategies.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Kartal Koşuyolu High Specialization Training and Research Hospital Clinical Researches Ethics Committee (Date: 07.01.2025, Decision No: 2025/01/999).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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