VIA MEDICA

ORIGINAL ARTICLE

Disaster and Emergency Medicine Journal
2022, Vol. 7, No. 3, 191–197
DOI: DEMJ.a2022.0034
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ISSN 2451–4691, e-ISSN 2543–5957

PROGNOSTIC NUTRITIONAL INDEX TO PREDICTING MORTALITY IN SURGICAL INTENSIVE CARE PATIENTS

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ABSTRACT

INTRODUCTION: It is known that immuno-nutritional status affects clinical outcomes in intensive care (ICU) patients. This study aimed to evaluate the relationship of the Prognostic Nutritional Index (PNI) with mortality in surgical ICU patients.

MATERIAL AND METHODS: The single-center, retrospective, observational study was conducted in a 17-bed surgical ICU. Patients over the age of 18 who were hospitalized between May 1, 2018, and May 1, 2019, were evaluated.

RESULTS: 217 patients followed in the surgical ICU were evaluated. The mean age of the study population was 51.84 ± 21.25 years, and 150 (69.10%) patients were male. ICU mortality was calculated as 16.10%. Trauma was the most common reason for hospitalization in both groups, and there was no difference between the two groups in terms of hospitalization reasons. The PNI score was found to be significantly lower in the non-survivor group compared to the survivors ($p < 0.001$). The PNI cut-off value in predicting mortality was found to be 32.01 with a sensitivity of 0.829 and a specificity of 0.956 [AUC = 0.957 (95% CI from 0.929 to 0.984); $p < 0.001$].

CONCLUSIONS: PNI is a cost-effective scoring system that can be calculated with a simple formulation. In our study, in which surgical ICU cases were evaluated, lower PNI values were found in patients with mortality compared to those who survived. We believe that PNI can be used in the prediction of mortality in surgical ICU cases, and our study will shed light on future studies on this subject.

KEY WORDS: Prognostic Nutritional Index; surgical ICU; malnutrition; mortality; intensive care

Disaster Emerg Med J 2022; 7(3): 191–197

INTRODUCTION

It is known that immuno-nutritional status has an effect on clinical outcomes in intensive care (ICU) patients [1]. Malnutrition may occur in critical patient groups due to various reasons. It has been reported that malnutrition is associated with poor outcomes such as the increased risk of infection, delayed wound healing, prolonged ICU length of stay, and increased hospital costs [2]. Early detection of malnutrition risk in ICU patients is important in preventing possible complications. Silently progressing malnutrition is difficult to recognize if it is not suspected and screened.

Many laboratory parameters that can be used in evaluating nutritional status have been studied, since they are associated with poor outcomes up to mortality, and scoring systems that can be used in

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Received: 5.09.2022 Accepted: 15.09.2022 Early publication date: 23.09.2022

the early detection of malnutrition risk have been developed [3–5]. Numerous scoring systems have been described in the literature. The Nutritional Risk Screening Test-2002 (NRS-2002) and the NUTRIC (Nutrition Risk in the Critically Ill) score are among the most frequently studied screening tests in ICU patients [4, 5]. However, there is still no consensus on which screening test is the gold standard in critically ill patients [6, 7]. The test to be used for screening should be easily applicable, standardized, and cost-effective. Due to the lack of consensus on the method that evaluates the nutritional status from all aspects, studies on scoring systems continue today. One is the Prognostic Nutritional Index (PNI), a combined score reflecting the immunological nutritional status. PNI is calculated using serum albumin and lymphocyte values [8]. It has become a prominent scoring system for using only blood parameters in evaluating PNI, not causing measurement-based differences due to the absence of clinical measurements, and being cost-effective by using laboratory parameters already evaluated in daily practice. It has been reported that the PNI score is significant in predicting prognosis and mortality due to the evaluation of both immunological and nutritional status [9, 10]. Studies on PNI in the literature have generally been conducted in specific patient groups such as infectious diseases, malignancies, and cardiovascular diseases [9–11]. Studies on this subject are generally small population studies evaluating non-critical service patients, and studies with large series evaluating ICU cases are not common in the literature. This study aimed to evaluate the relationship between PNI, which is used in evaluating the nutritional status, and mortality in surgical ICU patients.

MATERIAL AND METHODS

The single-center, retrospective, observational study was conducted in a 17-bed surgical ICU in Turkey. Patients over the age of 18 who were hospitalized between May 1, 2018, and May 1, 2019, were evaluated.

The study protocol was approved by the institutional review board (Approval Date and Number:10.05.2022/E-64106871). The Declaration of Helsinki's principles were followed in conducting this study. All data were obtained from electronic medical records and patient files after ethics committee approval. Patients with ICU hospitalization for less than 24 hours, patients with diseases such as cirrhosis, and acute and chronic hepatitis that may affect serum albumin levels, and patients with sepsis, septic shock, and kidney failure were excluded from the study.

Demographic data of patients including age, gender, comorbidities, Acute Physiology and Chronic Health Assessment-2 (APACHE-II) and NRS-2002 scores, reasons for ICU hospitalization, ICU and hospitalization times, intubation status, operation status, ICU mortality, laboratory parameters including urea creatine, albumin, C-reactive protein (CRP), white blood cell (WBC), neutrophil, lymphocyte and platelet counts were retrospectively analyzed and recorded. The PNI values of all patients were recorded using the formula: $10 \times$ serum albumin (g/dL) $+ 0.005 \times$ absolute lymphocyte count (/mm^3) [8].

Statistical analysis

SPSS 25.0 package program was used for the statistical analysis of the study. In the study, continuous variables were expressed as median (minimum-maximum) and mean $\pm$ SD values, and categorical variables were expressed as frequency and percentage values. The suitability of the data to the normal distribution was evaluated with histogram, probability graphs, and Shapiro-Wilk test. Student t-test or Mann-Whitney U test was used to compare continuous variables according to the normal distribution. The chi-square test was used to compare categorical variables. Receiver operating characteristics (ROC) analysis was performed to predict mortality with PNI. The area under the curve was calculated as the cut-off giving the most optimal sensitivity and selectivity value. A p-value of < 0.05 was considered statistically significant in all analyses.

RESULTS

Between the study dates, 370 patients were hospitalized in the surgical ICU. Two hundred seventeen patients over the age of 18 who met the inclusion criteria and whose data could be accessed were included in the evaluation. The mean age of the study population was 51.84 $\pm$ 21.25 years, and 150 (69.10%) patients were male. ICU mortality of the whole population was calculated as 16.10%. The patients were divided into two groups as survivors and non-survivors. The two groups were similar in terms of age and gender. Trauma was the most common reason for hospitalization in both groups, and there was no difference between the two groups in terms of hospitalization reasons. ICU length of stay was significantly longer in the non-survivor group ($p < 0.05$). The most common comorbidity in both groups was hypertension. The APACHE-II score on the day of hospitalization was significantly higher in the non-survivor group ($p < 0.05$) (Tab. 1).

When the two groups were compared in terms of laboratory parameters, the albumin level of the non-survivor group was significantly lower than that of the survivor group. There was no difference between the two groups regarding other laboratory parameters (Tab. 2). The NRS 2002 score was 5 (3–7) in non-survivors and 1 (0–4) in survivors ($p < 0.001$). In the evaluation of the NRS 2002 score with the ROC curve to predict mortality, the cut-off value was found to be 3.5 with a sensitivity of 0.914 and a specificity of 0.978 [AUC = 0.991 (95% CI from 0.981 to 1,000); $p < 0.001$] (Fig. 1).

The PNI score was found to be 39.0 (26.0–49.0) in the survivor group and significantly higher than 28.0 (20.0–35.0) in the non-survivor group ($p < 0.001$). In the evaluation of the PNI score with the ROC curve in predicting mortality, the cut-off value was found to be 32.01 with a sensitivity of 0.829 and a specificity of 0.956 [AUC = 0.957 (95% CI from 0.929 to 0.984); $p < 0.001$] (Fig. 2).

Table 1. Baseline characteristics of patients according to groups

	Survivors n (%)	Non-survivors n (%)	p
	182 (83.90%)	35(16.10%)	
Age	53 (17–92)	63 (18–93)	0.112**
Gender			
Female	51 (28.00%)	16 (45.70%)	0.061*
Male	131 (72.00%)	19 (54.30%)	
APACHE-II	15 (3–29)	31 (15–48)	< 0.001**
Length of hospital stay. days	10 (2–57)	8 (2–36)	0.042**
Length of ICU stay. days	4 (2–22)	5 (2–27)	0.033**
NRS-2002	1 (0–4)	5 (3–7)	< 0.001**
PNI	39.0 (26.0–49.0)	28.0 (20.0–35.0)	< 0.001**
Reasons for ICU admission			
Trauma	88 (48.40%)	14 (40.00%)	0.225*
Postoperative Follow-Up After Major Surgery	45 (24.70%)	9 (25.70%)	
Hemodynamic Instability	33 (18.10%)	5 (14.30%)	
Respiratory Distress	14 (7.70%)	7 (20.00%)	
Unconsciousness	2 (1.10%)	0 (0.00%)	
Intubation			
Yes	136 (74.70%)	35(100%)	0.052*
No	46 (25.30%)	0 (0.00%)	
Surgery			
Yes	108 (59.30%)	17 (48.60%)	0.320*
No	74 (40.70%)	18 (51.40%)	
Comorbidities			
Hypertension	79 (43.40%)	19 (54.30%)	0.318*
DM	30 (16.50%)	13 (37.10%)	0.005*
COPD	12 (6.60%)	4 (11.40%)	0.316*
CVD	20 (11.00%)	5 (14.30%)	0.576*

*Chi-squared test, **Mann Whitney U test; DM — diabetes mellitus; COPD — chronic obstructive pulmonary disease; CVD — Cardiovascular disease; NRS-2002 — Nutritional Risk Screening Test 2002; PNI — Prognostic Nutritional Index

Table 2. Laboratory values of patients according to groups			
	Survivors (n = 182, 83.90%)	Non-survivors (n = 35, 16.10%)	p
Urea	36.1 (15.5–81.3)	40 (18.7–81)	0.155
Creatinine [mg/dL]	0.97 ± 0.27	1.03 ± 0.29	0.218**
Albumin [g/L]	3.9 (2.6–4.9)	2.8 (2.0–3.5)	< 0.001*
CRP [mg/L]	6.7 (0.3–300.3)	8.9 (0.6–189.6)	0.401
WBC [number/mm^3]	12.8 (3.7–40.0)	11.3 (3.5–25.9)	0.051
Neutrophil [number/mm^3]	8.8 (2.2–36.6)	8.0 (1.4–20.9)	0.228
Lymphocyte [number/mm^3]	2.4 (0.8–6.3)	2.2 (0.8–4.4)	0.197
Platelet, ×10^3/mL	256.5 (42–1407)	230 (61–417)	0.076

*Mann Whitney U test, **Student t test, ortalama ± ss; CRP — C-reactive protein; WBC — white blood cell

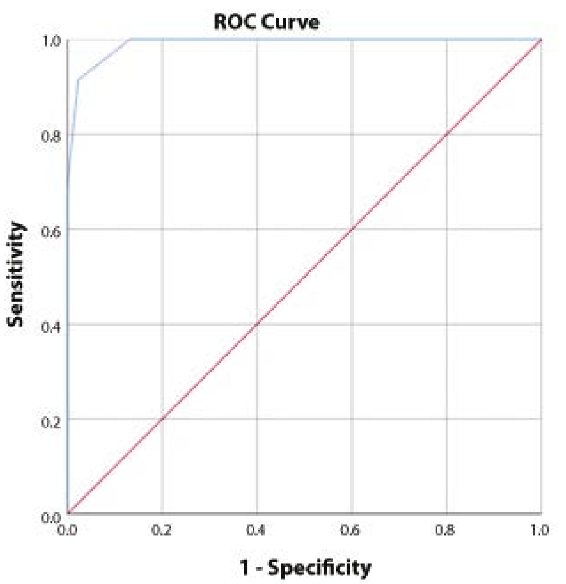

FIGURE 1. Receiver operating characteristics (ROC) curve of Nutritional Risk Screening Test-2002 (NRS-2002). ROC analyses for NRS 2002 to predict mortality, the cut-off value was 3.5 with a sensitivity of 0.914 and a specificity of 0.978 [AUC = 0.991 (95% CI from 0.981 to 1,000); p < 0.001]; AUC — area under the curve; CI — confidence interval

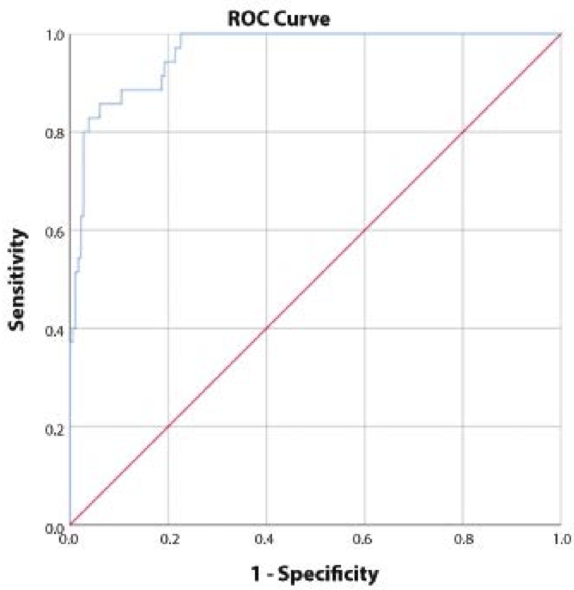

FIGURE 2. Receiver operating characteristics (ROC) curve of Prognostic Nutritional Index (PNI). ROC analyses for PNI to predict mortality, the cut-off value was 32.01 with a sensitivity of 0.829 and a specificity of 0.956 [AUC = 0.957 (95% CI from 0.929 to 0.984); p < 0.001]; AUC — area under the curve; CI — confidence interval

DISCUSSION

The PNI, calculated based on albumin and lymphocyte values, is a combined score used to evaluate the immuno-nutritional status. PNI, the first study in the literature, was in the group of patients who underwent gastrointestinal surgery and was subsequently investigated in a wide variety of patient groups, such as infectious diseases, malignancies, and cardiovascular diseases [5, 9, 11]. Although it has also been evaluated in ICU patient groups such as geriatric patients, COVID-19, and cardiovascular patients, to the best of our knowledge, there is no current study evaluating the relationship between mortality in surgical ICU patients [9, 12, 13].

Patients hospitalized in the ICU have a higher risk of malnutrition than other patient groups for many reasons, such as the developing critical process, hemodynamic instability, accompanying comorbidities, and complications [14]. Surgical ICUs differ from medical ICUs due to the inpatient population, underlying causes of critical illness, surgical, and interventional procedures. In our study, the most common reason for ICU hospitalization was trauma. Trauma cases; It is the patient group in which conditions that may cause muscle loss are more common due to the fact that immobilization is seen more frequently due to various reasons such as surgery, extremity damage, and the developing hypercatabolic state. Numerous scoring systems have been studied to evaluate malnutrition in ICU cases [15]. NRS-2002 is the scoring system frequently preferred in clinical practice to define nutritional risk. BMI is evaluated by questioning parameters such as weight loss in the last three months and food intake in the last week. Cases with an NRS-2002 score of 3 and above are considered to be under nutritional risk [5]. In our study, the NRS-2002 score was found to be higher in the non-survivor group compared to the survivors, and the cut-off value of the NRS 2002 score was found to be 3.5 in the evaluation of mortality with the ROC curve. Fact that the laboratory results are not included in the NRS-2002 scoring, the questions included in the evaluation were obtained from the relatives of the patients who can be reached, not from the patient himself, for reasons such as generally intubated monitoring and unconsciousness; Considering the circumstances such as the inability to reach the relatives of the patients where this information can be obtained in emergency cases and trauma situations, there may be situations where the evaluation of the ICU patient group may be insufficient. There is still no consensus in the literature about a generally accepted method that can be used in surgical ICU cases.

PNI has become a prominent scoring system in terms of being a cost-effective method by saving time using albumin and lymphocyte parameters, which do not include clinical evaluation and measurements, require extra time in ICU practice, and are frequently examined in daily practice routines. It has been reported that a low PNI score is associated with poor outcomes and mortality [15]. In our study, in which we evaluated surgical ICU patients, the PNI score, which is on the agenda to predict prognosis, was significantly lower in the non-survivor group compared to the survivors. The cut-off value was 32.01 in the evaluation of the PNI score with the ROC curve in predicting mortality (with a sensitivity of 0.829 and a specificity of 0.956).

Although studies evaluating various patient groups have shown the relationship between low PNI and mortality, there is no clear consensus about the PNI cut-off value, and there are different results in the literature. Peng et al. [16], in a multicenter study including 494 cases of chronic obstructive pulmonary disease (COPD) followed in the ICU with acute exacerbation, reported the cut-off value of PNI score to predict mortality as 31.8, similar to the results of our study (with sensitivity 62.3% and specificity 64.1%). In a study in which the place of PNI in predicting postoperative outcome was evaluated and 7781 cases who underwent gastrectomy were included, it was reported that when the cut-off PNI was 46.7 in the statistical analysis, significantly higher mortality was observed in cases with a PNI score lower than this value (hazard ratio ¼ 1.383, 95). % CI¼ 1.221–1.568, $p < 0.001$) [10]. Detection of higher PNI cut-off values compared to our study; This can be explained by the fact that most of the cases included in this study were ward patients and that our study was conducted entirely on critically ill patients followed in the ICU. In the recent COVID-19 pandemic, which has affected the world, studies have been conducted on many prognostic and mortality markers. PNI is among the scores evaluated for its use as a prognostic marker [12, 17]. Nalbant et al. [17], in the study in which the efficacy of nutritional indices in predicting disease severity in COVID-19 cases was evaluated, it was reported that PNI $\leqslant$ 36.7% cut-off was significant in predicting disease severity with 73.4% sensitivity and 70.8% specificity, and ICU admissions were 4.4 times higher in the group with low PNI compared to those with high PNI. Although a common result was obtained in these studies in the literature that mortality rates are higher in patients with low PNI, we think that the differences in the PNI cut-off value reported as a predictor of mortality may be related to the fact that the patient groups evaluated in the studies included different populations. Considering that most of the studies conducted with PNI are studies involving specific patient groups in which ward patients are evaluated, we think that it can be supported by studies to be conducted in ICU patients who are at higher risk of malnutrition compared to other patient groups in order to determine the cut-off in critically ill patients.

The value of PNI in predicting mortality, which was defined to assess nutritional risk, can probably be explained by the fact that albumin and lymphocyte count in its formula is associated with many negative prognostic factors. Albumin, one of the components of PNI, is among the laboratory parameters used in evaluating malnutrition [18]. In our study, the serum albumin level was found to be significantly lower in the non-survivor group compared to the survivors. However, it has been reported in recent studies that serum albumin level, which can be affected by various clinical conditions, alone is insufficient to define malnutrition risk [19, 20]. Hypoalbuminemia can be seen in ICU patients for reasons such as increased renal or gastrointestinal loss in critical illness, decreased albumin synthesis due to increased cytokine release with inflammation, and increased escape to the interstitial space due to increased capillary permeability [21]. Peng et al. [16] in their studies in which they evaluated the mortality prediction of the PNI score in critically ill patients, it was reported that the PNI score was more significant in predicting 30-day mortality compared to serum albumin level alone.

It is known that malnutrition can cause negative effects on the immune system and changes in the inflammatory response [22]. Lymphocytes have an important role in the immune system, and in the case of critical illness, changes in lymphocyte numbers can be seen depending on many factors. It has been reported that malnutrition may cause atrophy of lymphoid tissues and a decrease in the rate of lymphocyte production [23]. The development of lymphopenia in critical cases has been associated with negative outcomes, and it has been stated that it can be used in predicting mortality, especially in the case of inflammation [24, 25]. In our study, no difference was found in terms of lymphocyte counts in survivor and non-survivor cases.

Malnutrition, which is associated with poor outcomes up to mortality, progresses silently, especially in ICU cases, and is difficult to recognize when not suspected. Evaluation of nutritional status in critically ill patients in admission to the ICU; It has been reported that it can help prevent bad outcomes by enabling the early detection of risky cases and providing more effective nutritional support [26]. Using a scoring system that is easy to implement and will not cause loss of time, labor, and cost can easily diagnose this patient group and provide a chance for early intervention in ICUs where critical cases are followed.

CONCLUSIONS

In our study, in which surgical ICU cases were evaluated, lower PNI values were found in patients with mortality compared to those who survived. The PNI cut-off value in predicting mortality is 32.01, and this value has generally been found to have higher sensitivity and specificity compared to the studies in the literature that gave PNI cut-off. On the other hand, its retrospective and single-center design are among the limitations of our study. We believe that our study will shed light on future studies to evaluate the use of PNI. Despite its limitations, this cost-effective method can be calculated with a simple formulation and does not require additional measurement and devices used in surgical ICU cases.

Funding

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

Conflict of interest

The authors have no conflicts of interest to declare.

Ethics approval

The study protocol was approved by the institutional review board (Approval Date and Number:10.05.2022/E-64106871). Because the study was designed retrospectively, no written informed consent form was obtained from patients.

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