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Prognostic Nutritional Index and CRP/Albumin Ratio in Predicting Acute Pancreatitis Outcomes

Akut Pankreatit Sonuçlarını Tahmin Etmede Prognostik Beslenme İndeksi ve CRP/Albümin Oranı

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ABSTRACT

Objectives: Acute pancreatitis (AP) remains a challenging condition with variable clinical outcomes. This study investigated the prognostic value of the C-reactive protein (CRP)/albumin ratio and the Prognostic Nutritional Index (PNI) in predicting disease severity and intensive care unit (ICU) admission in patients with AP.

Materials and Methods: This retrospective observational study was conducted on 444 patients diagnosed with AP at Internal Medicine Department of Ankara Etlik City Hospital. Disease severity was classified using the Revised Atlanta Classification. The CRP/albumin ratio and PNI were calculated from admission laboratory data. Receiver operating characteristic (ROC) curve analysis was performed to determine their predictive performance.

Results: Among 444 patients, 340 (76.6%) had mild and 104 (23.4%) moderate-to-severe acute pancreatitis. The moderate-to-severe group had significantly higher CRP/albumin ratios ($p < 0.001$) and lower PNI scores ($p < 0.001$). ICU patients likewise showed elevated CRP/albumin ratios ($p < 0.001$) and reduced PNI ($p < 0.001$). ROC analysis showed that the CRP/albumin ratio (AUC = 0.698) and PNI (AUC = 0.806) predicted disease severity, with optimal cut-offs of 13.43 and 40.17, respectively. For ICU admission, PNI showed superior predictive power (AUC = 0.904) to the CRP/albumin ratio (AUC = 0.705).

Conclusion: The CRP/albumin ratio and PNI are simple, cost-effective biomarkers for early risk stratification in acute pancreatitis. Both showed strong predictive value for disease severity and ICU need, with PNI demonstrating superior accuracy. These indices may support clinical decision-making, particularly in resource-limited settings.

Keywords: Acute pancreatitis, CRP/albumin ratio, Prognostic Nutritional Index, Revised Atlanta Classification, intensive care unit

ÖZET

Amaç: Akut pankreatit (AP), değişken klinik sonuçlara sahip zorlu bir hastalık olmaya devam etmektedir. Bu çalışma, AP hastalarında hastalık şiddetini ve yoğun bakım ünitesi (YBÜ) yatışını öngörmede C-reaktif protein (CRP)/albümin oranı ile Prognostik Nütrisyonel İndeks'in (PNI) prognostik değerini araştırmayı amaçlamaktadır.

Gereç ve Yöntem: Bu retrospektif gözlemsel çalışma, Ankara Etlik Şehir Hastanesi İç Hastalıkları Kliniği'nde AP tanısı almış 444 hasta üzerinde gerçekleştirildi. Hastalığın şiddeti, Revize Edilmiş Atlanta Sınıflaması kullanılarak sınıflandırıldı. CRP/albümin oranı ve PNI, laboratuvar verilerinden hesaplandı. Tahmini performanslarını belirlemek için alıcı çalışma karakteristiği (ROC) eğrisi analizi yapıldı.

Bulgular: Toplam 444 hastanın 340'ı (%76,6) hafif AP, 104'ü (%23,4) orta-ağır AP grubundaydı. Orta-ağır grupta CRP/albümin oranı anlamlı olarak daha yüksek ($p < 0,001$) ve PNI skorları anlamlı olarak daha düşüktü ($p < 0,001$). YBÜ'ye kabul edilen hastalarda da CRP/albümin oranı yüksek ($p < 0,001$) ve PNI düşük ($p < 0,001$) bulundu. ROC analizi, CRP/albümin oranının (AUC = 0,698) ve PNI'nın (AUC = 0,806) hastalık şiddetini öngörebildiğini ve optimal kesim değerlerinin sırasıyla 13,43 ve 40,17 olduğunu gösterdi. YBÜ yatışı için PNI, CRP/albümin oranına (AUC = 0,705) kıyasla daha güçlü prediktif yeteneğe sahipti (AUC = 0,904).

Sonuç: CRP/albümin oranı ve PNI, akut pankreatitte erken risk sınıflandırması için erişilebilir ve düşük maliyetli biyo-belirteçlerdir. Her iki parametre de hastalık şiddeti ve YBÜ gereksinimi açısından güçlü prediktif değer göstermiş; PNI, yoğun bakım ihtiyacını belirlemede daha üstün doğruluk sağlamıştır. Bu indeksler, özellikle kaynakların kısıtlı olduğu ortamlarda klinik kararın doğruluğunu destekleyebilir.

Anahtar kelimeler: Akut pankreatit, CRP/albümin oranı, Prognostik Nutrisyonel İndeks, Revize Atlanta Sınıflaması, yoğun bakım ünitesi

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Introduction

Acute pancreatitis (AP) is an inflammatory condition of the pancreas characterized by a wide spectrum of clinical presentations, ranging from mild, self-limiting disease to severe, life-threatening illness with multi-organ failure (1). The annual incidence of AP varies globally, reported between 4.3 and 100 cases per 100,000 population. Despite supportive management strategies, approximately 20–30% of hospitalized patients with AP experience a severe disease course, with a mortality rate reaching up to 30% in severe cases. While the overall mortality rate of AP is estimated at around 5%, early identification of high-risk patients remains crucial to improve outcomes (2). The most common etiological factors include gallstones and alcohol consumption, followed by less frequent causes such as hypertriglyceridemia, drug-induced pancreatitis, and idiopathic cases (1,2).

Currently, no specific pharmacological treatment exists for AP, and management primarily relies on supportive care and treatment of underlying etiologies. Therefore, accurately assessing the severity of the disease is essential for guiding clinical decisions and allocating healthcare resources. Several scoring systems, such as the Bedside Index for Severity in Acute Pancreatitis (BISAP), the Acute Physiology and Chronic Health Evaluation (APACHE II), the Glasgow criteria, Ranson's score, and the Revised Atlanta Classification, have been proposed to predict disease severity (3,4). However, these tools often require complex calculations, serial measurements, or variables not readily available at admission.

C-reactive protein (CRP), a widely used biomarker of systemic inflammation, has been shown to correlate with disease severity in AP. However, the interpretation of CRP values alone may be limited by inter-individual variability and the lack of established threshold values in this context. Albumin, a major plasma protein, often decreases in critically ill patients due to decreased hepatic synthesis, increased catabolism, and capillary leakage. The CRP/albumin ratio, combining an acute-phase reactant and a negative acute-phase protein, has recently emerged as a potentially valuable prognostic indicator in various inflammatory diseases (5-8). Nevertheless, limited data exist regarding its utility in AP (9,10).

Another parameter, the Prognostic Nutritional Index (PNI), calculated using serum albumin levels and peripheral lymphocyte counts, reflects both nutritional and immunological status. Initially developed for surgical oncology patients, PNI has been increasingly utilized in predicting outcomes in various diseases, including sepsis, heart failure, and malignancies (11-13). In the context of AP, systemic inflammation, increased catabolism, and malnutrition are frequently observed, yet studies examining the prognostic value of PNI in this setting remain scarce (14,15).

In this study, we aimed to investigate the clinical utility of the CRP/albumin ratio and the PNI in predicting disease severity, intensive care unit (ICU) requirement, and prognosis in patients diagnosed with AP. By evaluating these parameters in relation to the Revised Atlanta Classification, this study sought to identify accessible, cost-effective, and practical prognostic markers for the early assessment of AP.

Materials and Methods

Study Design and Population

This retrospective observational study was conducted in the Internal Medicine Clinic of Ankara Etlik City Hospital. The medical records of patients hospitalized with a diagnosis of AP between November 1, 2022, and December 31, 2024, were reviewed. The diagnosis of AP was confirmed based on the clinical presentation, laboratory findings (serum amylase and/or lipase elevation ≥3 times the upper limit of normal), and imaging studies, if available. Patients younger than 18 years, those with a history of chronic pancreatitis, known malignancy, hematological diseases, known autoimmune diseases, known history of infection from another cause, those with a history of malabsorption, or pre-existing organ failure were excluded from the study. A total of 542 patients were initially screened for eligibility. After applying exclusion criteria and accounting for missing data or incomplete records, the final analysis included 444 patients. All laboratory parameters used in the study,

including CRP, albumin, lymphocyte count, and routine biochemical tests, were measured at the time of hospital admission. Only baseline admission values were evaluated, and serial laboratory measurements obtained within the first 24 hours were not included in the analysis. Imaging studies (abdominal ultrasonography and/or contrast-enhanced CT) were performed as diagnostic evaluations at the time of hospital presentation.

Data Collection

Sociodemographic data, including age and gender, comorbidities, AP etiology (biliary, alcohol, hyperlipidemia, drug-induced, or idiopathic), polypharmacy (defined as use of five or more medications), ICU admission, and clinical parameters such as length of hospital stay were retrospectively collected from electronic medical records.

The severity of AP was classified according to the 2012 Revised Atlanta Classification, which divides the disease into three categories: Mild AP, characterized by the absence of organ failure and local or systemic complications; Moderately severe AP, defined by the presence of transient organ failure (resolving within 48 hours) and/or local complications such as peripancreatic effusion, and/or systemic complications without persistent organ failure; and Severe AP, characterized by persistent organ failure (lasting longer than 48 hours) that may affect one or more organs (16). In the current study, patients were divided into two groups for analysis: the Mild group, patients who met the criteria for mild AP; and the Moderate-to-severe group, patients with moderate or severe disease as defined above.

Comorbidity burden was assessed using the Charlson Comorbidity Index (CCI), and patients were categorized according to their CCI scores (0, 1, 2, 3, and ≥4) (17).

Laboratory Parameters and Indices

The following laboratory tests performed at hospital admission were analyzed: Complete blood count: hemoglobin (g/dL), hematocrit (%), white blood cell (WBC) count (/mm^3), lymphocyte count (/mm^3), and platelet count (×10^3/mm^3), CRP (mg/L), and serum albumin (g/dL).

Furthermore, the following indices were calculated based on these parameters: CRP/Albumin ratio: CRP (mg/L) divided by albumin (g/dL), PNI: Calculated as (10 × albumin [g/dL]) + (5 × total lymphocyte count [/mm^3] ÷ 1000) (18).

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics software (version 26, Armonk, NY, USA). The distribution of continuous variables was assessed for normality using the Kolmogorov–Smirnov test. Normally distributed continuous variables are presented as mean ± standard deviation (SD), whereas variables with non-normal distribution are expressed as median (minimum–maximum). Categorical variables are reported as frequencies and percentages.

For comparisons between two independent groups, the Student's t-test was used for normally distributed variables, while the Mann–Whitney U test was applied to non-normally distributed variables. Categorical variables were compared using the chi-square (χ^2) test.

Receiver operating characteristic curve analyses were performed to evaluate the predictive performance of the PNI for disease severity and ICU admission. The area under the curve (AUC) was calculated to assess diagnostic accuracy. Optimal cutoff values were determined using the Youden Index, and corresponding sensitivity and specificity values were reported.

Univariate logistic regression analyses were conducted to identify potential predictors of disease severity and ICU admission. Variables with a p-value < 0.10 in univariate analysis were subsequently included in multivariate logistic regression models. Results are presented as odds ratios with 95% confidence intervals.

A p-value < 0.05 was considered statistically significant in all analyses.

Results

A total of 444 patients diagnosed with AP were evaluated and classified according to the Revised Atlanta Classification. Of these, 340 (76.6%) were cate-

Table 1. Comparison of Sociodemographic and Clinical Characteristics in Acute Pancreatitis Patients Stratified by Revised Atlanta Classification

Parameter	Mild (n = 340)	Moderate–Severe (n = 104)	*p-value*
Age (years), mean ± SD	53.89 ± 18.21	60.94 ± 18.45	<0.001
Female sex, n (%)	205 (60.3)	61 (58.7)	0.765
Etiology, n (%)			
Biliary	180 (52.8)	53 (50.5)	
Alcoholic	18 (5.3)	11 (10.5)	0.003
Hyperlipidemic	15 (4.4)	6 (5.8)	
Drug-induced	24 (7.2)	9 (4.2)	
Idiopathic	103 (30.3)	25 (24.0)	
ICU admission, n (%)	1 (0.3)	28 (26.9)	<0.001
Length of hospital stay (days), mean ± SD	5.84 ± 3.31	13.91 ± 9.17	<0.001
Polypharmacy (≥5 drugs), n (%)			<0.001
No	279 (82.1)	55 (52.9)	
Yes	61 (17.9)	49 (47.1)	
CCI, n (%)			<0.001
0	120 (35.2)	22 (21.1)	
1	51 (15.0)	12 (11.5)	
2	54 (15.9)	13 (12.5)	
3	47 (13.8)	10 (9.6)	
≥4	68 (20.1)	47 (45.3)	

Abbreviations: ICU, intensive care unit; SD, standard deviation; CCI, Charlson Comorbidity Index.

Notes: Continuous variables are presented as mean ± standard deviation, and categorical variables as number (%). Comparisons between groups were performed using the Student's t-test or Mann–Whitney U test for continuous variables, and the chi-square test for categorical variables. A p-value < 0.05 was considered statistically significant.

gorized as having mild pancreatitis, and 104 (23.4%) as moderate to severe pancreatitis. The mean age was significantly higher in the moderate-severe group compared to the mild group (60.94 ± 18.45 vs. 53.89 ± 18.21 years, $p < 0.001$). Gender distribution was similar between groups, with females constituting 60.3% of the mild group and 58.7% of the moderate-severe group ($p = 0.765$). Regarding etiology, biliary pancreatitis was the most common cause in both groups, whereas alcohol-related pancreatitis was significantly more frequent in the moderate-to-severe group (10.5% vs. 5.3%, $p = 0.003$). ICU admission was required in 26.9% of patients in the moderate-severe group, compared to only 0.3% in the mild group ($p < 0.001$). Hospital length of stay was significantly longer in the moderate-severe group (13.91 ± 9.17 vs. 5.84 ± 3.31 days, $p < 0.001$). Polypharmacy was more common in the moderate-severe group, with 47.1% of patients reporting the use of five or more medications, compared to 17.9% in the mild group ($p < 0.001$). When evaluated using the CCI, patients with a score ≥4 were significantly more prevalent in the moderate-severe group (45.3%) than in the mild group (20.1%). Conversely, a CCI score of 0 was more common in the mild group (35.2% vs. 21.1%, $p < 0.001$) (Table 1).

Laboratory and nutritional parameters, including the PNI, were compared between patients with mild and moderate-to-severe AP according to the Revised Atlanta Classification. Patients with moder-

Table 2. Comparison of Prognostic Nutritional Index and Laboratory Parameters According to Revised Atlanta Classification

Parameter	Mild (n = 340)	Moderate–Severe (n = 104)	*p-value*
CRP/Albumin ratio, median (min–max)	3.24 (0.03–94.02)	15.15 (0.07–99.51)	<0.001
CRP (mg/L), median (min–max)	13.47 (0.29–306.51)	58.00 (0.34–321.82)	<0.001
Albumin (g/dL), mean ± SD	3.97 ± 0.36	3.45 ± 0.41	<0.001
Hematocrit (%), mean ± SD	41.09 ± 4.99	40.14 ± 6.01	0.109
Hemoglobin (g/dL), mean ± SD	13.48 ± 1.72	13.46 ± 1.86	0.818
WBC (/mm^3), mean ± SD	10,728 ± 3,821	12,099 ± 4,898	0.004
Lymphocyte count (/mm^3), mean ± SD	1,805 ± 919	1,391 ± 855	<0.001
Platelets (×10^3/mm^3), mean ± SD	271 ± 81	259 ± 81	0.323
PNI, mean ± SD	47.92 ± 6.33	44.65 ± 6.19	<0.001

Abbreviations: CRP, C-reactive protein; PNI, Prognostic Nutritional Index; WBC, white blood cell count; SD, standard deviation; Min, minimum; Max, maximum.

Notes: Continuous variables are presented as mean ± standard deviation or median (minimum–maximum), as appropriate. Minimum–maximum values represent the lowest and highest observed values in the study population. Variables with non-normal distribution, including C-reactive protein (CRP) and the CRP/albumin ratio, are presented as median (min–max). Group comparisons were performed using the Student's t-test or Mann–Whitney U test, as appropriate. A p-value < 0.05 was considered statistically significant.

ate-to-severe disease exhibited significantly higher levels of systemic inflammatory markers, including CRP (median: 58.00 mg/L [min–max: 0.34–321.82] vs. 13.47 mg/L [0.29–306.51], $p < 0.001$) and the CRP/albumin ratio (median: 15.15 [0.07–99.51] vs. 3.24 [0.03–94.02], $p < 0.001$). In addition, lymphocyte counts were significantly lower (1,391 ± 855 vs. 1,805 ± 919 /mm^3, $p < 0.001$), while WBC counts were significantly higher (12,099 ± 4,898 vs. 10,728 ± 3,821 /mm^3, $p = 0.004$) in the moderate-to-severe group. Serum albumin levels were also significantly reduced in patients with moderate-to-severe AP compared with those with mild disease (3.45 ± 0.41 vs. 3.97 ± 0.36 g/dL, $p < 0.001$). No significant differences were observed in hematocrit, hemoglobin, or platelet counts between the two groups. Importantly, the PNI, reflecting both nutritional and immunological status, was significantly lower in the moderate-to-severe group (44.65 ± 6.19 vs. 47.92 ± 6.33, $p < 0.001$) (Table 2).

Patients requiring admission to the ICU were compared in terms of PNI and laboratory parameters. Although the mean age of the patient group in the ICU was higher (61.00 ± 19.80 vs. 55.16 ± 18.36 years), the difference was not statistically significant ($p = 0.100$). Gender ratios were similar between the groups (65.5% vs. 59.5%, $p = 0.524$). Markers of systemic inflammation were significantly more pronounced among patients admitted to the ICU. Accordingly, CRP levels were significantly higher in the ICU group compared with non-ICU patients (median: 67.33 mg/L [min–max: 5.12–321.82] vs. 15.12 mg/L [0.29–318.80], $p < 0.001$). Likewise, the CRP/albumin ratio was significantly elevated in patients requiring ICU admission (median: 19.10 [min–max: 1.50–92.32] vs. 4.01 [0.30–99.51], $p < 0.001$). Serum albumin levels were significantly lower in ICU patients compared with non-ICU patients (3.57 ± 0.48 vs. 3.96 ± 0.39 g/dL, $p = 0.001$). Additionally, WBC counts were significantly higher in the ICU patient group (13.258 ± 6.162 vs. 10.895 ± 3.918 /mm^3, $p = 0.029$) and lymphocyte counts were significantly lower (1.218 ± 752 vs. 1.742 ± 922 /mm^3, $p < 0.001$). PNI was significantly lower in patients requiring ICU admission (41.96 ± 5.06 vs. 47.51 ± 6.38, $p < 0.001$) (Table 3).

In multivariate logistic regression analysis, the CRP/albumin ratio, CRP levels, and the PNI were

Table 3. Comparison of Prognostic Nutritional Index and Laboratory Parameters in Patients Admitted to and not Admitted to the Intensive Care Unit

Parameter	ICU-Admitted (n = 29)	Non-ICU Patients (n = 415)	*p-value*
Age (years), mean ± SD	61.00 ± 19.80	55.16 ± 18.36	0.100
Female sex, n (%)	19 (65.5)	247 (59.5)	0.524
CRP/Albumin ratio, median (min–max)	19.10 (1.50–92.32)	4.01 (0.30–99.51)	<0.001
CRP (mg/L), median (min–max)	67.33 (5.12–321.82)	15.12 (0.29–318.80)	<0.001
Albumin (g/dL), mean ± SD	3.57 ± 0.48	3.96 ± 0.39	0.001
Hematocrit (%), mean ± SD	41.45 ± 6.44	40.83 ± 5.17	0.611
Hemoglobin (g/dL), mean ± SD	13.93 ± 2.31	13.45 ± 1.72	0.271
WBC (/mm^3), mean ± SD	13,258 ± 6,162	10,895 ± 3,918	0.029
Lymphocyte count (/mm^3), mean ± SD	1,218 ± 752	1,742 ± 922	<0.001
Platelets (×10^3/mm^3), mean ± SD	272 ± 106	268 ± 80	0.903
PNI, mean ± SD	41.96 ± 5.06	47.51 ± 6.38	<0.001

Abbreviations: CRP, C-reactive protein; ICU, intensive care unit; PNI, Prognostic Nutritional Index; SD, standard deviation; WBC, white blood cell count; Min, minimum; Max, maximum.

Notes: Continuous variables are presented as mean ± standard deviation or median (minimum–maximum), as appropriate. Variables with non-normal distribution, including C-reactive protein (CRP) and the CRP/albumin ratio, are presented as median (min–max). Categorical variables are presented as number (%). Group comparisons were performed using the Student's t-test or Mann–Whitney U test for continuous variables, and the chi-square test for categorical variables. A p-value < 0.05 was considered statistically significant.

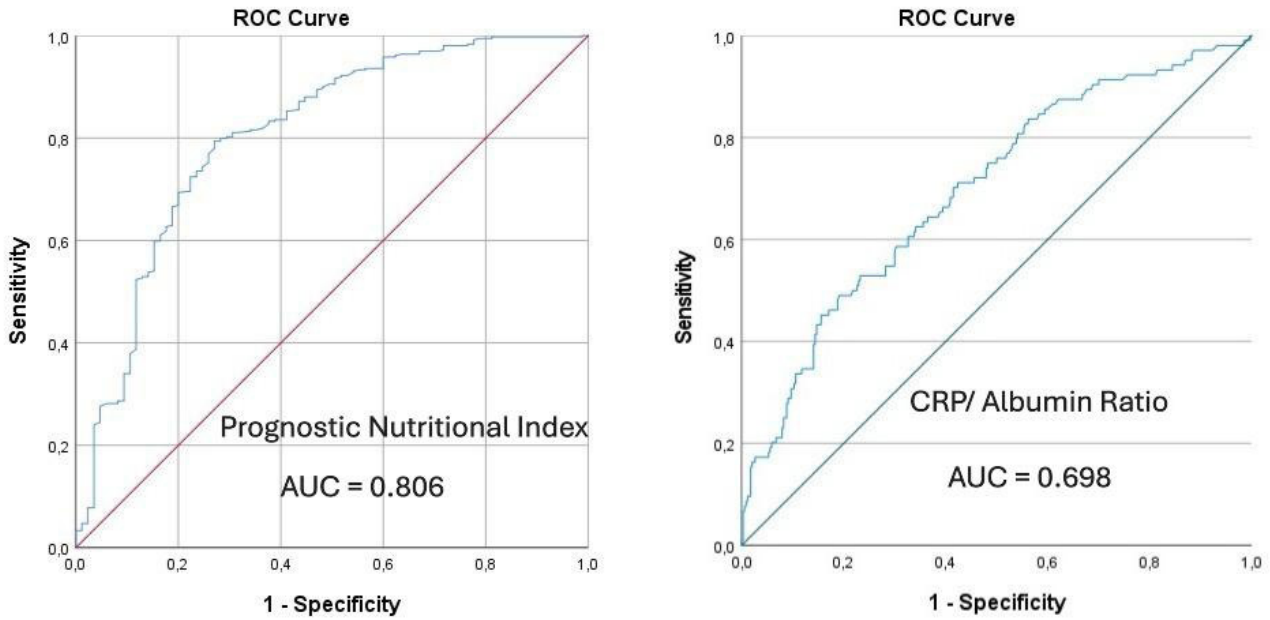


Figure 1. Receiver Operating Characteristic curve analysis of the Prognostic Nutritional Index and CRP/Albumin ratio for predicting disease severity in acute pancreatitis based on the Revised Atlanta Classification.

AUC: Area under curve, CRP: C-reactive protein, ROC: Receiver Operating Characteristic.

Table 4. Multivariate Logistic Regression Analysis of Factors Associated with Intensive Care Unit Admission

Variable	*p-value*	OR	95% CI
CRP/Albumin ratio	<0.015	1.248	1.044–1.491
CRP	<0.016	1.064	1.012–1.119
PNI	<0.001	0.694	0.617–0.780

Abbreviations: CRP, C-reactive protein; PNI, Prognostic Nutritional Index; OR, odds ratio; CI, confidence interval.
Notes: Multivariate logistic regression analysis was performed including variables with p < 0.10 in univariate analysis. Results are presented as odds ratios with 95% confidence intervals. A p-value < 0.05 was considered statistically significant.

identified as independent predictors of intensive care unit admission. Higher CRP/albumin ratio (OR = 1.248, 95% CI: 1.044–1.491, $p < 0.015$) and higher CRP levels (OR = 1.064, 95% CI: 1.012–1.119, $p < 0.016$) were independently associated with an increased risk of ICU admission. Importantly, lower PNI values were also independently associated with an increased risk of ICU admission (OR = 0.694, 95% CI: 0.617–0.780, p < 0.001 (Table 4).

Receiver Operating Characteristic curve analysis showed that the PNI had good discriminatory ability in predicting disease severity according to the Revised Atlanta Classification, with an AUC of 0.806 (95% CI: 0.750–0.862). The optimal cut-off value for the PNI was 40.17. Similarly, the CRP/albumin ratio demonstrated predictive performance with an AUC of 0.698 (95% CI: 0.640–0.756). The optimal cut-off value for the CRP/albumin ratio was calculated as 13.43 (Figure 1).

Receiver Operating Characteristic curve analysis demonstrated that both the PNI and the CRP/albumin ratio had significant predictive value for intensive care unit admission in patients with AP. The PNI exhibited strong discriminative ability with an AUC of 0.904 (95% CI: 0.846–0.962), clearly outperforming its performance in disease severity prediction. The optimal cut-off value for the PNI was 32.675, which provided high diagnostic accuracy. Similarly, the CRP/albumin ratio demonstrated meaningful predictive capability with an AUC of 0.705 (95% CI: 0.615–0.795). The optimal threshold value of the CRP/albumin ratio was determined to be 16.53, offering additional prognostic value in identifying patients requiring intensive care (Figure 2).

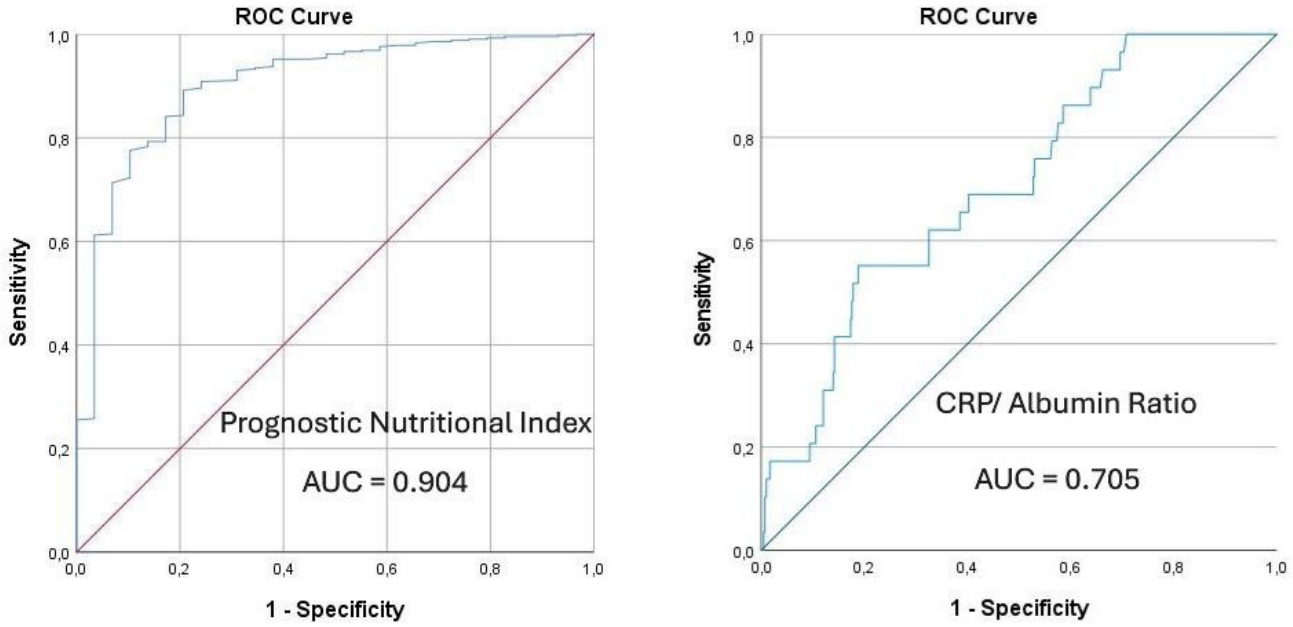


Figure 2. Receiver Operating Characteristic curve analysis of the Prognostic Nutritional Index and CRP/Albumin ratio for predicting intensive care unit admission in patients with acute pancreatitis.
AUC: Area under curve, CRP: C-reactive protein, ROC: Receiver Operating Characteristic.

Discussion

In this retrospective study, we investigated the prognostic value of the CRP/albumin ratio and the PNI in predicting disease severity and the need for ICU admission in patients with AP. Our findings indicate that both indices were strongly associated with clinical outcomes, with significantly higher CRP/albumin ratios and lower PNI values observed in patients with moderate-to-severe AP compared with those with mild disease, according to the Revised Atlanta Classification. Furthermore, both markers demonstrated significant predictive ability for ICU admission, with the PNI outperforming the CRP/albumin ratio as a prognostic tool.

Consistent with previous studies, advanced age, polypharmacy, and a greater comorbidity burden were more common among patients with moderate-to-severe AP (19–21). These patients also experienced longer hospital stays and higher ICU admission rates, reflecting their poorer prognosis. Such clinical characteristics underscore the importance of incorporating demographic and comorbidity profiles into the assessment of disease severity.

Our findings demonstrated that CRP levels and, more prominently, the CRP/albumin ratio were significantly higher in patients with severe AP and in those requiring ICU admission. This observation is consistent with previous studies reporting that although CRP alone is a well-established marker of systemic inflammation, its diagnostic and prognostic performance is limited by interindividual variability and the delayed rise in serum concentrations during the early phase of the disease (5,6,22). By combining CRP with serum albumin, a negative acute-phase reactant that decreases in critical illness due to capillary leakage, impaired hepatic synthesis, and catabolism, the CRP/albumin ratio integrates two complementary pathophysiological processes: inflammation and nutritional status. Consequently, this composite index has been shown to provide superior prognostic accuracy compared with CRP alone in several inflammatory and malignant conditions (9,23,24). In the context of AP, our results reinforce the growing body of evidence indicating that the CRP/albumin ratio is an independent predictor of disease severity and adverse clinical outcomes, and may therefore serve as a simple, readily available, and cost-effective tool to aid early risk stratification.

Prognostic Nutritional Index, which reflects both nutritional reserves and immune competence, was significantly lower in patients with severe AP and in those requiring intensive care. This finding is pathophysiologically plausible, as malnutrition and lymphopenia are common in critically ill patients due to systemic inflammation, catabolic stress, and impaired immune function. Similar associations have been reported across diverse patient populations, including oncology, sepsis, and cardiovascular disease, where reduced PNI consistently correlates with increased morbidity and mortality (11–13). In the setting of AP, where systemic inflammatory response and metabolic derangements frequently compromise nutritional and immunological status, recent studies have underscored the prognostic utility of PNI. Notably, its predictive value appears to be enhanced when used in combination with other inflammatory markers or established scoring systems such as BISAP or Ranson's criteria (14,25,26). In our study, ROC curve analysis further confirmed the clinical relevance of the PNI, demonstrating a robust discriminatory performance for ICU admission (AUC = 0.904). This emphasizes its potential role as an easily obtainable, cost-effective, and objective tool for early risk stratification, enabling timely identification of high-risk patients at hospital presentation.

Furthermore, the identification of CRP levels, the CRP/albumin ratio, and the PNI as independent predictors of the ICU admission in multivariate logistic regression analysis supports the central role of both inflammatory burden and nutritional–immunological status in determining disease severity and adverse clinical outcomes in AP. These findings support the potential utility of these markers during clinical follow-up to monitor disease progression and guide risk stratification

Receiver operating characteristic curve analyses provide important insights into the comparative discriminatory ability of these indices. For predicting

overall disease severity according to the Revised Atlanta Classification, the PNI demonstrated superior discriminatory ability with an AUC of 0.806 compared with the CRP/albumin ratio (AUC: 0.698). This indicates that nutritional and immunologic parameters incorporated in the PNI may better reflect the multifactorial determinants of disease severity beyond acute inflammatory activity alone. More strikingly, when ICU admission, a clinically more relevant endpoint reflecting persistent organ dysfunction and critical illness, was considered, the PNI achieved an excellent predictive accuracy (AUC: 0.904), substantially outperforming the CRP/albumin ratio (AUC: 0.705). These findings highlight the prognostic strength of the PNI in identifying patients at highest risk for deterioration and the need for advanced supportive care. In contrast, the CRP/albumin ratio, while showing moderate predictive capability, may primarily capture the acute inflammatory phase of the disease. Taken together, the differential performance of these two indices underscores their complementary nature: the CRP/albumin ratio provides information on the inflammatory burden, whereas the PNI offers additional prognostic value by integrating nutritional and immunologic reserves, ultimately improving risk stratification in patients with AP.

The clinical implications of these findings are considerable. Both the PNI and the CRP/albumin ratio can be calculated from inexpensive, routinely performed laboratory tests, offering rapid and cost-effective risk stratification at the time of hospital admission. Compared with more complex prognostic tools such as APACHE II and BISAP, which require the integration of multiple clinical and biochemical parameters and may delay early decision-making (27,28), these indices provide timely and practical alternatives. The markedly higher predictive accuracy of the PNI, particularly for ICU admission, underscores its potential role in guiding early triage decisions and identifying patients at greatest risk for deterioration. At the same time, the CRP/albumin ratio retains value in reflecting the inflammatory burden during the initial phase of disease. Incorporating these indices into routine assessment could therefore facilitate the prompt recognition of high-risk patients, support decisions regarding closer monitoring or transfer to intensive care, and optimize healthcare resource utilization, especially in emergency and resource-limited settings. Importantly, their complementary nature suggests that using the PNI together with the CRP/albumin ratio may further enhance prognostic accuracy by bridging acute inflammatory markers with indicators of nutritional and immunologic reserve.

The threshold values identified in our study provide clinically significant information that can contribute to early risk stratification in patients with AP. A PNI value below 40.17 and a CRP/albumin ratio above 13.43, associated with moderate to severe disease, may reflect an increased inflammatory burden and indicate a need for closer monitoring and more intensive treatment in the early stages of hospitalization. More importantly, a PNI value below 32.675 and a CRP/albumin ratio above 16.53 can be considered strong indicators for admission to the ICU. These thresholds help identify a particularly high-risk subgroup that may benefit from early assessment of potential ICU needs. Integrating these parameters into routine clinical assessment can facilitate early triage and support more personalized management strategies for patients with AP.

This study has several limitations that should be acknowledged. First, its retrospective, single-center design may have introduced selection bias and restricts the generalizability of the results. Second, although both the CRP/albumin ratio and the PNI demonstrated significant prognostic value, their predictive accuracy was only moderate, suggesting that they should be regarded as adjunctive tools rather than substitutes for established scoring systems. Finally, the optimal cut-off values identified in this study require external validation in prospective, multicenter cohorts before they can be reliably implemented in routine clinical practice. Additionally, the retrospective design did not allow for complete and standardized documentation of clinical management variables, such as changes in treatment protocols. These factors may have influenced both biomarker levels and clinical outcomes. Therefore,

these potential confounders should be considered when interpreting the results, and the generalizability of the findings should be assessed based on these limitations. Another limitation of this study is that CRP and other laboratory parameters were evaluated only at the time of hospital admission. Since CRP levels in AP typically peak 48–72 hours after symptom onset, admission CRP values may underestimate the inflammatory burden in patients presenting early in the disease course.

In conclusion, this study highlights that both the CRP/albumin ratio and the PNI are valuable, readily accessible biomarkers that provide a more comprehensive reflection of systemic inflammation and nutritional status. By capturing these complementary aspects, they offer a rapid and cost-effective approach to early risk stratification in AP, particularly for identifying patients at risk of severe disease and ICU admission. Their integration into clinical practice has the potential to facilitate timely intervention and improve patient outcomes, while their use alongside established prognostic scoring systems may further enhance predictive accuracy. Future prospective, multicenter studies are warranted to validate these findings and to explore the prognostic significance of dynamic changes in these indices throughout the clinical course of AP.

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