

Evaluating Inflammatory and Metabolic Syndrome Components as Early Predictors of Acute Pancreatitis Severity

Zsombor Szász*, Imola Török, Monica Pantea, Ioana-Izabela Băncilă, Simona Bătagă

Department of Gastroenterology 1, County Emergency Clinical Hospital, Târgu Mureș, Romania

CORRESPONDENCE

Zsombor Szász

Email: szaszzsombi3@gmail.com

ARTICLE HISTORY

Received: August 1, 2025

Accepted: August 21, 2025

ABSTRACT

Introduction: Acute pancreatitis is a common inflammatory condition with potentially severe progression. Several prognostic systems (Ranson's criteria, Glasgow score, APACHE II, BISAP) are available to assess severity; however, they are complex, require multiple data points, and are of limited utility in emergency settings. This study investigated inflammatory and metabolic syndrome components at admission as predictors of acute pancreatitis severity. **Materials and Methods:** We retrospectively analyzed 103 patients admitted with acute pancreatitis to the Gastroenterology Department of Mureș County Emergency Hospital. Patients were classified as mild, moderate, or severe according to the Revised Atlanta Classification. Demographic data, laboratory findings, and metabolic syndrome components were compared across groups. **Results:** The mean patient age was 56 years, and most were male. Disease severity was moderate in 36%, severe in 24%, and mild in 40% of cases. Elevated neutrophil-to-lymphocyte ratio (NLR), CRP, hypoalbuminemia, and admission glucose levels were independent, dose-dependent risk factors for severity ($p < 0.05$). The optimal baseline NLR cut-off for severe acute pancreatitis was ≥ 10.5 (sensitivity 87.5%, specificity 78.9%; $p = 0.001$). Hypertension was also significantly associated with increased severity ($p = 0.016$). Necrosis was strongly associated with severe cases ($p = 0.0001$). Hospital stay increased with severity ($p = 0.005$). **Conclusion:** At admission, hypertension as a component of metabolic syndrome, elevated glucose, hypoalbuminemia, elevated NLR (≥ 10.5), and increased CRP are independent and dose-dependent risk factors for severe acute pancreatitis. These readily available markers may improve early risk stratification in emergency settings.

Keywords: acute pancreatitis, severity, risk factors

INTRODUCTION

Acute pancreatitis (AP) is one of the most common inflammatory conditions requiring emergency care worldwide. Its incidence, morbidity, and mortality are increasing, making it a global public health concern. In a recently published retrospective study, we showed that over the past 10 years, the number of AP cases admitted to the 1st Department of Gastroenterology at the Country Emergency Clinical Hospital of Târgu Mureș has doubled, as has the disease-related mortality rate.¹

Although most cases of AP are mild, approximately 25% develop severe complications such as necrosis or organ failure, where the mortality rate may reach 50%. The severity of the disease is associated with extra-pancreatic organ damage and multi-organ failure, which results from systemic inflammatory response syndrome.²

Several prognostic scoring systems are available to assess the severity of AP (e.g., Ranson's criteria, Glasgow score, APACHE II, BISAP). However, in emergency care, the biomarkers required for these assessments are not always readily available. In addition, some biomarkers, such as white blood cell count, can be affected by hydration status, blood sample handling, and emotional stress, which may limit their reliability.³

In contrast, the neutrophil-to-lymphocyte ratio (NLR) has proven to be a more reliable predictive biomarker. One study found it to be a better predictor of disease severity and a more accurate reflection of immune status than total white blood cell count.⁴

Although serum glucose level is included in the Ranson criteria, some research suggests it is independently and dose-dependently associated with worse outcomes in AP.⁵ Similarly, hypoalbuminemia at admission, part of the Glasgow scoring system, has been found to be an independent risk factor associated with more severe disease progression and mortality, affecting about one-third of patients with AP.⁶

Multiple studies have confirmed that obesity, hyperlipidemia, and diabetes mellitus increase the risk of severe disease, complications, and mortality in AP. According to Fu et al., the components of metabolic syndrome act synergistically: the more components present, the higher the risk of complications.⁷

In this study, we evaluated the impact of the NLR, C-reactive protein, and serum albumin at admission, along with selected components of metabolic syndrome, such as serum glucose level and hypertension, on the severity of AP.

MATERIAL AND METHOD

In this retrospective study, we analyzed the clinical, laboratory, and radiological data of patients diagnosed with AP and admitted to the 1st Department of Gastroenterology at the Mureş County Emergency Clinical Hospital. The study was approved by the institution's Ethics Committee (approval no. 18016/23.07.2025).

Inclusion criteria:

- age over 18 years;

- diagnosis of AP according to the International Association of Pancreatology/American Pancreatic Association (IAP/APA) guidelines, requiring at least two of the following three criteria: (1) abdominal pain; (2) serum amylase or lipase levels at least three times the upper limit of normal; (3) imaging findings characteristic of AP;
- alcohol-related etiology: alcohol consumption of ≥ 70 g/day or ≥ 490 g/week;
- biliary etiology: presence of gallstones, including bile duct stones, biliary sludge, or microlithiasis;
- hypertriglyceridemia-related AP: serum triglyceride level ≥ 11 mmol/L;
- other etiologies: patients not falling into any of the three main groups (alcoholic, biliary, hypertriglyceridemia). These included acute exacerbation of chronic pancreatitis, drug-induced AP, post-endoscopic retrograde cholangiopancreatography pancreatitis, idiopathic cases, or other defined causes.

If both biliary and alcoholic etiologies were present, the case was classified as biliary. If both hypertriglyceridemia and alcoholic etiologies were present, the case was classified as hypertriglyceridemia. If both biliary and hypertriglyceridemia etiologies were present, the case was classified as biliary.

Exclusion criteria:

- Incomplete or unclear data.

AP severity was classified according to the Revised Atlanta Classification into three categories:

- Mild AP (MAP): No organ failure and no local or systemic complications.
- Moderately severe AP (MSAP): Transient organ failure (<48 h), presence of local complications (e.g., peripancreatic fluid collection, pseudocyst, necrosis), or worsening of preexisting comorbidities.
- Severe AP (SAP): Persistent organ failure (>48 h) involving the respiratory, renal, or cardiovascular systems.

Definitions of organ failure:

- Shock: Systolic blood pressure <90 mmHg
- Respiratory failure: Arterial PO₂ <60 mmHg on room air or need for mechanical ventilation
- Renal failure: Serum creatinine >2 mg/dl after rehydration or need for hemodialysis.

TABLE 1. Patient demographics, AP etiology and laboratory findings comparing mild, moderate, and severe acute pancreatitis at admission

	MAP	MSAP	SAP	p value
Age, years, mean \pm s.d.	54.08 \pm 16.43	58.44 \pm 16.035)	55.81 (\pm 16.830)	0.669
Sex, male/female, n (%)	23 (57.5%)/17 (42.5%)	24 (66.7%)/12 (35.3%)	19 (79.2%)/5 (20.8%)	0.207
Etiology				0.793
Biliary, n (%)	16 (40%)	14 (38.9%)	7 (29.2%)	
Alcohol, n (%)	9 (22.5%)	6 (16.7%)	7 (29.2%)	
Hypertriglyceridemia, n (%)	9 (22.5%)	12 (33.3%)	8 (33.3%)	
Other, n (%)	6 (15%)	4 (11.1%)	2 (8.3%)	
Laboratory findings at admission				
Albumin, g/dl, mean \pm s.d.	3.89 \pm 0.36	3.67 \pm 0.45	3.24 \pm 0.53	0.0001
NLR, mean \pm s.d.	6.65 \pm 3.79	10.81 \pm 8.23	21.79 \pm 15.19	0.0001
Glucose, mg/dl, mean \pm s.d.	126.43 \pm 52.33	152.50 \pm 76.82	243.58 \pm 208.84	0.001
C-reactive protein, mg/dl, mean \pm s.d.	69.2 \pm 68.27	103.19 \pm 122.19	216.92 \pm 140.81	0.0001
Amylase, U/L, mean \pm s.d.	955.53 \pm 1,202.83	1,094.19 \pm 1,164.59	809.63 \pm 853.11	0.623
Hospital stay, days, mean \pm s.d.	7.40 \pm 2.12	9.31 \pm 3.26	10.13 \pm 4.96	0.005
Hypertension, n (%)	17 (42.5%)	27 (75%)	14 (58.3%)	0.016
Complications, n				0.0001
No complications	5	2	0	
Peripancreatic fluid collection	31	22	11	
Pseudocysts	1	10	1	
Necrosis	1	1	11	
De novo diabetes	2	1	1	

Local complications included acute peripancreatic fluid collection, pseudocyst, acute necrotic collection, and walled-off necrosis. Diabetes mellitus was also recorded as a complication if newly diagnosed after the AP episode. Systemic complications were defined as acute exacerbation of existing comorbidities (e.g., coronary artery disease or chronic pulmonary disease) triggered by AP.

The NLR was calculated as the ratio between the percentage of neutrophils and lymphocytes reported in the complete blood count.

Statistical analysis

For descriptive statistics, the following continuous variables were analyzed: age, albumin level at admission, glucose level at admission, NLR at admission, length of hospital stay, amylase level at admission, and CRP level at admission. Comparisons across the three severity groups (MAP, MSAP, and SAP) were performed using the one-way ANOVA test. Categorical variables included sex, AP etiology, and history of hypertension. These were compared across severity groups using the chi-squared test. The optimal cut-off values for NLR, albumin, and glucose at admission were determined by balancing sensitivity and specificity on receiver operating characteristic (ROC) curves. The predictive accuracy of NLR was further as-

sessed by calculating the area under the curve (AUC). A p value of <0.05 was considered statistically significant.

RESULTS

During the study period (1 January 2025 – 30 June 2025), 103 patients diagnosed with AP were enrolled. Three patients were excluded due to missing baseline data. The mean age of the study population was 56 years, and most patients were male (66%). The majority of cases were of biliary origin (37%), followed by hypertriglyceridemia (29%), alcohol-induced pancreatitis (22%), and other causes (12%), including tumor, iatrogenic, or drug-induced pancreatitis. With regard to severity, 40% of cases were classified as mild, while 36% were moderately severe and 24% severe. The clinical characteristics and initial laboratory findings of the study population are summarized in Table 1.

The distribution of age by severity group is presented in Figure 1. Ordinal logistic regression revealed no significant association between age and severity ($p = 0.669$), likely reflecting the small sample size.

To assess the relationship between NLR and disease severity, we used ANOVA with Tukey's post hoc test. Patients in the severe group had significantly higher NLR values compared with both mild and moderate groups

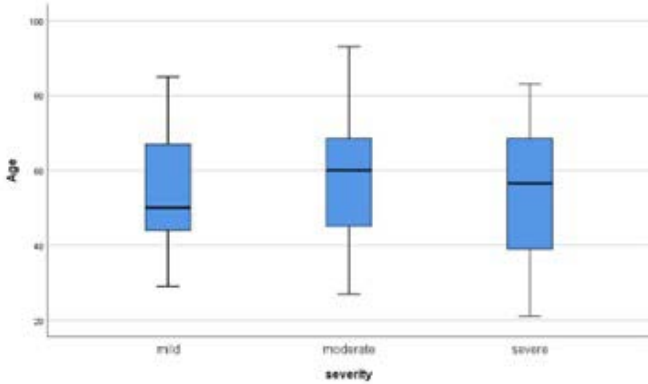


FIGURE 1. Boxplot of age distribution by severity group (mild, moderate, severe). Boxes represent the interquartile range, whiskers indicate the full range, and the median is shown as a horizontal line.

($p = 0.0001$), but there was no significant difference between the mild and moderate groups ($p = 0.127$). The mean NLR was markedly elevated in the severe group (21.79) compared with the mild group (6.65), indicating a strong association between higher NLR values and disease severity. Standard deviation was also higher in the severe group (15.19), reflecting greater variability, and the standard error of the mean was larger (3.10), partly due to the smaller sample size ($n = 24$) and higher variability. The distribution of mean NLR across severity groups is illustrated in Figure 2.

Based on the ROC analysis (Figure 3), the optimal cut-off value of baseline NLR for predicting the development of SAP was identified as ≥ 10.5 (Youden's Index = 0.664; sensitivity 87.5%; specificity 78.9%).

Patients with SAP also had significantly higher glucose levels at admission than those with mild disease ($p = 0.001$). The mean serum glucose level was 126.43 mg% in the mild group, 152.5 mg% in the moderate group, and

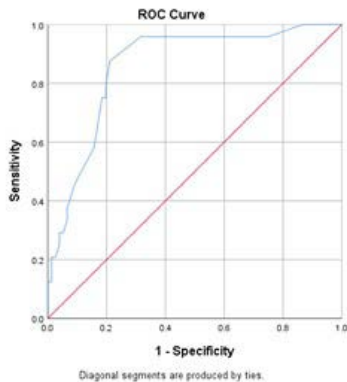


FIGURE 3. ROC and corresponding AUC analysis for NLR in predicting AP severity.

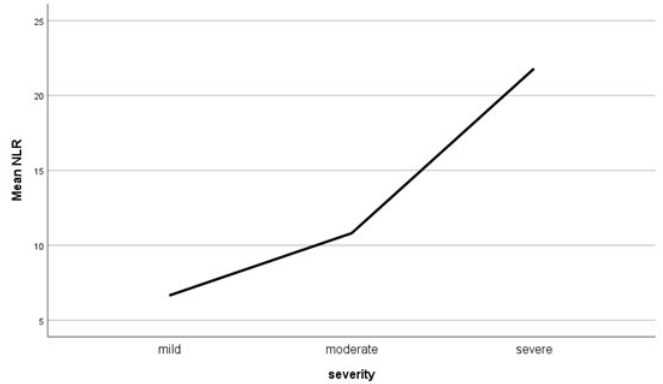


FIGURE 2. Line chart of mean NLR across severity groups.

243.58 mg% in the severe group. The distribution of mean glucose levels by severity is illustrated in Figure 4.

Analysis of serum albumin at admission showed a progressive decline with increasing disease severity. Mean albumin levels were 3.89 g/dl in the mild group, 3.67 g/dl in the moderate group, and 3.24 g/dl in the severe group. The differences were statistically significant between the mild and severe ($p = 0.0001$) and between the moderate and severe groups ($p = 0.001$). These results are shown in Figure 5.

Patients were categorized according to the presence or absence of hypertension (Figure 6). Among those without hypertension, most had MAP (23 out of 42), while only 10 developed SAP. In contrast, among patients with hypertension, a greater proportion presented with MSAP (27) or SAP (14). The chi-squared test confirmed a statistically significant association between hypertension and disease severity ($p = 0.016$).

We also examined the relationship between severity and complications. The most common complication overall was peripancreatic fluid collection (64%), especially fre-

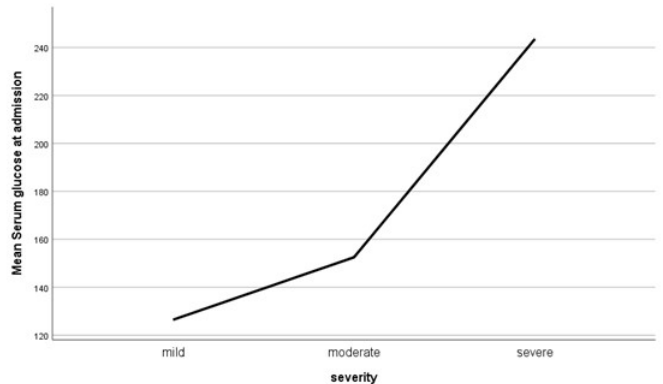


FIGURE 4. Mean serum glucose levels at admission across severity groups of AP.

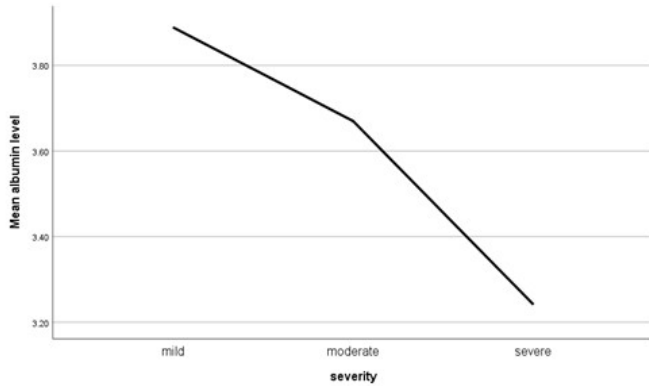


FIGURE 5. Mean serum albumin levels at admission across severity groups of AP.

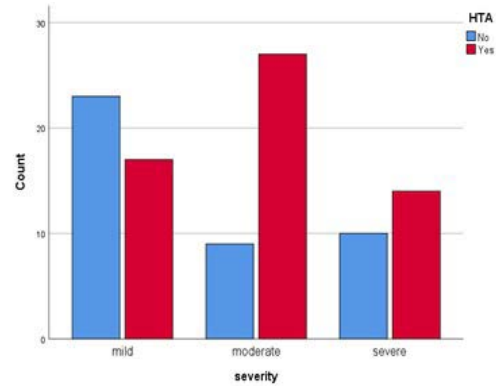


FIGURE 6. Distribution of hypertensive and non-hypertensive patients across severity groups of AP.

quent in mild cases (77.5%). Pseudocysts occurred most often in moderate cases, while nearly half of severe cases (45.8%) developed necrosis. Necrosis was strongly associated with severe pancreatitis, with 11 of 13 necrosis cases (84.6%) occurring in this group ($p = 0.0001$). Moreover, hospital stay also increased with disease severity (Figure 8). Patients with MAP stayed an average of 7.4 days, those with MSAP 9.3 days, and those with SAP 10.1 days ($p = 0.005$). However, no statistically significant relationship was observed between the presence of complications and the length of hospital stay ($p = 0.351$).

DISCUSSION

This study evaluated inflammatory and metabolic syndrome components as early predictors of AP severity. Data from 100 patients diagnosed with AP were analyzed, with a mean age of 56 years; most were male (66%). The most frequent etiology was biliary (37%), followed by hypertriglyceridemia (29%), alcohol-induced pancreatitis (22%), and other causes (12%). In terms of severity,

36% of cases were moderately severe and 24% severe, while 40% were mild.

Age has been reported as a factor influencing outcomes in AP.⁸ However, in our cohort, ordinal logistic regression showed no significant association between age and disease severity across the MAP, MSAP, and SAP groups ($p = 0.669$).

Tae *et al.*⁹ evaluated sequential NLR measurements at admission and on days 1–3 in patients with MAP and SAP and reported optimal baseline cut-off values for predicting SAP of 4.76 at admission and 5.18 on day 1. In our study, only baseline NLR at admission was analyzed, as the first 24 h of hospitalization are considered the most critical for management decisions. The mean NLR was significantly higher in the severe group (21.79) compared with the mild group (6.65), suggesting a strong association between higher NLR values and disease severity. ROC curve analysis identified an optimal baseline cut-off value of ≥ 10.5 (Youden's Index 0.664; sensitivity 87.5%; specificity 78.9%). The higher threshold observed in our study may be explained by the relatively small sample size.

Patients with SAP had significantly higher glucose levels at admission than those with mild disease ($p = 0.001$). These findings demonstrate a clear trend of increasing glucose levels with disease severity. This observation is supported by the study conducted by Nagy *et al.* (2021), which confirmed that both admission and peak in-hospital glucose levels are independently associated with increased severity of AP.⁵

The mean albumin levels were 3.89 g/dl in the mild group, 3.67 g/dl in the moderate group, and 3.24 g/dl in the severe group, with statistically significant differences between mild and severe ($p = 0.0001$) and between moderate and severe groups ($p = 0.001$). These findings are consistent with Ocskay *et al.* (2021), who demonstrated

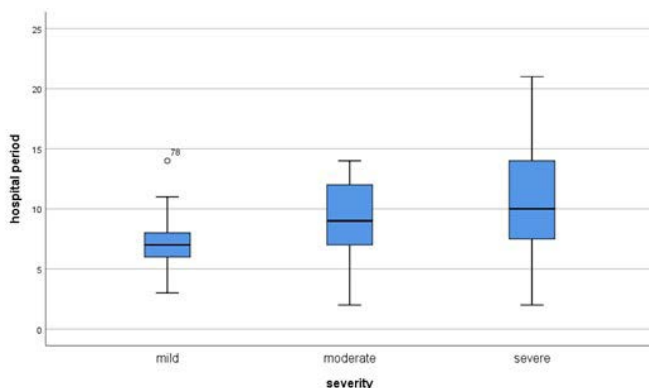


FIGURE 7. Mean hospital stay across severity groups of AP.

that admission hypoalbuminemia is dose-dependently associated with the severity of AP.⁶ This underscores the prognostic value of serum albumin as a marker for both initial assessment and ongoing monitoring in AP.

The chi-squared test showed a statistically significant association between hypertension and disease severity ($p = 0.016$). Patients with hypertension were more likely to present with moderate or severe disease. Szentesi *et al.* (2019) introduced the concept of the ‘multiple hits’ model, suggesting that components of metabolic syndrome, including hypertension, may act synergistically to worsen outcomes. Their study demonstrated that hypertension is independently associated with severity and with an increased risk of renal failure. The sympathetic nervous system may contribute to the mechanism, amplifying elevated blood pressure and having a role in the development of hypertension-related complications during the course of AP.¹⁰

Several scoring systems are available for predicting adverse outcomes in AP, including Ranson’s criteria, Glasgow score, Apache II, and the Bedside Index of severity in Acute Pancreatitis (BISAP). However, their utility in emergency settings is often limited, as they require data that may not be immediately available or that take time to develop. Consequently, we need markers with rapid confirmation of the results.

Further research should focus on evaluating additional components of metabolic syndrome in patients with AP, ideally in larger cohorts. A more comprehensive assessment could help elucidate the cumulative or synergistic effects of metabolic syndrome on disease progression and severity, and support the development of predictive models that integrate both metabolic and inflammatory parameters.

CONCLUSION

In this study, we demonstrated that several parameters that are measurable at admission, including hypertension as a component of metabolic syndrome, elevated glucose

levels, hypoalbuminemia, an elevated NLR (≥ 10.5), and increased C-reactive protein, are independent and dose-dependent risk factors associated with the severity of AP. These markers are routinely available in most emergency settings and may provide a rapid and reliable method for early identification of patients at risk of developing severe forms of the disease.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no external funding.

REFERENCES

1. Török I, Futó F, Băţaga S, et al. Follow-up of the acute pancreatitis - a comparative study from a 10-years perspective. *J Gastrointest Liver.* 2025;30:59-60.
2. Yu L, Xie F, Lou L, et al. Clinical characteristics and risk factors of organ failure and death in necrotising pancreatitis. *BMC Gastroenterol.* 2023;23:19.
3. Zengin O, Göre B, Öztürk O, et al. Evaluation of Acute Pancreatitis Severity and Prognosis Using the Aggregate Systemic Inflammation Index (AISII) as a New Marker: A comparison with other Inflammatory Indices. *J Clin Med.* 2025;14(10):3419.
4. Shrestha A, Pradhananga S, Shakya N. Prediction of severity of acute pancreatitis using neutrophil to lymphocyte ratio. *Int Surg J.* 2024;11(9):1477-1483.
5. Nagy A, Juhász M, Görbe A, et al. Glucose levels show independent and dose-dependent association with worsening acute pancreatitis outcomes: Post-hoc analysis of a prospective, international cohort of 2250 acute pancreatitis cases. *Pancreatology.* 2021;21(7):1237-1246.
6. Ocskay K, Vinkó Zs, Németh D, et al. Hypoalbuminemia affects one third of acute pancreatitis patients and it independently associated with severity and mortality. *Sci Rep.* 2021;11(1):24158.
7. Fu Zh, Zhao ZY, Liang YB, et al. Impact of metabolic syndrome components on clinical outcomes in hypertriglyceridemia-induced acute pancreatitis. *World J Gastroenterol.* 2024;30(35):3996-4010.
8. Zhang S, Chen Z, Hu C, et al. The clinical Characteristics and Outcomes of Acute Pancreatitis Are different in Elderly Patients: A Single-Center Study over a 6-Year Period. *J Clin Med.* 2024;13(16):4829.
9. Joen TJ, Park JY. Clinical significance of the neutrophil-lymphocyte ratio as an early predictive marker for adverse outcomes in patients with acute pancreatitis. *World J Gastroenterol.* 2017;23(21):3883-3889.
10. Szentesi A, Párniczky A, Vincze Á, et al. Multiple Hits in Acute pancreatitis: Components of Metabolic Syndrome Synergise Each Other’s Deteriorating Effects. *Front Physiol.* 2019;10:1202.