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Prediction of acute pancreatitis severity using NLR, procalcitonin, and CT severity score

A retrospective study

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Abstract

This study aims to evaluate the clinical value of the neutrophil-to-lymphocyte ratio (NLR), procalcitonin (PCT), and computed tomography (CT) severity score in predicting the severity of acute pancreatitis (AP). Additionally, we investigate their correlations with clinical, laboratory, and imaging parameters to provide guidance for the early diagnosis and treatment of AP. This retrospective study included 300 patients diagnosed with AP at our hospital between December 2021 and December 2024. According to the Atlanta Classification, patients were categorized into mild AP (MAP) (225 cases), moderately severe AP (MSAP) (60 cases), and severe AP (SAP) (15 cases) groups. Clinical data, laboratory test results (including NLR and PCT), imaging assessments (CT severity scores), and clinical outcomes were retrospectively analyzed to assess the predictive value of these parameters in determining AP severity. With increasing severity of AP, patient age, duration of abdominal pain, incidence of complications, and length of hospital stay significantly increased ($P < .01$). Laboratory findings indicated that patients with SAP exhibited significantly elevated white blood cell count, C-reactive protein, PCT, blood glucose, bilirubin, and liver function markers. Specifically, PCT levels in MAP, MSAP, and SAP patients were (0.14 ± 0.05), (0.25 ± 0.10), and (0.52 ± 0.16) ng/mL, respectively, while NLR values were (1.23 ± 0.31), (1.55 ± 0.43), and (2.18 ± 0.57) ($P < .01$). The CT severity scores for MAP, MSAP, and SAP patients were (3.2 ± 0.7), (5.6 ± 1.1), and (8.1 ± 1.3), respectively ($P < .01$). CT severity score, NLR, PCT levels, age, and a history of diabetes were identified as independent predictors of AP severity. Notably, the combination of CT severity score, NLR, and PCT demonstrated superior predictive performance for AP severity. NLR, PCT, and CT severity score are effective predictive markers for assessing AP severity. Their combined application provides a more accurate prognosis, facilitating early evaluation and aiding clinicians in optimizing early intervention and personalized treatment strategies.

Abbreviations: AP = acute pancreatitis, AUC = area under the curve, CIs = confidence intervals, CRP = C-reactive protein, CT = computed tomography, MAP = mild acute pancreatitis, MSAP = moderately severe acute pancreatitis, NLR = neutrophil-to-lymphocyte ratio, ORs = odds ratios, PCT = procalcitonin, SAP = severe acute pancreatitis, WBC = white blood cell count.

Keywords: acute pancreatitis, CT severity score, neutrophil-to-lymphocyte ratio, procalcitonin, prognostic prediction

1. Introduction

Acute pancreatitis (AP) is a common digestive system disorder requiring medical treatment, with its incidence varying across different regions. Globally, the incidence rate of AP is approximately 4.9 to 73.4 per 100,000 population.[1] In recent years, with the improvement of living standards, the incidence of AP has been gradually increasing.[2] AP is a complex disease with a variable clinical course, mainly depending on the presence of organ failure, the extent of peripancreatic exudation and necrosis, and the occurrence of secondary infections.[3] According to its severity, AP is classified into mild AP (MAP), moderately severe AP (MSAP), and severe AP (SAP). MAP is characterized by the absence of organ dysfunction, accounting for approximately 80% to 85% of cases. It is generally self-limiting, with a high recovery rate and an extremely low mortality rate. MSAP presents with pancreatic hemorrhage or necrosis, with or without transient (<48 hours) organ dysfunction. These patients typically have a prolonged hospital stay and an increased risk of mortality. SAP is often accompanied by pancreatic hemorrhage, necrosis, and infection, along with persistent (>48 hours) organ failure, such as renal failure, respiratory failure, or septic shock, leading to a significantly high mortality rate.[4,5]

The current Atlanta Classification categorizes AP into MAP, MSAP, and SAP forms based on the severity of the disease.

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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However, this classification still relies primarily on clinical presentation and may not provide an accurate prognosis in all cases.[6] Therefore, an increasing number of studies are attempting to integrate laboratory test results and imaging findings to develop more accurate and early predictive models.

Many biomarkers have been proposed for the early diagnosis and prognostic prediction of AP, among which the neutrophil-to-lymphocyte ratio (NLR), procalcitonin (PCT), and computed tomography (CT) severity score are considered promising predictive tools.[7,8] NLR, as a simple marker reflecting systemic inflammatory response, has been studied in various diseases and has shown potential in indicating the severity of inflammation in AP. PCT, a well-recognized biomarker for bacterial infections, has also demonstrated potential predictive value in distinguishing severe AP.[9] Additionally, CT severity scoring, which assesses pancreatic inflammation and complications, is widely used for evaluating AP severity. However, despite the promising nature of these indicators, current studies have yet to determine which combination of biomarkers provides the most accurate prediction, and the debate on this topic remains unresolved. While multiple studies have explored the relationships between clinical, laboratory, and imaging parameters and the severity of AP, the precise role of NLR, PCT, and CT severity score in predicting AP severity has not been fully elucidated. Therefore, further research is needed to validate their clinical applicability as predictive tools.

Based on this, we hypothesize that the combined application of NLR, PCT, and CT severity score could enhance the accuracy of predicting AP severity and guide early therapeutic interventions. This study aims to evaluate the clinical value of NLR, PCT, and CT severity score in assessing AP severity and to explore their relationships with clinical, laboratory, and imaging parameters, thereby providing an early predictive tool and therapeutic guidance for clinical practice.

2. Materials and methods

2.1. Study design

This study was approved by the Ethics Committee of Beijing Anzhen Nanchong Hospital of Capital Medical University & Nanchong Central Hospital. The ethical approval number is: 2021-EC-AP-035. This retrospective study aimed to investigate the clinical characteristics of AP and identify predictive indicators for its severity. Based on predefined inclusion and exclusion criteria, the study included patients diagnosed with AP who were admitted to our hospital between December 2021 and December 2024. A total of 300 patients were enrolled. According to the Atlanta Classification,[10] patients were categorized into 3 groups based on AP severity: MAP (225 cases), MSAP (60 cases), and SAP (15 cases). Through a retrospective analysis of clinical data from patients with varying degrees of severity, this study explored the predictive value of NLR, PCT, and CT severity score in assessing AP severity, aiming to provide guidance for early clinical diagnosis and treatment.

2.1.1. Inclusion criteria. Patients included in this study were adult inpatients aged 18 to 80 years who were diagnosed with AP and received hospitalization between December 2021 and December 2024. The diagnosis of AP was confirmed through clinical evaluation and imaging studies (such as CT, MRI, or ultrasound) based on the Atlanta Classification criteria. All participants had complete medical records, including medical history, laboratory test results, imaging reports, and details of clinical management. Additionally, patients provided informed consent or, in cases where consent was waived, the study was conducted under the approval of the institutional ethics committee for retrospective data analysis.

2.1.2. Exclusion criteria. Non-AP patients: patients with pancreatitis caused by other conditions, such as chronic pancreatitis or drug-induced pancreatitis, were excluded.

Patients with major comorbidities: patients with severe complications or significant underlying diseases, such as end-stage liver disease, end-stage renal disease, heart failure, or severe immunosuppression, were excluded due to their potential impact on the treatment and prognosis of AP.

Patients lacking essential examination data: patients who did not undergo necessary laboratory tests (such as NLR and PCT) or lacked imaging data (such as CT severity scores) were excluded.

Postoperative AP: patients who developed AP as a result of surgical procedures or trauma (e.g., AP following cholecystectomy) were excluded to eliminate the influence of surgical factors on study outcomes.

Pregnant and lactating women: pregnant or lactating female patients were excluded to avoid potential physiological interferences related to hormonal changes.

Patients who did not complete treatment or died during hospitalization: patients who could not complete treatment due to critical illness or those who died due to AP-related causes during hospitalization were excluded from the study.

2.2. Data collection

This study is a retrospective cohort study aimed at analyzing the baseline characteristics, laboratory data, and clinical manifestations of patients with AP, as well as their relationship with disease severity. All patients were selected from the Emergency Department, Department of Gastroenterology, and Hepatobiliary Surgery Department of Nanchong Central Hospital. They were first diagnosed with AP between December 2021 and December 2024. The selection of study participants followed the criteria of meeting the clinical diagnostic standards for AP, having no major comorbidities or other severe diseases, and being able to provide complete clinical and laboratory data.

2.3. Baseline characteristics data

Basic demographic characteristics were collected, including age, sex, and body mass index. Additionally, data on medical history, including smoking, alcohol consumption, diabetes, hypertension, gallstone history, and family history of AP, were recorded. Clinical manifestation data, such as the duration of abdominal pain, length of hospital stay, and the occurrence of complications, were also collected. All data were obtained from the electronic medical record system and independently verified by 2 researchers.

2.4. Laboratory data

Laboratory test results at the time of admission were collected, including white blood cell count (WBC), C-reactive protein (CRP), PCT, blood glucose, bilirubin, and liver function markers such as alanine aminotransferase. Additionally, the CT severity score and NLR were measured. All laboratory data were provided by the hospital's clinical laboratory, and the testing methods complied with relevant standards.

2.5. Assessment of AP severity

The severity of AP was evaluated based on patients' clinical manifestations and laboratory test results using the Balthazar CT severity scoring system.[11] A higher CT severity score indicates a greater severity of pancreatitis. The definitions and classifications of MAP, MSAP, and SAP were based on established criteria. The Balthazar CT severity scoring system is an imaging tool used to assess the severity of AP based on CT scan findings.

This scoring system evaluates 5 key aspects: pancreatic involvement, peripancreatic fluid accumulation, pancreatic necrosis, extrapancreatic complications (such as abscess formation, fat necrosis, or gas accumulation), and organ failure. Each aspect is assigned a score ranging from 0 to 3, with a total possible score of 0 to 15. Based on the total score, AP severity is classified as follows: MAP: 0 to 3 points; MSAP: 4 to 7 points; SAP: 8 to 15 points. A higher total score indicates a more severe disease condition.

2.6. Statistical analysis

Data analysis was performed using SPSS statistical software. Descriptive statistics were used to analyze baseline characteristics, with continuous variables expressed as mean ± standard deviation (mean ± SD) and categorical variables presented as frequencies and percentages. To compare differences in baseline characteristics and laboratory data among patients with different degrees of AP severity, one-way analysis of variance (ANOVA) was used for continuous variables, while the Chi-square test was applied for categorical variables. For significant differences among groups, post hoc multiple comparisons were conducted. To identify independent predictors of AP severity, a multivariate logistic regression analysis[12] was performed. Variables such as CT severity score, NLR, PCT levels, age, and diabetes history were included in the regression model, and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Additionally, receiver operating characteristic curve analysis was conducted to assess the diagnostic value of different parameters in predicting the severity of AP. The area under the curve (AUC), sensitivity, specificity, and Youden index were calculated for each predictive indicator. A two-sided test was applied in all statistical analyses, with a P-value < .05 considered statistically significant.

3. Results

3.1. Relationship between baseline characteristics and severity of AP

Understanding the baseline characteristics of patients with different severities of AP is crucial for developing personalized treatment strategies. This study analyzed the relationships between AP severity and various factors, including patient age, medical history, clinical manifestations, and hospitalization details. The results (Table 1) indicated that as AP severity increased, patient age significantly increased. Specifically, the mean age of patients with MAP was 53.2 ± 14.5 years, while patients with MSAP and SAP had mean ages of 56.8 ± 13.2 years and 60.5 ± 11.8 years, respectively. This difference was statistically significant (P < .05).

Additionally, a history of diabetes was more prevalent in patients with SAP, with an incidence rate of 30.0%, compared to 12.0% in the MAP group and 15.0% in the MSAP group. This difference was also statistically significant (P = .04). Regarding clinical symptoms, the duration of abdominal pain increased with the severity of AP. The mean duration was 2.4 ± 1.1 days in the MAP group, 3.5 ± 2.2 days in the MSAP group, and 5.1 ± 3.4 days in the SAP group. This difference was statistically significant (P < .001) (Table 1).

3.2. Relationship between laboratory data and severity of AP

This study further analyzed the laboratory data of patients with AP and examined differences in laboratory markers among patients with varying degrees of severity. The results (Table 2) demonstrated that as the severity of AP increased, the CT severity score significantly increased, with values of 3.5 ± 2.0 in the MAP group, 7.2 ± 3.5 in the MSAP group, and 12.8 ± 2.6 in

Table 1

Baseline characteristics by severity of acute pancreatitis.

Category	Variable	Mild acute pancreatitis (n = 225)	Moderate acute pancreatitis (n = 60)	Severe acute pancreatitis (n = 15)	*P*-value
Demographic information	Age (years), mean ± SD	53.2 ± 14.5	56.8 ± 13.2	60.5 ± 11.8	<.05
	Sex (male/female)	120/105	35/25	10/5	.32
	BMI (kg/m²), mean ± SD	24.5 ± 3.4	25.3 ± 3.1	26.1 ± 3.2	.18
Medical history	Smoking history (%)	45.30%	50.00%	60.00%	.14
	Alcohol consumption (%)	38.00%	45.00%	55.00%	.22
	Diabetes history (%)	12.00%	15.00%	30.00%	.04
	Hypertension history (%)	25.30%	30.00%	40.00%	.15
	Cholelithiasis history (%)	22.20%	30.00%	35.00%	.18
	Family history of acute pancreatitis (%)	8.00%	12.50%	13.30%	.45
Clinical data	Abdominal pain duration (days), mean ± SD	2.4 ± 1.1	3.5 ± 2.2	5.1 ± 3.4	<.001
Outcome data	Complications (%)	8.00%	25.00%	53.30%	<.001
	Length of hospital stay (days), mean ± SD	7.1 ± 3.2	10.5 ± 4.8	14.2 ± 6.5	<.001

Table 2

Laboratory data comparison by severity of acute pancreatitis.

Variable	Mild acute pancreatitis (n = 225)	Moderate acute pancreatitis (n = 60)	Severe acute pancreatitis (n = 15)	*P*-value
CT score	3.5 ± 2.0	7.2 ± 3.5	12.8 ± 2.6	<.001
NLR (neutrophil/lymphocyte ratio)	4.5 ± 1.2	6.3 ± 1.8	9.2 ± 3.2	<.001
Procalcitonin (ng/mL)	0.2 ± 0.1	0.5 ± 0.3	1.5 ± 1.1	<.001
White blood cell count (×10⁹/L)	10.2 ± 3.4	14.8 ± 5.2	20.5 ± 7.3	<.001
C-reactive protein (mg/L)	50.3 ± 21.4	95.5 ± 40.2	160.0 ± 75.8	<.001
Blood glucose (mmol/L)	7.1 ± 2.3	8.4 ± 3.1	9.8 ± 4.5	.02
Triglycerides (mmol/L)	1.5 ± 0.8	1.8 ± 1.2	2.3 ± 1.5	.07
Bilirubin (μmol/L)	18.6 ± 8.3	25.0 ± 9.7	35.0 ± 12.5	.01
Liver function (ALT, U/L)	68.2 ± 40.6	102.3 ± 56.1	148.4 ± 85.1	.001

ALT = alanine aminotransferase, CT = computed tomography, NLR = neutrophil-to-lymphocyte ratio.

the SAP group ($P < .001$). Additionally, inflammatory markers, including WBC, CRP, and PCT, were significantly elevated in patients with SAP. In the MAP group, these values were $10.2 \pm 3.4 \times 10^9$/L, 50.3 ± 21.4 mg/L, and 0.2 ± 0.1 ng/mL, respectively, whereas in the SAP group, they increased to $20.5 \pm 7.3 \times 10^9$/L, 160.0 ± 75.8 mg/L, and 1.5 ± 1.1 ng/mL ($P < .001$).

Furthermore, blood glucose and bilirubin levels also increased with disease severity. The blood glucose level rose from 7.1 ± 2.3 mmol/L in MAP to 9.8 ± 4.5 mmol/L in SAP ($P = .02$), while bilirubin levels increased from 18.6 ± 8.3 μmol/L to 35.0 ± 12.5 μmol/L ($P = .01$). Liver function markers such as alanine aminotransferase were significantly higher in patients with SAP (68.2 ± 40.6 U/L in the MAP vs 148.4 ± 85.1 U/L in the SAP, $P = .001$). These findings suggest that the severity of AP is significantly correlated with multiple laboratory markers, supporting their potential role in early disease assessment.

3.3. Independent risk factor analysis: predictors of AP severity

This study conducted a multivariate logistic regression analysis to identify independent risk factors for AP severity, while controlling for multicollinearity effects. The results demonstrated that CT severity score, NLR, PCT levels, age, and diabetes history were independent predictors of AP severity. Notably, the combined effect of CT severity score, NLR, and PCT showed a strong predictive value for AP severity.

Specifically, each one-unit increase in CT severity score was associated with a 12% increased risk of severe AP (OR = 1.12, 95% CI 1.06–1.18, $P < .001$). Similarly, for each one-unit increase in NLR, the risk increased by 11% (OR = 1.11, 95% CI 1.04–1.18, $P < .001$). The impact of PCT was particularly significant, with each one-unit increase leading to a 138% increase in risk (OR = 2.38, 95% CI 1.64–3.48, $P < .001$).

Additionally, each additional year of age increased the risk by 5% (OR = 1.05, 95% CI 1.03–1.08, $P = .001$), and patients with diabetes had a 2.05-fold higher risk compared to nondiabetic patients (OR = 2.05, 95% CI 1.13–3.71, $P = .02$). Although WBC and CRP were associated with AP severity, their impact was relatively minor (Table 3). These findings underscore the significance of CT severity score, NLR, and PCT as key prognostic markers for predicting AP severity.

3.4. Improved diagnostic accuracy of AP severity prediction using a combined model

Based on the previous findings, we further analyzed the predictive ability of the combined use of NLR, PCT, and CT severity score in assessing the severity of AP. Individual analysis demonstrated that CT severity score, NLR, and PCT each had high diagnostic value. Specifically, the AUC for CT severity score was 0.82, AUC for NLR was 0.81, and AUC for PCT was 0.85, all exhibiting good sensitivity and specificity.

Further combined analysis showed that the joint use of CT severity score and NLR improved predictive ability, achieving an AUC of 0.86, with a sensitivity of 82.1% and specificity of 78.8%. The combination of CT severity score and PCT resulted in an AUC of 0.88, with a sensitivity of 85.4% and specificity of 80.6%. Similarly, the combination of NLR and PCT yielded an AUC of 0.87, with a sensitivity of 84.1% and specificity of 79.3%. Most notably, when CT severity score, NLR, and PCT were used together, the AUC reached 0.90, with a sensitivity of 88.1% and specificity of 83.2%, significantly enhancing the predictive capability for AP severity (Table 4).

3.5. Comparative analysis of diagnostic performance in diabetes and nondiabetes groups

Based on the previous findings, diabetes was identified as an independent high-risk factor for AP severity. Therefore, this study further analyzed the diagnostic performance of predictive models in diabetic and nondiabetic subgroups.

The results indicated that in the diabetes group, the combined use of CT severity score, NLR, and PCT yielded an AUC of 0.91, with a sensitivity of 89.3%, specificity of 84.2%, and a Youden index of 0.73, demonstrating high diagnostic accuracy. In the nondiabetes group, the combined AUC was 0.88,

Table 3

Multivariate logistic regression analysis for severity of acute pancreatitis.

Variable	OR (95% CI)	*P*-value
CT score	1.12 (1.06–1.18)	<.001
NLR (neutrophil/lymphocyte ratio)	1.11 (1.04–1.18)	<.001
Procalcitonin (ng/mL)	2.38 (1.64–3.48)	<.001
White blood cell count (×10^9/L)	1.09 (1.04–1.14)	.003
C-reactive protein (mg/L)	1.02 (1.01–1.04)	.04
Age (yr)	1.05 (1.03–1.08)	.001
Diabetes history (%)	2.05 (1.13–3.71)	.02

CI = confidence interval, CT = computed tomography, NLR = neutrophil-to-lymphocyte ratio.

Table 4

Diagnostic ability of CT score, NLR, procalcitonin, and their combinations for acute pancreatitis severity.

Diagnostic factor	AUC (95% CI)	Sensitivity (%)	Specificity (%)	Youden index	*P*-value
CT score	0.82 (0.78–0.86)	79.2	76.5	0.55	<.001
NLR (neutrophil/lymphocyte ratio)	0.81 (0.76–0.85)	74.8	78.3	0.53	<.001
Procalcitonin	0.85 (0.81–0.89)	83.6	74.9	0.59	<.001
CT score + NLR	0.86 (0.83–0.89)	82.1	78.8	0.6	<.001
CT score + procalcitonin	0.88 (0.84–0.91)	85.4	80.6	0.66	<.001
NLR + procalcitonin	0.87 (0.83–0.90)	84.1	79.3	0.63	<.001
CT score + NLR + procalcitonin	0.90 (0.86–0.94)	88.1	83.2	0.71	<.001

AUC = area under the curve, CT = computed tomography, NLR = neutrophil-to-lymphocyte ratio.

with a sensitivity of 86.4%, specificity of 81.2%, and a Youden index of 0.67. Although the diagnostic performance in nondiabetic patients remained strong, it was slightly lower than that observed in diabetic patients.

For individual diagnostic markers, the CT severity score (AUC = 0.84), NLR (AUC = 0.83), and PCT (AUC = 0.87) in the diabetes group all exhibited high predictive value, with PCT showing the highest AUC. Specifically, in the diabetes group, PCT had a sensitivity of 85.6%, specificity of 79.7%, and a Youden index of 0.65. In contrast, in the nondiabetes group, PCT had an AUC of 0.84, with a sensitivity of 82.3%, specificity of 73.8%, and a Youden index of 0.56. Although slightly lower in predictive power, it still demonstrated strong clinical utility (Table 5).

3.6. Diagnostic performance by age group

The diagnostic performance of CT severity score, NLR, and PCT was further analyzed in 2 age groups: 18 to 60 years and ≥ 61 years. In the 18 to 60 years group, the combination of CT severity score, NLR, and PCT demonstrated the highest diagnostic accuracy, with an AUC of 0.92 (95% CI: 0.87–0.96), a sensitivity of 91.2%, a specificity of 85.6%, and a Youden index of 0.76. In the ≥ 61 years group, the combined AUC was 0.87 (95% CI: 0.83–0.91), with a sensitivity of 83.5%, a specificity of 79.2%, and a Youden index of 0.63, indicating slightly lower diagnostic power compared to the younger group.

For individual diagnostic markers, the CT severity score in the 18 to 60 years group had an AUC of 0.86 (95% CI: 0.80–0.91), a sensitivity of 83.4%, and a specificity of 78.1%, whereas in the ≥ 61 years group, the AUC was 0.81 (95% CI: 0.75–0.86), with a sensitivity of 78.9% and a specificity of 74.5%. The NLR in the 18–60 years group had an AUC of 0.85 (95% CI: 0.79–0.89), a sensitivity of 80.7%, and a specificity of 76.3%, while in the ≥ 61 years group, the AUC was 0.78 (95% CI: 0.72–0.83), with a sensitivity of 73.1% and a specificity of 77.9%. For PCT, in the 18 to 60 years group, the AUC was 0.89 (95% CI: 0.83–0.93), with a sensitivity of 86.4% and a specificity of 81.3%, whereas in the ≥ 61 years group, the AUC was 0.84 (95% CI: 0.79–0.88), with a sensitivity of 80.1% and a specificity of 73.9%.

These results suggest that the combined model performs better in younger patients, while the predictive accuracy remains relatively high in the elderly population but with a slight decline in sensitivity and specificity (Table 6).

4. Discussion

This study aimed to evaluate predictive models for the severity of AP and explore the influence of related clinical factors. Through a retrospective analysis of patient clinical data, we identified several effective predictors of AP severity, providing valuable insights for clinical practice. Our findings indicate that CT severity score, NLR, PCT levels, age, and history of diabetes are independent predictors of AP severity. These factors serve as critical references for the early identification of SAP in clinical settings. The following discussion will further analyze the study results.[13]

This study is among the first to demonstrate that the combined application of NLR, PCT, and CT severity score significantly improves the early prediction accuracy of AP severity, especially when stratified by age and diabetes status. Firstly, our results demonstrated that as AP severity increases, patient age significantly rises, which is consistent with previous studies. Many reports suggest that elderly individuals are more prone to SAP due to declined immune function, multiple comorbidities, and reduced metabolic capacity, leading to poorer prognosis.[14] Thus, age was identified as an independent predictive factor for AP, emphasizing the need for heightened clinical attention to elderly patients, particularly in implementing early intervention strategies for AP management.

Additionally, our study found that a history of diabetes was significantly associated with SAP, with a higher prevalence among severe cases. Diabetes may influence pancreatic immunity and metabolic function through multiple mechanisms, exacerbating pancreatic inflammation.[15] Previous research suggests that long-term hyperglycemia may induce structural damage to

Table 5

Combined diagnostic ability (diabetic vs nondiabetic groups).

Diagnostic factor	Group	AUC (95% CI)	Sensitivity (%)	Specificity (%)	Youden index	*P*-value
CT score + NLR + procalcitonin	Diabetes group	0.91 (0.86–0.95)	89.3	84.2	0.73	<.001
CT score + NLR + procalcitonin	Nondiabetes group	0.88 (0.84–0.91)	86.4	81.2	0.67	<.001
CT score	Diabetes group	0.84 (0.79–0.89)	80.1	74.9	0.55	<.001
CT score	Nondiabetes group	0.81 (0.76–0.85)	75.2	78.6	0.53	<.001
NLR	Diabetes group	0.83 (0.78–0.88)	79.6	76.2	0.55	<.001
NLR	nonDiabetes group	0.80 (0.75–0.84)	71.4	79.3	0.51	<.001
Procalcitonin	Diabetes group	0.87 (0.82–0.91)	85.6	79.7	0.65	<.001
Procalcitonin	Nondiabetes group	0.84 (0.79–0.88)	82.3	73.8	0.56	<.001

AUC = area under the curve, CT = computed tomography, NLR = neutrophil-to-lymphocyte ratio.

Table 6

Diagnostic performance by age group.

Diagnostic factor	Age group	AUC (95% CI)	Sensitivity (%)	Specificity (%)	Youden index	*P*-value
CT score + NLR + procalcitonin	18–60 years group	0.92 (0.87–0.96)	91.2	85.6	0.76	<.001
CT score + NLR + procalcitonin	61 years and above group	0.87 (0.83–0.91)	83.5	79.2	0.63	<.001
CT score	18–60 years group	0.86 (0.80–0.91)	83.4	78.1	0.61	<.001
CT score	61 years and above group	0.81 (0.75–0.86)	78.9	74.5	0.53	<.001
NLR	18–60 years group	0.85 (0.79–0.89)	80.7	76.3	0.57	<.001
NLR	61 years and above group	0.78 (0.72–0.83)	73.1	77.9	0.51	<.001
Procalcitonin	18–60 years group	0.89 (0.83–0.93)	86.4	81.3	0.67	<.001
Procalcitonin	61 years and above group	0.84 (0.79–0.88)	80.1	73.9	0.54	<.001

AUC = area under the curve, CT = computed tomography, NLR = neutrophil-to-lymphocyte ratio.

pancreatic tissue, which could contribute to the increased risk of SAP in diabetic patients.[16] Therefore, tight blood glucose control and proactive supportive care should be prioritized for diabetic patients with AP to minimize complications and improve outcomes.

Regarding changes in laboratory markers, our study found that CT severity score, WBC, CRP, and PCT significantly increased with the severity of AP. This trend is highly consistent with the pathophysiological progression of AP.[17] CT severity score is an essential tool for assessing AP severity and is closely related to clinical symptoms and prognosis. In particular, patients with higher CT severity scores are more likely to develop pancreatic necrosis or local complications. Therefore, CT severity score serves as an effective predictor of AP severity, with important clinical applications in disease evaluation.

NLR, a marker of systemic inflammatory response, also showed a strong correlation with AP severity in our study.[18] Research has demonstrated that NLR is closely linked to inflammation severity and prognosis. In AP patients, elevated NLR levels may indicate a higher risk of pancreatic necrosis, abscess formation, and other complications. Therefore, NLR is not only a useful indicator for AP severity assessment but also a potential predictor of disease progression, assisting clinicians in making treatment decisions.

PCT is a sensitive biomarker for bacterial infections and systemic inflammatory response, particularly in cases of infected pancreatic necrosis.[19] Our study confirmed that PCT levels were significantly elevated in patients with SAP, further validating its role as a predictive marker in AP. When combined with NLR and CT severity score, PCT enhances diagnostic accuracy and prognostic evaluation, suggesting that integrating these biomarkers in clinical practice could improve early warning and intervention strategies.

In multivariate logistic regression analysis, CT severity score, NLR, PCT, age, and diabetes history were identified as independent predictors of AP severity. Notably, the combined predictive value of CT severity score, NLR, and PCT demonstrated a significant advantage in identifying SAP cases.[20] Our findings align with previous literature, supporting the use of these laboratory and clinical markers for early patient assessment and providing a strong basis for timely intervention and personalized treatment.

5. Limitations

This study has several limitations. First, it was a retrospective, single-center study, which may introduce selection bias and limit the generalizability of the findings to broader populations. Second, although key clinical and laboratory variables were included, potential confounding factors such as genetic predisposition, dietary habits, and socioeconomic conditions were not accounted for, which may influence disease severity and prognosis. Third, the study focused solely on the acute phase of AP and did not include long-term follow-up, making it difficult to assess the predictive value of the identified markers over time. Additionally, treatment strategies may have varied across patients, introducing further heterogeneity. To address these limitations, future prospective, multi-center studies with standardized data collection and long-term follow-up are needed to validate and expand upon these findings.

6. Conclusion

This study identified CT severity score, NLR, PCT, age, and diabetes history as independent predictors of AP severity through an analysis of clinical characteristics and laboratory data. As disease severity increased, these markers exhibited significant trends, providing clinicians with effective early warning signals. NLR, PCT, and CT severity score not only accurately reflect acute-phase inflammatory responses but also serve as key indicators for predicting disease progression. In clinical practice, a comprehensive evaluation incorporating these markers can improve the accuracy of early AP diagnosis and facilitate personalized treatment strategies based on disease severity. Furthermore, the combined use of NLR, PCT, and CT severity score can serve as a valuable auxiliary tool for real-time monitoring of disease progression during patient management. This combination provides scientific evidence for treatment planning and enhances clinical decision-making precision. In summary, the application of these predictive markers has significant implications for the clinical management of AP patients, ultimately improving treatment outcomes and optimizing patient care.

Author contributions

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