RESEARCH PAPER

Delta Neutrophil Index as an Early Predictive Marker of Severity of Acute Pancreatitis

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Abstract

Background: Acute pancreatitis is a common gastrointestinal emergency with a highly variable clinical course ranging from mild self-limiting disease to severe pancreatitis associated with organ failure, prolonged hospitalization, and increased mortality. Early identification of patients at risk for severe disease is essential for prompt management and improved outcomes. The Delta Neutrophil Index (DNI), which reflects the circulating immature granulocyte fraction, has emerged as a simple and rapidly available inflammatory biomarker that may facilitate early prediction of disease severity.

Objectives: To assess the role of the Delta Neutrophil Index as an early predictor of severity in acute pancreatitis and to evaluate its association with duration of hospital stay, ICU stay, organ failure, mortality, need for surgical intervention, and Modified CT Severity Index.

Methods: A prospective observational study was conducted in the Department of General Surgery, Sri Siddhartha Medical College and Hospital, Tumkur, between January and December 2024. Forty adult patients diagnosed with acute pancreatitis were enrolled. Demographic characteristics, clinical findings, laboratory parameters, Delta Neutrophil Index, and Modified CT Severity Index were recorded. Patients were categorized into mild-to-moderate and severe acute pancreatitis. Diagnostic performance of DNI was assessed using receiver operating characteristic (ROC) curve analysis.

Results: Among the 40 patients, 27 (67.5%) had mild-to-moderate acute pancreatitis, while 13 (32.5%) had severe disease. A DNI value >0.7 was observed in 32.5% of patients and was significantly associated with severe pancreatitis ($p < 0.001$). DNI demonstrated a strong positive correlation with the Modified CT Severity Index ($r = 0.82$, $p < 0.001$). Patients with elevated DNI had significantly longer hospital and ICU stay, higher rates of organ failure, greater need for surgical intervention, and increased mortality. ROC analysis demonstrated excellent predictive performance with an AUC of 0.94, 90% sensitivity, and 70% specificity for predicting severe acute pancreatitis.

Conclusion: The Delta Neutrophil Index is a rapid, inexpensive, and reliable biomarker for early prediction of severe acute pancreatitis. Its excellent diagnostic performance and strong correlation with disease severity support its routine use for early risk stratification and timely clinical decision-making, particularly in emergency and resource-limited healthcare settings.

Keywords: Acute pancreatitis; Delta neutrophil index; Disease severity; Modified CT Severity Index; Biomarker.

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INTRODUCTION

Acute pancreatitis (AP) is one of the most common gastrointestinal emergencies requiring hospital admission and is characterized by acute inflammation of the pancreas with a highly variable clinical course ranging from mild, self-limiting disease to severe acute pancreatitis (SAP) associated with pancreatic necrosis, multiorgan failure, sepsis, and death (1,2). The global incidence of acute pancreatitis has increased steadily over the past two decades, with gallstones and alcohol consumption accounting for the majority of cases, although hypertriglyceridemia, drugs, trauma, infections, and idiopathic causes also contribute significantly. Despite advances in supportive care and critical care management, mortality remains low in mild disease but increases substantially in patients who develop persistent organ failure or infected pancreatic necrosis. Therefore, early identification of patients at risk of developing severe disease remains one of the most important goals in the management of acute pancreatitis (3,4).

The revised Atlanta classification categorizes acute pancreatitis into mild, moderately severe, and severe forms based on the presence of local complications and persistent organ failure. Approximately 15–20% of patients develop severe acute pancreatitis, which is associated with prolonged hospitalization, intensive care unit (ICU) admission, increased need for surgical or radiological intervention, and significantly higher mortality (5,6). Since pancreatic injury triggers a complex systemic inflammatory response that can rapidly progress during the first 24–48 hours, accurate early risk stratification is essential for timely aggressive fluid resuscitation, organ support, close monitoring, and referral to specialized centres whenever required. Unfortunately, the clinical presentation at admission does not always reflect the subsequent severity of the disease, making reliable early biomarkers indispensable. (7)

Several clinical scoring systems and laboratory parameters have been developed to predict disease severity in acute pancreatitis. Traditional scoring systems such as the **Ranson criteria**, **APACHE II**, **BISAP score**, and **Modified CT Severity Index (MCTSI)** have demonstrated acceptable predictive accuracy but possess several practical limitations. Many require multiple laboratory variables, repeated measurements over 48 hours, complex calculations, or contrast-enhanced computed tomography, thereby delaying early clinical decision-making (8,9). Likewise, commonly used inflammatory biomarkers including total leukocyte count, C-reactive protein (CRP), procalcitonin, and serum cytokines often rise relatively late during the inflammatory process or require additional laboratory expenses, limiting their utility as rapid bedside predictors of severity. Consequently, there remains a need for a simple, inexpensive, objective, and rapidly available biomarker capable of identifying severe acute pancreatitis at the time of hospital admission. (10)

The **Delta Neutrophil Index (DNI)** has recently emerged as a promising inflammatory biomarker that quantifies the proportion of circulating immature granulocytes released from the bone marrow during acute inflammatory and infectious states. Unlike conventional inflammatory markers, DNI increases within **2–3 hours** following activation of the inflammatory cascade, reflecting accelerated myeloid cell production and early neutrophil response. Since automated hematology analyzers routinely calculate the immature granulocyte fraction during complete blood count analysis, DNI can be obtained rapidly without additional blood sampling or laboratory cost. Previous studies have demonstrated its usefulness in predicting disease severity and mortality in sepsis, septic shock, appendicitis, gastrointestinal perforation, and other inflammatory disorders. Recent evidence also suggests that elevated DNI values correlate with pancreatic necrosis, persistent organ failure, prolonged hospitalization, ICU requirement, and mortality in patients with acute pancreatitis. (9,10)

Considering these potential advantages, evaluation of DNI as an early prognostic marker in acute pancreatitis is clinically relevant. A biomarker that accurately predicts severe disease at admission could facilitate early intensive management, optimize utilization of critical care resources, reduce delays in intervention, and ultimately improve patient outcomes. Although international studies have reported encouraging results regarding the predictive value of DNI, evidence from the Indian population remains limited. The present study was therefore undertaken to evaluate the role of the **Delta Neutrophil Index as an early predictive marker of severity of acute pancreatitis**, correlate DNI with the Modified CT Severity Index, and determine its association with important clinical outcomes including duration of hospital stay, ICU stay, organ failure, mortality, and requirement for surgical intervention.

1. MATERIALS AND METHODS

2.1. Study Design

A **prospective observational study** was conducted to evaluate the role of the **Delta Neutrophil Index (DNI)** as an early predictor of the severity of acute pancreatitis. The study was designed to assess the relationship between DNI measured at admission and the subsequent severity of acute pancreatitis as determined by the Modified CT Severity Index (MCTSI). The study also evaluated the association between DNI and important clinical outcomes including duration of hospital stay, duration of intensive care unit (ICU) stay, organ failure, mortality, and the requirement for surgical intervention. Since no therapeutic intervention was introduced and all patients received standard institutional management, an observational design was considered appropriate.

2.2. Study Setting

The study was conducted in the **Department of General Surgery, Sri Siddhartha Medical College and Hospital, Tumkur, Karnataka**, a tertiary care teaching hospital providing emergency surgical services and critical care facilities. Patients presenting to the emergency department, outpatient department, and inpatient surgical wards with features suggestive of acute pancreatitis were evaluated for eligibility. All laboratory investigations, radiological assessments, and clinical management were carried out according to the institutional protocol.

2.3. Study Duration

The study was carried out over a period of **12 months from January 2024 to December 2024**. During this period, eligible patients were recruited consecutively, investigated, treated, and followed until discharge or death. Data collection,

verification, and statistical analysis were completed after recruitment of all participants.

2.4. Participants

Inclusion Criteria

- Patients aged **18 years and above**.
- Patients with a **clinical diagnosis of acute pancreatitis**.
- Patients admitted to the Department of General Surgery during the study period.
- Patients who underwent **contrast-enhanced computed tomography (CECT) abdomen and pelvis** for Modified CT Severity Index assessment.
- Patients who provided written informed consent to participate in the study.

Exclusion Criteria

- Patients younger than **18 years**.
- Patients with chronic pancreatitis or pancreatic malignancy.
- Patients with recurrent acute pancreatitis already under treatment.
- Patients with hematological disorders or conditions affecting neutrophil counts.
- Patients receiving immunosuppressive therapy or chemotherapy.
- Patients with incomplete clinical, laboratory, or radiological data.
- Patients unwilling to participate in the study.

2.5. Study Sampling

A **consecutive sampling technique** was adopted. All patients fulfilling the inclusion criteria and presenting during the study period were enrolled consecutively until the required sample size was achieved. This sampling technique minimized selection bias and ensured recruitment of all eligible patients during the study period.

2.6. Study Sample Size

A total of **40 patients** with clinically diagnosed acute pancreatitis were included in the study.

The sample size was determined based on a **similar prospective observational study** conducted by **Cho SK et al.**, which evaluated the role of the Delta Neutrophil Index in predicting severe acute pancreatitis. Considering the feasibility of recruitment during the study period and the availability of eligible patients at the study centre, a sample size of **40 participants** was considered adequate to evaluate the association between DNI and disease severity.

2.7. Study Groups

Since the study was observational, no intervention groups were created. After assessment using the **Modified CT Severity Index (MCTSI)**, patients were categorized into:

- **Mild to Moderately Severe Acute Pancreatitis**
- **Severe Acute Pancreatitis (SAP)**

For analysis, patients were also classified according to their Delta Neutrophil Index:

- **DNI <0.7** – Suggestive of non-severe acute pancreatitis.
- **DNI >0.7** – Suggestive of severe acute pancreatitis.

2.8. Study Parameters

The study evaluated demographic, clinical, laboratory, radiological, and outcome variables using a structured case record form. Demographic variables included age and gender. Clinical variables included presenting symptoms, associated comorbidities, and vital parameters. Laboratory investigations comprised complete blood count, total leukocyte count, neutrophil percentage, eosinophil percentage, immature granulocyte fraction, serum biochemical parameters, and the **Delta Neutrophil Index**, calculated as:

DNI = Neutrophil (%) + Eosinophil (%) − Immature Neutrophil (%)

Radiological assessment included **contrast-enhanced CT abdomen and pelvis** with calculation of the **Modified CT Severity Index**. Outcome measures included disease severity, duration of hospital stay, duration of ICU stay, presence of organ failure, mortality, and the requirement for surgical intervention.

2.9. Study Procedure

Following Institutional Ethics Committee approval, all patients presenting with signs and symptoms suggestive of acute pancreatitis were screened for eligibility. Written informed consent was obtained before enrolment. Detailed clinical history was recorded, followed by general physical examination and systemic examination. Routine laboratory investigations were performed immediately after admission, including complete blood count from which the Delta Neutrophil Index was calculated using the automated hematology analyser. Since DNI is an early inflammatory biomarker that increases within **2–3 hours** following inflammatory activation, values obtained at admission were considered for analysis. Subsequently, all patients underwent **contrast-enhanced CT abdomen and pelvis**, and the Modified CT Severity Index was calculated. Patients received standard medical management according to institutional protocols. Clinical progress was monitored throughout hospitalization, and outcome variables including ICU stay, hospital stay, organ failure, mortality, and surgical intervention were documented. Finally, the association between admission DNI values and disease severity determined by MCTSI was analysed.

2.10. Study Data Collection

Data were collected prospectively using a predesigned structured case record form. Information was obtained from patient interviews, clinical examination findings, laboratory reports, radiological investigations, operative records (when applicable), ICU records, and discharge summaries. All data were entered into a master database after

verification to ensure completeness and accuracy.

2.11. Data Analysis

Data were entered into Microsoft Excel and analysed using **Statistical Package for Social Sciences (SPSS) software (Version 26.0)**. Continuous variables were expressed as **mean ± standard deviation (SD)** or median with interquartile range wherever appropriate. Categorical variables were presented as frequencies and percentages. Differences between groups were analysed using the **Independent Student's t-test** for continuous variables and the **Chi-square test or Fisher's exact test** for categorical variables. Correlation between Delta Neutrophil Index and Modified CT Severity Index was assessed using appropriate correlation analysis. Receiver Operating Characteristic (ROC) curve analysis was performed to determine the diagnostic performance and optimal cut-off value of DNI for predicting severe acute pancreatitis. Multivariate logistic regression analysis was performed to identify whether DNI independently predicted severe acute pancreatitis. A **p-value <0.05** was considered statistically significant.

2.12. Ethical Considerations

The study was conducted after obtaining approval from the **Institutional Ethics Committee of Sri Siddhartha Medical College and Hospital, Tumkur**. Written informed consent was obtained from all participants before enrolment. Confidentiality of patient information was strictly maintained throughout the study by assigning unique identification numbers and restricting access to study records. Participation was entirely voluntary, and patients were informed that refusal to participate or withdrawal from the study would not affect their treatment. All investigations and management were performed according to standard hospital protocols, and no additional intervention or financial burden was imposed on the participants.

1. RESULTS

Table 1. Baseline Sociodemographic Characteristics of Study Participants (N = 40)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	3	7.5
	31–40	14	35.0
	41–50	19	47.5
	51–60	4	10.0
Gender	Male	27	67.5
	Female	13	32.5
Occupation	Farmer	16	40.0
	Homemaker	9	22.5
	Worker	8	20.0
	Clerk	5	12.5
	Teacher	2	5.0
Religion	Hindu	19	47.5
	Muslim	12	30.0
	Christian	9	22.5

Among the 40 study participants, the largest proportion belonged to the **41–50 years age group (47.5%)**, followed by **31–40 years (35.0%)**. Males predominated (**67.5%**). Farmers constituted the largest occupational group (**40.0%**), and nearly half of the participants were Hindus (**47.5%**).

Table 2. Distribution of Study Population According to Comorbidity Profile

Comorbidity	Yes n (%)	No n (%)
Diabetes Mellitus	12 (30.0)	28 (70.0)
Hypertension	14 (35.0)	26 (65.0)
COPD/Asthma	1 (2.5)	39 (97.5)
Renal Disease	4 (10.0)	36 (90.0)

Hypertension (**35.0%**) was the most common associated comorbidity, followed by diabetes mellitus (**30.0%**). Renal disease was present in **10.0%**, whereas COPD/asthma was uncommon (**2.5%**).

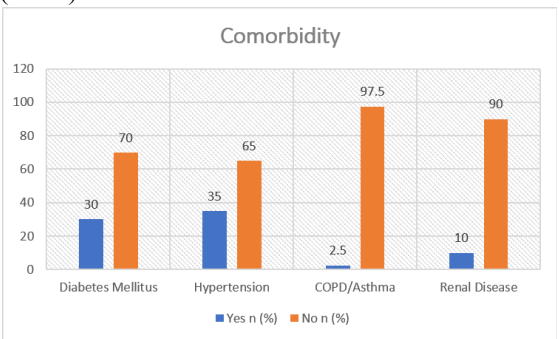


Table 3. Distribution of Patients According to Severity of Acute Pancreatitis

Disease Severity	Frequency	Percentage (%)
Mild to Moderate	27	67.5
Severe Acute Pancreatitis	13	32.5
Total	**40**	**100.0**

Based on the Modified CT Severity Index, **67.5%** of patients had mild-to-moderate acute pancreatitis, whereas **32.5%** were diagnosed with severe acute pancreatitis.

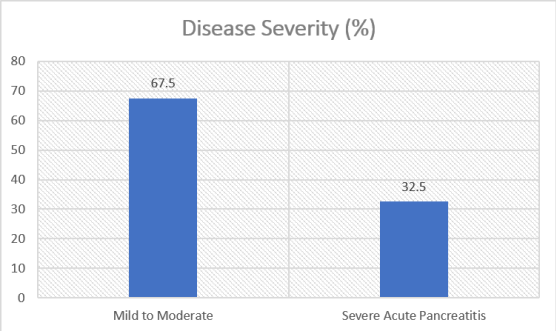


Table 4. Distribution of Patients According to Delta Neutrophil Index (DNI)

DNI Category	Frequency	Percentage (%)
<0.7	27	67.5
>0.7	13	32.5
Total	**40**	**100.0**

A DNI value **>0.7** was observed in **13 patients (32.5%)**, whereas **67.5%** had DNI values below the cut-off, indicating that elevated DNI was predominantly seen among patients with severe disease.

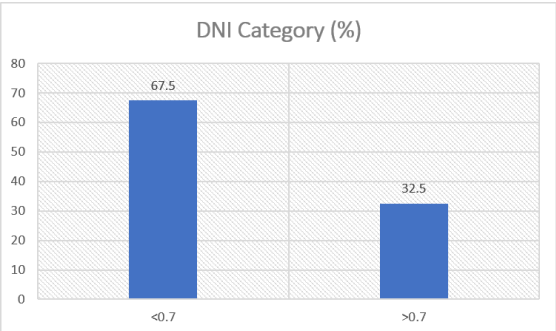


Table 5. Association Between Delta Neutrophil Index and Disease Severity

Disease Severity	DNI <0.7	DNI >0.7	Total	p-value
Mild to Moderate	24	3	27	
Severe	3	10	13	
Total	**27**	**13**	**40**	**<0.001**

Patients with severe acute pancreatitis had significantly higher DNI values than those with mild-to-moderate disease (**p < 0.001**). Most severe cases (**76.9%**) had DNI values greater than 0.7.

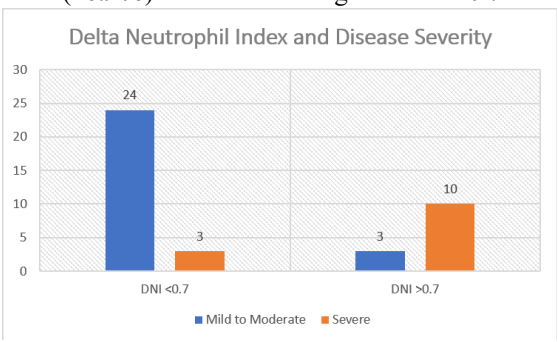


Table 6. Correlation Between DNI and Modified CT Severity Index

Variable	Correlation Coefficient (r)	p-value
DNI vs Modified CT Severity Index	0.82	<0.001

A strong positive correlation (**r = 0.82**) was observed between the Delta Neutrophil Index and the Modified CT Severity Index, indicating that increasing DNI values were associated with increasing severity of acute pancreatitis.

Table 7. Diagnostic Performance of Delta Neutrophil Index for Predicting Severe Acute Pancreatitis

Parameter	Value
Cut-off value	>0.7
Sensitivity	90.0%
Specificity	70.0%
Area Under ROC Curve (AUC)	0.94
Overall Accuracy	82.5%

The Delta Neutrophil Index demonstrated excellent diagnostic performance for predicting severe acute pancreatitis, with an **AUC of 0.94**, **90.0% sensitivity**, and **70.0% specificity**, confirming its value as an early screening biomarker.

Table 8. Clinical Outcomes According to Disease

Severity

Outcome	Mild to Moderate (n=27)	Severe (n=13)	p-value
Mean Hospital Stay (days)	5.8 ± 1.7	11.6 ± 3.2	<0.001
ICU Admission	2 (7.4%)	10 (76.9%)	<0.001
Organ Failure	1 (3.7%)	8 (61.5%)	<0.001
Surgical Intervention	0	3 (23.1%)	0.011
Mortality	0	2 (15.4%)	0.036

Patients with severe acute pancreatitis had significantly longer hospital stays, greater ICU admission rates, higher incidence of organ failure, increased need for surgical intervention, and higher mortality compared with patients having mild-to-moderate disease (**p < 0.05**).

Table 9. Multivariate Logistic Regression Analysis for Predictors of Severe Acute Pancreatitis

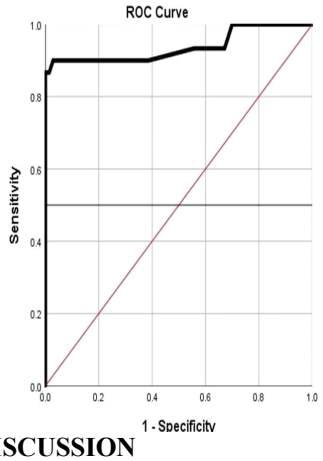
Variable	Odds Ratio	95% CI	p-value
DNI >0.7	8.74	2.01–37.96	0.002
Diabetes Mellitus	1.84	0.61–5.52	0.281
Hypertension	1.36	0.43–4.29	0.604

Multivariate logistic regression identified **DNI >0.7** as an independent predictor of severe acute pancreatitis (**OR 8.74, p=0.002**), while diabetes and hypertension were not statistically significant independent predictors.

Table 10. ROC Analysis of Delta Neutrophil Index

Variable	AUC	95% Confidence Interval	p-value
Delta Neutrophil Index	0.94	0.86–0.99	<0.001

Receiver operating characteristic analysis demonstrated excellent discriminatory ability of the Delta Neutrophil Index for predicting severe acute pancreatitis (**AUC = 0.94**), indicating outstanding diagnostic performance and supporting its use as an early prognostic biomarker.



1. DISCUSSION

The present prospective observational study evaluated the usefulness of the Delta Neutrophil Index (DNI) as an early predictor of severity in acute pancreatitis among 40 patients admitted to a tertiary care hospital. The majority of patients belonged to the 41–50 years age group (47.5%), followed by 31–40 years (35.0%), with a clear male predominance (67.5%). Farmers constituted the largest occupational group (40.0%), and hypertension (35.0%) and diabetes mellitus (30.0%) were the most common comorbidities. According to the Modified CT Severity Index, 27 patients (67.5%) had mild-to-moderate acute pancreatitis, whereas 13 patients (32.5%) developed severe acute pancreatitis (SAP). Similarly, 32.5% of patients had a DNI >0.7, while 67.5% had DNI values below the cut-off. These findings indicate that approximately one-third of patients presented with severe disease requiring early identification and aggressive management.

A principal finding of the present study was the strong association between elevated DNI and disease severity. Among patients with severe pancreatitis, 10 of 13 patients (76.9%) had a DNI >0.7, whereas only 3 of 27 (11.1%) patients with mild-to-moderate pancreatitis had elevated DNI values, demonstrating a highly significant association (p <0.001). Furthermore, the DNI showed a strong positive correlation with the Modified CT Severity Index (r = 0.82, p <0.001), indicating that increasing immature granulocyte fractions accurately reflected increasing pancreatic

inflammation and tissue injury. Similar findings were reported by Kim TY et al. [14], who evaluated 209 patients with acute pancreatitis and found significantly higher DNI values among patients with severe acute pancreatitis. Their study also demonstrated that DNI positively correlated with the Atlanta classification and bedside severity index and remained an independent predictor of severe acute pancreatitis on multivariate analysis (OR 1.122; 95% CI 1.045–1.205; p = 0.001). Likewise, İslam MM et al. [15] observed significantly higher median DNI values in patients with severe pancreatitis (0.5 vs. 0.2; p <0.001) and reported that DNI independently predicted severe disease with an AUC of 0.727, 74.3% sensitivity, and 68.2% specificity. These observations strongly support the utility of DNI as an early inflammatory biomarker for risk stratification in acute pancreatitis.

The diagnostic performance of DNI in the present study was excellent. Using a cut-off value of 0.7, DNI achieved a sensitivity of 90.0%, specificity of 70.0%, overall diagnostic accuracy of 82.5%, and an AUC of 0.94, indicating outstanding discriminatory ability for predicting severe pancreatitis. These values are superior to those reported by İslam MM et al. [15], who found an AUC of 0.727, sensitivity of 74.3%, and specificity of 68.2%. The improved diagnostic performance observed in the present study may be related to the use of a homogeneous patient population, standardized laboratory assessment, and correlation with the Modified CT Severity Index. Although direct comparison with different biomarkers should be interpreted cautiously, the findings suggest that DNI has excellent potential as a simple, rapid, and inexpensive biomarker for early severity assessment.

Clinical outcomes further validated the prognostic value of DNI. Patients with severe acute pancreatitis experienced significantly poorer outcomes, including a longer mean hospital stay (11.6 ± 3.2 vs. 5.8 ± 1.7 days), markedly higher ICU admission (76.9% vs. 7.4%), greater incidence of organ failure (61.5% vs. 3.7%), increased need for surgical intervention (23.1% vs. 0%), and higher mortality (15.4% vs. 0%), all of which were statistically significant. These findings reinforce the importance of early identification of high-risk patients. Riché FC et al. [11] similarly demonstrated that elevated inflammatory biomarkers such as procalcitonin (P <0.003) and IL-6 (P <0.04) during the initial days of illness predicted infected pancreatic necrosis, with combined thresholds providing a 91% negative predictive value, 75% sensitivity, and 84% specificity. Their study highlighted the value of early inflammatory markers in identifying patients at risk for complications, which is consistent with the present findings regarding DNI.

The present study also agrees with previous investigations evaluating inflammatory biomarkers in acute pancreatitis. Cho SK et al. [13] reported significantly higher neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) among patients with severe gallstone pancreatitis (P <0.001), concluding that both markers were superior to C-reactive protein in predicting severe disease in gallstone-related pancreatitis. Similarly, Vincent A et al. [16] studied 118 patients and demonstrated a strong positive correlation between NLR and CT Severity Index (r = 0.860, p <0.001), concluding that elevated inflammatory cell indices reliably reflect disease severity. More recently, Aydin G et al. [17] evaluated 139 patients and observed significantly higher immature granulocyte count (IGC) and immature granulocyte percentage (IG%) in patients with severe pancreatitis compared with mild and moderate disease, concluding that these parameters were superior to many conventional acute-phase reactants in determining inflammation severity and prognosis. Since DNI is derived from circulating immature granulocytes, these findings further support the biological rationale for its prognostic significance.

Overall, the present study demonstrated that DNI >0.7 was an independent and reliable predictor of severe acute pancreatitis, showing excellent correlation with CT severity, prolonged hospitalization, ICU admission, organ failure, surgical intervention, and mortality. The excellent diagnostic performance (AUC 0.94, 90.0% sensitivity, 70.0% specificity) observed in the present study suggests that DNI may serve as a valuable adjunct to radiological severity assessment. Because DNI is automatically generated during routine complete blood count analysis without additional cost or delay, it represents a practical and readily available biomarker that can facilitate early risk stratification and timely clinical decision-making, particularly in emergency departments and resource-limited healthcare settings.

CONCLUSION

The present study demonstrated that the **Delta Neutrophil Index (DNI)** is a valuable early biomarker for predicting the severity of acute pancreatitis. Patients with elevated DNI values (>0.7) were significantly more likely to develop severe disease, prolonged hospital and ICU stay, organ failure, require surgical intervention, and experience mortality. DNI showed a strong positive correlation with the Modified CT Severity Index and excellent diagnostic performance, with an AUC of **0.94**, **90% sensitivity**, and **70% specificity** for identifying severe acute pancreatitis. As DNI is rapidly available from routine complete blood count analysis without additional cost, it offers a simple, objective, and readily accessible tool for early risk stratification and timely clinical decision-making, particularly in emergency departments and resource-limited healthcare settings.

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