

## Retrospective Study

**Clinical significance of the neutrophil-lymphocyte ratio as an early predictive marker for adverse outcomes in patients with acute pancreatitis**

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**Abstract****AIM**

To investigate the prognostic value of the neutrophil-lymphocyte ratio (NLR) in patients with acute pancreatitis and determined an optimal cut-off value for the prediction of adverse outcomes in these patients.

**METHODS**

We retrospectively analyzed 490 patients with acute pancreatitis diagnosed between March 2007 and December 2012. NLRs were calculated at admission and 24, 48, and 72 h after admission. Patients were grouped according to acute pancreatitis severity and organ failure occurrence, and a comparative analysis was performed to compare the NLR between groups.

**RESULTS**

Among the 490 patients, 70 had severe acute pancreatitis with 31 experiencing organ failure. The severe acute pancreatitis group had a significantly higher NLR than the mild acute pancreatitis group on all 4 d (median, 6.14, 6.71, 5.70, and 4.00 vs 4.74, 4.47, 3.20, and 3.30, respectively,  $P < 0.05$ ). The organ failure group had a significantly higher NLR than the group without organ failure on all 4 d (median, 7.09, 6.72, 6.27, and 6.24 vs 4.85, 4.49, 3.35, and 2.34, respectively,  $P < 0.05$ ). The optimal cut-off value for baseline NLR was 4.76 in predicting severity and 4.88

in predicting organ failure in acute pancreatitis.

## CONCLUSION

Elevated baseline NLR correlates with severe acute pancreatitis and organ failure.

**Key words:** Acute pancreatitis; Neutrophil-lymphocyte ratio; Organ failure; Severe acute pancreatitis

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**Core tip:** This is a retrospective study to demonstrate the usefulness of the neutrophil-lymphocyte ratio in predicting the manifestation of severe acute pancreatitis and organ failure in the early stages in patients with acute pancreatitis. The neutrophil-lymphocyte ratio is cost-effective and easy to use, utilizing tests already routinely performed. This study found the neutrophil-lymphocyte ratio to be a reliable predictor of adverse outcomes in patients with acute pancreatitis and established the optimal cut-off value of the neutrophil-lymphocyte ratio for predicting these outcomes.

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## INTRODUCTION

Acute pancreatitis is an acute inflammatory process of the pancreas that starts with local acinar cell injury with variable involvement of other regional tissues or remote organ systems<sup>[1]</sup>. Although the majority of acute pancreatitis cases are mild and self-limiting, severe cases can be accompanied by complications such as necrosis or organ failure in approximately 25% of patients<sup>[2-5]</sup>. In such severe acute pancreatitis (SAP), high mortality rates of up to 50% have been reported<sup>[4]</sup>. The severity of acute pancreatitis is related to extrapancreatic organ failure secondary to the patient's systemic inflammatory response, and a poor prognosis of SAP is thought to be the result of uncontrolled systemic inflammatory response syndrome or multi-organ dysfunction syndrome<sup>[2,4,6,7]</sup>. White blood cell (WBC) counts and C-reactive protein (CRP) levels are non-specific markers of systemic inflammation that can be measured using routine serum hematological tests. In addition, the WBC count is correlated with poor prognosis as a compositional element of Ranson's criteria, Glasgow score, Acute Physiology and Chronic Health Evaluation-II (APACHE-II), and Bedside Index of Severity in Acute Pancreatitis (BISAP), which are the prognostic scoring systems

of acute pancreatitis<sup>[4,8]</sup>. However, the total WBC count can fluctuate based on various physiological and pathological conditions including hydration status, stress, and pregnancy in addition to how the blood specimen is handled<sup>[8]</sup>. The neutrophil-lymphocyte ratio (NLR) has been identified as a more reliable predictor of adverse outcomes in several benign and malignant diseases, such as coronary heart disease, esophageal cancer, colorectal cancer, and hepatocellular carcinoma, when compared with the WBC count<sup>[9-14]</sup>. Neutrophils and lymphocytes reflect the immune response better than the total WBC count<sup>[9-11]</sup>. In particular, studies have demonstrated the correlation between peripheral lymphocytopenia and the severity of acute pancreatitis<sup>[15,16]</sup>. In addition, one study established the superiority of the NLR over the total WBC counts in predicting the severity of acute pancreatitis<sup>[8]</sup>.

The aim of this study was to demonstrate the usefulness of the NLR in predicting the manifestation of SAP and organ failure in the early stages in patients with acute pancreatitis. In addition, this study examined the optimal cut-off value of the NLR in predicting adverse outcomes in patients with acute pancreatitis.

## MATERIALS AND METHODS

We retrospectively analyzed the clinical, laboratory, and radiological data of patients diagnosed with acute pancreatitis and hospitalized at Sanggye Paik Hospital in Seoul, South Korea, between March 2007 and December 2012. Up to 72 h of data were analyzed during the course of hospitalization for each patient. Patients with missing baseline laboratory or vital signs data (as they were transferred from a different hospital) were excluded from further analysis. According to the protocol of our department, all the hospitalized patients with organ failure or fever were routinely administered a broad-spectrum antibiotic intravenously from the first day to at least 72 h of hospitalization. This study was approved by the Institutional Review Board.

### Definitions

Patients were diagnosed with acute pancreatitis if more than 2 of the following conditions were satisfied: (1) abdominal pain consistent with acute pancreatitis (acute onset of a persistent, severe, epigastric pain often radiating to the back); (2) serum amylase and/or lipase level at least 3 times greater than the upper limit of the normal value; and (3) characteristic manifestation of acute pancreatitis on contrast-enhanced computed tomography, magnetic resonance imaging, or transabdominal ultrasonography<sup>[6]</sup>. Acute pancreatitis was categorized into mild acute pancreatitis (MAP), moderately severe acute pancreatitis, and severe acute pancreatitis (SAP) in accordance with the revised Atlanta classification<sup>[6]</sup>. For the purpose of analysis, we grouped the moderately severe pancreatitis cases with the SAP

**Table 1 Patient demographics, pancreatitis etiology and laboratory findings comparing mild and severe acute pancreatitis at day 0**

	All (n = 490)	MAP (n = 420)	SAP (n = 70)	P value
Age (yr)	52.36 ± 16.98	52.34 ± 17.15	52.46 ± 16.01	0.958
Sex: male (%)	352 (71.8)	297 (70.7)	55 (78.6)	0.176
Etiology, n (%)				0.839
Gallstones	136 (27.8)	119 (28.3)	17 (24.3)	
Alcohol	250 (51.0)	212 (50.5)	38 (54.3)	
Hypertriglyceridemia	8 (1.6)	6 (1.4)	2 (2.9)	
Idiopathic	84 (17.1)	73 (17.4)	11 (15.7)	
Cancer	12 (2.4)	10 (2.4)	2 (2.9)	
Laboratory (at admission)				
WBC (× 10 <sup>9</sup> /L)	11.90 ± 5.61	11.80 ± 5.68	12.53 ± 5.14	0.315
CRP (mg/dL)	6.55 ± 8.10	5.90 ± 7.32	10.32 ± 11.03	0.001
Hct (%)	41.51 ± 5.78	41.61 ± 5.81	40.89 ± 5.52	0.330
BUN (mg/dL)	14.91 ± 9.51	14.76 ± 9.63	15.84 ± 8.76	0.382
Calcium (mg/dL)	8.50 ± 0.85	8.60 ± 0.78	7.90 ± 0.99	0.001
Albumin (g/dL)	3.90 ± 0.63	3.94 ± 0.62	3.71 ± 0.63	0.006
Glucose (mg/dL)	155.25 ± 98.25	153.45 ± 100.41	165.54 ± 84.76	0.343
LDH (U)	523.36 ± 480.75	518.47 ± 492.08	553.15 ± 406.77	0.585
BMI (kg/m <sup>2</sup> )	23.85 ± 4.12	23.93 ± 4.19	23.42 ± 3.72	0.368
Hospital stay (d)	9.81 ± 7.15	9.21 ± 6.34	13.36 ± 10.11	0.001

Data expressed as mean ± SD. MAP: Mild acute pancreatitis; SAP: Severe acute pancreatitis; WBC: White blood cell; CRP: C-reactive protein; Hct: Hematocrit; BUN: Blood urea nitrogen; LDH: Lactate dehydrogenase; BMI: Body mass index, *P* value < 0.05.

cases<sup>[6]</sup>. Consequently, SAP was considered to be the presence of transient (less than 48 h) or persistent (over 48 h) organ failure and/or local or systemic complications. Local complications included an acute peripancreatic fluid collection, a pancreatic pseudocyst, an acute necrotic collection, and a walled-off necrosis. Exacerbation of pre-existing co-morbidities, such as coronary artery disease or chronic lung disease, precipitated by the acute pancreatitis was defined as a systemic complication. Organ failure included shock (systolic blood pressure < 90 mmHg), pulmonary insufficiency (arterial PO<sub>2</sub> < 60 mmHg at room air or the need for mechanical ventilation), or renal failure (serum creatinine level > 2 mg/dL after rehydration or hemodialysis)<sup>[2,3]</sup>. The NLR was computed by calculating the ratio of the absolute neutrophil and lymphocyte counts, and the analysis was conducted using the NLR values on the day of hospitalization (baseline, NLR 0) and at 24 (NLR 1), 48 (NLR 2), and 72 h (NLR 3) after hospitalization.

### Statistical analysis

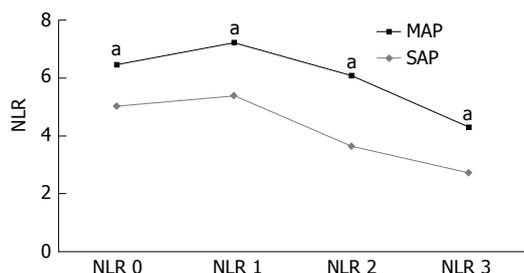
Descriptive data are presented as median and interquartile ranges for continuous variables. The Student's *t*-test or Mann-Whitney *U* test was used for the analysis of continuous data for comparison between the SAP and MAP patients. The  $\chi^2$  test or Fisher's exact test was used for categorical data analysis. The NLR was treated as a continuous variable, and severity of acute pancreatitis and organ failure distribution were treated as categorical variables. Correlation of the NLR with the severity of acute pancreatitis or the organ failure distribution was determined by using the Spearman's rank correlation test. The optimal cut-off value of NLR was

computed by using the trade-off between sensitivity and specificity on the receiver-operating characteristic (ROC) curves, and the accuracy of prediction of the NLR was estimated using the area under the receiver-operating curve (AUC). Statistical significance was defined as a *P* value < 0.05.

## RESULTS

During the period of the study, 531 patients were admitted with acute pancreatitis. Among these, 41 patients with unavailable baseline data were excluded, and a total of 490 patients were enrolled in this study. Of these 490 patients, 70 were diagnosed with SAP.

Clinical characteristics and initial laboratory findings of all patients are summarized in Table 1. The patients with SAP demonstrated higher CRP levels and lower total calcium and albumin levels compared to those in patients with MAP at the time of hospitalization. There was no significant difference in the total WBC count upon admission between the MAP and SAP groups. The differences in the NLR between the MAP and SAP groups are shown in Table 2. Although there was no significant difference in the baseline total WBC count between the 2 groups, the baseline NLR was 6.14 in the SAP group, which was significantly higher than that in the MAP group at 4.74 (median, *P* = 0.013). The NLRs after 24, 48, and 72 h of hospitalization in the SAP group were significantly higher compared to those in the MAP group (median, 6.71, 5.70, and 4.00 vs 4.47, 3.20, and 3.30, respectively, *P* < 0.05). The sequential changes in the NLR are illustrated in Figure 1. Although the MAP group demonstrated the highest NLR on admission with a gradual decrease after 24 h of hospitalization, the SAP group demonstrated the



**Figure 1** Sequential changes in the neutrophil-lymphocyte ratio in mild and severe acute pancreatitis groups during the first 72 h following presentation (<sup>a</sup>*P* < 0.05 when compared between two groups).

**Table 2** Sequential changes in the neutrophil-lymphocyte ratio in mild acute pancreatitis and severe acute pancreatitis groups

	All (n = 490)	MAP (n = 420)	SAP (n = 70)	P value
NLR 0	4.95 (6.15)	4.74 (5.79)	6.14 (6.64)	0.010
NLR 1	4.64 (6.28)	4.47 (5.82)	6.71 (7.71)	0.002
NLR 2	3.39 (4.50)	3.20 (4.15)	5.70 (6.75)	0.001
NLR 3	2.45 (3.47)	3.30 (3.26)	4.00 (5.90)	0.001

NLR 0, Neutrophil-lymphocyte ratio at admission; neutrophil-lymphocyte ratio (NLR) 1, on day 1; NLR 2, on day 2; NLR 3, on day 3; *P* value < 0.05. Value expressed as median NLR (IQR). MAP: Mild acute pancreatitis; SAP: Severe acute pancreatitis; IQR: Interquartile range.

**Table 3** Sequential changes in the neutrophil-lymphocyte ratio of acute pancreatitis between with and without organ failure groups

	All (n = 490)	Organ failure (-) (n = 459)	Organ failure (+) (n = 31)	P value
NLR 0	4.95 (6.15)	4.85 (6.09)	7.09 (7.87)	0.03
NLR 1	4.64 (6.28)	4.49 (6.08)	6.72 (12.37)	0.003
NLR 2	3.39 (4.50)	3.35 (4.29)	6.27 (12.19)	0.002
NLR 3	2.45 (3.47)	2.34 (3.35)	6.24 (8.37)	0.001

Value expressed as median NLR (IQR); IQR: Interquartile range; NLR 0, neutrophil-lymphocyte ratio at admission; NLR 1, on day 1; NLR 2, on day 2; NLR 3, on day 3; *P* value < 0.05. NLR: Neutrophil-lymphocyte ratio.

highest NLR after 24 h of hospitalization with a gradual decrease thereafter, and the NLR after 48 h remained higher than the highest score in the MAP group, indicating ongoing inflammation.

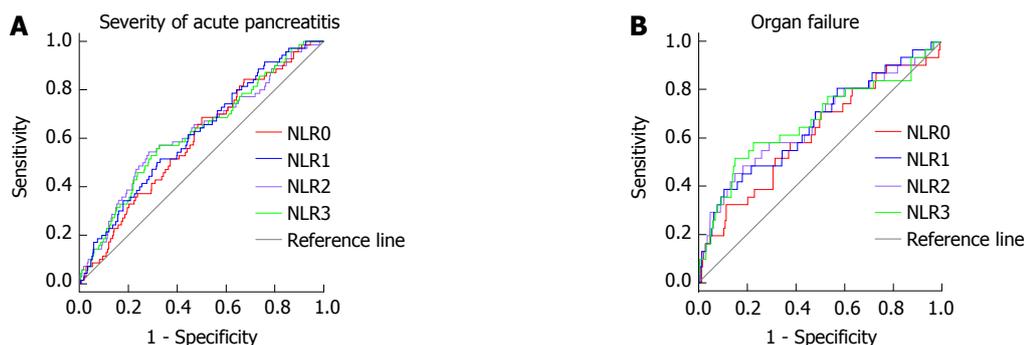
We examined the differences in the NLRs by dividing the acute pancreatitis patients into those with and without organ failure (Table 3). All of the NLR 0, NLR 1, NLR 2, and NLR 3 measurements were significantly higher in the group of patients with organ failure than in the group of patients without organ failure (median, 4.85, 4.49, 3.35, and 2.34 vs 7.09, 6.72, 6.27, and 6.24, respectively, *P* < 0.05). Both the groups showed the highest NLR value at admission followed by a gradual decrease thereafter.

The ROCs for the NLR of each day predicting SAP and organ failure are shown in Figure 2. The ROC yielded an AUC of 0.59 (95%CI: 0.52-0.66) for

baseline NLR in predicting disease severity and 0.62 (95%CI: 0.51-0.72) in predicting development of organ failure. The AUC for NLR 1 was higher than the baseline NLR and similar to NLR 2 and NLR 3 both for predicting disease severity and development of organ failure. On the basis of the highest sensitivity and specificity values generated from the ROC, we generated the optimal cut-off values of baseline NLR and NLR 1 for predicting the development of SAP and organ failure. This demonstrated an optimal baseline NLR of 4.76 and NLR 1 of 5.18 for SAP and a baseline NLR of 5.03 and NLR 1 of 4.81 for organ failure (Table 4).

## DISCUSSION

In this study, we evaluated the usefulness of the NLR as an early predictive marker for development of SAP and organ failure in acute pancreatitis. Although the total WBC count is a compositional element of Ranson’s criteria, Glasgow score, APACHE-II, and BISAP (scoring systems for evaluation of the prognosis of acute pancreatitis), the total WBC count itself, unlike CRP or blood urea nitrogen, is not assessed as an independent marker for the prediction of the prognosis of acute pancreatitis<sup>[4,8]</sup>. However, the NLR was identified by several existing studies as an index that reflects the prognosis of various benign inflammatory or malignant diseases<sup>[9-14]</sup>. This study demonstrated that the NLR was elevated in patients presenting with acute pancreatitis and that NLR can allow providers to classify patients according to disease severity and the presence of organ failure. In particular, evaluating the severity of acute pancreatitis at the initial stage of manifestation is critical to improve the patient’s prognosis<sup>[2,3]</sup>. Therefore, there is a need for a simple indicator that can easily predict the patient’s prognosis within 24 h of the manifestation of the disease<sup>[2,3]</sup>. Prognostic scoring systems such as the Ranson’s criteria, APACHE-II, and sequential organ failure assessment (SOFA) score have limitations in actual application since they are complex and contain data not routinely ordered or collected during hospitalization at the current time<sup>[2,4]</sup>. However, the NLR is a simple test that is inexpensive, routinely performed during the initial evaluation of patients, not affected by the volume status of the patient, and can be repeated easily<sup>[4,8]</sup>. In particular, since neutrophilia and lymphopenia are indexes of systemic inflammation and physiological stress, they can better reflect complications such as necrosis or organ failure<sup>[4,8,15,16]</sup>. The neutrophil, as a major cell associated with the active inflammation response, is the main initiator of tissue destruction caused by several inflammatory cytokines such as interleukin 1 and interleukin 6<sup>[4,8]</sup>. Therefore, neutrophilia generated by the acute and severe pancreatic tissue damage and inflammation in SAP increases the NLR<sup>[4,8]</sup>. On the other hand, there was a decreased number of peripheral total and lymphocyte subsets measured within 48 h after admission in



**Figure 2** Receiver operator curves and corresponding area under curve analyses demonstrating the accuracy of the neutrophil-lymphocyte ratio 0, 1, 2, and 3 in predicting (A) severity of acute pancreatitis and (B) organ failure.

**Table 4** Area under curve (95%CI) value for predicting disease severity, development of organ failure, necrosis, local complications, ICU admission and mortality

	Severity	Organ failure	Necrosis	Local Cx	ICU adm	Mortality
NLR 0	0.59 <sup>a</sup> (0.52-0.66)	0.62 <sup>a</sup> (0.51-0.72)	0.52 (0.44-0.60)	0.54 (0.48-0.60)	0.58 (0.47-0.70)	0.44 (0.21-0.67)
NLR 1	0.62 <sup>a</sup> (0.55-0.69)	0.66 <sup>a</sup> (0.55-0.77)	0.60 <sup>a</sup> (0.52-0.68)	0.57 (0.51-0.63)	0.73 <sup>a</sup> (0.63-0.83)	0.62 (0.38-0.85)
NLR 2	0.62 <sup>a</sup> (0.55-0.70)	0.66 <sup>a</sup> (0.55-0.78)	0.61 <sup>a</sup> (0.53-0.69)	0.59 <sup>a</sup> (0.53-0.66)	0.74 <sup>a</sup> (0.64-0.84)	0.60 (0.30-0.85)
NLR 3	0.62 <sup>a</sup> (0.55-0.70)	0.67 <sup>a</sup> (0.56-0.79)	0.59 <sup>a</sup> (0.51-0.66)	0.60 <sup>a</sup> (0.54-0.67)	0.73 <sup>a</sup> (0.63-0.83)	0.62 (0.39-0.85)

NLR 0, baseline neutrophil-lymphocyte ratio; NLR 1, on day 1; NLR 2, on day 2; NLR 3, on day 3; <sup>a</sup>P value < 0.05. Cx: Complications; adm: Admission; NLR: Neutrophil-lymphocyte ratio.

patients with acute pancreatitis<sup>[4,8]</sup>. As evidenced by existing studies, patients with SAP had a significantly lower number of lymphocytes in comparison with patients having the mild form of the disease, thereby further increasing the NLR. It is probably due to an impaired lymphocyte proliferative response to mitogens in acute pancreatitis patients<sup>[4,8,15,16]</sup>. In the literature review, elevation of the NLR in early phase of SAP was estimated to be abnormalities in cellular immunity due to early apoptosis of lymphocytes and delay of neutrophil apoptosis<sup>[16]</sup>.

This study demonstrated that the NLR values from the time of admission to 72 h after admission are significantly different depending on disease severity and existence of organ failure. In particular, we aimed to identify the standards for early evaluation of SAP and organ failure by computing the cut-off value of baseline NLR. The cut-off value of baseline NLR presented in this study for predicting SAP is 4.76, which is similar to the NLR of 4.7 presented by Azab *et al*<sup>[8]</sup>. In addition, this displayed a sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy (63.6, 56.7, 21.2, 89.5, and 57.7, respectively) similar to those for the cut-off value presented by Suppiah *et al*<sup>[4]</sup>. However, when compared with the results of other studies performed by the author, the NLR had a lower accuracy for predicting adverse outcomes in acute pancreatitis compared with other prognostic scoring systems of acute pancreatitis (BISAP, Ranson's criteria, APACHE-II, and CT severity index) (AUC; 0.80, 0.74, 0.80, and 0.67 vs 0.59 in SAP; 0.93, 0.84, 0.95, and 0.57 vs 0.62 in organ failure, respectively)<sup>[3]</sup>. In

addition, the NLR cannot be asserted to have superior predictability in comparison to other scoring systems with the sensitivity of APACHE-II, Imrie, Ranson, SOFA score, and Pancreatitis Outcome Prediction score ranging from 60% to 90% in numerous studies<sup>[2,5,17]</sup>. This implies that although a high NLR can predict adverse outcomes of acute pancreatitis, its accuracy is lower than the accuracy of other currently used scoring systems. However, further studies are needed for more accurate evaluation since a comparative analysis between the NLR and other scoring systems was not carried out in this study.

Similar to other published studies by Azab and Suppiah<sup>[4,8]</sup>, this study investigated the predicting value of the NLR for development of organ failure. In our study, baseline NLR predicted the development of organ failure with a slightly higher accuracy than it predicted SAP with an AUC of 0.62 and 0.59, respectively. This is because the NLR represents the patients' inflammatory response, and organ failure occurs because of a systemic inflammatory response. Assuming that organ failure reflects systemic inflammation in acute pancreatitis, the ability of the sequential changes of the NLR to predict development of organ failure might be affected by antibiotic use (Table 5).

Although there may be differences in the normal range of the NLR based on race or gender<sup>[8]</sup>, we computed the NLR in accordance with the normal reference range presented by the diagnostic laboratory of our unit since there was no alternative reference range. Computation of the highest possible NLR value by dividing the highest measured neutrophil count by

**Table 5** Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of optimal cut-off value of baseline and on day 1 neutrophil-lymphocyte ratio in predicting severe acute pancreatitis and organ failure

	Cut-off value	P value	Sensitivity	Specificity	PPV	NPV	Accuracy
SAP	NLR 0 = 4.76	0.013	68.6%	50.0%	18.6%	90.5%	52.7%
	NLR 1 = 5.18	0.002	62.9%	55.5%	18.7%	89.6%	46.9%
Organ failure	NLR 0 = 5.03	0.032	64.3%	53.1%	8.3%	95.6%	49.4%
	NLR 1 = 4.81	0.003	62.9%	55.5%	8.7%	96.0%	49.2%

$P < 0.05$ . NLR 0, baseline neutrophil-lymphocyte ratio; NLR 1, on day 1; PPV: Positive predictive value; NPV: Negative predictive value; SAP: Severe acute pancreatitis; NLR: Neutrophil-lymphocyte ratio.

the lowest measured lymphocyte count resulted in the value of 3.75. The median baseline NLR of all the patients enrolled in this study was 4.95, and the NLR of the MAP patients was 4.74, thereby confirming that the NLR of the acute pancreatitis patient is higher than that of a healthy person, irrespective of the severity of the disease.

The majority of existing studies that evaluated the usefulness of the NLR as a prognostic marker used a cut-off value of NLR of  $\geq 5$  to predict adverse outcomes of several benign or malignant diseases<sup>[9-11]</sup>. This finding is similar to the values of 4.76 for predicting SAP and 5.03 for predicting organ failure presented in this study. As the result of analysis of prognostic accuracy of the NLR when the cut-off value of initial NLR is set at  $\geq 5$  by using the data obtained from this study, both SAP and organ failure demonstrated sensitivity, specificity, PPV, NPV, and accuracy that were similar to those for the cut-off value presented in this study (64.3%, 52.9%, 18.5%, 89.9%, and 54.5% in predicting SAP, respectively, and 64.5%, 51.4%, 8.2%, 95.5%, and 52.2% in predicting organ failure, respectively).

In this study, unlike the study by Suppiah *et al*<sup>[4]</sup>, the cut-off values of baseline NLR and NLR 1 were computed because the initial assessment within 24 h of admission is considered the most important in the treatment of acute pancreatitis<sup>[2,3]</sup>. The greatest benefit of the NLR that differentiates it from other prognostic markers is the rapid confirmation of the results in an emergency examination. In this study, the MAP group demonstrated continuous reduction in the NLR over time to 3.20 after 48 h of hospitalization, which is a lower value than the normal highest possible NLR of 3.75 that we have determined. This can be explained by the fact that MAP patients generally recover with 48-72 h of hospital treatment<sup>[1,2]</sup>. On the contrary, the NLR was maintained at higher than the normal levels after 72 h of hospitalization in the SAP group.

The NLR is a simple, inexpensive, and easy to carry out prognostic tool to predict adverse outcomes in patients with acute pancreatitis. Although the accuracy of the NLR for predicting adverse outcomes in patients with acute pancreatitis is not higher than the other currently used prognostic scoring systems, the NLR can be used to classify patients according to disease severity or presence of organ failure. In addition,

sequential changes in the NLR over time seem to reflect the progress and therapeutic response of acute pancreatitis. Additional studies would be required to compare the prognostic value of the NLR to other currently used scoring systems in patients with acute pancreatitis.

## COMMENTS

### Background

Several prognostic scoring systems have been developed to predict severe acute pancreatitis. However, they are complex and some laboratory data are not obtained immediately. The neutrophil-lymphocyte ratio (NLR) can be obtained easily and is usually included in routine orders. This study investigated clinical usefulness of the NLR to predict severe acute pancreatitis at an early stage.

### Research frontiers

The NLR has been studied as a more reliable predictor of adverse outcomes in several benign and malignant diseases, such as coronary heart disease, esophageal cancer, colorectal cancer, and hepatocellular carcinoma. There have been few studies in acute pancreatitis.

### Innovations and breakthroughs

This study demonstrated that the NLR values from the time of admission to 72 h after admission are significantly different depending on disease severity and existence of organ failure. In particular, the aimed to identify the standards for early evaluation of severe acute pancreatitis and organ failure by computing the cut-off value of baseline NLR.

### Applications

The NLR is the simple, easy, and inexpensive method to predict the severe acute pancreatitis and organ failure. Further large randomized controlled study would be required.

### Terminology

The NLR was computed by calculating the ratio of the absolute neutrophil and lymphocyte counts, and the analysis was conducted using the NLR values on the day of hospitalization (baseline, NLR 0) and at 24 (NLR 1), 48 (NLR 2), and 72 h (NLR 3) after hospitalization.

### Peer-review

The paper adds some interesting information to the discussion of study about the prognostic value of the NLR in patients with acute pancreatitis and it an optimal cut-off value for the prediction of adverse outcomes in these patients. The proposed test is cheap and easy to use, using tests routinely performed.

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