

Neutrophil-to-Lymphocyte Ratio as a Cost-Effective Early Prognostic Marker in Acute ST-Elevation Myocardial Infarction (STEMI)Kundan Kumar¹, Nikhil Kumar², Ajay Kumar Sinha³, Sapna Kumari⁴¹Senior Resident, Department of General Medicine, Nalanda Medical College and Hospital, Patna, Bihar, India²Senior Resident, Department of General Medicine, Nalanda Medical College and Hospital, Patna, Bihar, India³Professor and HOD, Department of General Medicine, Nalanda Medical College and Hospital, Patna, Bihar, India⁴Junior Resident, Department of General Medicine, Nalanda Medical College and Hospital, Patna, Bihar, India

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Abstract:**Background:** Acute ST-elevation myocardial infarction (STEMI) is characterized by an intense inflammatory response that significantly influences infarct size, complications, and short-term prognosis. Identifying simple and cost-effective inflammatory markers for early risk stratification is crucial, particularly in resource-limited settings.**Objective:** To evaluate the prognostic significance of the neutrophil-to-lymphocyte ratio (NLR) in patients with acute STEMI and to assess its association with clinical severity, TIMI risk score, Killip class, and in-hospital outcomes.**Methods:** A prospective observational study was performed involving 100 patients with acute STEMI and 100 age- and sex-matched controls. Hematological parameters at admission were recorded, and NLR was calculated. Clinical risk stratification was performed using TIMI score and Killip classification. In-hospital outcomes were documented and analyzed statistically.**Results:** STEMI patients demonstrated significantly higher neutrophil counts and lower lymphocyte counts, resulting in elevated NLR compared to controls ($p < 0.001$). NLR showed a strong positive correlation with TIMI risk score and Killip class. Higher NLR values were significantly associated with adverse in-hospital outcomes including cardiogenic shock, reduced left ventricular ejection fraction, ICU admission, complications, and mortality.**Conclusion:** NLR is a simple, inexpensive, and reliable prognostic marker in acute STEMI. Its strong association with disease severity and adverse outcomes supports its routine use for early risk stratification.**Keywords:** STEMI, Neutrophil-to-lymphocyte ratio, Inflammation, Prognosis, TIMI score.**DOI:** 10.25258/ijcpr.18.1.156

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Introduction

Acute ST-elevation myocardial infarction (STEMI) remains one of the leading causes of morbidity and mortality worldwide despite advances in reperfusion strategies and pharmacotherapy [1]. Early risk stratification is critical for guiding therapeutic decisions and improving clinical outcomes.

Atherosclerosis and plaque rupture are now well established as inflammation-driven processes [2,3]. Plaque rupture triggers an intense systemic inflammatory response characterized by neutrophil activation, lymphocyte suppression, endothelial dysfunction, and thrombosis [4].

Neutrophils play a central role in myocardial injury through the release of reactive oxygen species,

proteolytic enzymes, and microvascular obstruction [5]. Conversely, lymphopenia reflects stress-induced apoptosis mediated by cortisol and catecholamines, and is associated with impaired immune regulation and poor prognosis [6].

The neutrophil-to-lymphocyte ratio (NLR) integrates these opposing inflammatory responses into a single marker of systemic inflammation [7]. Elevated NLR has been consistently associated with infarct size, heart failure, arrhythmias, and mortality in patients with acute coronary syndromes, particularly STEMI [8–10].

Risk stratification tools such as the TIMI risk score and Killip classification are widely used to assess

prognosis in acute myocardial infarction [11,12]. However, the addition of inflammatory markers like NLR may enhance their predictive accuracy [13].

This study was undertaken to evaluate the prognostic role of NLR in acute STEMI and to correlate it with established clinical risk scores and in-hospital outcomes.

Materials and Methods

Study Design and Setting: Prospective observational study conducted at Nalanda Medical College and Hospital, Patna, Bihar.

Study Duration: Six months (April 2025 – September 2025).

Sample Size: 100 patients with acute STEMI. The control group consisted of 100 age- and sex-matched individuals without acute coronary syndrome or active inflammatory conditions.

Inclusion Criteria

- Age ≥ 18 years
- Diagnosis of acute STEMI
- Presentation within 24 hours of symptom onset

Exclusion Criteria

- Active infection or inflammatory disease
- Malignancy
- Hematological disorders

Data Collection: Baseline demographic details, cardiovascular risk factors, complete blood count at admission, TIMI risk score, Killip class, echocardiographic findings, and in-hospital outcomes were recorded.

Statistical Analysis: Continuous variables were expressed as mean \pm standard deviation and compared using Student's t-test. Categorical variables were expressed as frequencies and percentages and compared using chi-square or Fisher's exact test as appropriate. Correlation was assessed using Pearson's correlation coefficient. A p-value < 0.05 was considered statistically significant.

Results

Baseline Demographic and Clinical Characteristics: A total of 100 patients with ST-elevation myocardial infarction (STEMI) and 100 control subjects were included in the study. The mean age of patients in the STEMI group was 50.4 ± 10.2 years, which was comparable to that of the control group (57.8 ± 9.6 years). Male predominance was observed in both groups, with males constituting a higher proportion of the STEMI cohort.

Traditional cardiovascular risk factors such as hypertension, diabetes mellitus, smoking, and

dyslipidemia were more frequently observed among STEMI patients compared to controls, with statistically significant differences noted for hypertension and smoking status ($p < 0.05$). Baseline demographic and clinical characteristics of the study population are summarized in Table 1.

Laboratory Parameters at Admission

On admission, STEMI patients demonstrated significant alterations in hematological parameters compared to controls. The mean neutrophil count was significantly higher in STEMI patients ($7.8 \pm 2.1 \times 10^9/L$) compared to controls ($4.6 \pm 1.5 \times 10^9/L$; $p < 0.001$). In contrast, the mean lymphocyte count was significantly lower among STEMI patients ($1.3 \pm 0.5 \times 10^9/L$) compared to the control group ($2.4 \pm 0.6 \times 10^9/L$; $p < 0.001$).

As a consequence of increased neutrophil counts and reduced lymphocyte counts, the neutrophil-lymphocyte ratio (NLR) was markedly elevated in STEMI patients (5.9 ± 2.4) when compared to controls (1.9 ± 0.8), with this difference being statistically significant ($p < 0.001$). These findings are detailed in Table 2.

Association Between NLR and TIMI Risk Score

STEMI patients were stratified according to TIMI risk score into low-, intermediate-, and high-risk categories. A progressive and statistically significant increase in mean NLR values was observed across these categories. Patients in the high-risk TIMI group exhibited the highest mean NLR levels, followed by the intermediate- and low-risk groups ($p < 0.001$).

Pearson correlation analysis demonstrated a strong positive correlation between NLR and TIMI risk score ($r = 0.68$, $p < 0.001$), indicating that higher inflammatory burden, as reflected by NLR, was associated with increased clinical risk. The relationship between NLR and TIMI risk categories is presented in Table 3 and Table 4.

Association Between NLR and Killip Class:

Patients were further classified according to Killip classification at presentation. Mean NLR values showed a progressive increase with worsening Killip class. Patients in Killip class III and IV demonstrated significantly higher NLR values compared to those in Killip class I and II ($p < 0.001$).

This finding suggests a strong association between elevated NLR and greater severity of heart failure at presentation. The distribution of NLR values across Killip classes is summarized in Table 5.

Association Between NLR and In-Hospital Outcomes:

Analysis of in-hospital outcomes revealed that STEMI patients who developed cardiogenic shock, required intensive care unit (ICU) admission, had left ventricular ejection

fraction (LVEF) < 50%, experienced in-hospital complications, or succumbed during hospitalization exhibited significantly higher mean NLR values compared to patients without these adverse outcomes ($p < 0.001$ for all comparisons).

Elevated NLR was consistently associated with poor clinical outcomes, underscoring its prognostic significance in STEMI patients. The association between NLR and in-hospital outcomes is detailed in Table 6.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population

Parameter	STEMI (n = 100)	Controls (n = 100)	p-value
Age (years), mean \pm SD	50.4 \pm 10.2	57.8 \pm 9.6	0.41
Male sex, n (%)	72 (72%)	68 (68%)	0.53
Female sex, n (%)	28 (28%)	32 (32%)	0.53
Hypertension, n (%)	46 (46%)	28 (28%)	0.01
Diabetes mellitus, n (%)	38 (38%)	30 (30%)	0.22
Smoking, n (%)	52 (52%)	31 (31%)	0.003
Dyslipidemia, n (%)	41 (41%)	35 (35%)	0.37

Table 2: Hematological Parameters at Admission

Parameter	STEMI (n = 100)	Controls (n = 100)	p-value
Neutrophil count ($\times 10^9/L$), mean \pm SD	7.8 \pm 2.1	4.6 \pm 1.5	<0.001
Lymphocyte count ($\times 10^9/L$), mean \pm SD	1.3 \pm 0.5	2.4 \pm 0.6	<0.001
Neutrophil-Lymphocyte Ratio (NLR), mean \pm SD	5.9 \pm 2.4	1.9 \pm 0.8	<0.001

Table 3: Distribution of NLR According to TIMI Risk Score

TIMI Risk Category	Number of Patients (n)	Mean NLR \pm SD	p-value
Low risk (0-2)	28	3.2 \pm 1.1	
Intermediate risk (3-4)	42	5.6 \pm 1.8	
High risk (5-7)	30	8.1 \pm 2.3	<0.001

Table 4: Correlation Between NLR and TIMI Risk Score

Variable	Correlation coefficient (r)	p-value
NLR vs. TIMI score	0.68	<0.001

Table 5: Association Between NLR and Killip Class

Killip Class	Number of Patients (n)	Mean NLR \pm SD	p-value
Class I	44	3.4 \pm 1.2	
Class II	28	5.1 \pm 1.6	
Class III	18	7.4 \pm 2.0	
Class IV	10	9.2 \pm 2.5	<0.001

Table 6: Association Between NLR and In-Hospital Outcomes

Outcome	Present (Mean NLR \pm SD)	Absent (Mean NLR \pm SD)	p-value
Cardiogenic shock	8.9 \pm 2.3	4.7 \pm 1.6	<0.001
ICU admission	7.6 \pm 2.1	4.1 \pm 1.4	<0.001
LVEF < 50%	7.2 \pm 2.0	4.3 \pm 1.5	<0.001
In-hospital complications	8.1 \pm 2.2	4.5 \pm 1.6	<0.001
In-hospital mortality	9.5 \pm 2.6	5.1 \pm 1.7	<0.001

Discussion

This study demonstrates that NLR is significantly elevated in people with acute STEMI and is strongly linked to the severity of the disease and adverse outcomes in the hospital. The high NLR seen in STEMI is a sign of a strong acute inflammatory response to myocardial necrosis. This response is marked by neutrophil-mediated tissue damage and repair, as well as stress-induced lymphocyte apoptosis.

Neutrophilia occurs due to increased bone marrow stimulation and mobilization in response to myocardial injury, while lymphopenia results from stress-induced apoptosis mediated by cortisol and catecholamines [14–16]. This imbalance leads to an elevated NLR, which serves as a reliable marker of systemic inflammation.

Our results align with prior research indicating that elevated NLR is associated with enlarged infarct size, elevated TIMI risk scores, advanced Killip class, and heightened mortality [17–20]. The significant correlation between NLR and TIMI score

identified in this study underscores the additive prognostic significance of inflammatory markers beyond conventional risk stratification tools.

Importantly, NLR is derived from routine complete blood counts, making it inexpensive, easily accessible, and particularly valuable in resource-limited healthcare settings [21–25].

Conclusion

The neutrophil-to-lymphocyte ratio is a simple, cheap, and reliable way to predict the outcome of acute STEMI. The fact that it is strongly linked to clinical severity, risk stratification scores, and adverse in-hospital outcomes makes it a good choice for early risk assessment and clinical decision-making.

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