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Original Article

Neutrophil-to-Lymphocyte Ratio and Major Adverse Cardiac Events in Patients With ST-Elevation Myocardial Infarction Undergoing Primary PCI in Vietnam

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ABSTRACT

Background: ST-elevation myocardial infarction (STEMI) is an acute cardiovascular condition associated with a high mortality rate. Primary percutaneous coronary intervention (pPCI) is the recommended treatment for STEMI. Nonetheless, complications may arise during and after the procedure. The present study evaluated the relationship between the neutrophil-to-lymphocyte ratio (NLR) and major adverse cardiac events occurring within 12 months following pPCI.

Methods: The current retrospective cohort study involved 148 STEMI patients who met the inclusion criteria and underwent pPCI at the Cardiovascular Center of Hue University of Medicine and Pharmacy Hospital. The patients were monitored for 12 months post-intervention.

Results: The rates of cardiovascular mortality, nonfatal MI, nonfatal cerebrovascular stroke, and in-stent restenosis increased as NLR rose. Logistic regression analysis indicated that NLR was an independent predictive factor (OR, 2.015, 95% CI, 1.718 to 2.984; $P = 0.007$).

Conclusions: NLR is an independent predictor of cardiovascular complications in patients with STEMI following pPCI. This straightforward, cost-effective, and highly accurate tool can be readily implemented in medical centers, enabling physicians to assess risks and develop appropriate preventive strategies for patients with STEMI after pPCI. ***(Iranian Heart Journal 2025; 26(3): 15-26)***

KEYWORDS: Neutrophil-to-lymphocyte ratio, Major adverse cardiac events, ST-elevation myocardial infarction, Percutaneous coronary intervention

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Myocardial infarction (MI) is a cardiovascular emergency associated with a high mortality rate globally. ST-elevation myocardial infarction (STEMI) carries a severe prognosis and significant mortality risk; nevertheless, immediate intervention can improve outcomes.[1, 2] Percutaneous

coronary intervention (PCI) is widely utilized in the treatment of coronary artery diseases, particularly STEMI, due to its advantages for patients. The American Heart Association (AHA) and the European Society of Cardiology (ESC) have also endorsed this approach for treating individuals with STEMI. [1, 2]

Numerous studies have demonstrated that inflammation plays a significant role in the pathogenesis of coronary artery disease. Therefore, several investigations have assessed changes in inflammatory markers, such as white blood cells and high-sensitivity C-reactive protein (hs-CRP), along with their association with treatment outcomes in patients with cardiovascular disease. Recently, multiple studies have indicated that the neutrophil-to-lymphocyte ratio (NLR) serves as a reliable predictor of hospital mortality risk in patients with STEMI following primary percutaneous coronary intervention (pPCI). In Vietnam, there is currently no research examining the application of NLR in the long-term prognosis of coronary revascularization for patients with STEMI after pPCI.

The primary objective of this study was to identify the clinical and paraclinical characteristics of STEMI patients at the time of hospital admission who underwent pPCI. Additionally, we aimed to analyze the relationship between NLR and major adverse cardiovascular events (MACE) in patients with STEMI following pPCI.

METHODS

Inclusion Criteria

All patients admitted to the hospital were diagnosed with STEMI and underwent pPCI. Coronary artery stents were placed at the Cardiovascular Center of the Hue University of Medicine and Pharmacy Hospital between January 1, 2015, and September 30, 2016.

Exclusion criteria

Patients with acute infectious diseases, malignant conditions, end-stage renal failure, or end-stage liver failure were excluded. In addition, patients with a history of MI, coronary artery stent placement, or coronary artery bypass grafting, as well as those with acute or chronic infectious diseases, hematological disorders, a history of permanent pacemaker implantation, or those requiring anticoagulants, were also excluded. STEMI patients diagnosed and treated during hospitalization and those lacking appropriate clinical and paraclinical results were not included in the study.

Data were collected from January 1, 2016, through October 30, 2017.

Study Design

The present cross-sectional descriptive study conducted a longitudinal follow-up of patients for 1 year after hospital discharge.

Sample Size and Sample Selection

Of the 156 patients who met the criteria, 6 patients or their family members declined to participate in the study, and 2 patients died in traffic accidents during the follow-up period. Consequently, 148 patients were included in this study.

The Characteristics of STEMI Patients Undergoing pPCI

The study evaluated patient characteristics, including sex, age, and medical history, specifically hypertension, diabetes, dyslipidemia, chronic obstructive pulmonary disease, heart failure, peripheral artery disease, stroke, and prior coronary artery digital subtraction angiography. Upon hospital admission, recorded indicators consisted of arterial blood pressure, heart rate, Killip classification, door-to-balloon time, and hospitalization duration. Paraclinical test results encompassed complete blood count, serum glucose, lipid

profile (total cholesterol, HDL-cholesterol, LDL-cholesterol, and triglycerides), serum creatinine, hs-CRP, creatine kinase-MB (CK-MB), and high-sensitivity troponin T (hs-troponin T). Imaging findings included left ventricular systolic ejection fraction (LVEF%) assessed via transthoracic echocardiography, identification of the infarct-related coronary artery, and the number of coronary artery stenoses determined by digital subtraction angiography. Key parameters of the pPCI procedure were the total number of stents placed, stent type (drug-eluting or bare metal) in the culprit artery, stent length and diameter, and post-intervention recanalization success (thrombolysis in myocardial infarction [TIMI] flow grade). The analysis focused on relationships between clinical events and the patients' baseline clinical and paraclinical characteristics.

The Relationship Between NLR and Events Occurring in the Studied Patients

This study examined the association between NLR and adverse events occurring both during hospitalization and after discharge. The analysis assessed the relationship between NLR and in-hospital complications and events recorded at follow-up intervals of 1 month, 3 months, 6 months, and 1 year post-discharge.

Definition of Research Variables

STEMI: STEMI was defined in accordance with the 2013 American Heart Association/American College of Cardiology (AHA/ACC) guidelines. Diagnosis required the presence of typical angina pectoris accompanied by specific 12-lead ECG changes: ST-segment elevation ≥ 2 mm in men or ≥ 1.5 mm in women in leads V_2–V_3, or ST-segment elevation ≥ 1 mm in at least 2 contiguous precordial or peripheral leads.[2]

NLR: This ratio was calculated as the ratio of absolute neutrophil count (G/L) to absolute lymphocyte count (G/L) in venous blood, measured via automated laser-based hematology analysis. Based on admission NLR values, the 148 patients were stratified into 3 groups: the low NLR group (NLR < 2.3; n = 50), the medium NLR group (2.3 ≤ NLR ≤ 4.0; n = 54), and the high NLR group (NLR > 4.0; n = 44).

Digital Subtraction Coronary Angiography and pPCI: Following the 2017 ESC guidelines, pPCI was defined as PCI performed emergently without preceding thrombolytic therapy. All coronary angiography and interventional procedures were conducted in accordance with standardized protocols at the Cardiovascular Center of Hue University of Medicine and Pharmacy Hospital. The treatment approach, whether balloon angioplasty or stent implantation (utilizing either drug-eluting or bare-metal stents), was determined by the attending physician in consultation with the patient's family members, who provided final consent for the selected intervention.

MACE: The study monitored MACE, composed of cardiovascular death, nonfatal MI, nonfatal cerebrovascular accident, and restenosis of the culprit coronary artery. Event tracking began at intervention and continued through hospitalization, with follow-up assessments at 1, 3, 6, 9, and 12 months post-procedure. Each event was recorded only at its first occurrence during follow-up, with monitoring concluding either at study completion or patient death.

Cardiovascular death was defined according to established criteria [8] as mortality attributable to: sudden death, acute MI, heart failure, cerebral infarction, cerebral hemorrhage, cardiovascular procedures, or other cardiovascular causes. Nonfatal MI required recurrent chest pain and/or suggestive ECG changes accompanied by a > 20% rise in

cardiac biomarkers. [8] Cerebrovascular stroke was defined as focal neurological deficits persisting > 24 hours, [9] categorized as cerebral hemorrhage, infarction, or unspecified type. Restenosis specifically was defined as angiographically confirmed occlusion (via digital subtraction coronary angiography) in the treated coronary artery. [8]

Other Biochemical and Paraclinical Tests

All patients underwent analysis of total blood cell counts, along with biochemical and immunological tests, using venous blood samples collected immediately upon hospital admission.

Data Collection Techniques

In-hospital data encompassed patient information, clinical symptoms, and retrospective paraclinical test results obtained from the patients' medical records. Follow-up information was gathered by reviewing medical records and conducting direct interviews with patients or their family members by telephone.

Statistical Analysis

Data analysis and graphical representation were performed using R-statistics and SPSS software (version 18.0). Normality distribution was assessed using the Kolmogorov-Smirnov test for the overall sample and the low/medium NLR groups, while the Shapiro-Wilk test was applied to the high NLR group. Categorical variables across the NLR groups were compared using the chi-square test. Continuous variables were analyzed via one-way ANOVA to examine relationships between means and standard deviations among the NLR groups.

The predictive capacity of the NLR index was evaluated using receiver operating characteristic (ROC) curve analysis to determine sensitivity, specificity, and optimal cutoff values for event prediction during follow-up. Survival outcomes were assessed through Kaplan-Meier curves with log-rank testing, complemented by Cox proportional hazards regression analysis.

Variable selection for multivariate analysis employed the backward stepwise likelihood ratio method. Additionally, multivariate linear regression was performed to examine the influence of clinical and paraclinical factors on cardiovascular events, incorporating all statistically significant variables ($P < 0.05$) from univariate analysis. This approach identified independent risk factors for cardiovascular events in the study population.

Ethical Statement

The authors were responsible for all aspects of the work, ensuring that any questions regarding the accuracy or integrity of any part of the study were thoroughly investigated and resolved. This study was conducted in accordance with the Declaration of Helsinki (revised in 2013) and received approval from the Ethics Council of Biomedical Research at the University of Medicine and Pharmacy, Hue University.

RESULTS

General characteristics of the studied patients

The study population comprised an approximately equal distribution of men and women, with a mean age of 61.0 ± 12.6 years. Comorbidities were prevalent among participants, with hypertension being most common (29.1%), followed by dyslipidemia (21.0%). A history of coronary artery disease was present in 18.9% of cases. The mean door-to-balloon time was 2.57 hours. After excluding 6 cases of post-intervention mortality and 11 cases of in-hospital STEMI occurring during treatment for other conditions, the average hospitalization duration was approximately 6 days.

Coronary artery analysis revealed that 63.5% of infarctions (94/148 patients) resulted from

left anterior descending artery occlusion. Right coronary artery and left circumflex occlusions accounted for 17.6% (26 patients) and 14.2% (21 patients) of cases, respectively. Multivessel disease was present in 82 patients (55.4%), predominantly among those with diabetes, peripheral vascular disease, or smoking history.

Regarding revascularization approaches, stent implantation (primarily drug-eluting stents) constituted the most common pPCI strategy, with only 9 cases undergoing balloon angioplasty alone.

A total of 148 patients were categorized into 3 groups based on NLR: low NLR (< 2.30), medium NLR (2.3–4.0), and high NLR (> 4.0). Table 1 outlines several clinical and paraclinical factors that influence prognosis in the study subjects, highlighting sex differences across the 3 NLR groups. Specifically, the proportion of men increased with higher NLR levels, at 38.0%, 59.3%, and 75.0%, respectively ($P = 0.031$). The average age also rose with increasing NLR levels, recorded as 59.4 ± 12.1, 61.8 ± 10.5, and 62.0 ± 15.6, respectively; however, this difference was not statistically significant. Likewise, the NLR groups did not exhibit significant differences in systolic blood pressure, diastolic blood pressure, or heart rate.

The history of coronary artery disease varied between the NLR groups; the proportion of patients with a history of coronary artery disease in the high NLR group was significantly greater than that in the low NLR group ($P = 0.026$). Still, diabetes mellitus type 2 and other coronary risk factors, such as smoking, diabetes, and hypertension, did not show significant differences between the groups.

Acute inflammation plays a crucial role in the pathophysiology of STEMI. The results of white blood cell counts in complete blood counts indicated an increase in hs-CRP in most cases, with serum hs-CRP levels rising progressively with increasing NLR groups (4.77 ± 1.06, 5.83 ± 3.40, 8.21 ± 4.14, respectively; $P = 0.003$).

The neutrophil ratio increased significantly across the groups, with values of 58.7 ± 4.5, 69.4 ± 7.2, and 75.2 ± 5.0, respectively ($P = 0.008$). In contrast, the lymphocyte ratio decreased significantly, with values of 30.4 ± 3.1, 22.7 ± 4.5, and 15.3 ± 6.2 in the 3 NLR groups ($P = 0.011$). A statistically significant correlation was observed between hs-CRP and the NLR index in the study subjects ($r = 0.463$; $P = 0.004$).

In addition, hs-troponin T levels differed significantly between the NLR groups, showing a gradual increase with a higher NLR ($P = 0.042$).

The results of lipid panel tests, venous blood glucose levels, and glomerular filtration rates revealed no differences between the NLR groups (Table 1).

Transthoracic echocardiography was conducted for all patients before the intervention. LVEF exhibited considerable variability among the study subjects; nevertheless, no differences were found between the NLR groups. This finding aligns with the results reported by Han et al. [5]

No significant differences were observed in the culprit coronary arteries between the NLR groups (Table 1). Nonetheless, notable differences were found in the prevalence of multivessel coronary artery disease between the 3 groups. Specifically, in the high NLR group, 77.3% of patients had multivessel coronary artery stenosis, while the proportion of patients with multivessel coronary artery disease decreased significantly with lower NLR levels ($P = 0.043$).

Most patients opted for drug-eluting stents (126 out of 148 patients); however, no statistically significant differences were observed when comparing the NLR groups ($P = 0.096$). All patients in the low and medium NLR groups achieved successful revascularization after the intervention (TIMI flow grade III). In contrast, 2 patients (4.5%)

in the high NLR group did not achieve revascularization after the intervention (TIMI flow grade 0), and this difference was statistically significant ($P = 0.013$).

Table 1. Comparison of clinical and paraclinical characteristics, coronary artery digital subtraction angiography, and pPCI results between the 3 NLR groups

Characteristics	Low NLR < 2.3 (n=50)	Mean NLR 2.3–4.0 (n=54)	High NLR >4.0 (n=44)	*P*-value
Clinical Characteristics				
Male	19 (38.0%)	32 (59.3%)	33 (75.0%)	**0.031**
Age, y	59.4 ± 12.1	61.8 ± 10.5	62.0 ± 15.6	0.079
Number of patients with chest pain symptoms	49 (98.0%)	54 (100%)	39 (88.6%)	0.092
Number of patients in shock when admitted to the hospital	2 (4.0%)	3 (5.6%)	6 (13.6%)	0.081
Systolic blood pressure, mm Hg	124.7 ± 18.7	126.1 ± 50.6	114.5 ± 27.2	0.066
Diastolic blood pressure, mm Hg	78.0 ± 13.8	78.8 ± 12.4	74.6 ± 10.5	0.093
Heart rate, bpm	84.5 ± 10.3	77.8 ± 11.7	86.2 ± 10.1	0.081
Killip grade ≥ 3	7 (14.0%)	10 (18.5%)	12 (27.3%)	**0.046**
Characteristics of the History of Diseases				
Hypertension	13 (26.0%)	14 (25.9%)	15 (34.1%)	0.084
Diabetes	5 (10.0%)	7 (13.0%)	6 (13.6%)	0.106
Dyslipidemia	8 (16.0%)	12 (22.2%)	11 (25.0%)	0.114
Chronic obstructive pulmonary disease	2 (4.0%)	2 (3.7%)	1 (2.3%)	0.238
Heart failure	6 (12.0%)	9 (16.7%)	9 (20.5%)	0.100
Peripheral vascular disease	0 (0%)	1 (1.9%)	2 (4.5%)	0.061
Stroke	3 (6.0%)	4 (7.4%)	5 (11.4%)	0.057
Digital subtraction coronary angiography	7 (14.0%)	7 (13.0%)	13 (29.5%)	0.071
Heart failure	4 (8.0%)	5 (9.3%)	9 (20.5%)	**0.026**
Current smokers	14 (28.0%)	10 (18.5%)	9 (20.5%)	0.092
Door-to-balloon time, h	2.7 ± 1.2	2.5 ± 1.4	2.4 ± 0.9	0.120
Hospitalization, d	5.1 ± 4.3	6.1 ± 2.3	7.1 ± 3.2	**0.036**
Paraclinical Features				
Complete Blood Count				
Red blood cells, T/l	4.61 ± 1.22	4.88 ± 0.57	4.65 ± 0.86	0.251
Hemoglobin, g/L	136.4 ± 11.2	127.1 ± 9.3	130.6 ± 6.8	0.174
White blood cells, G/l	8.8 ± 2.5	10.4 ± 2.3	10.9 ± 3.1	**0.022**
Neutrophil, %	58.7 ± 4.5	69.4 ± 7.2	75.2 ± 5.0	**0.008**
Lymphocyte, %	30.4 ± 3.1	22.7 ± 4.5	15.3 ± 6.2	**0.011**
Eosinophil, %	2.5 ± 0.9	2.0 ± 1.4	2.0 ± 0.8	0.087
Monocyte, %	1.8 ± 0.9	2.7 ± 0.3	2.2 ± 0.6	0.173
Platelets, G/l	240.6 ± 28.8	244.5 ± 36.1	232.8 ± 30.7	0.305
NLR	1.9 ± 0.3	3.1 ± 0.8	4.9 ± 1.6	**<0.001**
Glucose, mmol/l	5.41 ± 1.64	5.65 ± 1.04	5.70 ± 0.92	0.080
Total cholesterol, mmol/l	5.36 ± 0.41	5.24 ± 0.62	5.47 ± 0.35	0.128
HDL-C, mmol/l	1.60 ± 0.83	1.78 ± 0.39	1.77 ± 0.40	0.303
LDL-C, mmol/l	3.65 ± 0.37	4.01 ± 0.78	4.05 ± 0.37	0.132
Triglycerides, mmol/l	1.70 ± 0.52	1.68 ± 0.87	1.80 ± 0.41	0.251
Estimated glomerular filtration rate, mL/min/1.73 m^2	105.7 ± 16.2	97.1 ± 19.4	102.6 ± 20.0	0.164
hs-CRP, mg/L	4.77 ± 1.06	5.83 ± 3.40	8.21 ± 4.14	**0.003**
CK-MB, ng/mL	548.4 ± 39.6	670.6 ± 57.8	671.2 ± 52.5	0.098
hs-troponin T, ng/mL	1.030 ± 0.442	1.186 ± 0.501	1.368 ± 0.706	**0.042**
Left ventricular ejection fraction, %	56.6 ± 17.3	58.1 ± 13.4	50.2 ± 16.0	0.067
Culprit Coronary Artery				
LAD	31 (62.0%)	40 (74.1%)	23 (52.3%)	0.225
RCA	8 (16.0%)	12 (22.2%)	6 (13.6%)	0.238

LCx	7 (14.0%)	6 (11.1%)	8 (18.2%)	0.184
Other Arteries	4 (8.0%)	1 (1.9%)	2 (4.5%)	0.185
Multivessel coronary artery disease (≥ 2 branches)	20 (40.0%)	28 (51.9%)	34 (77.3%)	**0.043**
Stent in the Culprit Coronary Artery				
Drug-eluting stents	43 (86.0%)	47 (87.0%)	36 (81.8%)	0.096
Bare metal stents	7 (14.0%)	7 (13.0%)	8 (18.2%)	0.064
Revascularization after intervention (TIMI flow grade III)	50 (100%)	54 (100%)	42 (95.5%)	**0.013**

NLR: neutrophil-to-lymphocyte ratio, HDL: high-density lipoprotein, LDL: low-density lipoprotein, hs-CRP: high-sensitivity C-reactive protein, CK-MB: creatine kinase-MB, LAD: left anterior descending coronary artery, RCA: right coronary artery, LCx: left circumflex

Data were presented as $\bar{X}$ or median ± standard deviation for normally distributed variables and proportion (%) for categorical variables.

As illustrated in Figure 1, in-hospital outcomes included 2 deaths, 1 recurrent MI, and 1 cerebrovascular stroke, with no instances of in-stent restenosis in the culprit artery. During follow-up monitoring, we observed a progressive increase in intervention-site restenosis, particularly between 6 and 12 months post-procedure (from 9 to 21 cases). The incidence of recurrent MI similarly demonstrated a marked increase during the final follow-up months, totaling 17 nonfatal cases over 12 months.

Nonfatal cerebrovascular strokes occurred in 9 patients (6.1%) during follow-up. This finding is concordant with a study by Guptill et al., [9] who reported a 6.28% (337/5372 cases) incidence rate of cerebrovascular stroke in a 9-month post-pPCI study population.

The hospital mortality rate was 1.4% (2 out of 148 cases), with the number of deaths gradually increasing over the following months. After 12 months of follow-up, 9 deaths (6.1%) were recorded. These rates were significantly lower than those reported by Han et al., [5] who noted an in-hospital mortality rate of 6.7% and a 12-month follow-up mortality rate of up to 10.4%.

During the follow-up period, 4 out of 148 patients (2.7%) experienced cardiovascular events, and during the 12 months following discharge, an additional 37 out of 144 patients (25.7%) continued to experience cardiovascular events. This result was considerably lower than that reported by Pan et al. [10] in a study of 636 Chinese STEMI patients, which indicated an in-hospital event rate of 21.4%.

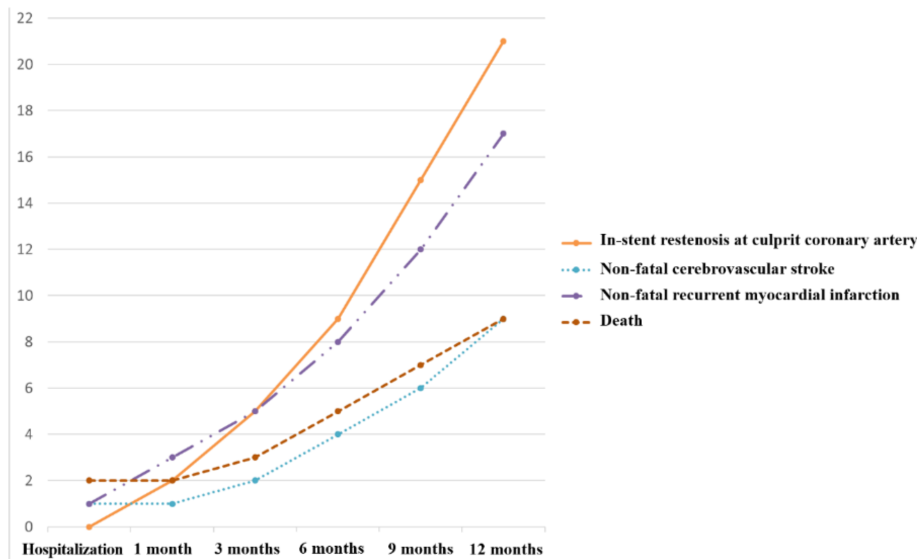

Figure 1. The image showcases cumulative cardiovascular events during the follow-up period.

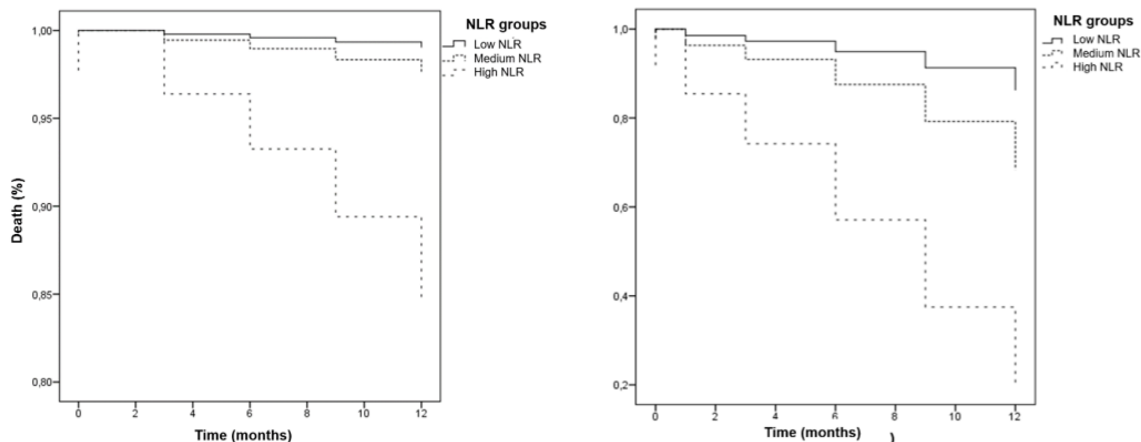

Figure 2. The images display Kaplan-Meier survival curves categorized by NLR groups. A total of 148 patients were divided into 3 NLR groups: low NLR (50 patients), medium NLR (54 patients), and high NLR (44 patients). The mortality rate increased with higher NLR levels (P = 0.012). The incidence of complications rose significantly with increasing NLR (P < 0.001).
NLR: neutrophil-to-lymphocyte ratio

The relationship between the occurrence of cardiovascular events and clinical and paraclinical characteristics of the study population

Univariate analysis identified 10 clinical and paraclinical factors significantly associated with cardiovascular events (Table 2): age, sex, Killip class ≥ 3, prior coronary artery disease, admission NLR, admission hs-CRP, admission serum glucose, CK-MB levels, hs-troponin T levels, and multivessel coronary artery disease.

Multivariate regression analysis revealed 5 independent predictors of cardiovascular events within 1 year post-pPCI (Table 2): (1) Killip class ≥3 at admission conferred a 1.411-fold increased risk (P = 0.041; 95% CI, 1.081 to 4.023); (2) each 1-unit increase in NLR was associated with a 2.015-fold higher risk (P = 0.007; 95% CI, 1.718 to 2.984); (3)

each 1 mg/dL hs-CRP increase corresponded to a 1.152-fold elevated risk (P = 0.041; 95% CI, 1.027 to 2.058); (4) each 1 ng/mL hs-troponin T increase predicted an 18.767-fold greater risk; and (5) multivessel disease (≥ 2 stenoses) showed a 2.206-fold higher risk than single-vessel disease.

The relationship between NLR and MACE

The analysis revealed 2 in-hospital deaths and 1 recurrent MI among all cases having undergone intervention, and all 3 events occurred exclusively in the high-NLR group. No instances of culprit artery restenosis were observed during the hospitalization period.
Twelve-month follow-up data demonstrated significant NLR-stratified differences in cardiovascular event rates (all Ps < 0.05). A graded rise was observed in adverse outcomes with higher NLR levels for cardiovascular mortality (P = 0.004), nonfatal recurrent MI (P < 0.001), nonfatal MI (P = 0.002), and culprit artery in-stent restenosis (P = 0.001).
Kaplan-Meier survival analysis confirmed this dose-response relationship, showing progressively worse 1-year outcomes (higher mortality and complication rates) with increasing baseline NLR values (Table 3).
Cox regression analysis, along with Figure 2, indicated that the mortality rate during the follow-up period differed significantly between the 3 NLR groups (P = 0.012). Similarly, the rate of complications during the follow-up period was statistically significant across the different NLR groups (P < 0.001). With a 95% confidence interval (Figure 3), the results suggested that patients with an NLR greater than 4.0 exhibited a sensitivity of 78% and a specificity of 80% in predicting the risk of cardiovascular events.

Table 2. The relationship between the prevalence of cardiovascular events and clinical and paraclinical characteristics of patients in univariate and multivariate analyses

Characteristics	Univariate	Multivariable		
	P-value	OR	95% CI	*P*-value
Age	**0.041**	1.218	1.065 - 1.727	0.265
Sex	**0.035**	1.024	0.870 - 1.337	0.192
Killip class ≥ III	**0.017**	1.411	1.081 - 4.023	**0.041**
History of hypertension	0.176			
History of diabetes mellitus	0.084			
History of coronary artery disease	**0.041**	3.027	1.261 - 3.952	0.079
Current smoker	0.062			
Diabetes mellitus type 2	0.105			
Neutrophil-to-lymphocyte ratio	**0.016**	2.015	1.718 - 2.984	**0.007**
High-sensitivity C-reactive protein	**0.011**	1.152	1.027 - 2.058	**0.041**
Glucose	**0.035**	1.024	0.826 - 1.714	0.488
Estimated glomerular filtration rate	0.157			
Low-density lipoprotein-cholesterol	0.106			
Cholesterol TP	0.231			
Left ventricular ejection fraction, %	0.845			
Creatine kinase-MB	**0.047**	1.010	0.963 - 1.730	0.117
High-sensitivity troponin T	**0.026**	18.767	8.358 - 33.006	**0.037**
Culprit coronary artery	0.068			
Multivessel coronary artery disease	**0.049**	2.206	1.780 - 3.136	**0.021**
Type of stent in the culprit coronary artery	0.072			

Table 3. The relationship between NLR and cardiovascular events during hospitalisation and the follow-up period

	Low NLR <2.3 (n=50)	Medium NLR: 2.3 – 4.0 (n=54)	High NLR >4.0 (n=44)	*P*-value
Cardiovascular Events During Hospitalisation, n (%)				
Cardiovascular death	0 (0.0)	0 (0.0)	2 (4.5)	0.081
Nonfatal recurrent myocardial infarction	0 (0.0)	0 (0.0)	1 (2.3)	0.417
Nonfatal cerebrovascular stroke	0 (0.0)	1 (1.9)	0 (0.0)	0.526
In-stent restenosis at the culprit coronary artery	0 (0.0)	0 (0.0)	0 (0.0)	1.000
Cardiovascular Events During a 12-Month Period After Discharge, n (%)				
Cardiovascular death	1 (2.0)	2 (3.7)	4 (9.1)	0.004*
Nonfatal recurrent myocardial infarction	2 (4.0)	5 (9.3)	9 (20.5)	<0.001*
Nonfatal cerebrovascular stroke	1 (2.0)	2 (3.7)	5 (11.4)	0.002*
In-stent restenosis at the culprit coronary artery	3 (6.0)	7 (13.0)	11 (25.0)	<0.001*
Events During the Entire Follow-Up Period, n (%)				
Cardiovascular death	1 (2.0)	2 (3.7)	6 (13.6)	<0.001*
Nonfatal recurrent myocardial infarction	2 (4.0)	5 (9.3)	10 (22.7)	<0.001*
Nonfatal cerebrovascular stroke	1 (2.0)	3 (5.6)	5 (11.4)	0.004*
In-stent restenosis at the culprit coronary artery	3 (6.0)	7 (13.0)	11 (25.0)	<0.001*

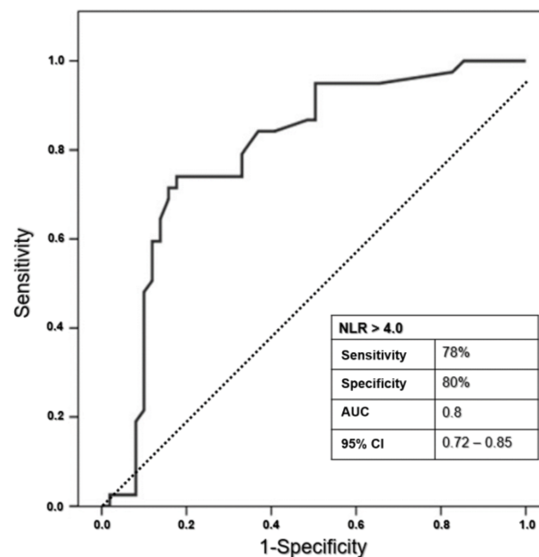

Figure 3. The image depicts the ROC curve of the sensitivity and specificity of NLR in predicting the risk of cardiovascular events.

ROC: receiver operating characteristic, NLR: neutrophil-to-lymphocyte ratio, AUC: area under the curve

DISCUSSION

Our study's findings reveal the following: (1) NLR serves as an independent prognostic factor for long-term mortality risk in STEMI patients following pPCI; (2) NLR acts as an independent prognostic factor for the prevalence of cardiovascular events during hospitalization; and (3) NLR functions as an independent prognostic factor for the prevalence of long-term cardiovascular events. Inflammation contributes to the development, progression, and destabilization of

atherosclerotic plaques. Consequently, inflammatory markers have been extensively studied for predicting cardiovascular disease risk. Numerous studies have demonstrated that serum hs-CRP levels are also prognostic factors for coronary artery disease risk. [3, 4]

Notably, NLR, which has demonstrated prognostic value in various diseases, has garnered substantial interest in cardiology. [11, 12] NLR reflects the differential blood levels of neutrophils and lymphocytes. In comparison with other inflammatory marker tests, NLR offers economic advantages, simplicity, rapid results, and widespread availability in most medical facilities. NLR has also been shown to hold significance in the diagnosis and prognosis of acute coronary syndromes, [11] angina, [13] severity of coronary artery disease, [14, 15] risk assessment for acute decompensated heart failure, [16] and other cardiovascular diseases. [17, 18]

Currently, only a limited number of studies have investigated the association between NLR and mortality prognosis, as well as the risk of long-term cardiovascular events in cardiovascular diseases worldwide. In our study, by monitoring MACE 1 year post-discharge, we established NLR as an independent predictor of the prevalence of cardiovascular events. We also demonstrated that Killip class, hs-CRP, hs-troponin T, and multivessel coronary artery disease were prognostic factors for future cardiovascular events.

CONCLUSIONS

The results of the present study's multivariate regression analysis revealed that 5 factors were statistically significantly associated with the risk of cardiovascular events during the follow-up period. STEMI patients with Killip class ≥ 3 at admission had a 1.411-fold higher risk of cardiovascular events within 1 year following pPCI than those with Killip class < 3 ($P = 0.041$; 95% CI, 1.081 to 4.023). Each additional unit of NLR was associated with a 2.015-fold increased risk of cardiovascular events within 1 year post-pPCI ($P = 0.007$; 95% CI, 1.718 to 2.984). For every 1 mg/dL increase in hs-CRP, patients were 1.152 times more likely to experience a cardiovascular event within 1 year post-pPCI (P = 0.041; 95% CI, 1.027 to 2.058). Each ng/mL increase in hs-troponin T resulted in an 18.767-fold higher risk of cardiovascular events within 1 year after pPCI. Patients with ≥ 2 coronary artery stenoses had a 2.206-fold increased risk of cardiovascular events 1 year post-pPCI compared to patients with 1 coronary artery stenosis.

The results established NLR as an independent prognostic factor for the risk of long-term mortality and cardiovascular events occurring during hospitalization and in the long term. With a 95% confidence interval, an NLR of greater than 4.0 was identified as a prognostic factor with 78% sensitivity and 80% specificity for the risk of long-term cardiovascular events.

Conflict of Interest

The authors declare no conflicts of interest.

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