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Neutrophil to lymphocyte ratio predicts short- and long-term mortality following revascularization therapy for ST elevation myocardial infarction

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Abstract

Background: *Several inflammation biomarkers have been implicated in the pathogenesis and prognosis of acute coronary syndromes. However, the prognostic role of the neutrophil--lymphocyte white cell interactive response to myocardial injury in predicting short- and long--term mortality after ST elevation myocardial infarction (STEMI) remains poorly defined.*

Methods: *We evaluated 250 consecutive STEMI patients presenting acutely for revascularization to our tertiary care center over 1 year. Patients with acute sepsis, trauma, recent surgery, autoimmune diseases, or underlying malignancy were excluded. Data gathered included demographics, clinical presentation, leukocyte markers, electrocardiograms, evaluations, therapy, major adverse cardiac events, and all-cause mortality.*

Results: *Mean age was 62 ± 15 years, 70.4% of subjects were males while majority (49.4%) were Caucasians. Mean duration of follow-up was 571 ± 291 days (median 730 days). Univariate analysis of several inflammatory biomarkers including C-reactive protein, revealed white cell count (OR = 1.09, p < 0.001) and neutrophil to lymphocyte ratio (NLR) (OR = 1.05, p = 0.011) as predictors of short- and long-term mortality; but not mean neutrophil count (OR = 1.04, p = 0.055) or lymphocyte count alone (OR = 0.96, p = 0.551). Multivariate analysis using backward stepwise regression revealed NLR (OR = 2.64, p = 0.026), female gender (OR = 5.35, p < 0.001), cerebrovascular accident history (OR = 3.36, p = 0.023), low glomerular filtration rate (OR = 0.98, p = 0.012) and cardiac arrest on admission (OR = 17.43, p < 0.001) as robust independent predictors of long-term mortality. NLR was divided into two sub-groups based on an optimal cut off value of 7.4. This provided the best discriminatory cut off point for predicting adverse mortality outcome. Both short-term (≤ 30 days) and long-term (≤ 2 years) mortality were predicted with Kaplan-Meier survival curve separation best stratified by a NLR cut off value of 7.4.*

Conclusions: *NLR based on an optimal cut off value of 7.4, was an excellent predictor of short- and long-term survival in patients with revascularized STEMI and warrants larger scale multi-center prospective evaluation, as a prognostic indicator. NLR offers improved prognostic capacity when combined with conventional clinical scoring systems, such as the Thrombolysis In Myocardial Infarction risk score.* (Cardiol J 2014; 21, 5: 500–508)

Key words: neutrophil to lymphocyte ratio, ST elevation myocardial infarction, Thrombolysis In Myocardial Infarction risk score, predictors of mortality, percutaneous coronary revascularization

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Introduction

Several researchers have shown an association between various biomarkers of inflammation and pathophysiology of acute coronary syndromes (ACS) [1, 2]. Recently, multiple studies have shown that inflammatory biomarkers, e.g. white cell count and neutrophil to lymphocyte ratio (NLR), may have prognostic value in stable coronary artery disease (CAD), as well as in ACS [3, 4]. NLR is a surrogate marker for the combined effects of the innate immune response (substantially mediated by neutrophils), and the subsequent adaptive immune response (substantially mediated by lymphocytes). NLR may also reflect the myocardial remodeling responses after reperfusion injury [5–7]. Nevertheless, the role of NLR in predicting short- and long-term mortality after ST-segment elevation myocardial infarction (STEMI), treated with primary percutaneous coronary intervention (PCI) in the drug eluting stent era remains undefined. Our study aimed to determine if NLR as an all-cause mortality outcome predictor, could be utilized alone, and in combination with current standardized cardiac risk score models, to improve the prediction of subsequent short- and long-term all-cause mortality.

Methods

Two hundred and seventy-eight consecutive patients presenting from January 2007 to January 2008 with a diagnosis of STEMI based on electrocardiographic (ECG) criteria were studied and followed until December 2010. Data prospectively collected in an ACS outcomes database were then retrospectively analyzed. Myocardial infarction (MI) was diagnosed by symptoms of ischemia and elevation in cardiac biomarkers, as defined by the Joint European Society of Cardiology and the American College of Cardiology [8, 9]. STEMI was defined as ST segment elevations measuring 0.2 mV in leads V1 to V3 or 0.1 mV in all other leads with the above-mentioned changes present in at least two contiguous leads. Twelve lead ECGs were obtained at 25 mm/s paper speed, and 10 mV gain. Analysis of the first presenting ECG included: heart rate (HR), PR interval, QRS duration, corrected QT interval, QRS axis and T-wave axis.

Exclusion criteria

Out of the cohort of 278 patients, 11 patients were excluded due to presence of left bundle branch block or atrial fibrillation on the presenting ECG. Five patients had a diagnosis of cancer; 4 patients had underlying sepsis on presentation while 2 patients had recently undergone cardiac surgery. In 6 patients a complete blood count was not available leaving 250 patients for analysis.

Data collected

At presentation 12 lead ECG, complete blood count, metabolic panel, radiographic investigations, and echocardiographic data were obtained. All patients underwent emergent coronary angiography, and based on angiographic and clinical findings were treated with percutaneous coronary revascularization or urgent coronary artery bypass grafting according to contemporaneous guidelines. Patients underwent concurrent anticoagulant therapy for PCI with unfractionated heparin/low molecular weight heparin and peri-procedural intravenous glycoprotein IIb/IIIa inhibitors, or bivalirudin (majority of cases). After coronary stent placement, patients received adjunctive dual antiplatelet therapy with aspirin and a thienopyridine antagonist (mostly clopidogrel). Clinical information abstracted included systemic hypertension, diabetes mellitus (DM), body mass index (BMI), prior MI, prior congestive heart failure (CHF), prior coronary revascularization, smoking status and relevant family history. Thrombolysis In Myocardial Infarction (TIMI) study group definitions for current smoking and family history were utilized [10]. Congestive heart failure was defined as ejection fraction (EF) less than 35%, elevated B-type natriuretic peptide (BNP) and/or evidence of fluid overload on chest radiograph. TIMI grade flow was measured as 0 = no perfusion, 1 = penetration without perfusion, 2 = partial reperfusion and 3 = complete reperfusion [11].

Blood sampling

Blood sampling was performed within 24 h of STEMI presentation. A complete blood count with 6-part differential was obtained with an automated Sysmex XE 5000 Hematology System (Sysmex America Inc., Mundelein, IL, USA). Cardiac biomarkers including BNP and troponin I levels using an Advia Centaur XP Immunoassay (Siemens AG, Erlangen, Germany). Renal function, electrolytes and fasting lipid panel were measured using Advia 1800 Clinical Chemistry systems (Siemens AG, Erlangen, Germany).

Outcome analysis

The primary endpoint used for the analysis was all cause mortality at the end of 2 years. Ma-

jor adverse cardiovascular events (MACE) data including cardiovascular death, CHF, recurrent MI, and cardiac arrest were assessed at 30 days, 6 months and 2 years. Mortality data during the index admission were obtained from hospital records. Subsequent 6 months and 2-year mortality data were obtained either from our hospital, or California Department of Public Health and Social Security Death Index records. Thrombolysis In Myocardial Infarction (TIMI-STEMI), Mayo Clinic Risk Score (MCRS) Global Registry of Acute Coronary Events (GRACE) scores were also calculated for all subjects [10, 12, 13].

This study was approved by the institutional review board of Community Regional Medical Centers.

Statistical analysis

Statistical analysis was performed using SPSS Software (PASW for Windows, Rel. 18.0.0. 2009; SPSS Inc., Chicago, IL, USA). Continuous variables were summarized as mean ± standard deviation (SD) and comparisons between continuous variables utilized the Student's t-test. Categorical variables were summarized as percentages of the group total and comparisons between groups were analyzed using either Fisher exact test or χ^2 where appropriate. NLR was utilized as both a continuous and categorical variable, based on relative risk of mortality. Assessment of the bivariate relationship between mortality and each risk factor was performed using data from 250 patients. Variables identified as significant (p value < 0.1) during univariate analysis were then fitted in a logistic regression model by a backward elimination method. This adjusted for confounders and enabled determination of variables of interest associated with increased risk of mortality or major cardiovascular adverse outcomes. Differences in survival curves obtained using Kaplan-Meier analysis were compared using the log-rank test. Receiver operating curves (ROC) were constructed to obtain area under the curve (AUC), and to predict cut off values of NLR that could be used to predict mortality. Statistical significance was accepted at p value < 0.05.

Results

Patient demographics, relevant medical history, medications, laboratory findings, ECG data and treatments received are summarized in Table 1. Mean age was 62 ± 15 years, 70.4% of subjects were males while majority (49.4%) were Caucasians. Mean duration of follow-up was 571 ± 291 days (median 730 days) and mean NLR was 6.60 ± 7.8. Age ($r = 0.198$, $n = 250$, $p = 0.002$) and BNP level ($r = 0.208$, $n = 127$, $p = 0.019$) were positively correlated with NLR. Patients with higher NLR were more likely to be: older ($p = 0.002$), have CHF on presentation ($p = 0.003$); have elevated white cell count ($p < 0.001$); prolonged QRS duration ($p = 0.040$) and less likely to undergo PCI ($p < 0.001$). Standardized risk assessment scores like (TIMI-STEMI, MCRS and GRACE) were correspondingly elevated in patients with higher NLR values.

Predictive value of NLR

NLR was divided into two sub-groups based on optimal cut off value of 7.4, which provided the highest predictive power for mortality. NLR values of ≥ 7.4 demonstrated a sensitivity of 47.5% (95% CI 34.3–60.9%), specificity of 81.2% (95% CI 74.9–86.4%), and positive likelihood ratio of 2.52 (95% CI 1.69–3.75) for mortality. ROC curves were constructed to assess the predictive value of NLR. To predict long-term mortality using NLR prediction ROC was performed to obtain AUC with C-statistic of 0.73. In order to improve the predictive power of NLR in point of care scenarios, the NLR was combined with standardized 'TIMI risk score for STEMI' variables. The predictive power was significantly improved when NLR was added to TIMI score clinical variables by assigning one point for NLR ≥ 7.4. Using this approach, the ROC AUC mortality prediction improved significantly to a C-statistic of 0.80, $p < 0.001$ (Fig. 1).

Outcomes

Mortality outcomes stratified by NLR cut off value of 7.4, at 3 time intervals (in-hospital and up to 30 days post STEMI, 30 days to 6 months, 6 months to ≤ 2 years) are shown in Figure 2. Compared to NLR < 7.4, patients with NLR ≥ 7.4 had significantly higher mortality at all 3 follow--up time points: immediate hospitalization period, short-term and long-term. In the first 30 days after hospitalization, a total number of 41 deaths were observed, while a total number of 59 deaths were observed at the end of 2 years. The prediction of mortality at these 3 time points is of considerable clinical significance, due to the varying spectrum of modifiable risk factors at differing post STEMI time points. Table 2 outlines the MACE endpoints measured during index hospitalization and up to 2 years of follow-up. The achievement of post--procedural TIMI grade 3 flow after PCI, did not differ significantly between patients with NLR

Table 1. Patient characteristics including demographics, medical history, medications, laboratory/electrocardiography variables, anticoagulant therapy, reperfusion modality, and clinical risk scores stratified by neutrophil to lymphocyte ratio cut off value of 7.4.

	All (n = 250)	NLR < 7.4 × 10^9/L (n = 186)	NLR ≥ 7.4 × 10^9/L (n = 64)	P
Demographics				
Age	62 ± 15	60 ± 14	67 ± 15	**0.002**
Gender (male)	176 (70.4%)	132 (71%)	44 (68.8%)	0.737
Race (Caucasian)	123 (49.4%)	88 (47.6%)	35 (54.7%)	0.368
Medical history				
Smoking	114 (45.6%)	82 (44.1%)	32 (50%)	0.413
Diabetes	68 (27.4%)	52 (28.3%)	15 (25%)	0.614
Hypertension	179 (71.9%)	130 (70.3%)	49 (76.6%)	0.334
Congestive heart failure	70 (28%)	43 (23.1%)	27 (42.2%)	**0.003**
Atrial fibrillation	47 (18.9%)	34 (18.4%)	13 (20.3%)	0.733
Renal disease	26 (10.4%)	17 (9.1%)	9 (14.1%)	0.266
Medications				
Aspirin use	83 (33.6%)	61 (33.2%)	22 (34.9%)	0.798
Beta-blocker use	79 (32.1%)	62 (33.9%)	17 (27%)	0.312
Statin use	83 (33.6%)	61 (33.2%)	22 (34.9%)	0.798
Angiotensin converting enzyme inhibitor use	92 (37.2%)	69 (37.5%)	23 (36.5%)	0.888
Presenting laboratory findings				
Troponin on admission	29.59 ± 122	19.27 ± 76.39	57.69 ± 201.22	0.148
B-type natriuretic peptide	946 ± 1314	862 ± 1336	1130 ± 1263	0.288
White cell count	11.9 ± 6.1	11.08 ± 5.45	14.68 ± 7.48	**< 0.001**
Neutrophil count	8.7 ± 6.65	7.43 ± 6.30	12.41 ± 6.28	**< 0.001**
Lymphocyte count	2.26 ± 2.29	2.69 ± 2.49	0.98 ± 0.52	**< 0.001**
Hematocrit	40.8 ± 6.4	41.84 ± 5.60	37.84 ± 7.84	**0.001**
Electrocardiogram changes				
Heart rate	83.66 ± 26.47	82.04 ± 24.4	88.78 ± 31.77	0.080
QRS duration	96.63 ± 24.67	94.53 ± 22.61	102.83 ± 29.74	**0.044**
Corrected QT interval	426 ± 39.67	425.4 ± 38.86	427.9 ± 43.14	0.666
ST segment resolution	168 (67.5%)	131 (70.8%)	37 (57.8%)	0.056
Treatment				
Heparin (unfractionated)	60 (24.2%)	43 (23.4%)	17 (26.6%)	0.607
Low molecular weight heparin	40 (16.1%)	31 (16.8%)	9 (14.1%)	0.602
Percutaneous coronary intervention	157 (63.1%)	128 (69.2%)	29 (45.3%)	**0.001**
Coronary artery bypass grafting	34 (13.7%)	26 (14%)	8 (12.7%)	0.798
Risk scores for mortality				
TIMI-STEMI	4.55 ± 2.87	4.16 ± 2.79	5.7 ± 2.75	**< 0.001**
Mayo Clinic Risk Score	8.25 ± 7.45	7.28 ± 6.42	11.38 ± 9.38	**< 0.001**
Global Registry of Acute Coronary Events©	125.8 ± 45.66	117.27 ± 42.68	150.78 ± 45.09	**< 0.001**

TIMI-STEMI — Thrombolysis in Myocardial Infarction-ST elevation myocardial infarction

< 7.4, as compared to patients with NLR ≥ 7.4. NLR was also not significantly different between patients who achieved TIMI 0 flow compared to TIMI grade 2 or 3 flow after PCI.

Regression analysis

Using all-cause mortality as the primary outcome, univariate analysis was performed to determine which variables predicted mortality. Female gender, Hispanic race, age, BMI, smoking status, CHF history, cerebrovascular accident history, Killip CHF class on admission, high white cell count, low hemoglobin, elevated BNP, low glomerular filtration rate (GFR) and cardiac arrest on presentation were all associated with elevated mortality risk (Table 3). When these variables were included in a multivariate model using backward stepwise regression, NLR (OR = 2.64, p = 0.026), female gender (OR = 5.35,

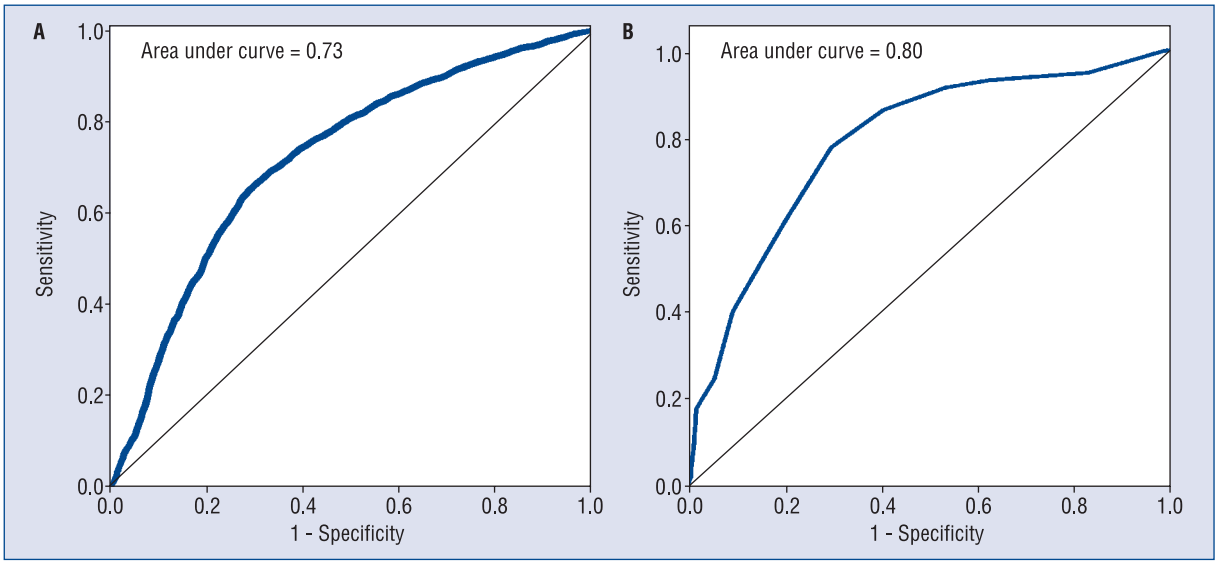

Figure 1. A. Receiver operating characteristic (ROC), area under the curve (AUC) analysis of neutrophil to lymphocyte ratio (NLR) alone in prediction of post-ST elevation myocardial infarction (STEMI) revascularization mortality; **B.** Significant improvement in predictive power of Thrombolysis in Myocardial Infarction-STEMI risk score variables by addition of NLR variable: c-statistic AUC improvement from 0.73 to 0.80 ($p < 0.001$).

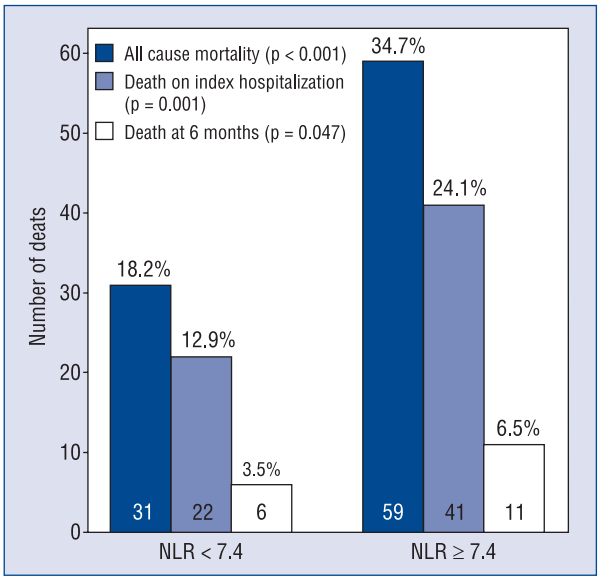

Figure 2. Stratification of all-cause mortality based on neutrophil to lymphocyte ratio (NLR) cut off value of 7.4 into 3 time periods: in-hospital and up to 30 days, 30 days to 6 months, and 6 months to ≤ 2 years mortality rates.

$p < 0.001$), cerebrovascular accident history (OR = 3.36, $p = 0.023$), low GFR (OR = 0.98, $p = 0.012$), and cardiac arrest on admission (OR = 17.43, $p < 0.001$) remained as independent predictors of long-term mortality as illustrated by the Forest plot (Fig. 3).

Table 2. Major adverse cardiac event (MACE) end point frequencies up to 2-year follow-up.

MACE endpoints at 2 years	All patients
Recurrent myocardial infarction	28 (11.2%)
Cardiac death	34 (13.6%)
Congestive heart failure	87 (34.8%)
Cerebrovascular accident	6 (2.4%)
Repeat coronary artery bypass graft	4 (1.6%)
Repeat percutaneous coronary intervention	5 (2%)

Survival analysis

Kaplan-Meier survival analysis was performed to measure all-cause mortality and survival free from systolic heart failure, stratified by NLR. Patients with NLR < 7.4 had higher survival compared to patients whose NLR was ≥ 7.4 during short-term follow-up of 30 days (Fig. 4A) and long-term follow-up of 2 years (Fig. 4B). NLR was also found to be a strong predictor of survival free from systolic heart failure (EF < 35%) as shown in Figure 4C.

Discussion

This study has demonstrated that in patients presenting for primary PCI revascularization with STEMI, an elevated NLR (based on an optimum

Table 3. Univariate predictors of long-term mortality following revascularized ST elevation myocardial infarction.

Variable	Mortality in 1 year (n = 59/250)	
	95% confidence interval	P
Gender: male = reference	3.95 (2.15–7.25)	**< 0.001**
Race: Caucasian = reference	3.6 (1.32–9.8)	**0.012**
Age	1.06 (1.04–1.08)	**< 0.001**
Body mass index	0.90 (0.85–0.95)	**< 0.001**
Diabetes type 2	1.30 (0.69–2.44)	0.416
Smoker	2.87 (1.52–5.42)	**0.001**
Hypertension	1.32 (0.67–2.59)	0.442
Hyperlipidemia	1.45 (0.81–2.60)	0.213
Congestive heart failure	3.43 (1.86–6.31)	**< 0.001**
Atrial fibrillation	1.17 (0.57–2.44)	0.667
Previous myocardial infarction	1.32 (0.72–2.41)	0.369
Cerebrovascular accident	4.10 (1.86–9.0)	**< 0.001**
Killip (Class 1 = reference)	7.46 (2.85–19.52)	**< 0.001**
Troponin at admit	1.00 (0.99–1.00)	0.644
White cell count	1.09 (1.04–1.1)	**< 0.001**
Neutrophil count	1.04 (0.99–1.09)	0.055
Lymphocyte count	0.96 (0.83–1.10)	0.551
Neutrophil to lymphocyte ratio	1.05 (1.01–1.08)	**0.011**
Anemia (hematocrit < 36)	5.61 (2.34–13.43)	**< 0.001**
Glomerular filtration rate	0.98 (0.97–0.99)	**< 0.001**
B-type natriuretic peptide	1.01 (1.00–1.01)	**0.003**
Left ventricular hypertrophy	1.19 (0.57–2.50)	0.646
Heart rate	1.09 (0.99–1.02)	0.086
PR interval	1.00 (0.96–1.00)	0.939
QRS duration	1.01 (0.99–1.02)	0.081
Corrected QT Interval	1.00 (0.996–1.01)	0.392
T wave changes	2.81 (1.20–6.56)	**0.017**
ST segment elevation	0.64 (0.35–1.16)	0.139
Cardiac arrest on admit	14.83 (7.30–30.12)	**< 0.001**
TIMI grade 3 flow after PCI	1.17 (0.59–2.32)	0.645
MVD (≥ 2 vessel involved)	2.94 (1.23–7.03)	**0.015**

PCI — percutaneous coronary intervention; TIMI — Thrombolysis in Myocardial Infarction MVD — multivessel disease

derived cut off value > 7.4) is independently associated with higher all-cause mortality and higher MACE rates at both short-term (≤ 30 days), and long-term (≤ 2 years) follow-up. Rapid separation of Kaplan-Meier survival curves was observed within 1-week post-STEMI PCI. An elevated NLR reflects both neutrophilia and relative lymphopenia. Several studies have examined the role of neutrophils and lymphocytes in modulating the inflammatory response to myocardial injury [14–16]. Neutrophils are speculated to mediate increased plaque rupture and thrombosis by secreting proteolytic enzymes causing vascular damage, activation of coagulation pathways, micro vascular plugging and myocyte necrosis mediated by secretion of pro-inflammatory cytokines [1, 17]. Activated leukocytes may also modulate the electrical activity of the myocardium (and therefore arrhythmogenesis), by release of oxygen free radicals [18]. Leukocyte count has an interplay with other known CAD risk factors, such that it enhances the diagnostic capacity of conventional risk factors in predicting CAD [19]. Physiological stress and the subsequent activation of the neurohormonal system during STEMI leads to cortisol release, which in turn mediates lymphopenia through apoptosis [20]. Atherosclerosis and plaque rupture leading to ACS is an inflammatory process mediated by the complex interplay

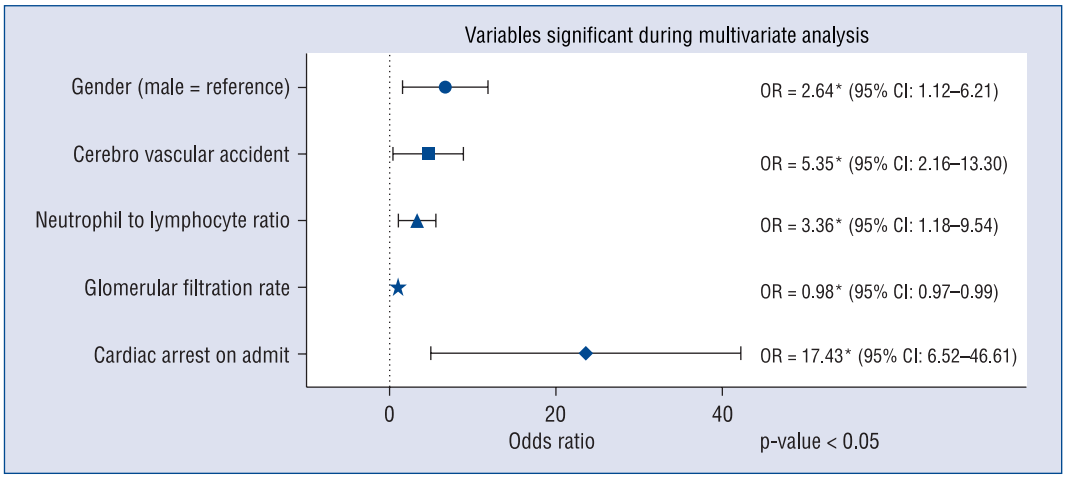

Figure 3. Multivariate analysis of long-term mortality risk factors; *p < 0.05.

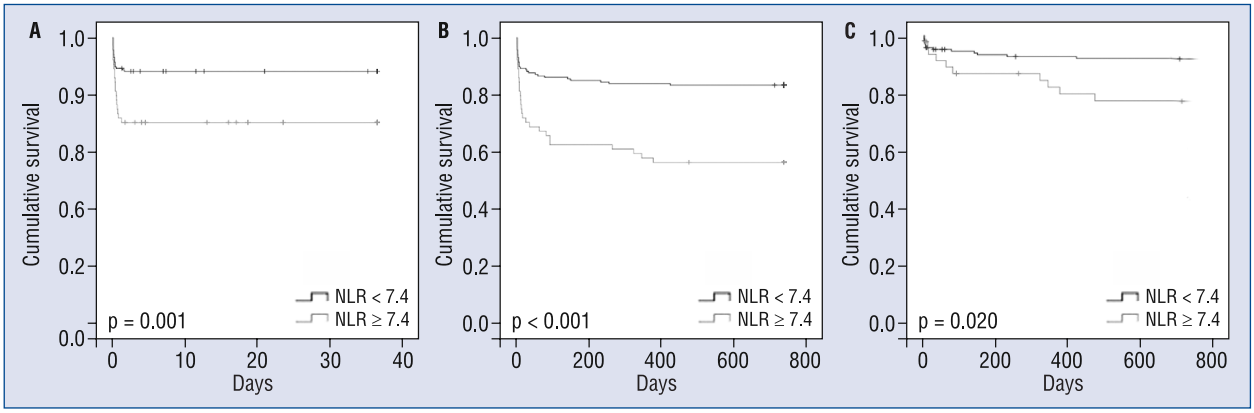

Figure 4. Kaplan-Meier survival curve analysis of all-cause mortality for short-term (**A**), long-term (**B**) end points stratified by neutrophil to lymphocyte ratio (NLR) cut off value of 7.4. Kaplan-Meier survival curve analysis of survival free of heart failure (**C**) stratified by NLR cut off value of 7.4.

between the innate neutrophil mediated reactive immune responses, and subsequent lymphocyte mediated adaptive immune responses [5–7]. Thus, NLR may act as a combined surrogate marker for both the reactive and adaptive components of the inflammatory response that result in plaque rupture, ischemic myocardial damage, adverse ventricular remodeling, and consequent left ventricular dysfunction.

Older age is a major predictor of adverse outcome in ACS. Age > 70 years has remained a major independent predictor of in-hospital cardiovascular mortality in many STEMI prognosis studies [21]. Similar to our cohort where NLR > 7.4 was independently associated with systolic heart failure, studies have shown that increased neutrophil count has been reliably associated with increased MI size and decreased left ventricular function [22]. Evidence of CHF with elevated BNP levels is associated with poor prognosis due to increased myocardial damage [23]. This is the proposed physiologic basis for the observed correlation between increased NLR, older age, increased BNP levels, and diminished long-term survival. Consistent with this, we also observed that prolonged QRS duration was associated with elevated NLR values, and diminished survival in our study. A post-hoc analysis of the Efficacy of Vasopressin Antagonism in Heart Failure Outcome Study with Tolvaptan (EVEREST) showed similar findings, where lymphopenia was associated with widened QRS duration and older age (both markers

of worse prognosis) [24]. Prolonged QRS reflects more extensive myocardial damage, and the adverse ventricular remodeling that accompanies this (vide supra).

We tested the predictive value of NLR both independently and in conjunction with well-validated standardized MI risk scores. We have shown that not only does NLR independently predict short- and long-term mortality; it significantly improves prediction of short- and long-term mortality, when incorporated as a co-variable in standardized risk scores (e.g. TIMI-STEMI risk score). Multiple ACS studies now support the use of NLR as an admission biomarker, which can be used to determine prognosis [25, 26]. NLR can be readily calculated at point of care, thereby facilitating short- and long-term risk prediction for STEMI patients, even prior to revascularization. Arbel et al. [27] found that increased NLR was associated with increased severity of CAD, thereby providing additive predictive value to conventional risk factors and commonly used biomarkers e.g. C-reactive protein and total white cell count. Similarly, in a large population based acute MI incident cohort, the absolute neutrophil count at presentation was strongly, positively, and independently associated with death/heart failure post-MI with an incremental discriminatory value for the absolute neutrophil count over traditional cardiac risk factors [28].

Female gender and low GFR has been shown in this study and others, to be independent predictors of mortality and MACE [23, 27, 28]. Our data was prospectively collected with NLR blood samples analyzed at admission, which is the most critical time point for clinicians to determine the choice of reperfusion therapy, based on the predicted interventional outcome of the presenting case. Pre-admission or initial presentation prognostic indices are of vital importance in the accurate triage of emergency room patients for STEMI revascularization. They may even be more important for the long-term prognosis of all-cause mortality, than the immediate outcome of PCI [25]. For instance, the overwhelmingly poor short- and long-term predicted mortality of certain STEMI patients, might preclude invasive intervention, and mandate more conservative management strategies. Interestingly, more complicated risk scoring systems that incorporate more comprehensive angiographic parameters and/or presentation hemodynamic variables, do not necessarily improve the long-term prediction of all-cause mortality [26]. Furthermore, the clinical variables used in risk prediction models vary in predictive risk assessment capacity according to the time point being considered post-MI [29, 30]. In this regard, we suggest that the NLR is robust in its consistent benefit for reliably predicting both immediate, intermediate, and long-term mortality following revascularized STEMI.

Limitations of the study

Our study has several inherent limitations since retrospective analyses are subject to selection bias. Moreover, the population studied was from a single tertiary care center. However, our study population demographics reveal a good mix of Hispanic, African American and Asian populations (51.6%) compared to the predominant Caucasian dominated populations studied in most major ACS clinical score derivation trials. While a single baseline admission complete blood count sampling has the benefit of being readily available, serial sampling may potentially yield a better analytical time point. However, since the exact time to peak inflammatory response after STEMI remains unknown, it is difficult to determine the most efficient collection time. Alternative concomitant etiologies for elevated NLR may have been present and not accounted for e.g. occult infection or malignancy. An NLR of 7.4 or greater at admission carried greater risk of adverse outcome in our study, although other studies have suggested differing NLR cut off points. A larger multi-center study with larger population size and diversity is warranted to best determine the future prognostic role of NLR, its best predictive cut off value, and sampling time.

Conclusions

NLR is a readily ascertainable, inexpensive, and reproducible biomarker for STEMI prognosis after PCI. It can be utilized as a robust stand-alone prognostic indicator for patients presenting with STEMI, even before eventual angiographic findings and outcomes are accounted for. When NLR is combined with standardized clinical mortality risk prediction scores, it markedly and significantly augments the predictive power of these scores.

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Conflict of interest: None declared

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