Section: Urology

Original Research Article

A CROSS SECTIONAL STUDY OF HAEMATOLOGICAL INDICES AND ITS PROGNOSTIC VALUE AMONG PATIENTS WITH ACUTE CORONARY SYNDROME IN A TERTIARY CARE HOSPITAL IN CHENGALPATTU DISTRICT

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ABSTRACT

Background: Acute Coronary Syndrome (ACS) represents a major public health burden in India, with significant morbidity and mortality, especially in low-resource settings. While diagnostic tools like ECG and cardiac biomarkers are pivotal, cost-effective, widely accessible prognostic indicators are needed. Hematological indices derived from routine complete blood count(CBC) have shown promise in this regard. This study aims to evaluate the prognostic value of hematological indices—specifically Red Cell Distribution Width (RDW), Neutrophil-to-Lymphocyte Ratio (NLR), Mean Platelet Volume (MPV), and Platelet Distribution Width (PDW)—in patients with ACS, and their association with left ventricular (LV) dysfunction and clinical outcomes. **Materials and Methods:** A hospital-based cross-sectional study was conducted at a tertiary care center in South India from May 2023 to October 2024, involving 85 adult ACS patients. Standard clinical assessments, ECG, echocardiography, cardiac biomarkers, and CBC-derived hematological indices were evaluated. Statistical analysis assessed associations between these markers and LV dysfunction severity, using ANOVA, t-tests, and chi-square tests. **Result:** STEMI was the most common ACS subtype (57.65%). LV dysfunction was present in 82.35%of patients, with significant associations observed between increased RDW, MPV, and LV dysfunction ($p < 0.05$). Higher RDW (>15%) and elevated NLR tertiles were significantly associated with more severe LV dysfunction ($p < 0.001$), indicating their utility in risk stratification. **Conclusion:** Hematological indices such as RDW, NLR, and MPV are significantly associated with adverse outcomes and LV dysfunction in ACS patients. These readily available and cost-effective markers can aid in early risk assessment and guide clinical decision-making, particularly in resource-limited settings.

INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of global mortality, responsible for about 17.9 million deaths annually, with acute coronary syndrome (ACS) accounting for a substantial share. ACS—including ST-elevation myocardial infarction (STEMI), non-ST-elevation myocardial infarction (NSTEMI), and unstable angina (UA)—results from sudden reduction in coronary blood flow, leading to myocardial ischemia and infarction. The Global Burden of Disease Study 2019 identified ischemic heart disease as the leading cause of death and disability worldwide.

In India, the burden of ACS has risen markedly over the past two decades. The ICMR–INDIAB study estimates that CVDs account for 28% of all deaths in the country, with increasing myocardial infarction rates among younger individuals. Regional disparities are evident, with South Indian states such as Tamil Nadu and Kerala reporting high prevalence rates. Hospital-based data from tertiary centers in Chennai and Puducherry show rising ACS admissions, substantial healthcare utilization, and significant economic impact.

Unlike trends in developed countries—where NSTEMI cases have increased due to high-sensitivity troponin testing—Indian cohorts show a predominance of STEMI. The CREATE registry reported that 61% of ACS cases in India were STEMI, possibly reflecting delays in healthcare access and differing risk factor profiles.

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The clinical presentation of ACS in India varies by age, gender, comorbidities, and socioeconomic status. While chest pain remains the most common symptom, atypical presentations such as dyspnea, fatigue, epigastric discomfort, and syncope are frequent, especially in elderly patients and women. Common risk factors include diabetes mellitus, hypertension, dyslipidemia, smoking, and family history of CVD.

Electrocardiography (ECG) remains central to early diagnosis and risk stratification. In rural and semi-urban settings, limited access to ECG expertise contributes to delayed diagnosis and treatment. Even among patients with ST-elevation, delays in ECG acquisition and thrombolysis significantly increase mortality

Biomarkers play a critical role in early detection and risk assessment. High-sensitivity cardiac troponin I and T are the gold standards for diagnosing myocardial injury due to their superior sensitivity and specificity. Although widely used in tertiary centers in India, resource-limited settings still rely on CK-MB, myoglobin, and lactate dehydrogenase (LDH), which have lower diagnostic accuracy.

Hematological indices derived from routine complete blood counts are increasingly recognized as valuable prognostic markers in ACS. These low-cost, widely available parameters reflect inflammation, thrombosis, and oxidative stress—key mechanisms in coronary artery disease.

Red Cell Distribution Width (RDW), a measure of variation in red blood cell size, has emerged as an independent predictor of mortality and major adverse cardiovascular events (MACE) in ACS. Elevated RDW is linked to systemic inflammation, possibly mediated by cytokines such as IL-6 and TNF-α. Indian studies report that RDW values above 14.5% are associated with increased in-hospital mortality in STEMI patients.

Platelet-to-Lymphocyte Ratio (PLR) reflects the interaction between thrombosis and inflammation. Elevated PLR has been associated with greater thrombus burden, poorer angiographic outcomes following primary percutaneous coronary intervention (PCI), and higher rates of recurrent ischemic events. In Indian cohorts, PLR values above 150 are linked with worse clinical outcomes.

Given the rising burden of ACS in South India and the need for cost-effective prognostic tools, this study aims to evaluate the significance of hematological indices in patients with ACS at a tertiary care center. It seeks to assess their association with in-hospital mortality, complications, and established risk scores such as GRACE and TIMI. The findings may enhance early risk stratification, guide clinical decision-making, and reduce dependence on costly diagnostic modalities.

MATERIALS AND METHODS

Study Design and Setting: A hospital-based cross-sectional study was conducted from May 2023 to October 2024 at a tertiary care hospital in Chengalpattu district near Chennai.

Study Population: Adult patients presenting with acute coronary syndrome (ACS) to the Emergency Room (ER) and Medical Intensive Care Unit (MICU) were included.

Inclusion Criteria

- Age ≥30 years
- Symptoms suggestive of angina or acute chest pain
- Ischemic or infarction changes on ECG (ST elevation/depression, T-wave inversion)
- Diagnosis of STEMI, NSTEMI, or unstable angina based on ACC/ESC guidelines
- Written informed consent

Exclusion Criteria

- Age <30 years
- Prior coronary artery disease or previous myocardial infarction
- Requirement of immediate CPR on arrival or death in the emergency department
- Hematological disorders, active infection, or medications affecting blood indices
- Refusal to consent

Sample Size: Assuming a 50% prevalence of elevated hematological biomarkers (based on prior studies), with 95% confidence and 10% precision, the minimum sample size was calculated as 96 and rounded to 100 to account for potential data loss.

Study Tools and Investigations:

- Electrocardiogram (ECG): To classify ACS into STEMI, NSTEMI, or unstable angina.
- Complete Blood Count (CBC): Performed using a Sysmex XS-800i analyzer, assessing total leukocyte count, neutrophils, lymphocytes, platelet count, mean platelet volume (MPV), and red cell distribution width (RDW).
- Biochemical Markers: CK-MB and Troponin I.
- Echocardiography (ECHO): To evaluate left ventricular function and detect complications.

Derived indices included:

- Neutrophil–Lymphocyte Ratio (NLR)
- Platelet–Lymphocyte Ratio (PLR)
- WBC–MPV Ratio (WMR)

Study Procedure: Eligible patients were clinically evaluated on admission. After stabilization and consent, demographic and clinical data were recorded. ECG confirmed ACS diagnosis per ACC/ESC criteria. Blood samples were collected before initiating antiplatelet or anticoagulant therapy to prevent alteration of hematological parameters and processed within one hour.

All patients received standard ACS management, including dual antiplatelet therapy, anticoagulants, beta-blockers, statins, and, when indicated, thrombolysis or percutaneous coronary intervention (PCI).

Patients were monitored during hospitalization for in-hospital mortality, recurrent angina, heart failure, cardiogenic shock, and major adverse cardiac events (MACE). Follow-up continued for 30 days via outpatient visits or telephone interviews. The primary

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outcome was MACE or death within 30 days, which was correlated with hematological indices.

RESULTS

The study included 85 patients diagnosed with acute coronary syndromes (ACS), analyzing their sociodemographic, clinical, and hematological characteristics.

The mean age of participants was 58.48 ± 10.92 years, indicating a predominantly older population. Most patients (70.59%) were aged 51–70 years, followed by 21.18% aged 30–50 years and 8.24% above 70 years. Males constituted 61.18% of the cohort, while females accounted for 38.82%, suggesting a male predominance. Overall, ACS was more common among middle-aged and elderly individuals, particularly men.

Regarding diagnosis, ST-elevation myocardial infarction (STEMI) was the most frequent presentation (57.65%), followed by non-ST-elevation myocardial infarction (NSTEMI) (24.71%) and unstable angina (17.65%). Among STEMI cases, the most common locations were inferior wall (34.69%) and anterior wall (32.65%), with smaller proportions involving anterolateral (12.24%), anteroseptal (12.24%), inferior and posterior (6.12%), and inferolateral regions (2.04%).

Table 1: The Socio demographic data of the study population(N=85)

Variable	Category of Response	Frequency	Proportion (%)
Age(years)	Mean (SD)	58.48(10.92)	
Age category	30-50years	18	21.18
	51-70years	60	70.59
	>70years	7	8.24
Gender	Male	52	61.18
	Female	33	38.82

Table 2: Distribution of diagnosis of acute coronary syndromes for the study participants (N=85)

Variable	Category of Response	Frequency	Proportion(%)
Diagnosis	Unstable angina	15	17.65
	NSTEMI	21	24.71
	STEMI	49	57.65
STEMI Location	Anterior wall	16	32.65
	Anterolateral	6	12.24
	Anteroseptal	6	12.24
	Inferior & Posterior	3	6.12
	Inferior wall	17	34.69
	Inferolateral	1	2.04

Hematological parameters showed a mean red cell distribution width (RDW) of 14.93 ± 1.25%, red cell volume index (RWVI) of 525.60 ± 81.00, hemoglobin-corrected RDW of 4.98 ± 1.00, neutrophil-to-lymphocyte ratio (NLR) of 4.58 ± 1.74, and eosinophil percentage of 2.02 ± 0.94. Platelet indices included a mean platelet distribution width (PDW) of 16.95 ± 1.28 and mean platelet volume (MPV) of 8.40 ± 0.88.

Table 3: Hematological indices among patients with acute coronary syndromes (N=85)

Variable	Mean (SD)
Red Cell Distribution Width(RDW)	14.93(1.25)
Red Cell Volume Index (RWVI)	525.60(81.00)
Hemoglobin Corrected RDW	4.98(1.00)
Neutrophil Lymphocyte Ratio(NLR)	4.58(1.74)
Eosinophil(%)	2.02(0.94)

Table 4: Acute coronary syndrome patients 'with platelet indices(N=85)

Variable	Mean (SD)
Platelet Distribution Width(PDW)	16.95(1.28)
Mean Platelet Volume(MPV)	8.40(0.88)

Electrocardiographic and biochemical findings demonstrated that 57.65% of patients had ST-segment elevation, while 42.35% did not. Elevated troponin levels were observed in 82.35% of participants, confirming myocardial injury, whereas 17.65% had normal troponin levels. These findings emphasize the diagnostic importance of ECG and troponin testing in ACS.

Table 5: Changes in ECHO and troponin levels in patients with acute coronary syndromes

Variable	Category of Response	Frequency	Proportion(%)
ECG ST Elevation	Absent	36	42.35
	Present	49	57.65
Troponin Elevated	Absent	15	17.65
	Present	70	82.35

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Several hematological indices were associated with LV dysfunction. RDW was significantly higher in patients with LV dysfunction (15.20 ± 1.17%) compared to those without (13.67 ± 0.74%) ($p < 0.001$). Hemoglobin-corrected RDW was also significantly elevated ($p < 0.001$). Eosinophil percentage was lower in patients with dysfunction ($p = 0.038$), and MPV was significantly higher ($p = 0.004$). RWVI, NLR, and PDW did not show significant associations.

Among patients with LV dysfunction (n = 70), severity was significantly associated with age ($p < 0.001$), with the highest mean age observed in severe dysfunction (69.22 ± 8.50 years). Gender distribution also differed significantly across severity categories ($p = 0.015$); females were more represented in the severe group, while males predominated in moderate dysfunction.

Table 6: Distribution of outcomes of patients with acute coronary syndromes (N=85)

Variable	Category of Response	Frequency	Proportion(%)
LV Dysfunction	Absent	15	17.65
	Present	70	82.35
LV Dysfunction Severity	Mild	11	12.94
	Moderate	32	37.65
	Severe	27	31.76
	Absent	15	17.65

Table 7: Association between socio demographic variables and presence of LV dysfunction

Variable	Category of Response	LV dysfunction present n(%)	LV dysfunction absent n(%)	p- value
Age(Mean±SD)		60.61(10.37)	48.53(7.57)	<0.001
Gender	Male	41(78.85)	11(21.15)	0.287
	Female	29(87.88)	4(12.12)	
Diagnosis	Unstable angina	3(20.00)	12(80.00)	<0.001
	NSTEMI	18(85.71)	3(14.29)	
	STEMI	49(100.00)	0(0.00)	

Diagnosis influenced severity ($p = 0.012$). STEMI was strongly associated with moderate and severe dysfunction, while unstable angina was mostly linked to mild or moderate dysfunction and none to severe cases.

RDW showed a significant association with severity ($p < 0.001$), increasing from mild (13.73 ± 0.81) to moderate (15.53 ± 0.85) and severe dysfunction (15.40 ± 1.19), suggesting a relationship between elevated RDW and worsening cardiac function. Other indices, including RWVI, hemoglobin-corrected RDW, NLR, PDW, MPV, and eosinophils, did not show statistically significant differences across severity groups, although trends were observed.

Table 8: Association between haematological indices and presence of LV dysfunction (N=85)

Variable	LV dysfunction present Mean (SD)	LV dysfunction Absent Mean(SD)	p-value
Red Cell Distribution Width (RDW)	15.20(1.17)	13.67(0.74)	<0.001
Red Cell with Volume Index (RWVI)	529.42(84.19)	507.79(63.41)	0.351
Hemoglobin Corrected RDW	5.18(0.88)	4.02(1.02)	<0.001
Neutrophil Lymphocyte Ratio (NLR)	4.65(1.80)	4.25(1.43)	0.43
Eosinophil%	1.92(0.97)	2.47(0.67)	0.038
Platelet Distribution Width (PDW)	17.04(1.27)	16.52(1.25)	0.151
Mean Platelet Volume(MPV)	8.53(0.90)	7.82(0.51)	0.004

Table 9: Association between hematological indices and severity of LV dysfunction(N=70)

Variable	Category of response	Mild LV dysfunction presentn(%)	Moderate LV dysfunction present n(%)	Severe LV dysfunction Present n(%)	p- value
Age	Mean age	60.27(3.77)	53.47(7.53)	69.22(8.50)	<0.001
Gender	Male	8(19.51%)	23(56.10%)	10(24.39%)	0.015
	Female	3(10.34%)	9(31.03%)	17(58.62%)	
Diagnosis	Unstable Angina	1(33.33%)	2(66.67%)	0(0%)	0.012
	NSTEMI	7(38.89%)	6(33.33%)	5(27.78%)	
	STEMI	3(6.12%)	24(48.98%)	22(44.90%)	

Table 10: Association between hematological indices and presence of LV dysfunction (N=70)

Variable	Mild LV dysfunction Mean (SD)	Moderate LV dysfunction Mean (SD)	Severe LV dysfunction Mean (SD)	p- value
Red Cell Distribution Width (RDW)	13.73(0.81)	15.53(0.85)	15.40(1.19)	<0.001
Red Cell with Volume Index(RWVI)	521.23(85.79)	539.45(77.79)	520.86(92.39)	0.664
Hemoglobin Corrected RDW	4.85(1.23)	5.11(0.81)	5.41(0.77)	0.166

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Neutrophil Lymphocyte Ratio(NLR)	3.79(1.60)	4.76(2.08)	4.86(1.43)	0.229
Eosinophil%	2.55(0.82)	1.86(0.94)	1.73(0.98)	0.054
Platelet Distribution Width (PDW)	16.45(1.02)	17.16(1.32)	17.15(1.29)	0.249
Mean Platelet Volume (MPV)	7.94(0.53)	8.66(1.04)	8.62(0.75)	0.056

Table 11: Association between NLR, RDW categories and severity of LV dysfunction (N=70)

Variable	Category of response	Mild LV dysfunction present n(%)	Moderate LV dysfunction present n(%)	Severe LV dysfunction present n(%)	p-value
NLR Tertile	Tertile1	7(31.82%)	12(54.55%)	3(13.64%)	<0.001
	Tertile2	1(4.35%)	5(21.74%)	17(73.91%)	
	Tertile3	3(12.00%)	15(60.00%)	7(28.00%)	
RDW	<=15	11(52.38%)	3(14.29%)	7(33.33%)	<0.001
Category	>15	0(0%)	29(59.18%)	20(40.82%)	

When categorized, both NLR tertiles and RDW categories were significantly associated with LV dysfunction severity ($p < 0.001$). Patients with RDW > 15 were predominantly found in moderate and severe dysfunction groups, whereas those with RDW ≤ 15 were more common in mild dysfunction.

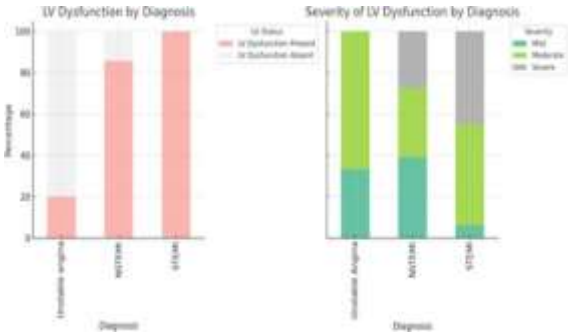

Figure 1: Stacked bar graph depicting the diagnosis category based on the presence and severity of LV dysfunction

In summary, this study demonstrates that ACS predominantly affects older males, with STEMI as the most common presentation. LV dysfunction was highly prevalent and strongly associated with age and diagnosis. Among hematological markers, RDW emerged as the most consistent parameter associated with both the presence and severity of LV dysfunction, suggesting its potential role as a prognostic indicator in ACS patients.

DISCUSSION

This study evaluated 85 patients with acute coronary syndromes (ACS), focusing on demographic characteristics, hematological indices, and their association with left ventricular (LV) dysfunction.

The mean age of participants was 58.48 ± 10.92 years, with the majority (70.59%) aged 51–70 years, confirming that ACS predominantly affects middle-aged and older adults. Males constituted 61.18% of cases, demonstrating male predominance, consistent with existing literature.

ST-elevation myocardial infarction (STEMI) was the most common ACS subtype (57.65%), followed by NSTEMI (24.71%) and unstable angina (17.65%). Among STEMI cases, anterior and inferior wall involvement were most frequent. The predominance of STEMI aligns with previous studies showing its association with greater myocardial injury and higher risk of complications, including heart failure and adverse remodeling.

Hematological Profile: The mean red cell distribution width (RDW) was 14.93 ± 1.25%, indicating moderate anisocytosis. Red cell volume index (RWVI) averaged 525.60 ± 81.00, and hemoglobin-corrected RDW was 4.98 ± 1.00. Inflammatory markers included a mean neutrophil-to-lymphocyte ratio (NLR) of 4.58 ± 1.74 and eosinophil percentage of 2.02 ± 0.94.

Platelet indices showed a mean platelet distribution width (PDW) of 16.95 ± 1.28 and mean platelet volume (MPV) of 8.40 ± 0.88. These markers reflect platelet activation, a key contributor to ACS pathophysiology.

LV Dysfunction and Associated Factors: LV dysfunction was strongly associated with increasing age. Patients with LV dysfunction were significantly older (60.61 years) than those without (48.53 years; $p < .001$), supporting evidence that advancing age contributes to myocardial remodeling and functional decline. No significant gender difference was observed in the presence of LV dysfunction ($p = .287$).

Hematological Indices and LV Dysfunction: RDW was significantly higher in patients with LV dysfunction (15.20% vs. 13.67%; $p < .001$), suggesting its potential role as a marker of adverse cardiac remodeling. Hemoglobin-corrected RDW showed similar associations.

Among platelet indices, MPV was significantly higher in patients with LV dysfunction (8.53 vs. 7.82; $p = .004$), indicating enhanced platelet activation and thrombotic risk. PDW did not show significant differences.

Severity of LV Dysfunction: Age was significantly associated with LV dysfunction severity ($p < .001$). Patients with severe dysfunction were oldest (mean 69.22 years), followed by mild (60.27 years) and moderate (53.47 years) groups, suggesting progressive age-related cardiac impairment.

Gender differences were observed in severity distribution ($p = .015$): females were more likely to

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present with severe dysfunction, while males predominated in moderate cases.

ACS subtype was significantly associated with severity ($p = .012$). STEMI cases were largely concentrated in moderate and severe dysfunction categories, whereas unstable angina was rarely associated with severe dysfunction.

Hematological Markers and Severity: RDW demonstrated a significant upward trend with increasing LV dysfunction severity ($p < .001$), rising from 13.73 in mild cases to over 15 in moderate and severe cases. RDW >15 was consistently linked to worse dysfunction, with no mild cases observed in this category.

NLR also showed a significant association with severity. Interestingly, patients in the middle tertile had the highest proportion of severe dysfunction, suggesting a nonlinear relationship between systemic inflammation and cardiac impairment.

Platelet indices (MPV and PDW) were higher in moderate and severe dysfunction groups, with MPV approaching statistical significance ($p = .056$).

Overall, RDW emerged as the most consistent hematological marker associated with both the presence and severity of LV dysfunction in ACS patients.

Strengths

1. Well-defined hospital-based cross-sectional design with clear inclusion and exclusion criteria.
2. Use of routine, inexpensive hematological parameters, enhancing feasibility in low-resource settings.
3. Objective assessment of LV dysfunction through echocardiography.
4. Inclusion of both traditional and novel hematological indices.
5. Standardized blood sampling prior to antiplatelet/anticoagulant therapy.
6. Assessment of short-term outcomes, including 30-day mortality and MACE.
7. Ethical approval and informed consent ensured.
8. Use of appropriate bivariate and multivariate statistical analyses.

Limitations

1. Single-center design limits generalizability.
2. Small sample size (N = 85) reduces statistical power.
3. Cross-sectional design prevents causal inference.
4. Lack of long-term follow-up beyond 30 days.
5. Incomplete adjustment for potential confounders (e.g., comorbidities, medications).
6. Absence of detailed quantitative echocardiographic measures (e.g., ejection fraction).
7. Single time-point hematological measurements.
8. Exclusion of critically unstable patients may underrepresent severe ACS cases.

Recommendations

1. Incorporate RDW, NLR, MPV, and hemoglobin-corrected RDW into routine early risk stratification of ACS patients.
2. Conduct multicentric studies with larger and more diverse populations.
3. Evaluate long-term prognostic value of these indices.
4. Combine hematological markers with established clinical scoring systems (e.g., GRACE, TIMI).
5. Establish standardized cut-off values for different ACS subtypes.
6. Integrate these markers into triage and monitoring protocols.
7. Provide training for clinicians on interpretation and clinical application.
8. Adjust future analyses for confounding factors such as anemia, inflammatory diseases, and polypharmacy.

CONCLUSION

The present study evaluated the hematological indices and their prognostic utility in the context of acute coronary syndrome (ACS) among patients admitted to a tertiary care hospital in Chengalpattu district, TamilNadu. Witha sample of85 patients diagnosed with ACS, this cross- sectional hospital-based study aimed to determine the correlation of routinely available complete blood count (CBC) parameters—specifically red cell distribution width (RDW), hemoglobin- corrected RDW, neutrophil-to-lymphocyte ratio (NLR), mean platelet volume (MPV), and platelet distribution width (PDW)—with short-term clinical outcomes, especially the presence and severity of left ventricular (LV) dysfunction.

The findings revealed that STEMI was the most prevalent type of ACS, accounting for 57.65%of cases, followed by NSTEMI and unstable angina. Importantly, more than 80% of the study population exhibited LV dysfunction, with a considerable proportion experiencing moderate to severe impairment. Among the hematological indices, RDW and hemoglobin-corrected RDW showed statistically significant associations with LV dysfunction, both in terms of presence and increasing severity. Similarly, MPV was elevated in patients with greater degrees of dysfunction, supporting its role as a surrogate marker for platelet activation and cardiovascular risk. The NLR, while not statistically significant in all comparisons, demonstrated a clinically relevant trend of elevation with worsening LV function, aligning with its role as a systemic inflammatory marker.

This study highlights that the hematological parameters are cost-effective, rapidly available, and non-invasive which is more useful in the period of early triage, risk stratification, and in assessing the prognosis of ACS patients. Their incorporation into clinical practice is more useful.

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