Application Value of NLR, PLR, LMR, HEART score, and POCT in Early Warning and Accurate Graded Diagnosis of High-Risk Chest Pain in Emergency Medicine

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Abstract: *Objective:* To evaluate the application value of neutrophils/lymphocytes (NLR), platelets/lymphocytes (PLR), lymphocytes/monocytes (LMR), HEART (history, electrocardiogram, age, risk factors, and troponin) score, and point-of-care testing (POCT) in the early warning and precise diagnosis of high-risk chest pain in emergency medicine. *Methods:* A total of 157 patients with acute chest pain who were admitted to the emergency department and chest pain treatment unit of our hospital between August 2022 and September 2023 were selected. Rapid testing of bedside myocardial markers (ultrasensitive troponin (hs-cTnI), myoglobin (MYO), creatine kinase isoenzyme (CK-MB), D-dimer (D-Dimer), and N-terminal B-type natriuretic peptide precursor (NT-proBNP)) was performed on the patients using a POCT device (ThermoKing BioMQ60proB). A HEART score was used to classify the patients into low (n = 53), intermediate (n = 59), and high-risk (n = 45) groups, and the NLR, PLR, and LMR were calculated. The NLR, PLR, and LMR values were compared among the three groups of patients, and the optimal cutoff values as well as sensitivity and specificity were determined based on receiver operating characteristic (ROC) analysis. *Results:* The HEART scores of patients in the low-risk, intermediate-risk, and high-risk groups were (2.72 ± 0.24), (4.75 ± 0.56), and (5.32 ± 0.73) respectively, and the differences were statistically significant (P < 0.05). Compared with the low-risk group, the intermediate-risk group and high-risk group had a significantly higher NLR and PLR, and a significantly lower LMR; the high-risk group had higher NLR and PLR and lower values of LMR as compared to the other two groups, and the difference was statistically significant (P < 0.05). The ROC curves suggested that the area under the curve, sensitivity, and specificity of the combined diagnosis of NLR, PLR, LMR, HEART score, and POCT were greater than those of LR, PLR, and LMR with HEART score and POCT alone. *Conclusion:* The combined application of NLR, PLR, LMR, HEART score, and POCT has significant application value in the early warning and precise diagnosis of emergency high-risk chest pain. It provides a more simple, easy-to-access, and efficient assessment index for the clinical prediction and treatment of emergency high-risk chest pain.

Keywords: NLR; PLR; LMR; POCT myocardial markers; HEART score; Emergency high-risk chest pain

1. Introduction

Acute chest pain is one of the most common diseases in the emergency department, and its etiology involves a wide range of causes, where timely and accurate diagnosis plays a key role in treatment and prognosis. Recently, with the continuous improvement of medical technology, the diagnostic accuracy for acute chest pain has improved [1]. However, some high-risk patients are still misdiagnosed as low-risk, which delays the treatment time and reduces the cure rate. Therefore, it is extremely critical to explore more accurate and effective detection methods and early warning factors for patients with acute chest pain who are admitted to the emergency department. Research has shown that relying solely on HEART (history, electrocardiogram, age, risk factors, and troponin) scoring may have false-positive results [2]. Therefore, emergency physicians and researchers are committed to discovering new detection methods or diagnostic factors to assist HEART scoring and develop a more accurate prediction and grading system for patients with acute chest pain. Not only can the disease be detected early but treatment can be performed promptly to shorten the emergency response time and reduce the financial burden of the patient. Hence, this system has high clinical practice significance and social and economic value [3]. Based on this, this study selected 157 patients with acute chest pain admitted to the emergency department and chest pain treatment unit of our hospital between August 2022 and September 2023 to explore the clinical value of peripheral blood NLR, PLR, LMR indexes combined with HEART scores and point-of-care testing (POCT) as a diagnostic index for the rapid assessment of patients with acute chest pain.

2. Information and methods

2.1. General information

In this study, 157 patients with acute chest pain admitted to the emergency department and chest pain treatment unit of our hospital between August 2022 and September 2023 were selected. There were 120 males and 37 females aged 15–87 years old, with a mean age of 59.27 ± 6.54 years. According to the HEART score combined with POCT, all patients were risk-stratified into low ($n = 53$), medium ($n = 59$), and high-risk groups ($n = 45$). Differences among the three groups in terms of general information were not statistically significant ($P > 0.05$), and were comparable. The study protocol complied with the ethical guidelines of the Declaration of Helsinki (1975) and was approved by our institutional ethics committee. All subject patients signed a written informed consent.

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) Patients diagnosed with non-ST-segment elevation acute myocardial infarction (NSTEMI) or unstable angina pectoris (UA), which were objectively confirmed by the presence of ischemic symptoms judged by the presence of electrocardiogram (ECG) changes consistent with ischemia; (2) elevated cardiac myosin enzyme levels (hsTnI and CKMB) were used to differentiate between patients with NSTEMI, UA, and myocarditis; (3) patients with unknown chest pain with elevated levels of D-dimer; (4) patients with chest pain who provided information about neutrophils, lymphocytes, and platelets and/or who provided NLR and PLR. (5) patients with an ECG diagnosis of ST-segment elevation acute myocardial infarction (STEMI). Exclusion criteria: (1) patients with clinically active infections, malignant neoplasms, and hematologic disorders including all types of anemia (hereditary and acquired); (2) patients with hematologic malignancies; (3) severe liver disease, active or chronic autoimmune disorders; (4) patients previously treated with steroids or chemotherapy; (5) history of trauma or surgery within the 10 days before admission.

2.3. Methodology
2.3.1. General data collection
Basic clinical statistics (age, gender, ethnicity, hypertension, diabetes mellitus, dyslipidemia, obesity, smoking, and family history of coronary artery disease) and clinical variables (mode of arrival to the emergency department, emergency department disposition, and total length of stay in the emergency department) of the patients were collected.

2.3.2. Measurement of peripheral blood NLR, PLR, and LMR levels
When eligible, blood was drawn for initial biomarker analysis as soon as the patient was admitted to the emergency department. A complete blood cell count (CBC) with automated sorting and counting was performed on the peripheral blood. Samples anticoagulated with ethylenediaminetetraacetic acid (EDTA) were analyzed for CBC using an automated cell counter within 30 minutes of collection. The levels of NLR, PLR, and LMR were calculated.

2.3.3. Determination of HEART score
The HEART score scale was used, which included 5 pragmatic factors (medical history, ECG, age, risk factors, and troponin). Each item was given a score of 0, 1, or 2 depending on the degree of abnormality. The total score was then calculated, with low scores (0–3) indicating a > 98% chance of no short-term major adverse cardiac event (MACE), and high scores (7–10) indicating a > 50% incidence of MACE.

2.3.4. Measurement of POCT
Rapid bedside cardiac marker testing was performed by the emergency department chest pain nurse using a POCT device (ThermoView Bio MQ60proB). The blood markers for POCT included ultrasensitive troponin (hs-cTnI), myoglobin (MYO), creatine kinase isoenzyme (CK-MB), D-dimer (D-Dimer), and the precursor of N-terminal B-type natriuretic peptide (NT- pro-BNP). Patients discharged with acute chest pain were followed up after 60 days to track any changes in the chest pain risk grouping.

2.4. Data analysis
All analyses were performed using the SPSS 20.0 software. Continuous variables were expressed as mean ± standard deviation and categorical variables were expressed as %. All data were tested for normal distribution using the Kolmogorov-Smirnov test. Differences between frequencies (qualitative variables) and percentages in groups were compared using the chi-squared (χ^2) test. Differences between independent groups for parametric quantification were assessed by t-tests. Results were considered statistically significant at $P < 0.05$. The optimal cutoff value as well as sensitivity and specificity were determined based on receiver operating characteristic (ROC) analysis. Optimal cutoff values were expressed using the Jordon index. The area under the ROC (AUROC) curve was also calculated.

3. Results
3.1. Comparison of HEART scores between the three groups
The HEART scores of patients in the low-risk group, medium-risk group, and high-risk group were 2.72 ± 0.24, 4.75 ± 0.56, and 5.32 ± 0.73, respectively. The difference was statistically significant ($P < 0.05$).

Table 1. Comparison of HEART scores between the three groups (mean ± standard deviation, points)

| Group	Cases, n	HEART score
Low-risk group	53	2.72 ± 0.24
Medium-risk group	59	4.75 ± 0.56
High-risk group	45	5.32 ± 0.73
F		11.928
P		0.000

3.2. Comparison of NLR, PLR, and LMR between the three groups

Compared with the low-risk group, the values of NLR and PLR were significantly higher and LMR was significantly lower in the medium-risk and high-risk groups; compared with the medium-risk group, the high-risk group had higher values of NLR and PLR and lower values of LMR, and the difference was statistically significant ($P < 0.05$).

Table 2. Comparison of NLR, PLR, and LMR between the three groups (mean ± standard deviation)

Group	Cases, n	NLR	PLR	LMR
Low-risk group	53	2.61 ± 0.45	120.85 ± 25.29	7.15 ± 0.91
Medium-risk group	59	4.34 ± 0.79	141.93 ± 42.38	6.38 ± 0.79
High-risk group	45	5.21 ± 0.93	175.94 ± 49.02	4.25 ± 0.67
F		8.016	16.129	11.363
P		0.002	0.000	0.000

3.3. ROC curve evaluation results
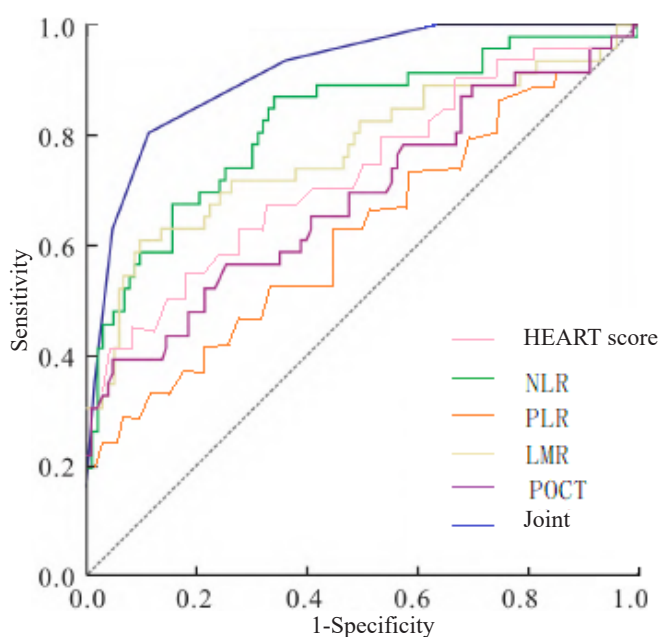
Figure 1. Evaluation of ROC curves

The ROC curve suggests that the area under the curve, sensitivity, and specificity of the combined diagnosis of NLR, PLR, LMR, HEART score, and POCT were greater than those of LR, PLR, LMR with HEART score, and POCT alone.

4. Discussion

Acute chest pain is one of the most common complaints in patients admitted to emergency departments. Approximately 5%–20% of emergency patients are involved in high-risk chest pain [4,5]. There are many causes of high-risk chest pain, mainly STEMI, NSTMI, UA, pulmonary embolism, aortic dissection, and myocarditis. Due to their complex and variable etiology and high risks, they pose a great threat to the patient's lives. The absence of a rapid and applicable triage system can result in diagnostic delays, misdiagnosis, and underdiagnosis [6]. Although the chest pain center model, which introduces telemedicine solutions for ECG transmission and direct transport to percutaneous intervention (PCI), has been gaining popularity in primary care, it mainly targets STEMI patients. However, STEMI patients represent only 3% of all chest pain patients and about one-third of all acute myocardial infarction (AMI) patients. Therefore, some researchers suggest that among patients who go to the emergency department of primary hospitals and community hospitals for chest pain, there are still some with hidden high-risk chest pain, which may lead to untimely and missed diagnosis [7,8].

Currently, the HEART score has been widely used for the risk classification of chest pain patients and has been well-validated in many studies [9]. POCT refers to clinical testing performed next to the patient (i.e., bedside testing) and can realize immediate analysis at the sampling site, eliminating the complex processing procedures during laboratory testing and allowing fast generation of results [10]. The current HEART scoring system and POCT diagnosis may be worthwhile, but there are certain limitations. This study included blood NLR, PLR, and LMR indicators to assist in improving the accuracy of HEART scoring and POCT in the early warning and accurate grading diagnosis of high-risk chest pain in primary care emergencies, to establish a fast and simple assessment system that can reduce diagnostic time, misdiagnosis rate and, leakage rate so that chest pain patients can be treated quickly and accurately. The results of this study showed that the HEART scores of patients in the low-risk group, medium-risk group, and high-risk group were 2.72 ± 0.24, 4.75 ± 0.56, and 5.32 ± 0.73 respectively, and the difference was statistically significant ($P < 0.05$). This indicated that the HEART scores were closely related to the degree of chest pain, and the higher the HEART scores, the greater the risk. When compared with the low-risk group, the NLR and PLR levels were significantly higher and LMR levels were significantly lower in the medium-risk and high-risk groups ($P < 0.05$). The ROC curves suggested that the area under the curve, sensitivity, and specificity for the combined diagnosis of NLR, PLR, LMR, HEART score, and POCT were greater than that of LR, PLR, LMR with HEART score, and POCT alone. Therefore, the joint application of NLR, PLR, LMR, HEART score, and POCT is significant in the early warning and accurate grading diagnosis of emergency high-risk chest pain.

5. Conclusion

The assessment system formed by whole blood NLR, PLR, and LMR indexes combined with HEART score and POCT is simple, fast, and requires little equipment, which is worthy of effective promotion in emergency departments. It can improve the success rate of acute chest pain treatment at the grassroots level, which is of great significance for the construction of an urban grassroots chest pain center treatment network.

Disclosure statement

The authors declare no conflict of interest.

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