Вестник РУДН. Серия: МЕДИЦИНА
RUDN Journal of MEDICINE. ISSN 2313-0245 (Print). ISSN 2313-0261 (Online)
2025;29(2)
http://journals.rudn.ru/medicine

ТЕМА НОМЕРА: КАРДИОЛОГИЯ
THEME OF THE ISSUE: CARDIOLOGY

DOI 10.22363/2313-0245-2025-29-2-143-152
EDN KRZZRO

ОРИГИНАЛЬНОЕ ИССЛЕДОВАНИЕ
ORIGINAL RESEARCH

Prognostic value of red cell distribution width in acute myocardial infarction

Truong Huy Hoang[1, 2] ✉, **Victor V. Maiskov**[3, 4], **Imad A. Merai**[3, 4], **Zhanna D. Kobalava**[3, 4]

[1] Pham Ngoc Thach University of Medicine, *Ho Chi Minh, Vietnam*
[2] Tam Duc Heart Hospital, *Ho Chi Minh, Vietnam*
[3] RUDN University, *Moscow, Russian Federation*
[4] Vinogradov Municipal Clinical Hospital, *Moscow, Russian Federation*
✉truonghh@pnt.edu.vn

Abstract. *Relevance*. Red cell distribution width (RDW), a marker of erythrocyte size variability, is considered a potential prognostic factor in cardiovascular diseases. Accurate risk assessment in acute myocardial infarction (MI) is crucial, yet identifying reliable prognostic markers remains essential for guiding clinical decisions and improving long-term survival. This study aims to investigate the prognostic value of RDW on admission for long-term mortality in patients with acute MI. *Materials and methods***.** The prospective observational study included 577 MI patients who underwent coronary angiography within 24 hours of admission. Demographic data, vital signs, laboratory test data, and comorbidities were collected from the database. The clinical endpoint was 18-month mortality. The associations between RDW, clinical parameters and clinical outcomes was evaluated using logistic regression and receiver operating characteristic (ROC) analysis. *Results and Discussion***.** The median age of patients was 65 (interquartile range [IQR]: 56–74) years, 60.7% were male. The 18-month mortality rate was 11.4% (n = 66). Median RDW was 14.2% (IQR 13.5–15.0). RDW was correlated with age, history of coronary artery disease, previous MI, previous cerebrovascular accidents, atrial fibrillation, peripheral artery disease, hemoglobin, left ventricular ejection fraction and GRACE score. Patients with 18-month mortality had significantly higher RDW values compared to survivors (15.0% vs. 14.1%, $p < 0.001$). Higher RDW values were associated with an increased 18-month mortality (quartile 1: 3.9%, quartile 2: 5.4%, quartile 3: 13.4%, quartile 4: 23.9%, $p < 0.001$). Univariate analysis revealed that RDW was associated with 18-month mortality (odds ratio [OR]: 1.38; 95% confidence interval [CI]: 1.20–1.58, $p < 0.001$). Multivariate analysis revealed RDW as an independent predictor of 18-month mortality (adjusted OR: 1.33, 95% CI: 1.12–1.58, $p < 0.001$). The area under the ROC curve of RDW was 0.708 (95% CI: 0.642–0.775, $p < 0.001$) for predicting 18-month mortality. The optimal cutoff value of RDW to predict 18-month mortality was 14.2% with a sensitivity of 78.8% and a specificity of 54.8%. *Conclusion***.** Elevated RDW value

on admission was associated with an increased risk of 18-month mortality in patients with acute MI. RDW was an independent predictor of 18-month mortality in patients with acute MI, highlighting its potential as a prognostic marker in this population.

Keywords: acute myocardial infarction, long-term mortality, prognosis, red cell distribution width

Funding. The authors received no financial support for the research, authorship, and publication of this article.

Author contributions. T.H. Hoang, V.V. Maiskov — data collection, T.H. Hoang, V.V. Maiskov — statistical data processing, T.H. Hoang, V.V. Maiskov, I.A. Merai — literature review, analysis, and interpretation of the results; T.H. Hoang, Z.D. Kobalava — research concept, study protocol. All authors have made significant contributions to the development concepts, research, and manuscript preparation, read, and approved final version before publication.

Conflict of interest statement. The authors declare no conflict of interest.

Ethics approval. The study was approved by the Ethics committee of the Peoples' Friendship University of Russia named after Patrice Lumumba.

Acknowledgements — not applicable.

Consent for publication. Voluntary written consent was obtained from the patients for the investigation and publication of relevant medical information according to WMA Declaration of Helsinki — Ethical Principles for Medical Research Involving Human Subjects, 2013.

Received 16.06.2024. Accepted 17.07.2024.

For citation: Hoang TH, Maiskov VV, Merai IA, Kobalava ZD. Prognostic value of red cell distribution width in acute myocardial infarction. *RUDN Journal of Medicine.* 2025;29(2):143—152. doi: 10.22363/2313-0245-2025-29-2-143-152 EDN KRZZRO

Introduction

Myocardial infarction (MI) is widely recognized as the predominant clinical manifestation of coronary artery disease (CAD), a leading cause of cardiovascular mortality globally with far-reaching health implications [1]. Despite the well-defined diagnostic criteria and established treatment strategies for acute MI [2], elevated mortality rates persist, emphasizing the crucial importance of identifying high-risk patients for optimal survival outcomes. Accurate risk stratification is thus imperative in the context of acute MI [3, 4].

In the pathogenesis of CAD, inflammation assumes a key role, contributing to plaque instability and rupture [5, 6]. The red blood cell distribution width (RDW) is a metric utilized in routine complete blood counts (CBCs) to measure the size variability among red blood cells [7]. Recent investigations have proposed that inflammatory processes, neurohormonal activity, and activation of the adrenergic system may influence erythrocyte maturation by disrupting the erythrocyte membrane, resulting in elevated RDW [8, 9]. While traditionally utilized for the differential diagnosis of anemia and hematological disorders, RDW has attracted attention for its potential prognostic relevance in individuals with acute MI [7, 10]. Recent studies indicate an adverse prognostic correlation between elevated RDW and various cardiovascular conditions, including stable CAD, heart failure, general population, acute MI, and stroke [6, 7, 10–14]. Despite the diversity in RDW research related to the clinical prognosis of patients with cardiovascular diseases [14–17], the predictive power of RDW in mortality for acute MI patients remains uncertain. The aim of the present study was to investigate the relationship between RDW on admission and long-term mortality within 18 months in patients with acute MI.

Materials and methods

The study was designed as a single-center prospective observational cohort investigation, conducted at the Vinogradov municipal clinical hospital (Moscow, Russia). All patients aged >18 years admitting with acute MI and undergoing coronary angiography (CAG) < 24 hours after symptom onset from January 1, 2020, to December 31, 2021 were included. We excluded men or women who were with type 3, 4 and type 5 MI as well as those who developed MI during hospitalization. MI was diagnosed by using the Third universal definition of MI [18].

The baseline demographic and clinical characteristics, cardiovascular risk factors and comorbidities, data on physical examination, blood tests and imaging methods (electrocardiography, echocardiography, CAG), and medications during hospitalization were collected. Access 2 Immunoassay System (Beckman Coulter. USA) was used for the measurement of cardiac Troponin I with 99th percentile upper reference limit (URL) being 0.02 ng/L. Patients with incomplete medical history were not originally included in the dataset. The CBCs, thus including the measurement of RDW and hemoglobin, was performed in all patients at admission using a Siemens ADVIA 2120i hematology analyzer (Siemens Healthcare Diagnostics, Erlangen, Germany). The Global Registry of Acute Coronary Events (GRACE) 2.0 score was used to assess risk stratification of MI patients [19].

The primary outcome was mortality occurred within 18 months after discharge. Mortality was defined as death from any causes that was recorded in patients' electronic medical records and death registers. In cases where patients were not followed up at our facility, the endpoint was monitored through telephone communication with patients' relatives. At the study closing date all of follow-up information was available. The study complies with the guidelines of the Declaration of Helsinki and was independently approved by the local Ethics Committee of the Institute of Medicine, Peoples' Friendship University of Russia. All patients provided written informed consent.

Statistical analysis. The baseline characteristics of all patients were stratified according to the RDW tertiles. Categorical variables were described as frequencies and percentages, while continuous variables were presented using mean, median (Me), and interquartile range (IQR) values. Chi-square test or Fisher's exact test was employed to compare categorical variables, and the Kruskal–Wallis test was used for continuous variables to compare groups. Correlations between RDW and other parameters were assessed using Spearman's rank correlation test. Logistic binomial regression was employed to evaluate the independent effects of RDW on clinical outcomes. Univariate logistic regression analysis was utilized to identify associations with mortality, generating odds ratios (OR) and their 95% confidence intervals (CIs). All variables found to be significantly associated with RDW were entered into a multivariate model using a stepwise method. The predictive accuracy of RDW for mortality within 18 months after acute MI was identified by receiver operating characteristics (ROC) curve analysis to measure the sensitivity and specificity of RDW, and the area under the curve (AUC) was calculated. Statistical analysis was performed using SPSS 25.0 (SPSS Inc., Chicago, IL, USA). All analyses with P values < 0.05 were considered statistically significant, and all reported P values were 2-sided.

Results and discussion

We identified 577 patients with MI undergoing CAG. The median age of patients was 65 (IQR: 56—74) years, 60.7% were male (n = 350). The median and IQR of RDW were 14.2% and 13.5—15.0%, respectively. The baseline characteristics of patients stratified according to quartiles of RDW are shown in Table 1. Patients in the highest quartile of RDW, compared to the lowest quartile, displayed a higher frequency of cardiovascular risk factors such as arterial hypertension, CAD, previous MI, and more concomitant comorbidities such as previous cerebrovascular accidents, atrial fibrillation, peripheral artery disease, and anemia. The median value of the GRACE score also increased in parallel with RDW values.

Table 1

Baseline characteristics and laboratory findings of the study population stratified according to quartiles of red blood cell distribution width

Characteristics	Quartiles of red blood cell distribution width (RDW), %				P
	< 13.5	13.5—14.2	14.3—15.0	>15.0	
Number of patients	127	167	149	137	–
Age, years, Me (IQR)	64 (55; 70)	64 (55; 74)	67 (56; 75)	67 (56.7; 77)	0.119
Men, n (%)	82 (64.6)	104 (62.3)	90 (60.4)	74 (55.2)	0.447
ST elevation, n (%)	58 (45.7)	85 (50.9)	73(49)	56 (41.8)	0.423
Arterial hypertension, n (%)	110 (86.6)	143 (85.6)	141 (94.6)	122 (91)	**0.041**
CAD, n (%)	45 (35.4)	63 (37.7)	78 (52.3)	76 (56.7)	**< 0.001**
Previous MI, n (%)	19 (15)	27 (16.2)	38 (25.5)	40 (29.9)	**0.005**
Prior revascularization, n (%)	15 (11.8)	15 (9.0)	19 (12.8)	23 (17.2)	0.201
Chronic HF, n (%)	7 (5.5)	10 (6.0)	13 (8.7)	10 (7.5)	0.699
Diabetes mellitus, n (%)	22 (17.3)	36 (21.6)	38 (25.5)	30 (22.4)	0.437
Previous cerebrovascular accident, n (%)	2 (1.6)	11 (6.6)	17 (11.4)	11 (8.2)	**0.016**
Atrial fibrillation, n (%)	8 (6.3)	9 (5.4)	25 (16.8)	20 (14.9)	**0.001**
CKD, n (%)	7 (5.5)	11 (6.6)	10 (6.7)	14 (10.4)	0.428
Peripheral artery disease, n (%)	1 (0.8)	1 (0.6)	7 (4.7)	9 (6.7)	**0.005**
Chronic obstructive pulmonary disease, n (%)	12 (9.4)	22 (13.2)	27 (18.1)	22 (16.4)	0.183
Anemia, n (%)	20 (15.7)	26 (15.6)	41 (27.5)	69 (51.5)	**< 0.001**
Systolic BP, mm Hg, Me (IQR)	140 (120; 160)	135 (120; 150)	140 (120; 158)	137 (118; 160)	0.911
Heart rate, b.p.m, Me (IQR)	74 (66; 88)	76 (68; 86)	78 (68; 90)	77 (69.5; 96)	0.094
Troponin, ng/mL, Me (IQR)	0.38 (0.08; 2.70)	0.39 (0.09; 2.94)	0.37 (0.10; 3.45)	0.34 (0.09; 2.61)	0.917
Hemoglobin, g/L, Me (IQR)	140 (128; 148)	141 (129; 149)	137 (123.5; 146)	124 (101; 138.2)	**< 0.001**
Creatinine, μmol/Le Me (IQR)	93 (83; 108)	92 (77; 106)	95 (79; 112)	91 (79; 113)	0.504
Non-obstructive CAD, n (%)	16 (12.6)	17 (10.2)	17 (11.4)	16 (11.9)	0.927
LV EF,%, Me (IQR)	46 (42;55)	46 (40.7; 55)	44 (40; 54.7)	44 (38; 50)	**0.001**
1 vessel CAD, n (%)	20 (15.7)	33 (19.8)	16 (10.7)	17 (12.7)	0.125
2 vessels CAD, n (%)	27 (21.3)	34 (20.4)	41 (27.5)	22 (16.4)	0.146
3 vessels CAD, n (%)	64 (50.4)	83 (49.7)	75 (50.3)	79 (59)	0.356
Percutaneous coronary intervention, n (%)	105 (82.7)	140 (83.8)	115 (77.2)	99 (73.9)	0.121
GRACE score, points, Me (IQR)	113 (95; 132)	116 (96; 139)	124 (100.5; 147)	124 (100; 149.2)	**0.009**
Medical treatment:					
Beta-blockers, n (%)	118 (92.9)	156 (93.4)	138 (92.6)	114 (85.1)	**0.044**
ACEi/ARBs, n (%)	115 (90.6)	145 (86.8)	133 (89.3)	115 (85.8)	0.608
Aspirin, n (%)	123 (96.9)	162 (97)	140 (94)	123 (91.8)	0.136
P_2Y_{12} inhibitors, n (%)	123 (96.9)	163 (97.6)	146 (98)	134 (100)	0.626
Statins, n (%)	123 (96.9)	161 (96.4)	141 (94.6)	134 (100)	0.617
Anticoagulants, n (%)	27 (21.3)	42 (25.1)	44 (29.5)	39 (29.1)	0.373

Note: ACEi: angiotensin converting enzyme inhibitor; ARB: angiotensin receptor blocker; BP: blood pressure, CAD: coronary artery disease; CKD: chronic kidney disease; GRACE: Global Registry of Acute Coronary Events; HF: heart failure; IQR: interquartile range; LV EF: left ventricular ejection fraction; Me: median, MI: myocardial infarction; RDW: red blood cell distribution width.

RDW levels were correlated well with age, history of CAD, previous MI, previous cerebrovascular accidents, atrial fibrillation, peripheral artery disease and the GRACE risk score. There was a negative correlation between RDW and the left ventricular ejection fraction (LV EF) and hemoglobin. We did not observe any significant correlation between RDW and other parameters (Table 2).

Table 2

Spearman's correlations analysis between red blood cell distribution width and other parameters

Variables	rho-value	p
Age	0.116	0.005
CAD	0.179	< 0.001
Previous MI	0.159	< 0.001
Previous cerebrovascular accident	0.099	0.018
Atrial fibrillation	0.132	0.001
Peripheral artery disease	0.136	0.001
Hemoglobin	-0.286	< 0.001
LV EF	-0.162	< 0.001
GRACE score	0.16	< 0.001

Note: CAD: coronary artery disease; GRACE: Global Registry of Acute Coronary Events; LV EF: left ventricular ejection fraction; MI: myocardial infarction.

As regards the follow-up, the median RDW value in patients who died during hospitalization and 18-month follow up was significantly higher than that of survived patients (14.8% vs. 14.2%; $p = 0.005$, respectively and 15.0% vs. 14.1%; $p < 0.001$, respectively). After stratifying the entire study population into quartiles of RDW, the incidence of in-hospital death and death during 18 months increased in parallel with RDW quartiles ($p = 0.008$ and $p < 0.001$, respectively) (Table 3).

Univariate logistic analysis demonstrated that RDW was associated with mortality within 18 months in patients with acute MI (OR 1.38; 95% CI, 1.20—1.58; $p < 0.001$). This association was then confirmed in multivariate analysis (Table 4), which showed that RDW remained independently associated with 18-month death (adjusted OR, 1.33; 95% CI, 1.12—1.58; $p < 0.001$). A higher GRACE score and three-vessel CAD were found to be additional independent predictors of 18-month death.

Table 3

Incidence of in-hospital and 18-month death in patients with an acute myocardial infarction, stratified according to quartiles of red blood cell distribution width

Outcome	Quartiles of red blood cell distribution width (RDW),%				P
	< 13.5	13.5—14.2	14.3—15.0	>15.0	
In-hospital death, n (%)	4 (3.1)	6 (3.6)	6 (4.0)	15 (11.2)	0.008
18-month death, n (%)	5 (3.9)	9 (5.4)	20 (13.4)	32 (23.9)	< 0.001

Table 4

Multivariate logistic regression analysis to assess predictors of 18-month mortality in patients with an acute myocardial infarction

Variables	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
RDW, %	1.38 (1.20—1.58)	< 0.001	1.33 (1.12—1.58)	**0.001**
Age, years	1.10 (1.07—1.13)	< 0.001	1.03 (0.99—1.08)	0.167
Female gender	2.87 (1.69—4.86)	< 0.001	1.71 (0.83—3.51)	0.143
CAD history	3.14 (1.81—5.46)	< 0.001	1.27 (0.62—2.58)	0.511
Previous cerebrovascular accident	3.69 (1.78—7.66)	< 0.001	1.64 (0.65—4.15)	0.293
Diabetes mellitus	2.12 (1.22—3.67)	0.008	1.45 (0.69—3.04)	0.327
Atrial fibrillation	2.60 (1.34—5.03)	0.005	1.41 (0.63—3.14)	0.400
CKD	3.10 (1.47—6.50)	0.003	1.01 (0.37—2.77)	0.983
Anemia	3.91 (3.31—6.61)	< 0.001	1.22 (0.60—2.48)	0.577

End of the table 4

Variables	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Killip class ≥2	4.87 (2.86–8.28)	< 0.001	1.03 (0.48–2.17)	0.948
LV EF ≤40%	2.56 (1.43–4.60)	0.002	1.61 (0.79–3.27)	0.188
GRACE score ≥140	9.83 (5.50–17.59)	< 0.001	3.26 (1.22–8.74)	**0.019**
Three-vessel CAD	4.32 (2.30–8.12)	< 0.001	3.42 (1.57–7.44)	**0.002**

Note: CAD: coronary artery disease; CI: confidence interval; CKD: chronic kidney disease; GRACE: Global Registry of Acute Coronary Events; LV EF: left ventricular ejection fraction; OR: odds ratio, RDW: red blood cell distribution width.Top of Form

In ROC curves analysis, the AUC value was 0.708 in the evaluation of RDW as a predictor of 18-month mortality (Figure 1). The optimal cut-off RDW for estimating 18-month mortality was 14.2, with 78.8% sensitivity and 54.8% specificity (adjusted OR, 4.19; 95% CI, 1.90—9.25; p < 0.001).

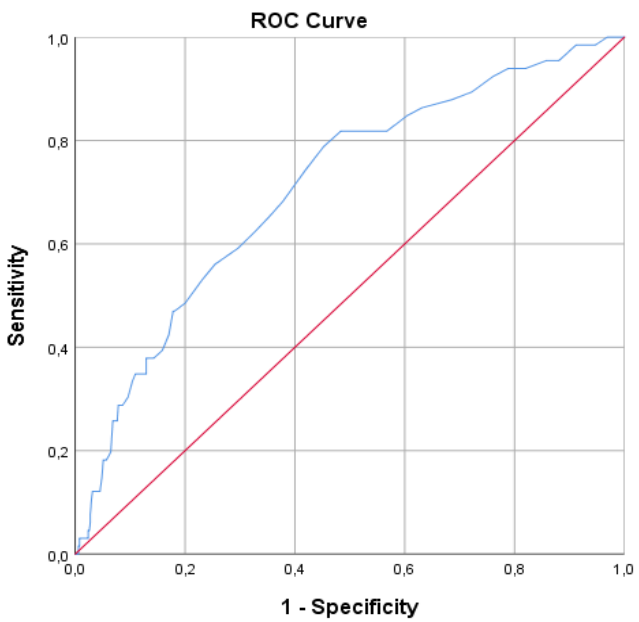

Fig. 1. The receiver-operating characteristic (ROC) curve for red blood cell distribution width for predicting 18-month mortality (area under curve = 0.708, 95% confidence interval: 0.642—0.775, p < 0.001)

In this study we aimed to establish the relationship between RDW and mortality in patients with acute MI patients. The main findings of this study are as follows: 1) patients with acute MI who died within 18 months had higher RDW on admission; 2) the rate of in-hospital and 18-month mortality was significantly higher in patients with high RDW than in those with low RDW; 3) RDW on admission was an independent predictor of 18-month mortality with acute MI.

Several studies previously investigated the role of RDW in predicting adverse outcomes after an acute MI. A high RDW value was found to be a significant predictor of adverse outcomes in patients with acute coronary syndrome (ACS), and especially of both in-hospital and long-term cardiovascular mortality. Uyarel et al. studied 2,506 patients undergoing primary percutaneous coronary intervention (PCI) for ST-segment elevation MI, and showed that patients with elevated RDW (i.e., 16.1%) at admission had higher in-hospital mortality rate compared to those with normal RDW (7.6% vs. 3.6%; P < 0.001) [19, 20]. In a cross-sectional study, included 3101 patients with acute MI, RDW was a significant risk predictor of in-hospital mortality after adjusting for age, sex, clinical and laboratory variables (tertile 3 (≥14.2%) vs tertile 1 (≤13.2%): hazard ratio [HR] 2.3; 95% CI 1.39–4.01; p for trend < 0.05) predictor of in-hospital mortality [13]. Khaki et al followed 649 patients with acute MI for 6 months and found that the 6-month mortality rate was significantly higher in patients with high RDW (≥14.6%) than in those with a low RDW (< 14.6%) (24.3% vs. 7.9%; p < 0.001) [21]. Gul et al. studied 310 patients with non-ST elevation MI and explored the association between RDW at admission and 3-year outcome [22]. The overall mortality rate was significantly higher in the high RDW group (>14.0%) comparted to the low RDW group (≤14.0%) (19% vs. 6%, p < 0.001). A significant association was also

found between high admission RDW and adjusted risk of cardiovascular mortality (HR, 3.2; 95% CI, 1.3-7.78). Similar to these results, our study also showed a positive correlation between RDW, and 18-month mortality of acute MI. Survival rates were highest when the RDW was 13.5% and lowest when the RDW was ≥15.0% after adjusting for age, sex, comorbidity, Killip class, LV EF and GRACE score. More specifically, a RDW higher than 14.2% was found to be associated with a more than 4-fold enhanced risk of 18-month death after an acute MI. Notably, the association between RDW and 18-month mortality was confirmed to be independent from other known risk factors of adverse outcome after cardiac ischemia, thus highlighting the valuable role of measuring RDW in this clinical setting.

While recent research has established RDW as a prognostic indicator for cardiovascular disease, the precise mechanistic pathways underlying the association between elevated RDW and adverse clinical outcomes in cardiovascular conditions remain incompletely elucidated. It is plausible that inflammatory and neurohormonal activation play a crucial role in establishing these mechanistic links, as suggested by recent investigations [23, 24]. Inflammatory factors are implicated in the desensitization of bone marrow erythroid progenitor cells, hindering the antiapoptotic and promaturation effects of erythropoietin. This process leads to an influx of reticulocytes into the peripheral blood, contributing to an elevation in RDW [25]. Additionally, it induces alterations in the lipid structure of red blood cells and compromises their degeneration capacity. Consequently, there is a reduction in the oxygen-carrying capacity of red blood cells and an increase in whole blood viscosity, thereby heightening the mortality risk in patients with MI [11, 16].

Our findings revealed a noteworthy positive correlation between RDW, age, and cardiovascular disease. Elevated RDW values have consistently been associated with adverse outcomes, including mortality and complications, in various chronic and prevalent conditions such as coronary artery disease [14], ischemic cerebrovascular disease [15], atrial fibrillation [26], peripheral artery disease [27], and anemia [28]. The higher RDW levels observed in older patients can be attributed to the increased prevalence of anemia, inflammatory burden, comorbidities, poor nutritional status, and age-associated diseases in this demographic [11, 22]. This observation contributes to a better understanding of the potential linkage between RDW and 18-month mortality among patients with acute MI.

The GRACE score's prognostic significance in ACS aligns with current guidelines [2, 29]. Our study establishes a significant correlation between RDW and the GRACE score, particularly for in-hospital and 18-month mortality. When combined with three-vessel CAD, this association enhances prognostic insights, especially in emergency outpatient settings. This dual assessment holds potential for guiding decisions on patient transfer and treatment strategies.

Our study has several limitations. The single-center design and a relatively small sample size may limit the generalizability of our findings. We did not concurrently assess factors that influence RDW, such as inflammatory markers, malnutrition indicators, and natriuretic peptides, potentially introducing confounding variables. Additionally, RDW was measured only once, preventing an exploration of temporal variations during hospitalization. Future studies with serial measurements are needed to assess the incremental prognostic value of such an approach. Furthermore, our study's exclusive focus on hemoglobin levels overlooks potential influences on RDW from deficiencies in iron, vitamin B12, or folate. Comprehensive assessments of these factors are essential for a more nuanced interpretation of RDW values.

Conclusion

RDW showed a correlation with traditional cardiovascular factors. Higher RDW at admission was independently associated with an elevated risk of 18-month mortality in acute MI patients, underscoring its potential as a prognostic marker in this population.

References / Список литературы

1. Salari N, Morddarvanjoghi F, Abdolmaleki A, Rasoulpoor S, Khaleghi AA, Hezarkhani LA, Shohaimi S, Mohammadi M. The global prevalence of myocardial infarction: a systematic review and meta-analysis. *BMC Cardiovasc Disord*. 2023;23(1):206. doi: 10.1186/s12872-023-03231-w
2. Byrne RA, Rossello X, Coughlan JJ, Barbato E, Berry C, Chieffo A, Claeys MJ, Dan GA, Dweck MR, Galbraith M, Gilard M, Hinterbuchner L, Jankowska EA, Jüni P, Kimura T, Kunadian V, Leosdottir M, Lorusso R, Pedretti RFE, Rigopoulos AG, Rubini Gimenez M, Thiele H, Vranckx P, Wassmann S, Wenger NK, Ibanez B; ESC Scientific Document Group. 2023 ESC Guidelines for the management of acute coronary syndromes. *Eur Heart J*. 2023;44(38):3720—3826. doi: 10.1093/eurheartj/ehad191
3. Chang XW, Zhang SY, Wang H, Zhang MM, Zheng WF, Ma HF, Gu YF, Wei JH, Qiu CG. Combined value of red blood cell distribution width and global registry of acute coronary events risk score on predicting long-term major adverse cardiac events in STEMI patients undergoing primary PCI. *Oncotarget*. 2018;9(17):13971—13980. doi: 10.18632/oncotarget.24128
4. Polat N, Yildiz A, Oylumlu M, Kaya H, Acet H, Akil MA, Yuksel M, Bilik MZ, Aydin M, Ulgen MS. Relationship Between Red Cell Distribution Width and the GRACE Risk Score With In-Hospital Death in Patients With Acute Coronary Syndrome. *Clin Appl Thromb Hemost*. 2014;20(6):577—82. doi: 10.1177/1076029613500707
5. 5. Reed GW, Rossi JE, Cannon CP. Acute myocardial infarction. *Lancet*. 2017;389(10065):197—210. doi: 10.1016/S0140-6736 (16) 30677-8
6. Lovochkina ED. Diagnostic and prognostic role of cardiac pathology multicomplex autoimmune biological markers. *RUDN Journal of Medicine*. 2023;27(1):71—82. doi:10.22363/2313-0245-2023-27-1-71-82. (In Russian). [*Лёвочкина Э.Д.* Диагностическая и прогностическая роль мультикомплексных аутоиммунных биологических маркеров кардиальной патологии // Вестник Российского университета дружбы народов. Серия: Медицина. 2023. Т. 27. № 1. С. 71—82.] doi: 10.22363/2313-0245-2023-27-1-71-82
7. Danese E, Lippi G, Montagnana M. Red blood cell distribution width and cardiovascular diseases. *J Thorac Dis*. 2015;7(10): E402—11. doi: 10.3978/j.issn.2072-1439.2015.10.04
8. 8. Salvagno GL, Sanchis-Gomar F, Picanza A, Lippi G. Red blood cell distribution width: A simple parameter with multiple clinical applications. *Crit Rev Clin Lab Sci*. 2015;52(2):86—105. doi: 10.3109/10408363.2014.992064
9. Förhécz Z, Gombos T, Borgulya G, Pozsonyi Z, Prohászka Z, Jánoskuti L. Red cell distribution width in heart failure: prediction of clinical events and relationship with markers of ineffective erythropoiesis, inflammation, renal function, and nutritional state. *Am Heart J*. 2009;158(4):659—66. doi: 10.1016/j.ahj.2009.07.024
10. Li N, Zhou H, Tang Q. Red Blood Cell Distribution Width: A Novel Predictive Indicator for Cardiovascular and Cerebrovascular Diseases. *Dis Markers*. 2017;2017:7089493. doi: 10.1155/2017/7089493
11. Arkew M, Gemechu K, Haile K, Asmerom H. Red Blood Cell Distribution Width as Novel Biomarker in Cardiovascular Diseases: A Literature Review. *J Blood Med*. 2022;13:413—424. doi: 10.2147/JBM.S367660
12. Liang L, Huang L, Zhao X, Zhao L, Tian P, Huang B, Feng J, Zhang J, Zhang Y. Prognostic value of RDW alone and in combination with NT-proBNP in patients with heart failure. *Clin Cardiol*. 2022;45(7):802—813. doi: 10.1002/clc.23850
13. Huang S, Zhou Q, Guo N, Zhang Z, Luo L, Luo Y, Qin Z, Ge L. Association between red blood cell distribution width and in-hospital mortality in acute myocardial infarction. *Medicine (Baltimore)*. 2021;100(15): e25404. doi: 10.1097/MD.0000000000025404
14. Ren H, Hua Q, Quan M, Chen H, Hou H, Wang L, Liu R, Yang Z. Relationship between the red cell distribution width and the one-year outcomes in Chinese patients with stable angina pectoris. *Intern Med*. 2013;52(16):1769—74. doi: 10.2169/internalmedicine.52.9314
15. Söderholm M, Borné Y, Hedblad B, Persson M, Engström G. Red cell distribution width in relation to incidence of stroke and carotid atherosclerosis: a population-based cohort study. *PLoS One*. 2015;10(5): e0124957. doi: 10.1371/journal.pone.0124957
16. Pernow J, Mahdi A, Yang J, Zhou Z. Red blood cell dysfunction: a new player in cardiovascular disease. *Cardiovasc Res*. 2019;115(11):1596—1605. doi: 10.1093/cvr/cvz156
17. Kobalava Zh.D., Tolkacheva V.V., Vatsik- Gorodetskaya M.V., Cabello- Montoya F.E., Nazarov I.S., Galochkin S.A. Implementation of a «seamless» model of providing specialized medical care to patients with heart failure. *RUDN Journal of Medicine*. 2023;27(2):141—154. doi:10.22363/2313. (In Russian). [*Кобалава Ж.Д., Толкачева В.В., Вацик- Городецкая М.В., Кабельо Монтойа Ф.Э., Назаров И.С., Галочкин С.А.* Реализация «бесшовной» модели оказания специализированной медицинская помощи пациентам с сердечной недостаточностью // Вестник Российского университета дружбы народов. Серия: Медицина. 2023. Т. 27. № 2. С. 141—154. doi: 10.22363/2313-0245-2023-27-2-141-154.]
18. Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD; Joint ESC/ACCF/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction; Katus HA, Lindahl B, Morrow DA, Clemmensen PM, Johanson P, Hod H, Underwood R, Bax JJ, Bonow RO, Pinto F, Gibbons RJ, Fox KA, Atar D, Newby LK, Galvani M, Hamm CW, Uretsky BF, Steg PG, Wijns W, Bassand JP, Menasché P, Ravkilde J, Ohman EM, Antman EM, Wallentin LC, Armstrong PW, Simoons ML, Januzzi JL, Nieminen MS, Gheorghiade M, Filippatos G, Luepker RV, Fortmann SP, Rosamond WD, Levy D, Wood D, Smith SC, Hu D, Lopez-Sendon JL, Robertson RM, Weaver D, Tendera M, Bove AA, Parkhomenko AN, Vasilieva EJ, Mendis S. Third universal definition of myocardial infarction. *Circulation*. 2012;126(16):2020—35. doi: 10.1161/CIR.0b013e31826e1058
19. Fox KA, Fitzgerald G, Puymirat E, Huang W, Carruthers K, Simon T, Coste P, Monsegu J, Gabriel Steg P, Danchin N, Anderson F. Should patients with acute coronary disease be stratified for management according to their risk? Derivation, external validation and outcomes using the updated GRACE risk score. *BMJ Open*. 2014;4(2): e004425. doi: 10.1136/bmjopen-2013-004425
20. Uyarel H, Ergelen M, Cicek G, Kaya MG, Ayhan E, Turkkan C, Yıldırım E, Kırbas V, Onturk ET, Erer HB, Yesilcimen K, Gibson CM. Red cell distribution width as a novel prognostic marker in patients undergoing primary angioplasty for acute myocardial infarction. *Coron Artery Dis*. 2011;22(3):138—44. doi: 10.1097/MCA.0b013e328342c77b
21. Khaki S, Mortazavi SH, Bozorgi A, Sadeghian S, Khoshnevis M, Mahmoodian M. Relationship Between Red Blood Cell Distribution Width and Mortality of Patients with Acute Myocardial Infarction Referring to Tehran Heart Center. *Crit Pathw Cardiol*. 2015;14(3):112—5. doi: 10.1097/HPC.0000000000000047
22. Gul M, Uyarel H, Ergelen M, Karacimen D, Ugur M, Turer A, Bozbay M, Ayhan E, Akgul O, Uslu N. The relationship between red blood cell distribution width and the clinical outcomes in non-ST elevation myocardial infarction and unstable angina pectoris: a 3-year follow-up. *Coron Artery Dis*. 2012;23(5):330—6. doi: 10.1097/MCA.0b013e3283564986

23. Fukuta H, Ohte N, Mukai S, Saeki T, Asada K, Wakami K, Kimura G. Elevated plasma levels of B-type natriuretic Peptide but not C-reactive protein are associated with higher red cell distribution width in patients with coronary artery disease. *Int Heart J*. 2009;50(3):301—12. doi: 10.1536/ihj.50.301

24. Allen LA, Felker GM, Mehra MR, Chiong JR, Dunlap SH, Ghali JK, Lenihan DJ, Oren RM, Wagoner LE, Schwartz TA, Adams KF Jr. Validation and potential mechanisms of red cell distribution width as a prognostic marker in heart failure. *J Card Fail*. 2010;16(3):230—8. doi: 10.1016/j.cardfail.2009.11.003

25. Afsar B, Saglam M, Yuceturk C, Agca E. The relationship between red cell distribution width with erythropoietin resistance in iron replete hemodialysis patients. *Eur J Intern Med*. 2013;24(3): e25—9. doi: 10.1016/j.ejim.2012.11.017

26. Adamsson Eryd S, Borné Y, Melander O, Persson M, Smith JG, Hedblad B, Engström G. Red blood cell distribution width is associated with incidence of atrial fibrillation. *J Intern Med*. 2014;275(1):84—92. doi: 10.1111/joim.12143

27. Zalawadiya SK, Veeranna V, Panaich SS, Afonso L. Red cell distribution width and risk of peripheral artery disease: analysis of National Health and Nutrition Examination Survey 1999—2004. *Vasc Med*. 2012;17(3):155—63. doi: 10.1177/1358863X12442443

28. Salisbury AC, Amin AP, Reid KJ, Wang TY, Alexander KP, Chan PS, Masoudi FA, Spertus JA, Kosiborod M. Red blood cell indices and development of hospital-acquired anemia during acute myocardial infarction. *Am J Cardiol*. 2012;109(8):1104—10. doi: 10.1016/j.amjcard.2011.11.045

29. Gulati M, Levy PD, Mukherjee D, Amsterdam E, Bhatt DL, Birtcher KK, Blankstein R, Boyd J, Bullock-Palmer RP, Conejo T, Diercks DB, Gentile F, Greenwood JP, Hess EP, Hollenberg SM, Jaber WA, Jneid H, Joglar JA, Morrow DA, O'Connor RE, Ross MA, Shaw LJ. 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation*. 2021;144(22): e368-e454. doi:10.1161/CIR.0000000000001029

Прогностическое значение ширины распределения эритроцитов при остром инфаркте миокарда

Ч.Х. Хоанг[1, 2] ✉, В.В. Майсков[3, 4], И.А. Мерай[3, 4], Ж.Д. Кобалава[3, 4]

[1]Медицинский университет Фам Нгок Тач, *г. Хошимин, Вьетнам*
[2]Кардиологическая больница Там Дык, *г. Хошимин, Вьетнам*
[3]Российский университет дружбы народов имени Патриса Лумумбы, *г. Москва, Российская Федерация*
[4]Городская клиническая больница им. В.В. Виноградова, *г. Москва, Российская Федерация*
✉ truonghh@pnt.du.vn

Аннотация. *Актуальность.* Ширина распределения эритроцитов (red blood cell distribution width, RDW), показатель вариабельности размера эритроцитов рассматриваются как потенциальный прогностический фактор при сердечно-сосудистых заболеваниях. Точное оценивание риска при остром инфаркте миокарда (ИМ) крайне важно, однако выявление надежных прогностических маркеров остается необходимым для принятия клинических решений и улучшения долгосрочной выживаемости. Цель исследования: изучить прогностическое значение RDW при поступлении на долгосрочную смертность у пациентов с острым ИМ. *Материалы и методы.* Проспективное наблюдательное исследование включало 577 пациентов с острым ИМ, которым была проведена коронарография в течение 24 часов с момента поступления. Демографические данные, витальные показатели, результаты лабораторных исследований и сопутствующие заболевания были получены из базы данных. Первичной конечной точкой являлась 18-месячная смертность. Ассоциация между RDW, клиническими параметрами и исходом оценивалась с использованием логистической регрессии и ROC-анализ (receiver operating characteristic). *Результаты и обсуждение.* Медиана возраста пациентов составила 65 лет (интерквартильный размах [ИКР]: 56–74), 60,7% были мужчинами. Частота 18-месячной смертности составила 11,4% (n = 66). Медиана RDW была 14,2% (ИКР 13,5–15,0%). RDW коррелировал с возрастом, ишемической болезнью сердца, предыдущи ИМ, предыдущими цереброваскулярными инцидентами, фибрилляцией предсердий, заболеванием периферических артерий, гемоглобином, фракцией выброса левого желудочка и баллами по шкале GRACE. У пациентов с 18-месячной смертностью уровень RDW был значительно выше по сравнению с выжившими (15,0% против 14,1%, $p < 0{,}001$). Более высокие значения RDW ассоциировались с увеличением 18-месячной смертности (квартиль 1: 3,9%, квартиль 2: 5,4%, квартиль 3: 13,4%, квартиль 4: 23,9%, $p < 0{,}001$). Однофакторный логистический регрессионный анализ показал, что RDW ассоциирован с 18-месячной смертностью (отношение шансов [ОШ], 1,38; 95%

доверительный интервал [ДИ], 1,20—1,58, $p < 0,001$). Многофакторный анализ выявил RDW как независимый предиктор 18-месячной смертности (скорректированное ОШ: 1,33, 95% CI: 1,12—1,58, $p < 0,001$). Площадь под ROC-кривой для RDW составила 0,708 (95% CI: 0,642—0,775, $p < 0,001$) для предсказания 18-месячной смертности. Оптимальное пороговое значение RDW для предсказания 18-месячной смертности составило 14,2% при чувствительности 78,8% и специфичности 54,8%. *Выводы.* Повышенное значение RDW при поступлении было связано с повышенным риском 18-месячной смертности у пациентов с острым ИМ. RDW была независимым предиктором 18-месячной смертности у пациентов с острым ИМ, подчеркивая ее потенциал как прогностического маркера в данной популяции.

Ключевые слова: долгосрочная смертность; острый инфаркт миокарда; прогноз; ширина распределения эритроцитов

Информация о финансировании. Авторы заявляют об отсутствии внешнего финансирования.

Вклад авторов: Ч.Х. Хоанг, В.В. Майсков — сбор материала; Ч.Х. Хоанг, В.В. Майсков — статистическая обработка данных; Ч.Х. Хоанг, В.В. Майсков, И.А. Мерай— литературный обзор, анализ и интерпретация результатов; Ч.Х. Хоанг, Ж.Д. Кобалава — концепция и дизайн исследования. Все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией.

Информация о конфликте интересов. Авторы заявляют об отсутствии конфликта интересов.

Этическое утверждение. Исследование одобрено Комиссией по вопросам этики Медицинского института Российского университета дружбы народов имени Патриса Лумумбы.

Благодарности — неприменимо.

Информированное согласие на публикацию. У всех пациентов было получено добровольное информированное согласие на участие в исследовании согласно Хельсинкской декларации Всемирной медицинской ассоциации (WMA Declaration of Helsinki — Ethical Principles for Medical Research Involving Human Subjects, 2013), обработку персональных данных и согласие на публикацию.

Поступила 16.06.2024. Принята 17.07.2024.

Для цитирования: *Hoang T.H., Maiskov V.V, Merai I.A., Kobalava Z.D.* Prognostic value of red cell distribution width in acute myocardial infarction // Вестник Российского университета дружбы народов. Серия: Медицина. 2025. Т. 29. № 2. С. 143—152. doi: 10.22363/2313-0245-2025-29-1-143-152 EDN KRZZRO

Corresponding author: Truong Huy Hoang — MD, PhD, Lecturer of the Department of Internal Medicine, Pham Ngoc Thach University of Medicine, 72410, Duong Quang Trung Street, Building 02, Ho Chi Minh City, Vietnam. Cardiologist at the Department of Cardiology 5, Tam Duc Heart Hospital, Ho Chi Minh City, Vietnam. E-mail: truonghh@pnt.edu.vn
Hoang T.H. ORCID 0000-0002-2013-2647
Maiskov V.V. ORCID 0009-0002-2135-2606
Merai I.A. ORCID 0000-0001-6818-8845
Kobalava Zh.D. ORCID 0000-0002-5873-1768

Ответственный за переписку: Чыонг Хюй Хоанг — кандидат медицинских наук, преподаватель кафедры внутренних болезней Медицинского университета Фам Нгок Тач, кардиолог отделения кардиологии 5 кардиологической больницы Там Дык, Хошимин, Вьетнам, 72410, г. Хошимин, улица Дуонг Куанг Трунг, дом 2. E-mail: truonghh@pnt.edu.vn
Хоанг Ч.Х. SPIN 5684-0275, ORCID 0000-0002-2013-2647
Майсков В.В. SPIN 7370-7545, ORCID 0009-0002-2135-2606
Мерай И.А. SPIN 4477-7559, ORCID 0000-0001-6818-8845
Кобалава Ж.Д. SPIN 9828-5409, ORCID 0000-0002-5873-1768