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Relationship between the red cell distribution width-to-platelet ratio and in-hospital mortality among critically ill patients with acute myocardial infarction: a retrospective analysis of the MIMIC-IV database

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ABSTRACT

Objectives We aimed to investigate the association between red cell distribution width-to-platelet ratio (RPR), and in-hospital mortality in critically ill patients with acute myocardial infarction (AMI).

Design A retrospective cohort study.

Setting Data were collected from the Medical Information Mart for Intensive Care database (MIMIC-IV) consisting of critically ill participants between 2008 and 2019 at the Beth Israel Deaconess Medical Centre in Boston.

Participants A total of 5067 patients with AMI were enrolled from the MIMIC-IV database.

Primary and secondary outcome In-hospital mortality.

Results A total of 4034 patients survived, while 1033 died. In a multiple regression analysis adjusted for age, weight and ethnicity, RPR also showed a positive correlation with in-hospital mortality (HR 1.91, 95% CI 1.42 to 2.56, p<0.0001). Moreover, after adjusting for additional confounding factors, obvious changes were observed (HR 1.63, 95% CI 1.03 to 2.57, p=0.0357). In model 2, the high ratio quartile remained positively associated with hospital mortality compared with the low ratio quartile (HR 1.20, 95% CI 1.01 to 1. 43), with a p-value trend of 0.0177. Subgroup analyses showed no significant effect modifications on the association between RPR and in-hospital mortality in the different AMI groups (p>0.05).

Conclusion RPR is an independent predictor of in-hospital mortality in critically ill patients with AMI.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study enrolled 5067 patients, which is a very large sample size for a clinical study of acute myocardial infarction.
⇒ We adjusted for additional confounding factors and improved the reliability of the results and performed a subgroup analysis of the association between red cell distribution width-to-platelet ratio and in-hospital mortality.
⇒ This was a retrospective study without long-term follow-up, so the results may be biased.
⇒ The data of this study come from a Medical Information Mart for Intensive Care database, and some data that may affect the results may be missing, which slightly offsets the results, and we look forward to clinical practice in the future.

INTRODUCTION

Acute myocardial infarction (AMI) is one of the most common acute and severe cardiovascular diseases worldwide. The incidence rate has increased in recent years, with a trend towards younger patients. It leads to myocardial ischaemia and hypoxia, and threatens life.[1] The risk of death in patients with AMI within 1 year is 4%–12%.[2] Due to the poor prognosis of AMI, it is necessary to explore the associated risk factors for death.

A complete blood count is a laboratory test frequently used in clinical practice and comprises white cell count, red cell count, platelet counts and morphological indices such as red cell distribution width (RDW). The measurement and morphological parameters of blood cells have been verified to be valuable in evaluating severity and predicting outcomes in various clinical settings.[3 4] RDW is a quantitative parameter that indicates the degree of volume variation in erythroid cells and is customarily used in haematology to help diagnose anaemia.[5] Population-based studies have shown that RDW independently and directly predicts mortality in cardiovascular and other acute and chronic diseases such as AMI, heart failure, pulmonary hypertension, ischaemic stroke, coronavirus disease 2019, acute pancreatitis and acute

kidney injury.[6–12] There is sufficient evidence to indicate that RDW is an effective parameter for predicting clinical prognosis and may have profound implications in clinical treatment.

Platelets are small bioactive masses in the cytoplasm that are shed by cytoplasmic lysis of bone marrow megakaryocytes. Studies have shown that platelets are markers of chronic inflammation and are associated with poor clinical outcomes in various cardiovascular diseases.[13] Relationships between platelet ratio and chronic obstructive pulmonary disease, acute aortic dissection, peritoneal dialysis, haemodialysis, and severe pneumonia have been reported in numerous studies.[14–18] Decreased platelet count in severe disease is a predictor of mortality.[19] This suggests that platelet ratio may be used as a tool for predicting the prognosis of patients with AMI.

The red cell distribution width-to-platelet ratio (RPR) is a new and simple indicator of inflammation and reflects the severity of inflammation. Studies have reported a significant correlation between RPR levels and mortality in patients with acute kidney injury, sepsis, severe burn injury and breast cancer.[20–23] To the best of our knowledge, only a few studies have explored the prognostic effects of RPR expression in AMI. Therefore, we designed this study to examine the association between RPR and in-hospital mortality in critically ill patients with AMI.

METHODS

Data source

We obtained data from the Medical Information Mart for Intensive Care (MIMIC-IV) (V.1.0) database, which includes more than 40 000 intensive care unit (ICU) inpatients admitted to the Beth Israel Deaconess Medical Center in Boston between 2008 and 2019. We completed the National Institute of Health's web-based course and passed the examination, which was approved by the Massachusetts Institute of Technology and the institutional review boards of Beth Israel Deaconess Medical Centre. One of the authors completed the Collaborative Institutional Training Initiative examination and obtained permission to access the database for data extraction (certificate number: 6182750).

Patient and public involvement

The patients and the public were not directly involved in this study.

Study population

AMI is characterised by myocardial ischaemic necrosis. On the basis of coronary artery disease, the rapid reduction or interruption of coronary artery blood supply causes severe and lasting acute ischaemia of the corresponding myocardium, leading to myocardial necrosis.[24] We restricted the search to adult patients (aged≥18 years) with AMI, defined as ICD-9 codes of 410 and ICD-10 code of I21. Inclusion criteria were as follows: (1) initial diagnosis of AMI at the first ICU admission; (2) aged ≥18 years. The exclusion criteria were as follows: (1) patients with AMI at ICU admission during the same hospitalisation; (2) ICU length of stay<24 hour; (3) RDW and missing platelet data.

Variable extraction

The data were obtained using a structured query language executed in the MIMIC-IV database. The extracted data included demographics, clinical characteristics, scoring systems, vital signs, laboratory parameters and drug use data. Data were extracted from patients admitted to the ICU for the first time. The primary endpoint of this study was in-hospital mortality among critically ill patients with AMI.

Statistical analyses

The baseline characteristics of all patients were stratified according to hospital mortality. The baseline characteristics of all patients were expressed as SD or median or IQR for continuous variables, and frequencies and percentages (%) for categorical variables. A t-test (normal distribution) or Mann-Whitney U test was used to detect differences among the different baseline characteristics. Univariate and multivariate analyses were used to explore the factors influencing in-hospital mortality in patients with AMI. Cox regression was used to determine whether RPR was independently associated with hospital mortality among patients with AMI, and the results were expressed

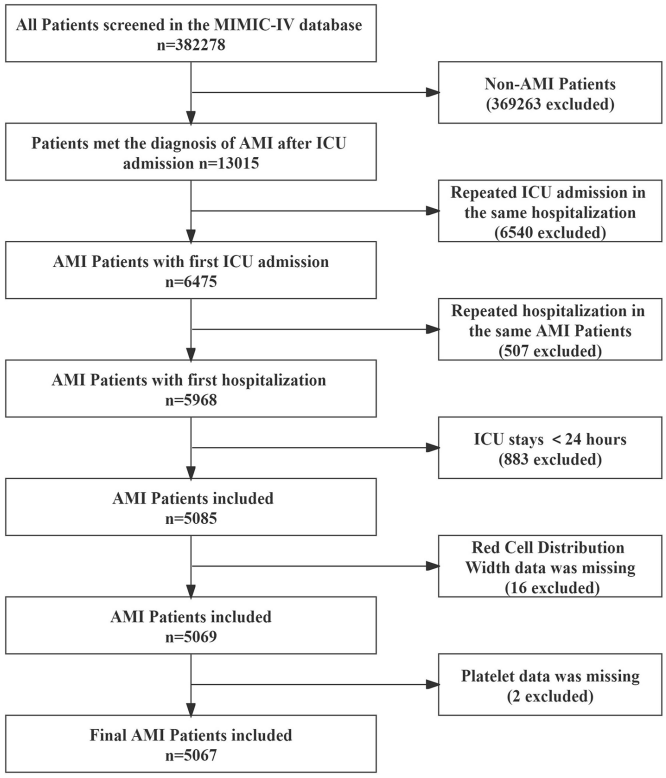

Figure 1 Flowchart of subject screening. Flow chart illustrating the inclusion and exclusion criteria. AMI, acute myocardial infarction; ICU, intensive care unit; MIMIC, Medical Information Mart for Intensive Care; Non-AMI, non-acute myocardial infarction.

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Table 1 Baseline characteristics of patients stratified by hospital mortality

	Survival, n=4034	Death, n=1033	P value	P value*
Age, mean (SD)	70.64 (13.07)	74.43 (12.52)	<0.001	<0.001
Gender			0.065	
Female, n (%)	2543 (63.04%)	619 (59.92%)		
Male, n (%)	1491 (36.96%)	414 (40.08%)		
Height, mean (SD)	169.80 (10.39)	168.56 (10.51)	0.006	0.005
Weight, mean (SD)	83.15 (21.00)	80.22 (22.23)	<0.001	<0.001
Ethnicity			0.002	
White, n (%)	2751 (68.20%)	680 (65.83%)		
Black/African, n (%)	295 (7.31%)	103 (9.97%)		
Asian, n (%)	76 (1.88%)	32 (3.10%)		
Unknown/American/Indian Alaska/Native, n (%)	912 (22.61%)	218 (21.10%)		
Clinical characters				
Charlson Comorbidity Index, mean (SD)	7.02 (2.63)	8.50 (2.61)	<0.001	
Urine output	1675.00 (1065.50–2470.00)	1078.00 (544.25–1863.25)	<0.001	<0.001
PCI			<0.001	
No, n (%)	3183 (78.90%)	909 (88.00%)		
Yes, n (%)	851 (21.10%)	124 (12.00%)		
Scoring systems				
SIRS score, mean (SD)	2.55 (0.92)	2.87 (0.87)	<0.001	<0.001
APS-III score, median (Q1, Q3)	43.38 (19.43)	65.35 (24.87)	<0.001	<0.001
SOFA score, median (Q1, Q3)	5.00 (2.00–7.00)	8.00 (5.00–12.00)	<0.001	<0.001
OASIS score, mean (SD)	32.04 (8.81)	39.25 (9.93)	<0.001	<0.001
HAS-BLED score, median (Q1, Q3)	1.00 (1.00–2.00)	1.00 (1.00–2.00)	<0.001	<0.001
Vital signs				
Heart rate, mean (SD)	85.70 (18.12)	91.19 (20.55)	<0.001	<0.001
Respiratory rate, mean (SD)	18.74 (5.79)	21.486 (6.46)	<0.001	<0.001
SpO_2, mean (SD)	97.07 (4.12)	96.01 (4.88)	<0.001	<0.001
Laboratory parameters				
White cell count median (Q1, Q3)	11.20 (8.30–15.00)	12.50 (8.70–17.40)	<0.001	<0.001
Red cell count mean (SD)	3.70 (0.85)	3.57 (0.83)	<0.001	<0.001
RDW, mean (SD)	14.56 (2.03)	15.80 (2.50)	<0.001	<0.001
PLT, median (Q1, Q3)	204.50 (154.00–264.00)	202.00 (140.00–283.00)	0.970	0.349
RPR	0.07 (0.05–0.09)	0.08 (0.05–0.11)	<0.001	<0.001
Glucose	135.00 (111.00–180.00)	160.00 (119.00–224.00)	<0.001	<0.001
Potassium, mean (SD)	4.39 (0.82)	4.55 (0.95)	<0.001	<0.001
Calcium, mean (SD)	8.53 (0.81)	8.40 (0.97)	<0.001	<0.001
Anion gap, mean (SD)	15.68 (4.92)	18.52 (5.42)	<0.001	<0.001
Creatinine median (Q1, Q3)	1.10 (0.80–1.60)	1.60 (1.10–2.60)	<0.001	<0.001
PT, median (Q1, Q3)	13.60 (12.10–15.80)	14.50 (12.70–18.68)	<0.001	<0.001
Haematocrit, mean (SD)	33.62 (7.29)	32.84 (7.25)	0.002	<0.001
Drugs				
Warfarin			<0.001	
No	3039 (75.33%)	868 (84.03%)		
Yes	995 (24.67%)	165 (15.97%)		
Aspirin			<0.001	
No	310 (7.68%)	181 (17.52%)		

Continued

Table 1 Continued

	Survival, n=4034	Death, n=1033	P value	P value*
Yes	3724 (92.32%)	852 (82.48%)		
Betablockers			<0.001	
No	1644 (40.75%)	541 (52.37%)		
Yes	2390 (59.25%)	492 (47.63%)		
Vasopressin			<0.001	
No	3785 (93.83%)	748 (72.41%)		
Yes	249 (6.17%)	285 (27.59%)		

HAS-BLED: a recently developed and validated scoring system to assess bleeding risk in patients with atrial fibrillation (AF) who are receiving anticoagulant therapy.
AMI, acute myocardial infarction; APS-III, Acute Physiology Score-III; OASIS, Overall Anxiety Severity and Impairment Scale; PCI, percutaneous coronary intervention; PLT, platelet; PT, prothrombin time; p-value*, u-test; p-value, t-test; (Q1, Q3), IQR; RDW, red cell distribution width; RPR, red cell distribution width-to-platelet ratio; SIRS, systemic inflammatory response; SOFA, sequential organ failure assessment; SPO_2, percutaneous oxygen saturation.

as HRs and 95% CIs. No covariates were adjusted in the non-adjusted model. In model I, only age, weight and ethnicity were adjusted. In model II, age, weight, ethnicity, hyperlipidaemia, Charlson Comorbidity Index (CCI) score, coronary artery bypass grafting (CABG), urine output, Acute Physiology Score-III (APS-III), Simplified Acute Physiology Score-II (SAPS-II), respiratory rate, temperature, a recently developed and validated scoring system to assess bleeding risk in patients with atrial fibrillation who were receiving anticoagulant therapy (HAS-BLED), creatinine, partial thromboplastin time (PTT), troponin, warfarin, beta-blockers and vasopressin were adjusted. Furthermore, we conducted subgroup analyses to evaluate whether the effect of RPR on in-hospital mortality differed across various subgroups, including different AMI groups. All analyses were performed using Free Statistics software V.1.4, and p<0.05 (two-sided) was considered statistically significant.

RESULTS

The characteristics of selected patients

As shown in figure 1, the MIMIC-IV database included 382 278 patients and 523 740 hospital admissions with 76 540 ICU admissions. This study included 5067 patients with AMI from the MIMIC-IV database. Patients were stratified by hospital mortality, with 4034 surviving patients and 1033 dying. There were 3162 women and 1905 men, with a mean age of (71.43±13.05) years. In this study, 3431 patients (67.71%) were Caucasian. Table 1 shows the general information of patients with AMI.

Univariate and multivariate analyses of hospital mortality in critically ill patients with AMI

Univariate analysis indicated that age (p<0.0001), CCI (p=0.0131), urine output (p<0.0001), mechvent (p<0.0001), systemic inflammatory response (SIRS) score (p<0.0001), sequential organ failure assessment (SOFA) score (p<0.0001), Overall Anxiety Severity and Impairment Scale (OASIS) score (p<0.0001), APS-III score (p<0.0001), HAS-BLED score (p=0.0032), heart rate (p=0.0001), respiratory rate (p<0.0001), white cell count (p<0.0001), RDW (p<0.0001), glucose (p=0.0053), calcium (p<0.01), anion gap (p<0.0001), creatinine (p=0.0217), RDW to total PLT ratio (p<0.01), vital signs and anticoagulant drugs, among others, were correlated with hospital mortality. Multivariate analysis showed that age (p<0.0001), urine output (p=0.0002), APS-III score (p=0.0006), HAS-BLED score (p=0.0296), respiratory rate (p=0.0024), RDW (p=0.0201), creatinine (p=0.0211), troponin (p<0.0001), warfarin (p<0.0001), betablockers (p<0.0001) and vasopressin (p<0.0001) were factors associated with hospital mortality; however, no significant differences were observed with the other variables (table 2).

The relationship between the ratio and hospital mortality in a multiple regression model in critically ill patients with AMI

The results of the Cox proportional hazard regression model are presented in table 3. In model 1, adjusted for age, weight and ethnicity, the ratio also showed a positive correlation with in-hospital mortality (HR 1.91, 95% CI 1.42 to 2.56, p<0.0001). In model 2, adjusted for age, weight, ethnicity, hyperlipidaemia, CCI, CABG, urine output, APS-III, SAPS-II, respiratory rate, temperature, HAS-BLED, creatinine, PTT, troponin, warfarin, betablockers, vasopressin and obvious changes were observed (HR 1.63, 95% CI 1.03 to 2.57, p=0.0357). Then, tests for trends were conducted using multivariate proportional hazard regression models by entering the median value of each ratio quartile as a continuous variable in the models. The patients with a lower ratio were included in the reference group. In model 1, a high quartile ratio was associated with an increased risk of in-hospital mortality (HR 1.30, 95% CI 1.10 to 1.53). In model 2, the high ratio quartile remained positively associated with hospital mortality compared with the low ratio quartile (HR 1.20, 95% CI 1.01 to 1. 43), with a p-value trend of 0.0177.

Table 2 Analysis of influencing factors of hospital mortality in critically ill patients with AMI

	Univariate		Multivariate	
Variable	HR (95% CI)	P value	HR (95% CI)	P value
Age, mean (SD)	1.02 (1.01 to 1.03)	<0.0001	1.03 (1.02 to 1.04)	<0.0001
Gender				
Female, n (%)	Ref			
Male, n (%)	1.05 (0.93 to 1.19)	0.4584		
Height, mean (SD)	0.99 (0.99 to 1.00)	0.1092		
Weight, mean (SD)	1.00 (0.99 to 1.00)	0.0016	1.00 (1.00 to 1.01)	0.2931
Ethnicity				
White, n (%)	Ref		Ref	
Black/African, n (%)	1.03 (0.83 to 1.27)	0.7948	0.74 (0.57 to 0.96)	0.0231
Asian, n (%)	1.22 (0.85 to 1.74)	0.2753	1.06 (0.69 to 1.62)	0.8066
Unknown/American/Indian Alaska/ Native, n (%)	1.22 (1.05 to 1.42)	0.0116	1.07 (0.89 to 1.28)	0.4936
Clinical characters				
Charlson Comorbidity Index, mean (SD)	1.10 (1.07 to 1.12)	<0.0001	1.04 (1.01 to 1.08)	0.0131
Mechvent				
No, n (%)	Ref		Ref	
Yes, n (%)	1.50 (1.32 to 1.69)	<0.0001	1.16 (0.89 to 1.52)	0.2678
Urine output	1.01 (1.02 to 1.06)	<0.0001	1.00 (1.00 to to 1.00)	0.0002
PCI				
No, n (%)	Ref			
Yes, n (%)	0.85 (0.70 to 1.02)	0.0812		
Scoring systems				
SIRS score, mean (SD)	1.22 (1.14 to 1.31)	<0.0001	0.99 (0.89 to 1.09)	0.8238
SOFA score, median (Q1, Q3)	1.14 (1.12 to 1.15)	<0.0001	1.01 (0.97 to 1.04)	0.8163
OASIS score, mean (SD)	1.06 (1.05 to 1.06)	<0.0001	1.00 (0.98 to 1.02)	0.8847
APS-III score, median (Q1, Q3)	1.02 (1.02 to 1.03)	<0.0001	1.01 (1.00 to 1.02)	0.0006
HAS-BLED score, median (Q1, Q3)	1.12 (1.04 to 1.20)	0.0032	0.90 (0.83 to 0.99)	0.0296
Vital signs				
Heart rate, mean (SD)	1.01 (1.00 to 1.01)	0.0001	1.00 (1.00 to 1.01)	0.1080
Respiratory rate, mean (SD)	1.04 (1.04 to 1.05)	<0.0001	1.02 (1.01 to 1.03)	0.0024
SpO_2, mean (SD)	0.97 (0.96 to 0.98)	<0.0001	1.00 (0.99 to 1.02)	0.8192
Laboratory parameters				
White cell count median (Q1, Q3)	1.01 (1.01 to 1.02)	<0.0001	1.00 (1.00 to 1.01)	0.2769
Red cell count median (Q1, Q3)	0.96 (0.90 to 1.03)	0.3045		
RDW, mean (SD)	1.11 (1.09 to 1.13)	<0.0001	1.04 (1.01 to 1.07)	0.0201
PLT, median Q1, Q3)	1.00 (1.00 to 1.00)	0.1141		
RPR	1.92 (1.44 to 2.58)	<0.0001	1.13 (0.65 to 1.97)	0.6548
Glucose	1.00 (1.00 to 1.00)	0.0053	1.00 (1.00 to 1.00)	0.4051
Potassium, mean (SD)	1.07 (1.00 to 1.14)	0.0572		
Calcium, mean (SD)	0.88 (0.82 to 0.94)	0.0002	0.96 (0.88 to 1.04)	0.3004
Anion gap, mean (SD)	1.05 (1.04 to 1.06)	<0.0001	1.02 (1.00 to 1.04)	0.1092
Creatinine median (Q1, Q3)	1.02 (1.00 to 1.04)	0.0217	0.93 (0.87 to 0.99)	0.0211
Troponint, median (Q1, Q3)	1.03 (1.01 to 1.06)	0.0006	1.04 (1.03 to 1.06)	<0.0001
Haematocrit, mean (SD)	1.00 (0.99 to 1.01)	0.6288		

Continued

Table 2 Continued

Variable	Univariate HR (95% CI)	Univariate P value	Multivariate HR (95% CI)	Multivariate P value
PT, median (Q1, Q3)	1.01 (1.00 to 1.01)	0.0006	1.01 (0.99 to 1.02)	0.4101
Drugs				
Warfarin				
No	Ref		Ref	
Yes	0.42 (0.36 to 0.50)	<0.0001	0.34 (0.28 to 0.43)	<0.0001
Aspirin				
No	Ref		Ref	
Yes	0.48 (0.41 to 0.57)	<0.0001	1.03 (0.41 to 2.55)	0.9542
Betablockers				
No	Ref			
Yes	0.61 (0.54 to 0.69)	<0.0001	0.76 (0.65 to 0.89)	0.0004
Vasopressin				
No	Ref			
Yes	2.63 (2.29 to 3.02)	<0.0001	1.70 (1.39 to 2.09)	<0.0001

HAS-BLED: a recently developed and validated scoring system to assess bleeding risk in patients with atrial fibrillation (AF) who are receiving anticoagulant therapy.
APS-III, Acute Physiology Score-III; OASIS, overall anxiety severity and impairment scale; PCI, percutaneous coronary intervention; PLT, platelet; PT, prothrombin time; p-value*, u-test; p-value, t-test; (Q1, Q3), IQR; RDW, red cell distribution width; RPR, red cell distribution width to platelet ratio; SIRS, systemic inflammatory response; SOFA, sequential organ failure assessment; SPO_2, percutaneous oxygen saturation.

Subgroup analyses

Table 4 shows no significant effect modifications on the association between RPR and hospital mortality in the different AMI groups (p>0.05).

DISCUSSION

This study focused on the association between RPR and in-hospital mortality in critically ill patients with AMI. RPR is a parameter that changes rapidly and may have less impact on long-term mortality. Therefore, we only included in-hospital mortality as the main outcome of this study. This study found that RPR was an independent predictor of in-hospital mortality in critically ill patients with AMI. After adjusting for age, weight, ethnicity and other confounding factors, higher RPR remained a significant predictor of in-hospital mortality. Furthermore, there were no significant interactions between RPR and the different AMI groups, and the interactions indicated that high RPR remained a significant predictor of in-hospital mortality.

Table 3 The relationship between the RPR ratio and hospital mortality in a Cox regression model

Variable	Non-adjusted model HR (95% CI)	Non-adjusted model P value	Adjust model I HR (95% CI)	Adjust model I P value	Adjust model II HR (95% CI)	Adjust model II P value
RPR ratio	1.92 (1.44 to 2.58)	<0.0001	1.91 (1.42 to 2.56)	<0.0001	1.63 (1.03 to 2.57)	0.0357
RPR ratio quartile						
Q1	Ref		Ref		Ref	
Q2	0.88 (0.73 to 1.06)	0.1906	0.89 (0.74 to 1.07)	0.2227	0.82 (0.68 to 1.01)	0.0565
Q3	0.94 (0.78 to 1.12)	0.4705	0.92 (0.77 to 1.10)	0.3650	0.92 (0.76 to 1.12)	0.4047
Q4	1.30 (1.10 to 1.53)	0.0016	1.30 (1.10 to 1.53)	0.0020	1.20 (1.01 to 1.43)	0.0473
P for trend	0.0009		0.0013		0.0177	

RPR ratio: cell distribution width to platelet ratio; Non-adjusted model adjust for: none; Adjust I model adjust for: age, weight, ethnicity; Adjust II model adjust for: age, weight, ethnicity, hyperlipdemia, Charlson Comorbidity Index; HAS-BLED, a recently developed and validated scoring system to assess bleeding risk in patients with atrial fibrillation (AF) who are receiving anticoagulant therapy, creatinine.
APS-III, Acute Physiology Score-III; CABG, coronary artery bypass grafting, urine output; PTT, partial thromboplastin time, troponint, warfarin, betablockers, vasopressin; SAPS-II, Simplified Acute Physiology Score-II, respiratory rate, temperature.

Table 4 AMI subgroup analyses by stratified Cox regression

Subgroup	N	HR (95% CI)	P value	P (interaction)
AMI group				0.9974
STEMI	1108	1.09 (0.32 to 3.74)	0.8897	
Non-STEMI	1443	1.38 (0.47 to 4.03)	0.5529	
Myocardial infarction type 2	621	1.03 (0.30 to 3.56)	0.9592	
Subendocardial infarction	1737	1.19 (0.37 to 3.78)	0.7697	
other	158	1.34 (0.03 to 69.75)	0.8846	

Risk factor: RPR.
Outcome variable: hospital mortality.
Stratification adjusted for: age, weight, ethnicity, hyperlipdaemia, Charlson Comorbidity Index. HAS-BLED: a recently developed and validated scoring system to assess bleeding risk in patients with atrial fibrillation (AF) who are receiving anticoagulant therapy, Creatinine.
AMI, acute myocardial infarction; RPR, red cell distribution width-to-platelet ratio; STEMI, ST-segment elevated myocardial infarction.

AMI is a leading cause of mortality worldwide, accounting for nearly 1.8 million deaths annually and 20% of all deaths in Europe.[25] In recent years, the number of inpatients with ST-segment elevated myocardial infarction (STEMI) in China has tripled, despite ongoing efforts to improve outcomes. However, the mortality rate associated with AMI continues to increase rapidly.[26] AMI is a serious threat to public health owing to its high incidence and poor prognosis. Plaque rupture or(and) thrombosis blocking the coronary artery, causing acute myocardial ischaemia, injury, and necrosis, are the main causes of AMI pathogenesis. In addition, AMI can cause relevant serological changes and activate inflammatory responses, leading to serious adverse cardiovascular and cerebrovascular events, such as left ventricular systolic dysfunction and heart failure.[27 28] Therefore, early identification of high-risk patients using serological indicators is important for improving patient outcomes. RDW is a novel inflammation-related predictive marker and independent risk factor that plays an important role in predicting the severity and progression of cardiovascular disease.[6] Therefore, many clinicians are eager to study the related factors affecting the prognosis in critically ill patients with AMI.

In the last couple of years, new research progress has been made regarding serological indicators for AMI risk assessment. Several studies have reported that in-hospital and long-term mortality doubled in STEMI patients with a high platelet-to-lymphocyte ratio (PLR) at admission, and PLR has a better predictive value for mortality in STEMI patients.[29 30] Platelets can promote thrombus formation and trigger acute coronary events through mechanisms such as stimulation of inflammatory processes. Song *et al*[31] showed that low and high platelet counts were associated with an increased risk of all-cause mortality in patients with AMI and that these associations were not affected by adjusting for a number of potential confounding factors. The RDW is the ratio of the SD of the RBC volume to the mean RBC volume and can be easily calculated. However, an increasing number of studies have suggested that a high RDW is also an independent predictor of poor prognosis in many diseases, such as coronary heart disease,[32] cardiogenic shock[33] and acute kidney injury.[11] A previous study[34] showed that RDW values were significantly associated with increased hazards of 1-year all-cause mortality in patients with AMI. RDW reflects the level of inflammation, and an inflammatory reaction plays an important role in the occurrence and development of AMI.[35] Previous studies[34 36] have found that when an inflammatory response occurs, red cell count proliferation and maturation are impaired, red cell count production is ineffective and RDW is increased. When RDW levels exceeded 14%, the deformability capacity of the red cell count in the microvessels and perfusion decreased, leading to disordered microcirculation.

According to previous studies, changes in RDW and platelet count reflect the severity of the inflammatory response and organ damage, which can reflect the prognosis of critically ill patients. The inflammatory response is likely to have a direct impact on pathophysiology and clinical course, not only via the initial extravasation of cytokines, but also through blood breakdown products. Therefore, early available inflammatory markers may provide an important information on early inflammatory events during the treatment in critically ill patients with AMI.[37] As early as 2017, RDW has attracted the attention of many scholars.[38] A recent article explored the relationship between whole blood cell count and N-terminal B-type natriuretic peptide precursor (NT-proBNP) and cardiac troponin I (cTnI) in patients with AMI. It was found that RDW and RDW-CV were significantly correlated with serum NT proBNP and cTnI levels at admission and the day before or on discharge.[39] After analysing the relationship between the RDW value in the blood of 80 patients with AMI and the occurrence of adverse cardiac events 6 months after discharge, the results showed that RDW was independently related to the increased risk of adverse cardiac events 6 months after discharge.[40] Platelets played a important role in coordinating systemic inflammation and immune responses, platelet P-selectin expression and subsequent formation of platelet-leucocyte aggregates upregulates leukocytepro-inflammatory functions.[41]

Platelets associated with the systemic inflammation that persisting in these patients often exhibit cardiovascular risk.[42] A retrospective observational study from large database showed that thrombocytopenia and platelet course on hospital mortality in neurological ICU patients.[43] Another population-based cohort study indicated that platelet count was associated with cardiovascular disease and mortality.[44] The studies showed that RDW and platelets has gradually been recognised by clinicians and applied in clinical practice.

Recent studies have confirmed that RPR is a powerful indicator of SIRS in various diseases and is closely related to the poor prognosis of the disease.[45] Wu *et al*[20] found that high RPR was significantly associated with increased mortality in critically ill patients with acute kidney injury and may thus serve as a novel predictor of prognosis for these patients. In addition, RPR also showed good predictive ability for mortality in patients with sepsis, breast cancer, severe burn injury and neonates.[21–23 46] Similarly, our study is consistent with previous results. In this study, we found that RPR was an independent predictor of in-hospital mortalityin critically ill patients with AMI. We conducted subgroup analyses using different AMI groups as stratification variables. The interaction test was not statistically significant, indicating that a high RPR remained a significant predictor of in-hospital mortality. The research found that RPR is an inexpensive and readily available clinical predictor compared with other measures of in-hospital mortality. Therefore, RPR has good clinical significance and application prospects, and relevant clinical studies will be carried out in the future.

Strengths and limitations

Our study had several strengths. First, 5067 patients were enrolled, and the effect of RPR on in-hospital mortality in critically ill patients with AMI has rarely been reported, which enriches the clinical research on AMI. Second, we adjusted for additional confounding factors and improved the reliability of our results. Third, we performed subgroup analysis of the association between RPR and in-hospital mortality.

This is the first cohort study to assess RDW/PLT ratio and the risk of mortality in critically ill patients with AMI admitted to the ICU. However, this was a retrospective study and there was no long-term follow-up. Therefore, some factors that affect in-hospital death risk in patients with AMI may not be considered; consequently, the results may be biased. In addition, the data of this study come from a mimic database, and some data that may affect the results may be missing, which slightly offsets the results, and we look forward to clinical practice in the future.

CONCLUSION

RPR is an independent predictor of in-hospital mortality in critically ill patients with AMI.

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