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Original research

PROGNOSTIC VALUE OF THE R-HF SCORE IN PREDICTING LENGTH OF HOSPITAL STAY AND IN-HOSPITAL COMPLICATIONS IN PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

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ABSTRACT

Objective: *This study aimed to evaluate the association between admission R-hf score and clinical outcomes, including hospital length of stay and in-hospital complications, in patients with acute myocardial infarction (AMI).*

Methods: *A cross-sectional correlational study was conducted in 142 patients hospitalized with AMI at Hue Central Hospital between November 2024 and July 2025. The R-hf score was calculated using the formula: (eGFR × LVEF × hemoglobin)/NT-proBNP. Patients were stratified into four risk categories according to R-hf thresholds. Clinical variables, length of stay, in-hospital complications, and mortality were analyzed across R-hf groups.*

Results: *The R-hf score was inversely associated with hospital length of stay (B = -0.002, p = 0.03). Patients with lower R-hf scores (< 50) had significantly higher rates of in-hospital complications and mortality compared to those with scores > 50 (p < 0.001 and p = 0.009, respectively). Higher R-hf scores were consistently observed among patients with favorable in-hospital outcomes (p < 0.001).*

Conclusion: *The R-hf score, integrating key physiological domains (renal function, cardiac function, anemia, and volume load), is a clinically applicable and prognostically informative tool for early risk stratification in AMI. Its simplicity and objectivity support its use in routine clinical decision-making.*

Keywords: *Acute myocardial infarction, R-hf score, NT-proBNP, in-hospital outcomes, risk stratification.*

I. INTRODUCTION

Acute myocardial infarction (AMI) remains a leading cause of cardiovascular mortality worldwide and contributes substantially to healthcare burden, particularly during hospitalization [1]. Despite advances in reperfusion strategies and pharmacological therapies, early risk stratification at admission remains crucial for predicting complications and optimizing management strategies [2].

Several prognostic models, including the GRACE, TIMI, and PURSUIT scores, have been developed to assist clinical decision-making. However, these scoring systems often require multiple variables, some of which may not be readily available at admission, and may not fully capture the complex pathophysiological mechanisms of AMI. Key factors such as cardiac dysfunction, renal impairment, anemia, and volume overload are known to influence outcomes but are rarely integrated into a single simplified prognostic tool [3].

The R-HF score, developed by Rajan et al., is a novel prognostic model based on four readily available parameters: estimated glomerular filtration rate (eGFR), left ventricular ejection fraction (LVEF), hemoglobin, and N-terminal pro-B-type natriuretic peptide (NT-proBNP) [4]. These variables represent important pathophysiological domains, including renal function, cardiac systolic function, anemia status, and volume burden. In the multinational Gulf CARE study (n = 776), a low

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R-HF score (≤ 5) was independently associated with increased 12-month all-cause mortality (adjusted OR = 3.84; 95% CI: 1.23 - 12.00; p = 0.021) [4]. The simplicity of the R-HF score and its reliance on routinely available clinical data make it potentially useful for early risk assessment.

Each component of the R-HF score has been independently linked to adverse outcomes in AMI. Elevated NT-proBNP reflects myocardial stress and volume overload and is associated with increased mortality and rehospitalization [5]. Anemia and renal dysfunction, particularly within the context of cardiorenal syndrome, are also established predictors of cardiogenic shock, acute heart failure, and mortality [6, 7]. Reduced LVEF remains a well-recognized indicator of adverse prognosis following myocardial infarction.

However, current evidence regarding the R-HF score has largely focused on patients with acute heart failure, and its prognostic value in AMI remains insufficiently investigated. Given the heterogeneous clinical presentation and high risk of in-hospital complications in AMI, evaluation of this simple multidimensional score may provide additional prognostic insight. Therefore, this study aimed to assess the prognostic value of the R-HF score in predicting length of hospital stay and in-hospital complications in patients with acute myocardial infarction.

II. METHODS

2.1. Study design and population

This cross-sectional study with correlational analysis was conducted at the Cardiovascular Center, Hue Central Hospital, between November 2024 and July 2025.

Patients were eligible for inclusion if they met the following criteria: (1) age ≥18 years; (2) diagnosis of acute myocardial infarction according to the 2023 European Society of Cardiology guidelines [8]; (3) availability of complete data required for calculation of the R-HF score, including hemoglobin (Hb), NT-proBNP, estimated glomerular filtration rate (eGFR), and left ventricular ejection fraction (LVEF); and (4) provision of informed consent.

Patients were excluded if they declined participation or had missing key variables affecting calculation or outcome assessment (Hb, NT-proBNP, eGFR, LVEF, admission date, or discharge date).

2.2. Study method

Convenience sampling was used, with an estimated sample size of 100–150 patients to ensure adequate statistical power for correlation and group comparison analyses.

Data collection:

Clinical data were obtained from electronic medical records. The following variables were collected: demographic and clinical characteristics at admission; laboratory parameters including hemoglobin, serum creatinine, and NT-proBNP; echocardiographic measurement of LVEF; classification of AMI (ST-segment elevation myocardial infarction [STEMI] or non-ST-segment elevation myocardial infarction [NSTEMI]); admission and discharge dates for calculation of hospital length of stay; and in-hospital complications.

In-hospital complications included cardiogenic shock, acute heart failure, life-threatening arrhythmias, reinfarction, acute kidney injury, major bleeding (BARC ≥3), and hospital-acquired infection. Composite in-hospital complications were defined as the occurrence of at least one complication during hospitalization. Discharge status was categorized as survival or in-hospital death. Favorable in-hospital outcome was defined as survival without any complications.

R-HF score calculation:

The R-HF score was calculated according to the formula proposed by Rajan et al. (2023) [4]:

$$R\text{-}HF = \frac{eGFR \times LVEF \times Hb}{NT\text{-}proBNP}$$

where eGFR is expressed in mL/min/1.73 m² (CKD-EPI equation), LVEF in percent, Hb in g/dL, and NT-proBNP in pg/mL.

Patients were stratified into four risk categories according to previously reported thresholds: high risk (<5), intermediate risk (5–10), low risk (10–50), and very low risk (>50).

2.3. Statistical analysis

Continuous variables were presented as mean ± standard deviation or median depending on distribution assessed using the Kolmogorov–Smirnov test. Comparisons between STEMI and NSTEMI groups were performed using the independent t-test or Mann - Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables.

Correlation between the R-HF score and length of hospital stay was evaluated using Pearson or Spearman correlation coefficients. Differences in length of stay across R-HF categories were assessed using the Kruskal - Wallis test. Associations between R-HF categories and in-hospital complications or mortality were evaluated using chi-square or Fisher's exact tests. Linear-by-linear association was applied to test trend across ordered groups.

Linear regression analysis was performed to evaluate the adjusted relationship between the R-HF score and length of hospital stay.

A two-sided p value < 0.05 was considered statistically significant. Statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

III. RESULTS

A total of 142 patients with acute myocardial infarction were included in the study and divided into two group: STEMI (n=65) and NSTEMI (n=77).

The STEMI group demonstrated significantly higher hsTnT levels and lower LVEF compared with the NSTEMI group, indicating more extensive myocardial injury. Hemoglobin concentration was also significantly higher in patients with STEMI. There were no statistically significant differences between the two groups in blood pressure, heart rate, NT-proBNP levels, renal function (eGFR), or length of hospital stay. Although the median R-HF score was higher in the NSTEMI group, this difference did not reach statistical significance (Table 1).

Table 1: Baseline clinical and paraclinical characteristics of patients with acute myocardial infarction according to STEMI and NSTEMI subgroups

Characteristics	Total (n=142)	STEMI (n=65)	NSTEMI (n=77)	p-value
Age (years)	70.11 ± 12.37	68.23 ± 14.12	71.70 ± 10.50	0.096
Sex (male)	95 (66.9%)	48 (73.8%)	47 (61.0%)	0.106
SBP (mmHg)	132.41 ± 27.32	129.49 ± 30.72	134.87 ± 24.02	0.244
DBP (mmHg)	76.16 ± 12.75	74.92 ± 13.82	77.21 ± 11.77	0.289
Heart rate (beats/min)	78.50 (38 - 167)	76.00 (38 - 167)	79.00 (38 - 130)	0.984
hsTnT (ng/mL)	0.08 (0.015 - 9.6)	0.31 (0.015 - 9.6)	0.04 (0.015 - 9.6)	0.000
NTproBNP (pg/mL)	719.00 (15.80 - 35000)	873.00 (15.80 - 35000)	558.00 (30.30 - 35000)	0.248
LVEF (%)	49.72 ± 10.53	47.05 ± 10.03	51.97 ± 10.47	0.005; 95% CI (-8.35; -1.51)
Hb (g/dL)	13.15 ± 1.86	13.61 ± 1.72	12.76 ± 1.89	0.006; 95% CI (0.25; 1.46)
Creatinin (µmol/L)	83.45 (40.80 - 537)	82.00 (41.80 - 388.10)	84.00 (40.80 - 537.00)	0.771
eGFR (mL/min/1.73m^2)	70.86 ± 24.08	73.94 ± 25.27	68.27 ± 22.86	0.163
Length of hospital stay (days)	8.00 (2-38)	8.00 (2-35)	9.00 (3-38)	0.078
R-hf score	66.68 (0.07-3913.27)	50.98 (0.20-3913.06)	81.29 (0.07-2418.88)	0.405

Overall, in-hospital complications occurred in 70.4% of patients, with a significantly higher incidence in the STEMI group compared with the NSTEMI group (p = 0.002). Acute heart failure was the most common complication and was also more frequent in STEMI patients (76.9% vs. 53.2%; p = 0.003). The rates of cardiogenic shock, malignant arrhythmias, acute kidney injury, and major bleeding did not differ significantly between the two groups (all p > 0.05; Fisher's exact test was applied in analyses with low expected frequencies).

In-hospital mortality was higher in the STEMI group (10.8% vs. 5.2%), although the difference did not reach statistical significance (p = 0.216). When analyzing poor prognosis, the STEMI subgroup showed a markedly higher proportion compared with NSTEMI (84.6% vs. 59.7%; p = 0.001), suggesting greater clinical severity in this population (Table 2).

Table 2: In-hospital complications in patients with acute myocardial infarction according to STEMI and NSTEMI subgroups

Characteristics (n, %)	Total (n=142)	STEMI (n=65)	NSTEMI (n=77)	p-value
In-hospital complications	100 (70.4%)	54 (83.1%)	46 (59.7%)	0.002
Cardiogenic shock	19 (13.4%)	12 (18.5%)	7 (9.1%)	0.102
Malignant arrhythmias	7 (4.9%)	5 (7.7%)	2 (2.6%)	0.247[a]
Acute heart failure	91 (64.1%)	50 (76.9%)	41 (53.2%)	0.003
Reinfarction	13 (9.2%)	8 (12.3%)	5 (6.5%)	0.231
Stroke	0	0	0	-
Acute kidney injury	11 (7.7%)	5 (7.7%)	6 (7.8%)	0.982
Major bleeding	6 (4.2%)	2 (3.1%)	4 (5.2%)	0.688[a]
In-hospital mortality	11 (7.7%)	7 (10.8%)	4 (5.2%)	0.216
Poor prognosis	101 (71.1%)	55 (84.6%)	46 (59.7%)	0.001

Note: [a]Fisher's test.

Linear regression analysis demonstrated a statistically significant inverse association between the R-HF score and length of hospital stay (B = -0.002, p = 0.03). Each one-point increase in the R-HF score was associated with a mean reduction of 0.002 days in hospital stay. However, the effect size was small, indicating limited clinical relevance (Figure 1).

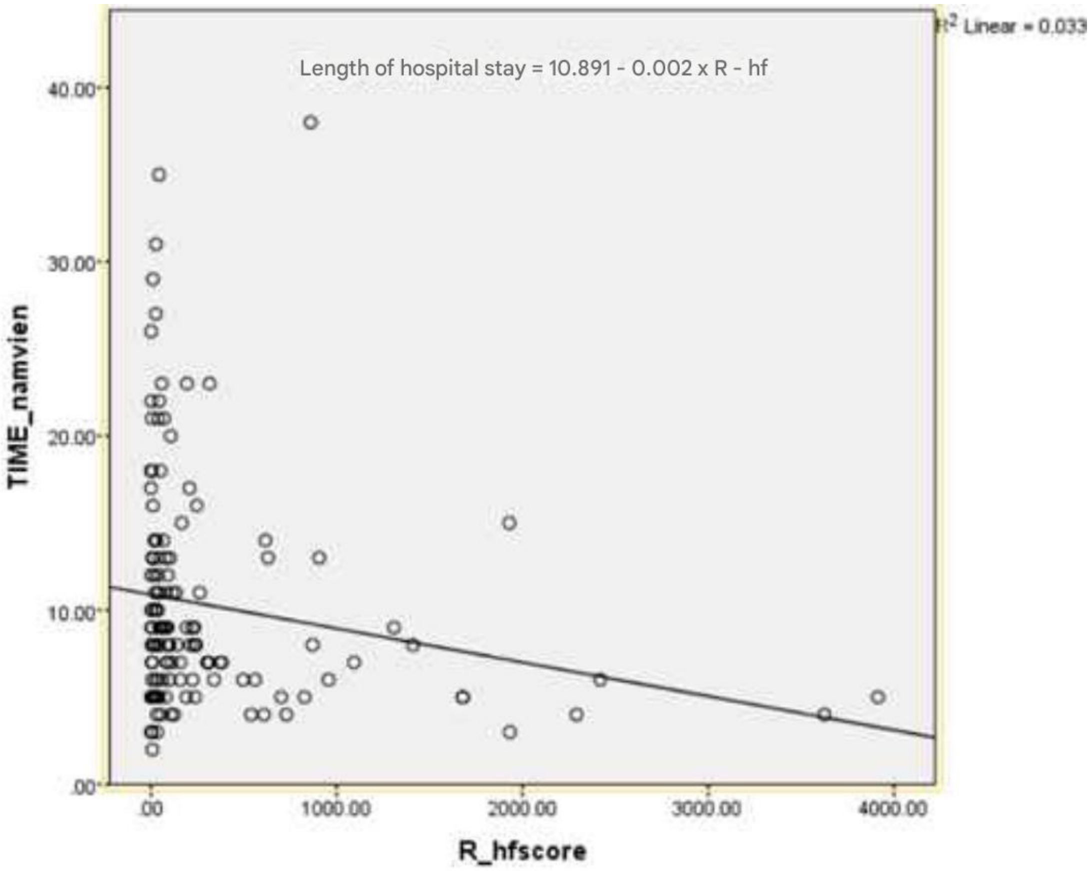

Figure 1: Correlation between R-HF score and length of hospital stay

The Kruskal - Wallis test showed no statistically significant difference in length of hospital stay among patient groups stratified by R-HF score (Chi-square = 5.949, df = 3, p = 0.114). However, patients in the lowest R-HF score group (< 5) and the intermediate group (10-50) exhibited higher mean ranks, suggesting a trend toward longer hospitalization compared with those in the higher R-HF score group (> 50). This difference, however, did not reach statistical significance (Table 4).

Table 4: Comparison of length of hospital stay across R-HF score groups

R-hf score group	Number (n)	Mean rank
< 5	14	83.29
5-10	12	59.13
10 - 50	37	82.05
> 50	79	66.35

Chi-square analysis demonstrated a statistically significant difference in the incidence of composite in-hospital events among R-HF score groups (p < 0.001). Patients with lower R-HF scores (< 50) showed markedly higher event rates (94.6 - 100%), whereas only 49.4% of patients in the R-HF > 50 group experienced in-hospital events.

This linear trend was further supported by the Linear-by-Linear Association test ($p < 0.001$), indicating a progressive decrease in event rates with increasing R-HF score (Table 5).

Table 5: Comparison of composite in-hospital events across R-HF score groups

R-hf score group	Event		Test
	No	Yes	
< 5	0 (0.0%)	14 (100.0%)	Chi-Square = 38.114, p < 0.001 Linear-by-Linear Association = 28.341, p < 0.001
5 - 10	0 (0.0%)	12 (100.0%)	
10 - 50	2 (5.4%)	35 (94.6%)	
> 50	40 (50.6%)	39 (49.4%)	
Total	42 (29.6%)	100 (70.4%)	

In-hospital mortality decreased progressively with increasing R-HF score categories. Chi-square analysis demonstrated a statistically significant association between R-HF score groups and discharge status (χ^2 = 11.679, p = 0.009). This trend was further supported by the Linear-by-Linear Association test (χ^2 = 10.238, p = 0.001). Although three cells had expected counts less than five, Fisher's exact test confirmed the statistical significance of the association (p = 0.006) (Table 6).

Table 6: Comparison of discharge status across R-HF score groups

R-hf score group	Discharge status		Test
	In-hospital mortality	Survival	
< 5	3 (21.4%)	11 (78.6%)	Chi-Square = 11.679, p = 0.009 Fisher's test: p = 0.006 Linear-by-Linear Association = 10.238, p = 0.001
5 - 10	3 (25.0%)	9 (75.0%)	
10 - 50	3 (8.1%)	34 (91.9%)	
> 50	2 (2.5%)	77 (97.5%)	
Total	11 (7.7%)	131 (92.3%)	

Note: Three cells had expected frequencies less than 5.

Mann - Whitney U analysis demonstrated a statistically significant difference in R-HF scores between patients stratified by length of hospital stay (U = 1822, Z = -2.446, p = 0.014). Patients discharged within ≤ 7 days had higher R-HF scores compared with those hospitalized for more than 7 days (Figure 3).

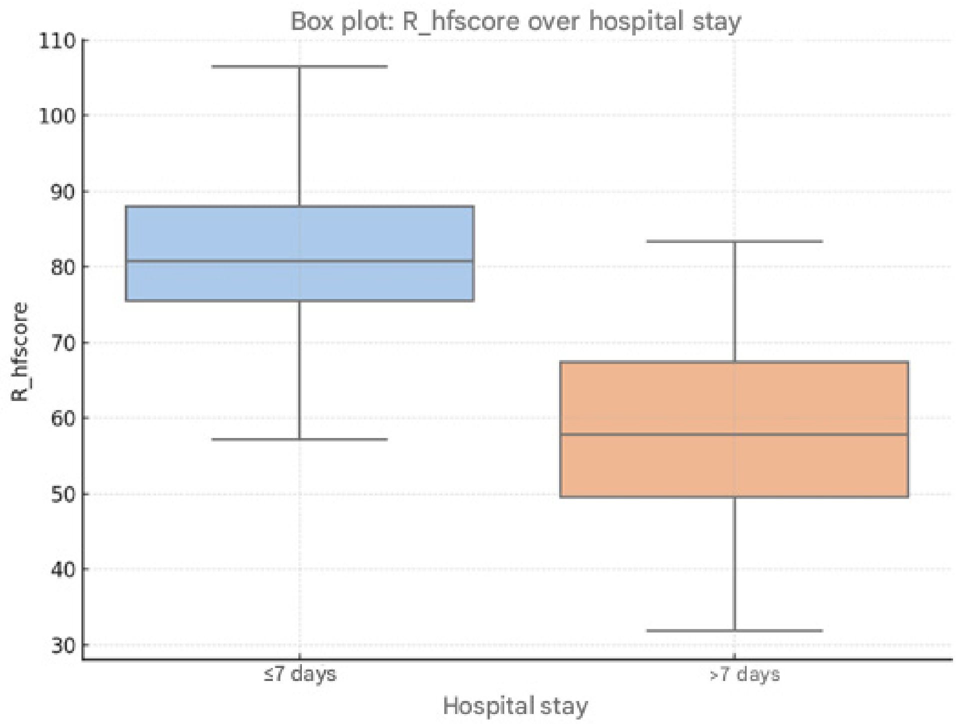

Figure 3: Comparison of R-HF score between patients with length of stay ≤ 7 days and > 7 days

Note: Mann - Whitney U analysis: U = 1822, Z = -2.446, p = 0.014.

Mann - Whitney U analysis demonstrated a highly significant difference in R-HF scores between the two prognosis groups (U = 311, Z = -7.921, p < 0.001). Patients with a favorable in-hospital prognosis had markedly higher mean ranks compared with those with poor prognosis, indicating a strong discriminative ability of the R-HF score for clinical risk stratification (Figure 4).

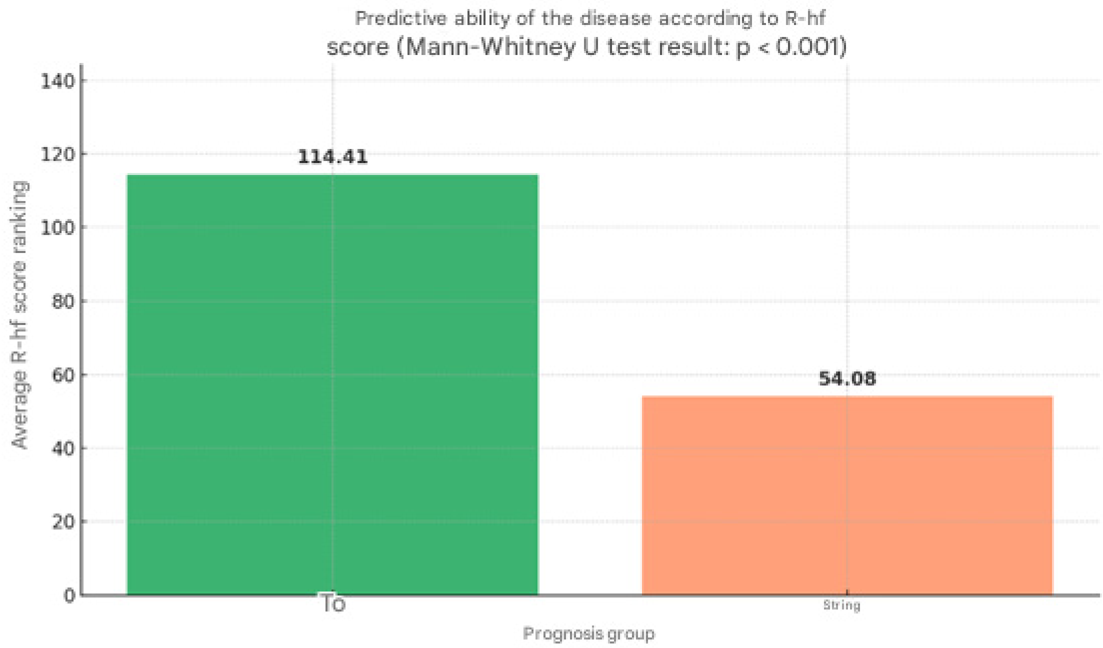

Figure 4: Distribution of R-HF score according to in-hospital prognosis groups

Note: Mann - Whitney U analysis: U = 311, Z = -7.921, p < 0.001.

IV. DISCUSSION

The present study demonstrated that the R-HF score at admission was significantly inversely correlated with length of hospital stay and was able to discriminate between patients with different in-hospital prognoses. These findings are clinically relevant, supporting the potential role of the R-HF score in risk stratification of patients with acute myocardial infarction, a population characterized by heterogeneous clinical presentation and a high risk of in-hospital complications.

The R-HF score is a clinical prognostic model developed by Rajan et al. in 2018, integrating four routinely available biomarkers: eGFR, LVEF, hemoglobin, and NT-proBNP [9]. These parameters comprehensively reflect key pathophysiological axes in acute myocardial infarction, including cardiac function, renal function, anemia, and volume overload. Rajan and colleagues demonstrated that an R-HF score ≤ 5 was associated with nearly a fourfold higher risk of 12-month mortality compared with an R-HF score > 50 (aOR = 3.84; 95% CI: 1.23 - 12.00) [4].

Our findings are consistent with these observations, as patients with lower R-HF scores exhibited markedly higher rates of in-hospital complications and mortality. Notably, patients with R-HF scores < 5 experienced complications in 100% of cases, underscoring the model's ability to predict short-term outcomes in acute myocardial infarction. Another prospective cohort study by Rajan et al. also demonstrated high prognostic accuracy of the R-HF score in both ischemic and non-ischemic heart failure populations [10]. Similarly, Peterson et al. highlighted the value of multivariable risk assessment models in early identification of patients at high risk of adverse outcomes [11].

Each component of the R-HF score has been independently validated as a strong prognostic marker. NT-proBNP reflects left ventricular end-diastolic pressure, volume overload, and myocardial injury, and has shown superior prognostic value compared with traditional clinical indicators [12, 13]. Low hemoglobin levels are associated with increased mortality and complications in acute myocardial infarction, likely due to reduced oxygen delivery and activation of neurohormonal pathways [7]. Reduced eGFR indicates acute or chronic renal dysfunction and is a well-established independent predictor of mortality and cardiovascular complications [13, 14]. Decreased LVEF remains a classical indicator of post-infarction left ventricular dysfunction and is incorporated into several prognostic models such as CADILLAC and Zwolle [15, 16].

Compared with traditional risk scores such as TIMI, GRACE, PAMI, and PURSUIT, the R-HF score offers the advantage of relying on objective quantitative parameters that are less influenced by subjective clinical variables (e.g., age, blood pressure, heart rate, or medical history), while remaining easy to calculate at admission once basic laboratory tests and echocardiography are available[17-20]. Although the GRACE score is widely considered the gold standard for risk stratification in acute myocardial infarction, it requires nine variables, including parameters that may not always be readily available in emergency settings [18].

The combination of NT-proBNP with hemoglobin, eGFR, and LVEF creates a comprehensive risk assessment model that supports rapid clinical decision-making, particularly in emergency departments or primary care settings due to its simplicity and feasibility. Consistent with the findings of Wang et al., the R-HF model demonstrated the ability to stratify patients with poor prognosis using simple biological and imaging data [21].

Furthermore, our results showed that higher R-HF scores were associated with favorable in-hospital outcomes, defined as survival without complications. This supports the concept that the R-HF score is not only predictive of adverse events but may also assist in guiding clinical management strategies, including decisions regarding monitoring intensity, referral, and resource allocation.

Several models, such as MAGGIC, ADHERE, and the Seattle Heart Failure Model, provide valuable long-term prognostic information but require numerous variables and complex calculations [22-24]. In contrast, the R-HF score - based on only four parameters - demonstrates comparable predictive performance, particularly for short-term in-hospital outcomes.

Taken together with international evidence and the findings of the present study, the R-HF score appears to be a simple yet powerful tool with broad potential applicability in clinical practice. Integration of this score into initial assessment protocols may improve risk stratification and outcome prediction in patients with acute myocardial infarction.

V. CONCLUSION

This study confirms that the R-HF score is a simple, feasible, and effective prognostic tool for risk stratification of in-hospital adverse events in patients with acute myocardial infarction. Lower R-HF scores were associated with a higher risk of in-hospital complications and longer hospital stay, demonstrating a clear inverse relationship and strong risk stratification value. Compared with long-term prognostic models such as MAGGIC, the Seattle Heart Failure Model, and ADHERE, the R-HF score offers notable advantages in simplicity and broad applicability in real-world clinical settings, particularly in frontline healthcare facilities or resource-limited environments.

Conflict of interest statement

The authors declare that there are no conflicts of interest related to this study, authorship, or publication of this article.

Ethics statement

The study protocol was approved by the Institutional Review Board of the University of Medicine and Pharmacy, Hue University (Approval No. H2024/419, dated August 5, 2024).

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