

STUDY OF THE MODIFIED HEART SCORE IN CHEST PAIN PATIENTS

Pham Quang Tuan¹, Huynh Ngoc Quoc Anh¹, Le Thi Bich Thuan³, Nguyen Ta Dong¹, Ho Anh Binh², Doan Chi Thang¹

¹Department of Internal Cardiology, Hue Central Hospital, Vietnam

²Department of Emergency and Interventional Cardiology, Hue Central Hospital, Vietnam

³Department of Internal Medicine, Hue University of Medicine and Pharmacy, Hue University, Vietnam

ABSTRACT

Background: Chest pain is one of the most common symptoms in patients visiting the emergency department (ED). Although the causes of chest pain are numerous, coronary heart disease is still one of the significant problems because it causes a high rate of hospitalization and mortality. The original HEART score was developed in Netherlands and utilized to stratify risk in chest pain patients as well as to identify the possibility of Major Cardiac Adverse Events (MACE) in 6 weeks. This study aimed to evaluate the modified HEART score, incorporating high sensitive troponin T measurement in patients with chest pain.

Methods: We used the data of patients who visited our Cardiology department, Hue University of Medicine and Pharmacy between June, 2022 and July, 2024. Patients aged ≥ 18 years old who presented with non-traumatic chest pain and undifferentiated chest pain were eligible for the study. On the basis of the total score, the patients were stratified as low risk (modified HEART score of 0-3), intermediate risk (modified HEART score of 4-6) and high risk (modified HEART score of 7-10). The major adverse cardiac events (MACEs) that occurred within 8 weeks were investigated, and the diagnostic value and efficiency of modified HEART score was analyzed.

Results: Over the study period, 264 patients met inclusion criteria. During 8 weeks of follow up, 59 patients (22.3%) developed a MACE with 58 percutaneous coronary intervention (22%), 12 acute myocardial infarction (4.5%) and 4 deaths (1.5%). The modified HEART score in the patients with or without MACEs was 6.46 ± 1.37 and 4.71 ± 1.65 respectively. The incidence rates of MACEs in patients with low (0-3 points), intermediate (4-6 points) and high (7-10) risk were 2%; 18.9% and 50.9% in the modified HEART score analysis ($p < 0.001$), respectively. The sensitivity and specificity for 8 weeks MACE was 78.0% (95%CI: 34.5 – 89.8) and 66.3% (95%CI: 24.8 – 80.0), respectively with a cut-off value of 5.5 ($p < 0.001$).

Conclusion: The modified HEART score is valuable in risk stratification and prognostication of coronary artery disease events in chest pain patients.

Keywords: Modified HEART score, acute coronary syndrome, chest pain, risk stratification, hs Troponin T.

I. INTRODUCTION

Chest pain is one of the most common reasons that people seek medical care [1]. The term “chest pain” is used by patients and applied by clinicians to describe the many unpleasant or uncomfortable sensations in the anterior chest that prompt concern for a cardiac problem. Chest pain should be considered acute

when it is of new onset or involves a change in pattern, intensity, or duration compared with previous episodes in a patient with recurrent symptoms. It is considered stable when symptoms are chronic and associated with consistent precipitants such as exertion or emotional stress [1]. Patients admitted with non-traumatic chest pain are a common clinical

Received: 31/5/2025. Revised: 06/11/2025. Accepted: 15/11/2025.

Corresponding author: Pham Quang Tuan. Email: tuanbshue@gmail.com. Phone: (+84) 914192908

issue. Although there are numerous potential causes, the initial assessment should focus on life-threatening conditions such as acute coronary syndrome (ACS), aortic dissection, pulmonary embolism, tension pneumothorax, or esophageal rupture to ensure timely and appropriate treatment [1, 2]. While the initial electrocardiogram (ECG) is crucial for evaluation, the patient's history, physical examination, and cardiac biomarker tests remain essential components of clinical decision-making [2, 3].

Over the years, various risk stratification scores for patients with chest pain have been developed. By assessing factors such as age, risk factors, and clinical characteristics, these scores help estimate the likelihood of cardiovascular events. The primary goal of early risk stratification is to optimize resource utilization, guide more advanced diagnostic testing, reduce unnecessary hospital admissions, and enhance comprehensive patient care. To stratify risk in patients with chest pain, cardiologists in the Netherlands developed the HEART score in 2008. HEART is an acronym representing its components: H (History), E (ECG), A (Age), R (Risk factors), and T (Troponin) [4]. The HEART score helps predict whether patients with chest pain are at risk of major adverse cardiac events (MACE).

Recent advancements in technology have significantly improved the sensitivity and accuracy of Troponin testing, leading to the development of high-sensitivity Troponin (hs-cTn). Most hospitals have replaced conventional Troponin tests with high-sensitivity Troponin T and I (hs-Troponin T/I), capable of detecting myocardial injury at concentrations 10 to 100 times lower than conventional tests. These hs-Troponin assays provide high diagnostic accuracy, enabling earlier detection of acute myocardial infarction (AMI). The negative predictive value (NPV) of hs-cTn exceeds 95%, allowing the exclusion of AMI at the time of emergency department admission. When repeated 3 hours later, diagnostic accuracy increases to nearly 100% [5, 6]. Furthermore, hs-Troponin has a superior ability to identify patients at higher risk among those with negative results compared to conventional Troponin assays [7]. The modified HEART score, which incorporates the use of high-sensitivity troponin and stratifies levels into three

categories: > 3 times, 1-3 times, and within the normal range, has recently been studied in China. It may complement the assessment of MACE risk and assist in decision-making for patients admitted to the emergency department with suspected ACS [8]. This study aimed to evaluate the modified HEART score, incorporating high sensitive troponin T measurement in patients with chest pain.

II. MATERIALS AND METHODS

2.1. Subject

We conducted study on patients aged 18 years or older with chest pain admitted to the Cardiology Department of Hue University of Medicine and Pharmacy Hospital from April 2022 to July 2024. Patients with chest pain due to trauma or ECG findings diagnosing ST-elevation myocardial infarction (STEMI) in the emergency department are excluded from the study.

2.2. Methods

We conduct a cross-sectional descriptive study with follow-up on major cardiac events within 8 weeks in patients aged ≥ 18 years with chest pain, who were admitted to the Cardiology Department of the Hue University of Medicine and Pharmacy Hospital from April 2022 to July 2024.

Medical records and admission data were utilized to calculate the modified HEART score (Table 1), following the criteria outlined in Table 1. Patients were assigned a final score ranging from 0 to 10 points and stratified, according to the original classification system, into low-risk (0-3 points), intermediate-risk (4-6 points), or high-risk (7-10 points) categories. A comprehensive description of all the elements of the HEART score can be found in the original validation studies conducted by Backus and Six et al [4, 9].

The history score was classified as follows: 2 points, high; 1 point, moderate; 0 points, low suspicion for ACS. With regard to ECG result, patients with normal or non-specific findings, 0 points were given. In patients with bundle branch block, left ventricular hypertrophy by voltage criteria with strain (LVH), digoxin use (the so-called "digoxin effect"), implanted ventricular pacemaker or inverted T wave in more than two consecutive leads, 1 point was assigned. In patients with significant ST-segment depressions in more than two consecutive

Study of the modified heart score in chest pain patients

leads, 2 points were assigned [10]. In terms of age, 0 points were allocated if the patient's age was less than or equal to 45 years; 1 point were assigned if the patient's age were greater than 45 and less than 65; 2 points, if 65 years or older [10]. In terms of the risk factors of coronary artery disease, the following were considered: hypertension, diabetes mellitus, hypercholesterolemia, obesity, family history of coronary artery disease and current or previous smoking history. In patients without risk factors, 0 points were given [10]. In patients with one or two

risk factors, 1 point was allocated. In patients with three or more risk factors, 2 points were assigned. In addition, 2 points were allocated for those with a history of atherosclerotic disease. With regard to hs Troponin T, 0 point was given if the patient's hs Troponin T at admission was less than or equal to the normal limit; 1 point was assigned if the patient's hs Troponin T was greater than the normal limit but less than 3 times the normal limit; 2 points were allocated if the patient's hs Troponin T was greater than or equal to 3 times the normal limit [8].

Table 1: The Modified HEART score for chest paint patients

Modified HEART score		
History	Highly suspicious	2
	Moderately suspicious	1
	Slightly or non suspicious	0
ECG	Significant ST-segment depression	2
	Non-specific repolarisation disturbance	1
	Normal	0
Age	> 65 years	2
	> 45 - < 65 years	1
	< 45 years	0
Risk factor ^a	> 3 risk factors or history of atherosclerotic disease ^b	2
	1 or 2 risk factors	1
	No risk factors known	0
hs-Troponin T	> 3× normal limit	2
	>1 - < 3× normal limit	1
	< Normal limit	0
Total		0-10
^a Risk factors: diabetes, currently treated; smoker, current or recent <90 days; hypertension, diagnosed and/or treated; obesity: body mass index > 25 kg/m ² ; hypercholesterolaemia, diagnosed and/or treated; family history of coronary artery disease ^b Atherosclerotic disease: prior myocardial infarction or coronary revascularisation (e.g. percutaneous coronary intervention or coronary artery bypass grafting), stroke or peripheral artery disease		

III. RESULTS

3.1. Study population

The study population included 264 adult patients with non-traumatic undifferentiated chest pain who visited the Cardiology Department from June, 2022 and July, 2024. We collected data from paper-based records, which were sufficiently relevant for that period. The baseline characteristics of the study cohort are presented in Table 2. The mean age of the study population was 66,62 years ($\pm 13,21$ SD), with 108 patients (40,9%) being male.

Study of the modified heart score in chest pain patients

Table 2: Baseline characteristics of the groups with or without major adverse cardiac events (MACEs)

Variable	All patients n = 264	Without MACEs n = 205	With MACEs n = 59	P value
Age, mean (SD)	66.62 ± 13.21	66.08 ± 13.79	68.49 ± 10.83	> 0.05
Male gender	108 (40.9%)	77 (29.2%)	31 (11.7%)	< 0.05
Diabetes mellitus	53 (20.1%)	39 (14.8%)	14 (5.3%)	> 0.05
Hypertension	180 (68.2%)	135 (51.1%)	45 (17%)	> 0.05
Current smoker	32 (12.1%)	18 (6.8%)	14 (5.3%)	< 0.01
Obesity	50 (18.9%)	38 (14.4%)	12 (4.5%)	> 0.05
Hypercholesterolaemia	121 (45.8%)	93 (35.2%)	28 (10.6%)	> 0.05
History of atherosclerotic disease	40 (15.2%)	30 (11.4%)	10 (3.8%)	> 0.05
History of myocardial infarction	5 (1.9%)	4 (1.5%)	1 (0.4%)	> 0.05
History of CABG	1 (0.4%)	1 (0.4%)	0 (0%)	> 0.05
History of PCI	24 (9.1%)	19 (7.2%)	5 (1.9%)	> 0.05
History of stroke	14 (5.3%)	10 (3.8%)	4 (1.5%)	> 0.05
Family history of coronary artery disease	14 (5.3%)	11 (4.2%)	3 (1.1%)	> 0.05

3.2. Dispositions and and major adverse cardiac events

The major adverse cardiovascular events (MACEs) were categorized as follows: 59 patients (22.3%) were diagnosed with MACE, Acute Myocardial Infarction was diagnosed in 12 patients (4.5%), 58 patients (22%) underwent PCI, no patient had CABG within 8 weeks. Four patients (1.5%) died within 8 weeks after presentation in the modified HEART score analysis.

3.3. The Modified HEART score

Elevated modified HEART scores were significantly associated with a higher incidence of major adverse cardiovascular events (MACEs) within 8 weeks. There was a progressive, significant pattern of increasing event rates as the score increased in the study cohort ($P < 0.001$ by χ^2 for trend; Figure 1).

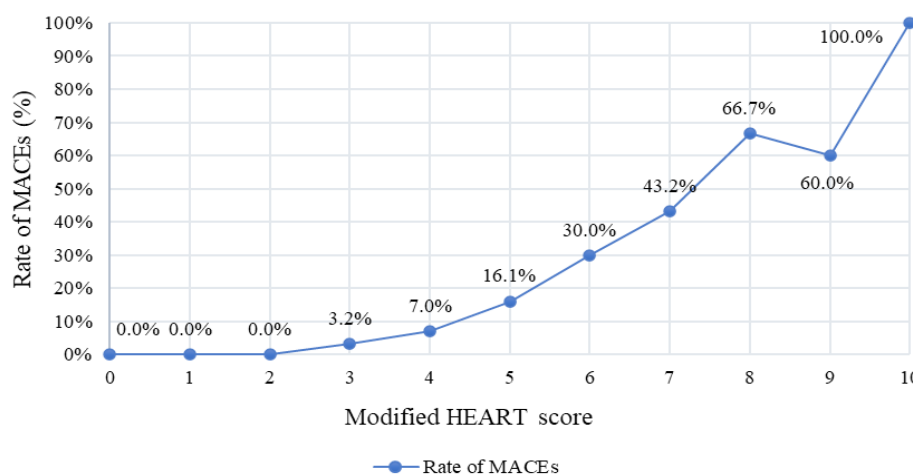


Figure 1: Rate of MACEs according to the Modified HEART score

Study of the modified heart score in chest pain patients

The numerical distribution of the modified HEART score for each component in groups with and without MACEs is reported in Table 3. The five elements of the modified HEART score differed significantly between the groups with and without MACE. In the modified HEART score analysis, significant differences were observed in history, ECG findings, and hs troponin T levels between groups with and without MACEs, while age and risk factors showed no significant differences ($P < 0.001$). The average modified HEART score was 4.71 ± 1.65 in the non-MACE group and 6.46 ± 1.37 in the MACE group.

Table 3: Numbers of patients in each element of the Modified HEART score in groups with or without MACEs

	Without MACEs n = 205			With MACEs n = 59			P value
Points	0	1	2	0	1	2	
History	28 (10.6)	85 (32.2)	92 (34.8)	0 (0)	9 (3.4)	50 (18.9)	< 0.001
ECG	122 (46.2)	78 (29.5)	5 (1.9)	18 (6.8)	32 (12.1)	9 (3.4)	< 0.001
Age	14 (5.3)	67 (25.4)	124 (47)	1 (0.4)	21 (8)	37 (14)	> 0.05
Risk factors	23 (8.7)	124 (47)	58 (22)	3 (1.1)	30 (11.4)	26 (9.8)	< 0.05
Hs Troponin T	159 (60.2)	38 (14.4)	8 (3)	28 (10.6)	17 (6.4)	14 (5.3)	< 0.001
Modified HEART score (average ± SD)	4.71 ± 1.65			6.46 ± 1.37			< 0.001
Data are shown as n (%). MACE, major adverse cardiac events. SD, standard deviation							

3.4. Risk stratification

Patients presenting to the emergency department (ED) with chest pain were stratified into three groups according to the modified HEART scores (Table 4). The scoring systems demonstrated good discriminatory performance in predicting major adverse cardiovascular events (MACEs) within 8 weeks. Based on the modified HEART score, the incidence of MACEs was 2% (95% CI: 0.35 - 10.50) in the low-risk group; 18.9% (95% CI: 13.55 - 25.66) in the intermediate-risk group; and 50.9% (95% CI: 38.08 - 63.62) in the high-risk group ($P < 0.001$; Figure 2).

Table 4: Risk stratification of the Modified HEART score

Classification	Score	Patients, n (%)	With MACEs (n)	Rate of MACEs (%)
Low risk	0 - 3	50 (18.9%)	1	2
Intermediate risk	4 - 6	159 (60.2%)	30	18.9
High risk	7 - 10	55 (20.8%)	28	50.9
Risk categorization was based on the total scores, which were: low risk, 0-3 points; intermediate risk, 4-6 points; and high risk, 7-10 points in the modified HEART score analysis. MACE, major adverse cardiac event.				

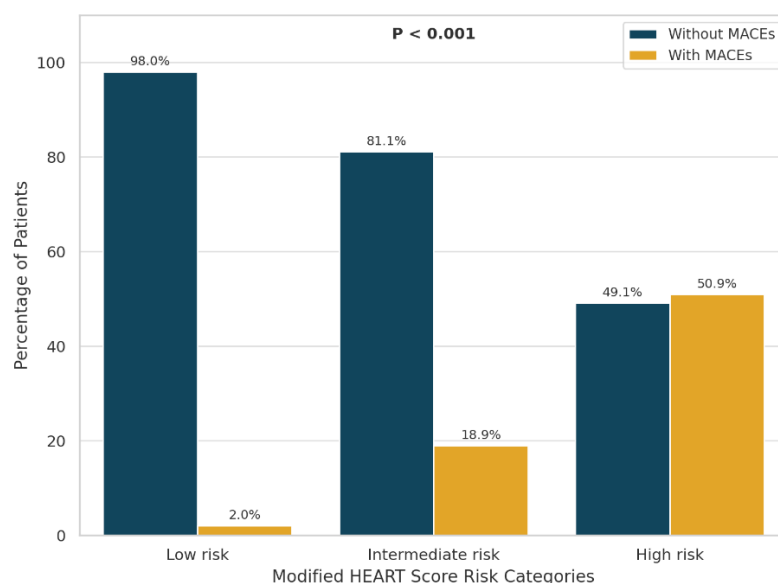


Figure 2: Risk stratification of the Modified HEART score. Risk categorization was based on total scores: low risk, 0-3 points; intermediate risk, 4-6 points; and high risk, 7-10 points in the Modified HEART score analysis. The incidence rate of MACEs in each risk group is shown as a percentage.

IV. DISCUSSION

This study evaluated the prognostic value of the modified HEART score, incorporating high-sensitivity troponin T (hs-TnT), in predicting 8-week major adverse cardiac events (MACEs) among patients presenting with undifferentiated chest pain. Our findings confirmed the score's utility for effective early risk stratification in an emergency setting.

In our cohort, the overall incidence of MACE was 22.3%, with a notable correlation between higher modified HEART scores and increased MACE rates. Specifically, patients classified as high-risk (scores 7-10) exhibited a MACE incidence of 50.9%, while those in the low-risk group (scores 0-3) had an incidence of only 2%. These results align closely with previous studies. For instance, Backus et al. reported a 50.1% MACE rate in the high-risk group and 1.7% in the low-risk group over a 6-week period [9]. Similarly, Six et al. found a 43.1% MACE rate in high-risk patients and 1.7% in low-risk patients within 30 days [11].

However, our study observed a slightly higher MACE rate in the intermediate-risk group (scores 4-6) at 18.9%, compared to 16.6% reported by Backus et al. [9]. This discrepancy may be

attributed to differences in patient populations, healthcare settings, or the incorporation of hs-TnT in our modified score, which enhances sensitivity for myocardial injury detection.

Our findings are also consistent with recent modified HEART score validations using hs-troponin. In a Japanese study by Otsuka et al., MACE rates were 0%, 23.2%, and 63.6% across increasing risk stratification [12]. The modified HEART score demonstrated high discriminative performance with a negative predictive value (NPV) of 100% in low-risk patients, supporting safe early discharge.

Similarly, a large retrospective study by Sajeed et al. in a multi-ethnic Asian population found MACE rates of 1.4% in low-risk, 5.2% in intermediate-risk, and 33.3% in high-risk groups over 6 weeks [13]. Although slightly lower than our MACE rate in the intermediate-risk group, this variability may be attributed to demographic and comorbidity differences.

The integration of hs-TnT into the HEART score is a significant advancement. High-sensitivity troponin assays have been shown to improve the early diagnosis of acute coronary syndromes (ACS) and provide superior prognostic information compared to conventional assays [14]. Our study's

Study of the modified heart score in chest pain patients

use of hs-TnT likely contributed to the more accurate risk stratification observed, particularly in identifying patients at higher risk for MACE.

Of particular interest is the integration of hs-troponin assays into prehospital and point-of-care (POC) workflows. The URGENT 1.5 study demonstrated that the modified HEART score using fingerstick POC hs-cTnI achieved a sensitivity of 97.0% and an NPV of 97.6% in ruling out acute coronary syndrome (ACS), reinforcing its applicability in non-hospital environments [15]. Additionally, Stopyra et al. found that a prehospital modified HEART score yielded an NPV of 98.1% and sensitivity of 94.1% for 30-day MACE, further supporting its frontline utility [16].

Compared to our findings, these studies generally used shorter follow-up periods (30 days or 6 weeks versus 8 weeks in our study) and different troponin isoforms (I vs. T), which may explain minor variations in MACE incidence. Furthermore, our study found that history, ECG changes, and hs-TnT levels were significantly associated with MACEs, whereas age and traditional risk factors did not show a statistically significant difference between patients with and without MACE. This finding is consistent with other studies suggesting that acute clinical presentation and biomarker levels may have greater predictive value than baseline demographic factors [17].

To further quantify risk escalation, odds ratios (ORs) for MACE were calculated using the low-risk category (0-3 points) as reference. Patients in the intermediate-risk group (4-6 points) had an OR of 0.61 (95% CI: 0.34-1.09), indicating no statistically significant increase in risk. In contrast, the high-risk group (7-10 points) demonstrated a markedly elevated risk with an OR of 5.95 (95% CI: 3.10-11.43). These results support the strong discriminative capacity of the modified HEART score at the upper end of the risk spectrum.

To assess the discriminative ability of the modified HEART score in predicting major adverse cardiac events (MACEs), a receiver operating characteristic (ROC) curve was constructed. At a cut-off value of ≥ 5.5 , the modified HEART score demonstrated a sensitivity of 78.0% (95% CI: 34.5-89.8) and a specificity of 66.3% (95% CI: 24.8-80.0). The area

under the curve (AUC) was 0.787, reflecting a good level of diagnostic accuracy ($P < 0.001$; Figure 3). An AUC of 0.787 indicates that the modified HEART score possesses reasonable discriminative power for identifying patients at increased risk of MACE within the study cohort. The sensitivity and specificity at the selected cut-off provide a clinically meaningful balance, enhancing its applicability in the emergency setting where timely and accurate risk stratification is essential. These findings are consistent with prior validation studies and support the continued use of the modified HEART score as a pragmatic, bedside decision-making tool for chest pain evaluation.

In addition to ROC analysis, predictive performance was further assessed at clinically relevant decision thresholds. For the traditional discharge threshold of ≤ 3 points, the modified HEART score demonstrated an excellent NPV of 98.0%, supporting safe early discharge, although the PPV was modest (27.1%). Using a higher threshold of ≥ 6 points, the score achieved a PPV of 40.0% and an NPV of 91.3%, indicating that patients above this threshold warrant inpatient evaluation or early intervention. These values align with previous validations and illustrate the differential clinical utility of low versus high cut-off points.

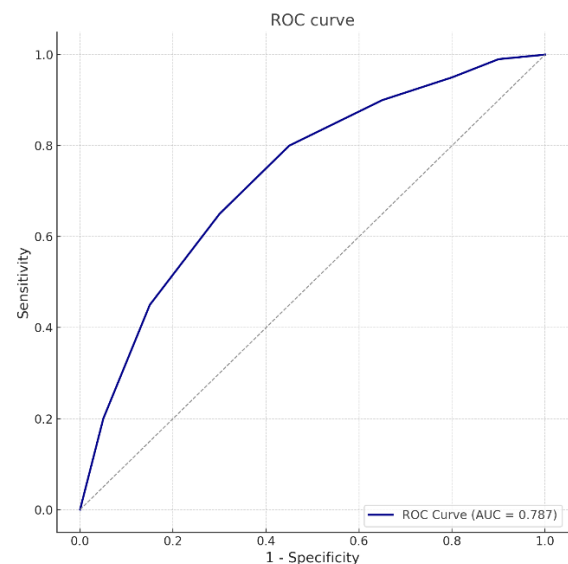


Figure 3: ROC curve of the Modified HEART score

This study has several limitations. First, it was conducted at a single tertiary care center, which

may restrict the generalizability of the findings to other clinical settings with different patient characteristics or diagnostic pathways. Another important limitation is the moderate sample size, which, although sufficient for primary analyses, did not allow for more detailed subgroup exploration.

In addition, only high-sensitivity troponin T (hs-TnT) was used, and no comparison was made with high-sensitivity troponin I (hs-TnI). Differences between these assays may influence risk stratification in institutions using alternative biomarkers. A further limitation concerns the inclusion of early percutaneous coronary interventions (PCI) during the index hospitalization within the MACE definition, which may have introduced procedural bias; a sensitivity analysis excluding periprocedural PCI was not performed.

It should also be noted that the follow-up period was limited to 8 weeks. Although consistent with earlier HEART score validations, longer-term follow-up could provide insights into sustained prognostic value. Finally, the study did not assess prehospital or point-of-care troponin workflows, which represent an emerging area of interest for accelerated chest-pain evaluation.

V. CONCLUSIONS

The modified HEART score, incorporating high-sensitivity troponin T, demonstrated good diagnostic performance for predicting 8-week major adverse cardiac events among patients presenting with chest pain. The score effectively stratified patients into distinct risk categories, with higher scores correlating with increased MACE incidence. At a cut-off value of ≥ 5.5 , the score achieved a favorable balance between sensitivity and specificity, underscoring its clinical utility as a rapid and reliable tool for early risk assessment in the emergency department.

These findings support the integration of the modified HEART score into routine clinical practice to guide decision-making, particularly in identifying low-risk patients suitable for early discharge and high-risk individuals requiring further evaluation or intervention. Future multicenter prospective studies are warranted to further validate its prognostic value across diverse populations and healthcare settings.

Ethical considerations

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Ethical approval for this study was obtained from the Institutional Review Board of Hue University of Medicine and Pharmacy Hospital.

Conflict of Interest

The authors declare that they have no conflicts of interest related to the content of this study.

REFERENCES

1. Gulati M, Levy PD, Mukherjee D. 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain: Executive Summary: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation*. 2021; 144(22): e368-e454.
2. Ng IKS, Chia YW, See KC, Teo DBS. Approach to acute chest pain and acute coronary syndrome in adults. *Singapore Med J*. 2024; 65(2): 111-118.
3. Sandoval Y, Apple FS, Mahler SA, Body R, Collinson PO, Jaffe AS. High-Sensitivity Cardiac Troponin and the 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guidelines for the Evaluation and Diagnosis of Acute Chest Pain. *Circulation*. 2022; 146(7): 569-581.
4. Six AJ, Backus BE, Kelder JC. Chest pain in the emergency room: value of the HEART score. *Neth Heart J*. 2008; 16: 191-6.
5. Mokhtari A, Lindahl B, Smith JG, Holzmann MJ, Khoshnood A, Ekelund U. Diagnostic Accuracy of High-Sensitivity Cardiac Troponin T at Presentation Combined With History and ECG for Ruling Out Major Adverse Cardiac Events. *Ann Emerg Med*. 2016; 68(6): 649-658.e3.
6. van den Berg P, Collinson P, Morris N, Body R. Diagnostic accuracy of a high-sensitivity troponin I assay and external validation of 0/3 h rule out strategies. *Eur Heart J Acute Cardiovasc Care*. 2022; 11(2): 127-136.
7. Kang T, Kim GS, Byun YS, Kim J, Kim S, Chang J, et al. An Algorithmic Approach Is Superior to the 99th Percentile Upper Reference Limits of High Sensitivity Troponin as a Threshold for Safe Discharge from the Emergency Department. *Medicina (Kaunas)*. 2021; 57(10).
8. Ma CP, Wang X, Wang QS. A modified HEART risk score in chest pain patients with suspected non-ST-segment elevation acute coronary syndrome. *J Geriatr Cardiol*. 2016; 13(1): 64-9.

Study of the modified heart score in chest pain patients

9. Backus BE, Six AJ, Kelder JC, Bosschaert MA. A prospective validation of the HEART score for chest pain patients at the emergency department. *International Journal of Cardiology*. 2013; 168(3): 2153-8.
10. Brady W, de Souza K. The HEART score: A guide to its application in the emergency department. *Turk J Emerg Med*. 2018; 18(2): 47-51.
11. Six AJ, Cullen L, Backus BE, Greenslade J, Parsonage W, Aldous S, et al. The HEART score for the assessment of patients with chest pain in the emergency department: a multinational validation study. *Crit Pathw Cardiol*. 2013; 12(3): 121-6.
12. Otsuka Y, Takeda S. Validation study of the modified HEART and HEAR scores in patients with chest pain who visit the emergency department. *Acute Med Surg*. 2020; 7(1): e591.
13. Sajeed SM, De Dios MP, Ong DWJ, Punyadasa AC. Performance of the modified HEART score in an Asian population. *Int J Emerg Med*. 2020; 13(1): 43.
14. Mahler SA, Riley RF, Hiestand BC. The HEART Pathway randomized trial: identifying emergency department patients with acute chest pain for early discharge. *Circ Cardiovasc Qual Outcomes*. 2015; 8(2): 195-203.
15. Koper LH, Frenk LDS, Meeder JG, van Osch FHM, Bruinen AL, Janssen MJW, et al. URGENT 1.5: diagnostic accuracy of the modified HEART score, with fingerstick point-of-care troponin testing, in ruling out acute coronary syndrome. *Neth Heart J*. 2022; 30(7-8): 360-369.
16. Stopyra JP, Harper WS, Higgins TJ. Prehospital Modified HEART Score Predictive of 30-Day Adverse Cardiac Events. *Prehosp Disaster Med*. 2018; 33(1): 58-62.
17. Poldervaart JM, Langedijk M, Backus BE. Comparison of the GRACE, HEART and TIMI score to predict major adverse cardiac events in chest pain patients at the emergency department. *Int J Cardiol*. 2017; 227: 656-661.