Journal of Acute Disease

Original Article

doi: 10.4103/2221-6189.326908 jadweb.org

Performance of HEART and TIMI scores in predicting major adverse cardiovascular events (MACEs) of chest pain patients in the emergency department: A prospective observational study

Sonal Kaushal Ginoya✉, Samira N. Parikh

Department of Emergency Medicine, GCS Medical College, Hospital and Research Centre, Ahmedabad, India

ABSTRACT

Objective: To compare the value of HEART and TIMI scores in predicting major adverse cardiovascular events (MACEs) of patients with chest pain in the emergency department at a tertiary care hospital in Ahmedabad, a city in western India.

Methods: A prospective study was conducted on chest pain patients from January to December 2019. All adult patients with non-traumatic chest pain presenting to the emergency department were included, and their HEART and TIMI scores were evaluated. The patients were followed up within 4 weeks for monitoring any major adverse cardiac events or death. The receiver-operating characteristics (ROC) curve was used to determine the value of HEART and TIMI scores in predicting MACEs. Besides, the specificity, sensitivity, positive predictive value (PPV), and negative predictive value (NPV) of the two scores were assessed and compared.

Results: A total of 350 patients were evaluated [mean age (55.03±16.6) years, 56.6% of males]. HEART score had the highest predictive value of MACEs with an area under the curve (AUC) of 0.98, followed by the TIMI score with an AUC of 0.92. HEART score had the highest specificity of 98.0% (95% *CI*: 96.4%-99.6%), the sensitivity of 75.0% (95% *CI*: 70.7%-79.3%), and PPV of 97.0% (95% *CI*: 94.1%-99.9%) and NPV of 82.5% (95% *CI*: 74.6%-90.4%) for low-risk patients. TIMI score had a specificity of 95.0% (95% *CI*: 92.4%-97.6%), sensitivity of 75.0% (95% *CI*: 69.4%-80.6%), PPV of 92.3% (95% *CI*: 88.1%-96.5%) and NPV of 82.3% (95% *CI*: 73.8%-90.8%) for low-risk patients.

Conclusions: HEART score is an easier and more practical triage instrument to identify chest pain patients with low-risk for MACEs compared to TIMI score. Patients with high HEART scores have a higher risk of MACEs and require early therapeutic intervention and aggressive management.

KEYWORDS: Chest pain; Emergency; Major adverse cardiovascular events; MACEs; HEART; TIMI

1. Introduction

Chest pain accounts for a significant proportion of visits to the emergency department (ED)[1]. The challenge for emergency physicians is to identify patients with critical cardiac ischemia timely and accurately[2]. The differential diagnosis of chest pain syndrome is a myriad of spectrum ranging from trivial to life-threatening conditions that can cause death within minutes or

Significance

Chest pain is the most life-threatening presentation in the emergency department, and needs systemic and complete evaluation. Failure to recognize potentially serious conditions can lead to MACEs and other serious complications including death. HEART and TIMI scores help physicians in risk stratification and optimizing management. Our study shows that HEART score has better specificity and comparable sensitivity versus TIMI score.

✉To whom correspondence may be addressed. E-mail: sonalginoya@yahoo.com

How to cite this article: Ginoya SK, Parikh SN. Performance of HEART and TIMI scores in predicting major adverse cardiovascular events (MACEs) of chest pain patients in the emergency department: A prospective observational study. J Acute Dis 2021; 10(5): 190-194.

Article history: Received 1 June 2021; Revision 16 September 2021; Accepted 21 September 2021; Available online 4 October 2021

hours[3]. Emergency physicians are responsible for identifying and treating a significant minority of patients with serious pathologies whilst avoiding unnecessary investigation and admission for the patients who can be safely discharged[4]. This is a difficult challenge as no perfect test exists, which can identify all major adverse cardiovascular events (MACEs)[5].

Risk stratification of patients with MACEs through some renowned scoring systems helps physicians to choose the optimizing management, which is recommended by some international guidelines[6-8]. The most widely-used scores are HEART (history, ECG, age, risk factors, and troponin) score, and thrombolysis in myocardial infarction (TIMI) score. It is challenging for emergency physicians to identify patients without high risk in a resource-constraint setting. Although guidelines for the management of low-risk chest pain are provided, these guidelines are largely limited due to the lack of validation studies and rare information related to the Indian patients[9]. The performance of different scores and different reference outcomes makes it difficult to compare the performance of these scores. Thus, relative literature is few, and studies on the same patient population are fewer. We aim to compare the performance of HEART and TIMI scores in predicting MACEs.

2. Patients and methods

2.1. Study design

This prospective observational study was conducted in the ED of a tertiary hospital in Ahmedabad from January to December 2019.

2.2. Inclusion and exclusion criteria

Inclusion criteria: All patients of >18 years with non-traumatic chest pain admitted to ED were included in the study.

Exclusion criteria: The patients<18 years and patients having a history of trauma were excluded.

2.3. Ethical Approval

This study was approved by the Ethical Committee of the GCS Medical College, Hospital and Research Centre, Ahmedabad, India. The approval serial number is GCSMC/EC/APPROVE/2018/212.

2.4. Data collection

Upon arrival in the ED, patients' cardiac monitoring followed by electrocardiograph (ECG) was obtained within 10 min after admission. Laboratory investigations including cardiac markers were collected. The HEART and TIMI scores were calculated in the ED on arrival, and these patients were followed up for 4 weeks for monitoring MACEs. According to the total HEART score calculated, patients were divided into low (0-3), intermediate (4-6), or high (7-10) risk of MACEs[10-12]. Similarly, TIMI score was calculated, and patients were divided into low (0-2), intermediate (3-4), or high (5-7) risk of MACEs[12,13].

2.5. End points

Primary outcome of this study was to compare value of HEART and TIMI scores on predicting major adverse cardiovascular events of patients with chest pain. The secondary outcome was to record readmission for any cause within 4 weeks of initial presentation and any death cases.

2.6. Data analysis

Data were analyzed by Microsoft Excel Version 2018 (Build 14326.20404) and calculation of confidence intervals using VassarStats.net. Numerical data were presented as the mean ± standard deviation (SD) while categorical variables were shown as the frequency with percentage. The discriminative potential of HEART and TIMI scores to predict MACEs was determined by the receiver-operating characteristics (ROC) curve. The performance of the two scores was assessed by calculating the specificity, sensitivity, positive predictive value, and negative predictive value.

3. Results

This study included 350 patients with non-traumatic chest pain. The mean age of the patients was (55.03±16.6) years. In our study, we had 198 male patients (56.6%) and 152 female patients (43.43%). We found that 192 (54.85%) patients developed MACEs within 4 weeks after initial presentation, among which 101 were male and 91 were females. The demographic and baseline information of patients with and without MACEs were shown in Table 1.

ROC curves of the HEART and TIMI scores to predict MACEs within 4 weeks were shown in Figure 1. HEART score had the highest overall discrimination to predict MACEs with an area under the ROC curve (AUC) of 0.98, followed by the TIMI score with an AUC of 0.92.

Based on the HEART score, 122 patients were classified as low risk, but 4 patients had developed MACEs. TIMI score showed that 129 patients were classified as low risk, but 10 patients had developed MACEs.

HEART score showed that moderate and high-risk patients were 54 (63.5%) and 134 (93.7%), respectively, while TIMI showed that are 133 (80.6%) and 49 (87.5%), respectively. The PPV and NPV of HEART and TIMI were shown in Table 2.

HEART score had the highest specificity of 98.0% (95% *CI*: 96.4%-99.6%), the sensitivity of 75.0% (95% *CI*: 70.7%-79.3%), and PPV of 97.0% (95% *CI*: 94.1%-99.9%) and NPV of 82.5% (95% *CI*: 74.6%-90.4%) for low-risk patients. TIMI score had a

Table 1. Demographic and baseline characteristics of the patients.

Variables	All patients	Patients with MACEs	Patients without MACEs
Gender, *n* (%)			
Male	198 (56.57%)	101 (51.01%)	97 (48.99%)
Female	152 (43.43%)	91 (59.87%)	61 (40.13%)
Age, years, mean±SD	55.03±16.60	58.00±14.00	51.30±18.00
Vital sign at presentation			
SBP, mm Hg, mean±SD	127.30±23.00	128.00±23.00	125.90±22.00
Heart rate, per minute, mean±SD	96.20±26.00	90.00±25.00	103.50±25.00
Cardiac risk factors			
Diabetes mellitus-Ⅱ, *n* (%)	55 (15.71%)	36 (65.45%)	19 (34.55%)
Obesity (BMI >30 kg/m^2), *n* (%)	68 (19.43%)	41 (60.29%)	27 (39.71%)
Hypercholesterolemia, *n* (%)	107 (30.57%)	64 (59.81%)	43 (40.19%)
Hypertension, *n* (%)	146 (41.71%)	93 (63.70%)	53 (36.30%)
Positive family history, *n* (%)	113 (32.29%)	58 (51.33%)	55 (48.67%)
Current smoking, *n* (%)	109 (31.14%)	57 (52.29%)	52 (47.71%)
History of CVD			
History of AMI, *n* (%)	23 (6.57%)	17 (73.91%)	6 (26.09%)
History of PCI, *n* (%)	18 (5.14%)	17 (94.44%)	1 (5.56%)
History of CABG, *n* (%)	5 (1.43%)	5 (100%)	0 (0%)
History of CVA/TIA, *n* (%)	41 (11.71%)	23 (56.10%)	18 (43.90%)
History of PAD, *n* (%)	30 (8.57%)	16 (53.33%)	14 (46.67%)
Anti−platelet medication, *n* (%)	85 (24.29%)	58 (68.24%)	27 (31.76%)

MACEs: Major adverse cardiovascular events; SBP: Systolic blood pressure; BMI: Body mass index; CVD: Cardiovascular disease; AMI: Acute myocardial infarction; PCI: Percutaneous coronary intervention; CABG: Coronary artery bypass grafting; CVA: Cerebrovascular accident; TIA: Transient ischemic attack; PAD: Peripheral arterial disease.

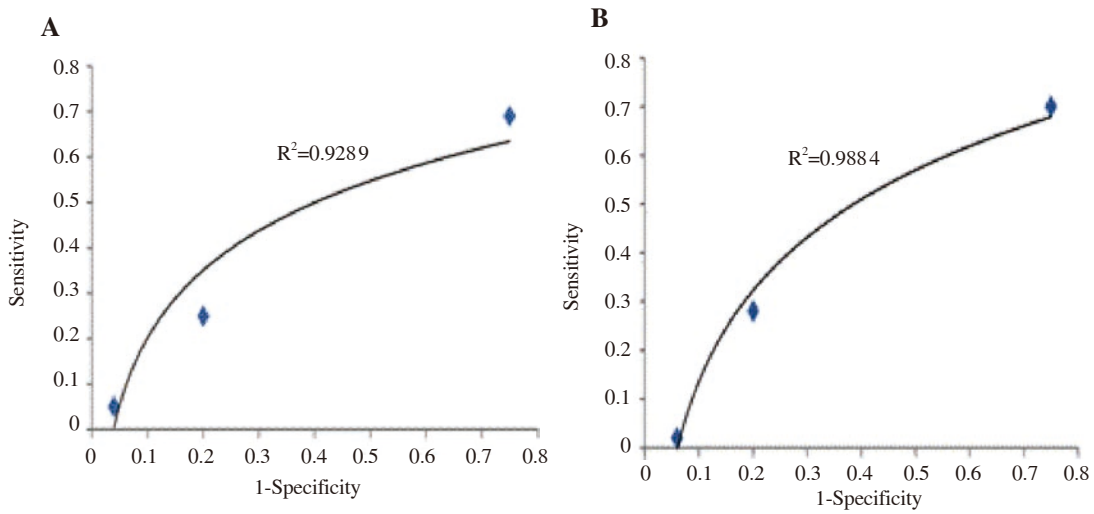

Figure 1. Receiver-operating-characteristic curves of HEART and TIMI score in predicting major adverse cardiovascular events (MACEs). A: ROC curve for TIMI score; B: ROC curve for HEART score.

Table 2. Comparison of performance of HEART score and TIMI in predicting MACEs.

Items	Low risk		Moderate risk		High risk	
	HEART score	TIMI score	HEART score	TIMI score	HEART score	TIMI score
Cut-off	⩽3	⩽2	3-4	4-6	7-10	5-7
Number of patients, *n*	122	129	85	165	143	56
Patients with MACE, *n* (%)	4 (3.3%)	10 (7.8%)	54 (63.5%)	133 (80.6%)	134 (93.7%)	49 (87.5%)
Death, *n*	1	1	2	5	6	8
Positive predictive value, %	97.0%	92.3%	36.5%	20.0%	93.7%	87.5%
Negative predictive value, %	82.5%	82.3%	52.0%	32.0%	72.0%	51.4%

specificity of 95.0% (95% *CI*: 92.4%-97.6%), sensitivity of 75.0% (95% *CI*: 69.4%-80.6%), PPV of 92.3% (95% *CI*: 88.1%-96.5%) and NPV of 82.3% (95% *CI*: 73.8%-90.8%) for low-risk patients.

Out of 350 patients, 110 patients were discharged (all were in the low-risk group), 69 patients were disposed to intensive care unit, critical care unit, and cardiac catheterization laboratory. Besides, 171 patients shifted to a high dependency unit. In this study out of 350 patients, a total of 42 patients were expired, and 8 patients with MACEs died within 24 h of admission, while 1 patient without MACEs died within 24 h of admission. Within 4 weeks of follow-up, 23 patients with MACEs expired, and 7 patients without MACEs expired.

4. Discussion

Chest pain is the most life-threatening presentation in the ED, and it needs systemic and complete evaluation because life-threatening conditions like acute coronary syndrome cannot be missed. Failure to recognize potentially serious conditions can lead to MACEs and other serious complications including death. Clinical history, risk factors, and history of aspirin use have a great significant correlation with the occurrence of MACEs. Serial ECG and measurement of the cardiac marker have a pivotal role in triaging patients presenting with chest pain in the ED.

It was evident that as the number of the risk factor of coronary artery disease increases the prevalence of MACEs will rise. A previous study was done by Poldervaart *et al.*[12] showed the prevalence of cardiac risk factors like diabetes mellitus (16%), Obesity (18%)[BMI>30 kg/m^2], hypercholesterolemia (32%), hypertension (48%), positive family history (36%), current smoking (25%); while in our study prevalence of cardiac risk factor like diabetes mellitus (16%), obesity (19.5%), hypercholesterolemia (30%), hypertension (41.7%), positive family history (32%), current smoking (31%) were reported.

According to a study by Reaney *et al.*[14] MACEs in low-risk patients classified in HEART score, and TIMI score was 0.5%, and 8.8%, respectively while in the study of Jeffrey *et al.*[12], that was 2%, and 16% respectively; in our study of MACEs in low-risk patients classified in HEART score and TIMI score was 3.3% and 7.8 %, respectively.

The population involved in the study by Six *et al.*[15] and Backus *et al.*[10] was 122 and 2388 respectively while our study covered a population of 350 patients. The mean age of patients involved in the study by Six *et al.* and Backus *et al.* was 61 years and 60.6 years, respectively while in the present study mean age of the population involved was 55.03 years. In studies of Six *et al.*[15], Backus *et al.* and present study male predominant population were seen. HEART score showed MACEs low-risk patients in 2.5%, 0.9%, and 3.3% of the patients in Six *et al.*, Backus *et al.*, and present study, respectively. HEART score showed that MACEs was observed in moderate-risk patients in 20.3%, 12%, and 63.5% study subjects in the studies of Six *et al.*, Backus *et al.*, and the present study, respectively. MACEs was observed in high-risk patients in 72.3%, 65%, and 93.7% study subjects in Six *et al.*, Backus *et al.*, and present study respectively. The reason caused the difference among the 3 studies could be that Six *et al.* conducted a pilot study in a single centre to validate HEART score while Backus *et al.* conducted a comparative study in 10 different centres to validate HEART score and comparing it with TIMI score too.

A study by Jeffrey *et al.* [16] showed the specificity (%), sensitivity (%), PPV, and NPV of HEART score in predict low risk of the patients was 25%, 91.6%, 42.2%, and 98%, while in our study it was 98%, 75%, 97%, 82.5%. As per Jeffrey *et al.* study showed the specificity (%), specificity (%), PPV, and NPV of TIMI score in predict low risk of the patients were 37.5%, 93.5%, 43.5%, and 83.9%; while in our study it was 95.0%, 75.0%, 92.3%, and 82.3%. The reason could lie in the fact that Jeffrey *et al.* compared HEART and TIMI scores for high acuity chest pain patients and found superiority of HEART score in predicting 30 day MACEs.

In our study, HEART score identified 122 (35%) patients with low risk out of which 6 (5%) patients developed MACEs, while TIMI score identified 129 (36.8%) patients with low risk out of which 12 (10.8%) patients developed MACEs, so that HEART score revealed less MACEs compared to TIMI score. The ROC curve of which overall discrimination to predict MACEs in our study population shows that HEART score with an AUC of 0.98 followed by the TIMI score with an AUC of 0.92. In the literature, mostly comparable results were found when comparing the HEART and TIMI scores. While comparison with the Six *et al.* study[15], the AUC of the HEART score was 0.83, and the AUC of the TIMI score was 0.75. We found HEART score had the highest specificity of 98.0%, sensitivity 75.0%, and PPV 97.0%, and NPV 82.5% for low-risk patients. TIMI score had specificity 95.0%, sensitivity same as HEART score of 75.0%, PPV of 92.3% and NPV of 82.3% for low risk patients. Thus, HEART score can quickly and efficiently triage chest pain patients.

The results showed that moderate and high-risk patients usually need admission, thorough investigation, early therapeutic intervention, and management. These patients are never considered for early discharge. It suggests that the above-mentioned scores are utilized exclusively for low-risk patients with chest pain.

Limitations: Firstly, we chose to validate the HEART and TIMI scores, while currently several other risk scores are available. We found that most currently available risk scores were not used in daily practice, or that the score included variables not routinely assessed by clinicians. Secondly, the TIMI score was calculated from prospectively collected variables, blinded for the primary endpoints. These variables were defined before the start of the trial and included in our data collection form at the ED. Clinicians might take other variables into account when calculating a risk score in daily practice; although the TIMI score consists of more objective variables than the HEART score, we cannot rule out that in our study the performance of the TIMI score could have been underestimated to some extent. Lastly, we did not include serial troponin measurements in our study. It should be noted that physicians did not perform second troponin

measurements in all patients, but only in the patients of whom they deemed this was necessary. Electrocardiographic changes and troponin elevations may be non-significant in the early stages of myocardial infarction, or they may be falsely elevated by other disorders such as chronic kidney disease, heart failure, arrhythmias, tachycardia, and sepsis, among others. There are limitations of the HEART score itself. Patients are not always good historians and risk factors may not always be consistently reported. Besides. this study was carried out in a single tertiary care center, which may not accurately reflect the behavior of other populations in centers with different levels of complexity or in different regions or countries. Therefore, studies with larger, multicentric populations will be required in the future to enhance the applicability of these findings. Finally, the follow-up information is based on the data provided by patients and their family members, which could limit the reliability of the data. Although the information is based on a structured format with clear questions, it may be subject to misinterpretation.

Our study shows HEART score has better specificity and the same sensitivity as the TIMI score. In our study HEART score is a more easily and practically implemental triage instrument to identify the largest number of patients at low risk with minimum MACE compare to the TIMI score. The use of HEART can help quickly triage, intervene, and admit chest pain patients. Patients with a high HEART score require more aggressive management and admission. In patients with lower HEART scores, outpatient follow-up may reduce admission costs and lower the risk of over-diagnosis and invasive testing or procedure. Further studies are required to focus on the use of the HEART score as a clinical decision-making aid in chest pain patients.

Conflict of interest statement

The authors report no conflict of interest.

Authors' contributions

S.N.P.: Creating idea of the study, data interpretation, and final approval of the version published. S.K.G.: Data collection, statistical analysis, article preparing and submission.

References

[1] Goodacre S, Cross E, Arnold J, Angelini K, Capewell S, Nicholl J. The health care burden of acute chest pain. *Heart* 2005; **91**(2): 229-230.

[2] Lai SM, Anaikatti P, Thiruchelvam P, Chai SC, Yong Th, Goh YS, et al. Utility of an emergency department chest pain protocol in ruling out acute coronary syndrome. *Int J Crit Care Emerg Med* 2018; **4**(2): 51.

[3] Walls RM, Hockberger RS, Gausche-Hill M. In: *Rosen's Emergency Medicine, Concepts and Clinical Practice*. 9th ed. Philadelphia: Elsevier; 2018.

[4] Fauci J, Hauser K, Loscalzo L. In: Shanahan JF, Davis KJ, (eds). *Harrison's principles of internal medicine*. 20th Edition. USA: McGraw-Hill Education; 2018.

[5] Herren KR, Mackway-Jones K. Emergency management of cardiac chest pain: a review. *Emerg Med J* 2001; **18**(1): 6-10.

[6] Yiadom MY. Acute coronary syndrome clinical presentations and diagnostic approaches in the emergency department. *Emerg Med Clin North Am* 2011; **29**(4): 689-697.

[7] Braunwald E, Antman EM, Beasley JW, Califf RM, Cheitlin MD, Hochman JS, et al. ACC/AHA guideline update for the management of patients with unstable angina and non-ST-segment elevation myocardial infarction-2002: summary article: a report of the American College of Cardiology/American Heart Association task force on practice guidelines (committee on the management of patients with unstable angina). *Circulation* 2002; **106**(14): 1893-1900.

[8] O'Gara PT, Kushner FG, Ascheim DD, Casey Jr DE, Chung MK, de Lemos JA, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation* 2013; **127**(4): e362-e425.

[9] Chauhan V, Shah PK, Galwankar S, Sammon M, Hosad P, Beeresha, et al. The 2017 International Joint Working Group recommendations of the Indian College of Cardiology, the Academic College of Emergency Experts, and INDUSEM on the management of low risk chest pain in emergency departments across India. *J Emerg Trauma Shock* 2017; **10**(2): 74-81.

[10] Backus BE, Six AJ, Kelder JC, Bosschaert MAR, Mast EG, Mosterd A, et al. A prospective validation of the HEART score for chest pain patients at the emergency department. *Int J Cardiol* 2013; **168**(3): 2153-2158.

[11] Jeff Dubin, Eric Kiechle, Matt Wilson, Christian Timbol, Rahul Bhat, Dave Milzman. Mean HEART score for hospitalized chest pain patients are higher in more experience provider. *Am J Emerg Med* 2017; **35**(1): 122-125.

[12] Poldervaart JM, Langedijk M, Backus BE, Dekker IMC, Six AJ, Doevendans PA, et al. 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.

[13] Ramsay G, Podogrodzka M, McClure C, Fox KAA. Risk prediction in patients presenting with suspectedcardiac pain: the GRACE and TIMI risk scores versus clinical evaluation. *QJM* 2007; **100**(1): 11-18.

[14] Reaney P, Elliott H, Cooper J. *Risk scoring in cardiac chest pain: A prospective cohort evaluation in emergency patients*.RCEM Annual Scientific Conference 2016, Bournemouth, UK. NHS Grampian; 2016.

[15] Six AJ, Backus BE, Kelder JC. Chest pain in the emergency room: Value of the HEART score. Neth Heart J 2008; **16**(6): 191-196.

[16] Sakamoto JT, Liu N, Koh ZX, Fung NXJ, Heldeweg MLA, Ng JCJ, et al. Comparing HEART, TIMI, and GRACE scores for prediction of 30-day major adverse cardiac events in high acuity chest pain patients in the emergency department. *Int J Cardiol* 2016; **221**: 759-764.