PAGE 163
2024 March; 30 (2): 163-167
p-ISSN 0854-4263   e-ISSN 2477-4685
Available at www.indonesianjournalofclinicalpathology.org

Modified HEART Score Analysis in Patients with NSTEMI and STEMI

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ABSTRACT

Cardiovascular disease is one of the leading causes of death. The utility of the risk score in the emergency department is for the initial examination of patients with chest pain suspected of acute coronary syndrome. HEART score was developed in the Netherlands and utilized to stratify chest pain patients and classify the risk of the patients as well as to identify the possibility of Major Adverse Cardiac Event (MACE) occurrences in 6 weeks. This study aimed to compare STEMI and NSTEMI using the modified HEART score in chest pain patients at the Integrated Heart Center (PJT) Dr. Wahidin Sudirohusodo Government Hospital, Makassar. This study used a cross-sectional approach from January 1 to March 31, 2022. The sample was drawn from patients with chest pain clinically diagnosed NSTEMI or STEMI based on the medical records containing the procedure of initial examination and HEART score risk stratification of each patient. The HEART score was found to be statistically significantly higher in STEMI (7.0 and 7.3) than in NSTEMI (6.0 and 5.6) (p<0,001). AUC 0.809 (p<0.001). The cut-off value of the HEART score can be used as a predictor of STEMI/NSTEMI. A cut-off value of 5.5 and 6.5 (alternative) were obtained from the ROC curve and can provide optimal sensitivity and specificity. The higher the score appeared on the HEART score (high risk), the higher the number of STEMI diagnoses compared to NSTEMI diagnoses. This is characterized by a significant increase of Troponin-I. Hence, the HEART score can be used as a scoring measure to predict whether the patient will be diagnosed with NSTEMI or STEMI.

Keywords: Chest pain, STEMI, NSTEMI, HEART score, Troponin-I

INTRODUCTION

Coronary heart disease is still one of the significant problems in the cardiovascular field because it causes a high rate of hospitalization and a high mortality rate. In 2016, coronary heart disease represented 31% of all global deaths.[1,2] There is a need for a risk score in the emergency department to stratify chest pain patients with suspected acute coronary syndrome to provide an appropriate treatment strategy.[1,3]

Chest pain is one of the most frequent reasons for patients visiting the emergency department.[2] More than 5% of visits to the emergency department and 40% of hospital admissions are due to chest pain.[3] In the United States, there is an Acute Myocardial Infarction (AMI) prevalence of about 650,000 cases, while in the United Kingdom, it is about 180,000 cases annually.[4] Based on the Primary Health Research (RISKESDAS) report in 2018, the prevalence of heart disease in Indonesia was at 1.5%, including acute myocardial infarction. The most considerable prevalence of heart disease in North Kalimantan province was 2.2%, Yogyakarta was 2.0%, and Gorontalo was 2.0%.[5]

The HEART score was developed in the Netherlands in 2008 by Six, Backus, and Kelder as an instrument for risk stratification in patients with chest pain based on short-term Major Adverse Cardiac Events (MACE) risk to help identify low-risk patients. This score has five variables: history, ECG, age, risk factor, and troponin levels (Table 1). The HEART score ranges from 0 to 10, divided into low risk (≤ 3), medium risk (4-6), and high risk (7-10).[6] The result shows that the MACE of low HEART score was 1.4%, intermediate was 5.2%, and high was 33.3%.[7]

Acute Myocardial Infarction (AMI), based on ECG results, is classified into ST-elevation Acute Myocardial Infarction (STEMI) and non-ST-elevation Myocardial Infarction (NSTEMI). In STEMI, there is a complete occlusion of the coronary arteries, causing a wider infarction area covering the entire myocardium, and an elevation of the ST-segment can be found on ECG examination. On the other hand, NSTEMI is signified when there is partial occlusion that does not involve the entire

myocardium, so ST-segment elevation is absent on the ECG examination.[8]

The severity of myocardial infarction depends on three factors: the degree of occlusion in the coronary arteries, the duration of the occlusion period, and the presence or absence of collateral circulation. Cardiac troponin is a protein component that plays a role in contractile myocardial cells and is present in almost all heart muscles. Elevated serum levels of cardiac troponin are associated with myocardial ischemia and necrosis symptoms.[8] In the modified HEART score, Troponin-I is a susceptible component.[9] Increased Troponin-I is a promising biomarker in the circulation of myocardial necrosis.[10,11]

The HEART score research on MACE conducted by Ma *et al.* resulted in 46.6% of patients experiencing MACE in 3 months and 15.8% of them being diagnosed with AMI.[1] Hence, the authors were interested in comparing the severity of STEMI and NSTEMI using the modified HEART score for chest pain patients at the Integrated Heart Center (PJT) Dr. Wahidin Sudirohusodo Hospital, Makassar.

METHODS

This research applied a cross-sectional method. The study was conducted at the PJT Dr. Wahidin Sudirohusodo Hospital from January 1 to March 31, 2022. The population in this study was all patients diagnosed with coronary heart disease who were hospitalized at PJT Dr. Wahidin Sudirohusodo and who had been tested for modified HEART scores. The study sample was a population that met the inclusion criteria, namely chest pain patients diagnosed by clinicians as NSTEMI and STEMI at PJT Dr. Wahidin Sudirohusodo Hospital.

The study sample was determined after tracking the medical records of the patients who had completed the initial examination and had a risk stratification of HEART score on arrival. Troponin-I was examined using VIDAS on serum or plasma using the Enzyme-Linked Fluorescent Assay (ELFA) method. The reference interval was 8-29 ng/L for females and 17-50 ng/L for males.

The data obtained was processed using SPSS version 25. The Statistical analysis was carried out using descriptive statistical calculations and frequency distribution. The statistical test used the Mann-Whitney test, Chi-Square test, and Receiver Operating Characteristics (ROC) curve to assess the Area Under Curve (AUC) and determine the cut-off value.

The statistical test results were said to be significant if $p<0.05$. Ethical eligibility approval was obtained from the Health Research Ethics Commission (KPEK) of the Faculty of Medicine, Hasanuddin University/Hasanuddin University Hospital/Dr. Wahidin Sudirohusodo Makassar Hospital article number 432/UN 4.6.4.5.31/ PP36/2022.

RESULTS AND DISCUSSIONS

This study consisted of 74 patients who met the inclusion and exclusion criteria. The subjects

Table 1. Five modified HEART score elements: history, electrocardiogram, age, risk factors, and troponin levels[8]

Components	Ranks	Points
History	Slightly or non-suspicious Moderate suspicious Highly suspicious	0 1 2
ECG	Normal Non-specific repolarization disturbance Significant ST-depression	0 1 2
Age	≤ 45 years 45-65 years ≥ 65 years	0 1 2
Risk factors	No risk factors known 1 or 2 risk factors ≥ 3 risk factors*, or history of atherosclerotic disease*	0 1 2
hs-cTnI	≤ 1 x normal limit 1-3 x normal limit ≥ 3 x normal limit	0 1 2
Range		0-10

ECG: electrocardiogram; HEART: History, ECG, Age, Risk factors and Troponin; hs-cTnI: high sensitivity cardiac Troponin-I. *Risk factors: diagnosed with hypertension, diagnosed hypercholesterolemia, diagnosed with diabetes mellitus, family history with premature coronary artery disease, current smokers (<1 month), and obesity (body mass index 30 kg/m^2); #Atherosclerotic diseases history: myocardial infarction, percutaneous intervention, coronary artery bypass graft, ischemic stroke, peripheral or carotid artery disease

included 37 patients with NSTEMI diagnoses and 37 patients with STEMI diagnoses. The age group was 36 - 82 years old, averaging 59.0±10.5 years. The distribution of variable categories as components of the HEART score is shown in Table 2.

Statistical tests using the Mann-Whitney test obtained results in the HEART score (median and mean) are found to be significantly higher in STEMI (7.0 and 7.3) than in NSTEMI (6.0 and 5.6) (p<0.001) (Table 3).

There was a significant association between HEART scores with diagnosis (p<0.01), STEMI at high risk (68.3%), and NSTEMI at high risk (31.7%) (Table 4, Figure 1).
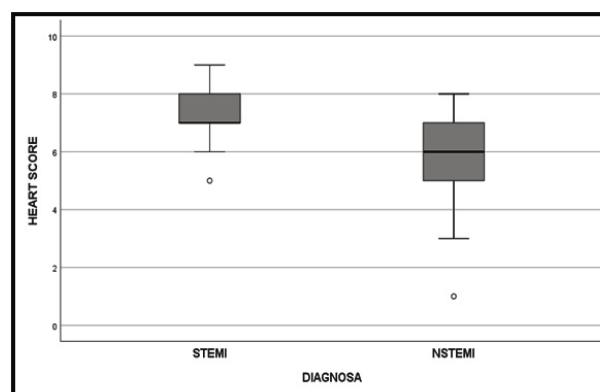
Table 2. Distribution of HEART score variables

Criterion		n	(%)
History	Slightly or non-suspicious	40	54.1
	Moderately suspicious	24	32.4
	Highly suspicious	10	13.5
ECG	Normal	2	2.7
	Non-specific repolarization disturbance	31	41.9
	Significant ST depression	41	55.4
Age	<=45 years	3	4.1
	46-65 years	46	62.2
	>=65 years	25	33.8
Risk factor	No risk factors are known	4	5.4
	1 or 2 risk factors	43	58.1
	>=3 risk factors	27	36.5
Troponin-I	<=1 x normal limit	3	4.1
	1-3 x normal limit	12	16.2
	>=3 x normal limit	59	79.7

Table 3. Comparison of HEART scores according to diagnosis

Diagnosis	n	Min	Max	Median	Mean	SD	p
STEMI	37	5	9	7.0	7.3	1.0	<0.001
NSTEMI	37	1	8	6.0	5.6	1.5	

Table 4. Relationship of HEART score with STEMI and NSTEMI diagnoses

Heart Scoring Value		Diagnosis		Total
		STEMI	NSTEMI	
Low risk	n	0	2	2
	%	0.0%	100.0%	100.0%
Medium risk	n	9	22	31
	%	29.0%	71.0%	100.0%
High risk	n	28	13	41
	%	68.3%	31.7%	100>0%
Total	n	37	37	74
	%	50.0%	50.0%	100.0%

Figure 1. Comparison of HEART scoring with STEMI and NSTEMI diagnostics
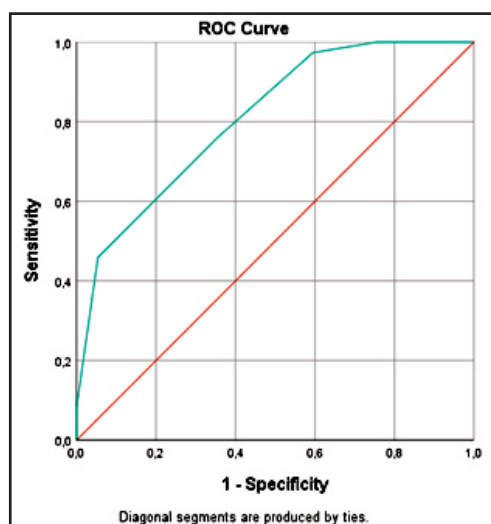
Figure 2. ROC curve HEART score

Table 5. The area under the curve

Area	Std. Error	p	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
0.809	0.049	0.000	0.713	0.905

Table 6. HEART score prognostic value calculation table using cut-off 5.50 and 6.50

HEART Score Cut-off Value	Diagnosis		Total	Sensitivity %	Specificity %	NPP %	NPN %	Accuracy %
	STEMI	NSTEMI						
> = 5.50	36	32	58					
< = 5.50	1	15	16	97.3	40.5	62	94	69
Total	**37**	**37**	**74**					
> = 6.50	28	13	41					
< = 6.50	19	24	33	75.7	64.9	68.3	72.7	70
Total	**37**	**37**	**74**					

The result indicates that the STEMI increases according to the increased risk on the HEART score.

HEART score on STEMI is 5 to 9, and the HEART score on NSTEMI is 1, the lowest, and 8, the highest.

An AUC value of 0.809 (p<0.001) is statistically significant. This result suggests that the HEART score cut-off value can be used as a STEMI/NSTEMI predictor. Based on the ROC curve, the cut-off values are 5.50 and 6.50 (alternative), which can provide optimal sensitivity and specificity (Table 5, Figure 2).

The results of the Chi-Square test showed a cut-off value of 5.50, and the HEART score was significantly associated with the diagnosis (Table 6).

The HEART score assesses the patient's history, ECG, age, risk factors, and troponin. Each point is scored 0, 1, and 2. The total sum of 5 points is used to predict the risk of coronary heart disease in 6 weeks after the patient suffered from chest pain. This study assessed the comparison of HEART scores with NSTEMI and STEMI diagnoses, and the results showed a significant relationship between HEART scores and diagnoses (p<0.01). This finding confirms the research conducted by Ma *et al*.[1,11]

The results of the HEART score in history variable distribution were at most 54.1% slightly or non-suspicious, indicating a history of mild chest pain and not suspected of chest pain caused by heart ischemia, followed by 32.4% moderately suspicious in the form of pressure/weight of the retrosternal area, radiating to the left arm, neck, jaw, interscapular area, shoulder, or epigastrium with sudden onset and intermittent/multiple-minute or persistent (>20-minute duration). As for the HEART ECG score, there was a maximum of 55.4% significant ST-depression followed by 41.9% non-specific repolarization disturbance. The HEART score in the age category was highest at the age of 46-65 years at 62.2% compared to those >65 years with only 33.8% due to unhealthy lifestyles such as lack of exercise, eating unhealthy food with a lot of cholesterol, smoking, obesity, and hypercholesterolemia.

Furthermore, 58.1% of risk factors occur in 1 or 2 risk factors, namely smoking and hypertension. These results show that these risk factors can be the

cause of myocardial infarction NSTEMI or STEMI. Troponin-I is the most specific indicator of cardiac infarction conditions. The results of this study showed that troponin >3 x normal value was 79.7%. Troponin-I increased at 4-9 hours, peak levels at 12-24 hours, and returned to normal in 7-14 days.

In calculating a prognostic value, the ROC curve is used to obtain the AUC value of the HEART score. If this AUC is significant, it is continued with determining the cut-off value and calculating the prognostic value. Based on the ROC curve, cut-off values of 5.50 and 6.50 (alternative) were obtained to provide optimal sensitivity and specificity. At cut-off 5.50, obtaining the sensitivity at 97.3% indicates that the HEART score successfully detects 36 out of 37 STEMI correctly. However, the specificity was only 40.5%, suggesting that the HEART score only managed to detect 15 out of 37 NSTEMI correctly. Furthermore, the accuracy was 69%, showing that the HEART score accurately detected 51 out of 74 STEMI and NSTEMI subjects.

CONCLUSIONS AND SUGGESTIONS

Chest pain is a common complaint often found in the ER and has a differential diagnosis of varying degrees of emergency. One of the causes of chest pain is ACS, which requires immediate treatment. HEART score examination of clinical diagnoses in NSTEMI and STEMI was shown to be related. The higher the score obtained on the HEART score (high risk), the greater the STEMI diagnosis rate compared to NSTEMI. The STEMI state results in a complete blockage of the coronary arteries, resulting in a halt in oxygenation to the myocardium tissue and causing the myocardium infarct. A significant increase in Troponin-I indicates this. Also, there is a relationship between HEART scores and STEMI and NSTEMI diagnoses, which is depicted on the ROC curve of HEART scores that can predict STEMI and NSTEMI occurrences with optimal sensitivity, specificity, and accuracy.

HEART scores are easy, fast, and reliable result predictors in chest pain patients and have more accurate validation values than other scoring systems. Therefore, they can be used for the triage of ACS patients.

REFERENCES

1. Ma CP, Xiao W, Wang Q, Li X, He X, Shao N. A modified HEART risk score in chest pain patients with suspected non-ST-segment elevation acute coronary syndrome. Journal of Geriatric Cardiology, 2016; 13: 64-69.
2. World Health Organization (WHO). Cardiovascular diseases (CVDs), fact sheet. 2017. Accessed August 26, 2022. Available from: http://www.who.int/mediacentre/factsheets/fs317/
3. Stopyra JP, Harper WS, Higgins TJ, Prokesova JV, Winslow JE, *et al.* Prehospital modified HEART score predictive of 30-day adverse cardiac events. Prehospital and Disaster Medicine, 2017; 33(1): 58-62.
4. Rathore V, Singh N, Mahat RK, Kocak MZ, Fidan K, *et al.* Risk factors for acute myocardial infarction: A review. EJMI, 2018; 2(1): 1-7.
5. Health Research and Development Agency. National report on basic health research 2018. Ministry of Health of the Republic of Indonesia. 2018; 144-147.
6. PERKI. Acute coronary syndrome management guidelines 2018. Indonesian Association of Cardiovascular Specialists, 2018; 76.
7. Sajeed SM, Dios MP, Ong J, Punyadasa AC. Performance of the modified HEART score in an Asian population. International Journal of Emergency Medicine, 2020; 13: 43.
8. Mitsis A, Gragnano F. Myocardial infarction with and without ST-segment elevation: A contemporary reappraisal of similarities and differences. Current Cardiology Reviews, 2021; 17(4): 1-6.
9. Iriana D, Nurulita A, Rauf D. Relationship of Troponin-I and high-sensitivity levels of Troponin-I with coronary angiography in coronary artery disease suspect patients. Studies at the Central General Hospital Dr. Wahidin Sudirohusodo Makassar-Indonesia year. Medical Science Digest, 2019; 10(2): 420-425.
10. Koper LH, Frenk S, Meeder JG, Osch FHM, Bruinen AL, *et al.* Diagnostic accuracy of the modified HEART score with fingerstick point of care troponin testing in ruling out acute coronary syndrome. Diagnostic accuracy of the modified HEART score. Neth Heart Journal, 2021; 30(7): 360-369.
11. Saleh M, Ambrose JA. Understanding myocardial infarction. F1000 Research, 2018; 7(1): 1-8.