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The HEART score is useful to predict cardiovascular risks and reduces unnecessary cardiac imaging in low-risk patients with acute chest pain

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Abstract

The present study was to investigate whether the HEART score can be used to evaluate cardiovascular risks and reduce unnecessary cardiac imaging in China.

Acute coronary syndrome patients with the thrombosis in myocardial infarction risk score < 2 were enrolled in the emergency department. Baseline data were collected and a HEART score was determined in each participant during the indexed emergency visit. Participants were follow-up for 30 days after discharge and the studied endpoints included acute myocardial infarction, cardiovascular mortality and all-cause mortality.

A total of 244 patients were enrolled and 2 was loss of follow-up. The mean age was 50.4 years old and male patients accounted for 64.5%. Substernal pain and featured as pressure of the pain accounted for 34.3% and 39.3%, respectively. After 30 days' follow-up, no patient in the low-risk HEART score group and 2 patients (1.5%) in the high risk HEART score group had cardiovascular events. The sensitivity of HEART score to predict cardiovascular events was 100% and the specificity was 46.7%. The potential unnecessary cardiac testing was 46.3%. Cox proportional hazards regression analysis showed that per one category increase of the HEART score was associated with nearly 1.3-fold risk of cardiovascular events.

In the low-risk acute chest pain patients, the HEART score is useful to physicians in evaluating the risk of cardiovascular events within the first 30 days. In addition, the HEART score is also useful in reducing the unnecessary cardiac imaging.

Abbreviations: ACC/AHA = American College of Cardiology/American Heart Association, ACS = acute coronary syndrome, CI = confidence interval, HR = hazard ratio, MACEs = major adverse cardiovascular events, TIMI = thrombosis in myocardial infarction.

Keywords: cardiac imaging, cardiovascular events, HEART score

1. Introduction

Acute chest pain is one of the major reasons of the emergency visit in both the developed and developing countries.[1,2] The total expenditure for the evaluation of acute chest pain in the United States was estimated up to nearly 10 billion dollars annually.[3] Nevertheless, only around 10% of these patients were diagnosed as acute coronary syndrome (ACS), which is a critical condition necessitates prompt evaluation and treatment.[4] Based on the American College of Cardiology/American Heart Association (ACC/AHA) guideline recommendations, patients with ACS should be stratified into low, intermediate and high risks so as to guide the next step of therapy.[5] In specific, those with high risk should be managed with intensive antiplatelet and statins treatment plus prompt reperfusion; while those with intermediate or low risk, besides appropriate medications treatment, closely monitoring electrocardiography, cardiac biomarker and symptom changes should also be applied. In addition, stress testing and/or cardiac imaging after discharge from emergency department is also appropriate and recommended.[5]

The HEART score, which includes components of history, electrocardiography, age, risk factors and troponin I, has been designated to help differentiate and identify the probability of ACS in patients with acute chest pain presented to the emergency department.[6–8] One European retrospective cohort showed that patients with low HEART score in terms of 0 to 3 had <1% risk of having major adverse cardiovascular events (MACEs) at the first 6 weeks after discharge.[7] In another study conducted in the United States, Mahler et al[9] found that the HEART score was useful to reducing unnecessary stress testing and cardiac imaging in a population with low-pretest probability of ACS. However, the HEART score has yet to be prospectively evaluated in acute chest paint patients presented to the emergency department in China.

We therefore conducted a prospective study and the objective of the present study was to determine whether the HEART score

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can be used to help physicians evaluate the short-term MACEs risks in China; in addition, whether the HEART score would be useful to reduce unnecessary stress testing and/or cardiac imaging in low-risk acute chest pain patients in China would also be evaluated.

2. Methods

2.1. Studied participants enrolment

The present study was approved by the Ethics Committee of Clinical Research of the Third People's Hospital of Huizhou and informed consent was obtained before enrolment. During October of 2016 to October of 2017, 3878 patients presented to our emergency department and 835 were due to acute chest pain. Among these acute chest pain patients, 522 were diagnosed as ACS, among which 383 were low risk with the thrombosis in myocardial infarction (TIMI) risk score <2[10] and 316 agreed to participate in the present study. Low-risk patients in terms of TIMI risk score <2 was enrolled. Included criteria were as follows: $\geq$ 18 years old, the first time test of cardiac biomarker (cardiac kinase MB, CK-MB, and troponin I) in the emergency department was negative and no typical ACS electrocardiography change. Excluded criteria were as follows: those presenting with shortness of breath, dyspnea, arrhythmia, or had documented history of coronary heart disease, coronary artery stenting or coronary artery bypass grafting.

2.2. Baseline data collection

Baseline data were collected during the indexed emergency visit using structured questionnaire by 2 independent investigators. The questionnaire comprised information of demographics (age and gender), smoking status, prior medical history and cardiovascular risk factors, and medication administration during the indexed emergency visit.

2.3. The HEART score evaluation

A HEART score was determined in each participant during the indexed emergency visit and the protocol to calculate the HEART score was done in accordance to prior description [11] (Table 1). To specify, the first time of electrocardiography and cardiac biomarker were used for the HEART score evaluation. In specific, Low risk was the score of 0 to 3 and high risk ≥ 4.[9]

2.4. Follow-up and studied endpoints

Participants were follow-up for 30 days after discharge via telephone call or at outpatient visit. The studied endpoints included acute myocardial infarction, cardiovascular mortality and all-cause mortality. All the endpoints were adjudicated by an independent cardiologist who was blinded to the clinical characteristics of individual participant.

2.5. Statistical analysis

Continuous variables were expressed as mean $\pm$ standard deviation or median (interquartile ranges) and categorical variables were expressed as number and frequency of cases. Between-group differences were evaluated by the independent Student *t* test or the Mann–Whitney *U* test for continuous variables as appropriate, or the chi-square analysis or Fisher exact tests for the categorical variables as appropriate. Cox proportional hazards regression analysis was used to evaluate the predictive value of the HEART score for studied endpoints. The hazard ratio (HR) and associated 95% confidence interval (CI) represents the risk associated with one category increase of HEART score for studied endpoints. Statistical analysis was conducted in SPSS 23.0 (IBM, USA). All *P* values were 2 sides, and statistical significance was defined as $P<.05$.

Table 1

The HEART score.

Variables		Points
History	Highly suspicious	2
	Moderately suspicious	1
	Slightly suspicious	0
Electrocardiography	Significant ST depression	2
	Non-specific repolarization	1
	Normal	0
Age, years	$\geq$ 65	2
	45–65	1
	$\leq$45	0
Risk factors	3 or more	2
	1–2	1
	0	0
Troponin I	$\geq$ 3* normal limit	2
	1–3* normal limit	1
	Within normal range	0

Risk factors include as follows: currently treated diabetes mellitus, current or recent (<90 days) smoker, diagnosed and/or treated hypertension, diagnosed hypercholesterolemia, family history of coronary heart disease, obesity (body mass index $>$ 30 kg/m^2), or a history of significant atherosclerosis (coronary revascularization, myocardial infarction, stroke, or peripheral arterial disease).

3. Results

3.1. Baseline characteristics

As presented in Figure 1, a total of 244 patients were enrolled and 2 was loss of follow-up and no significant differences in baseline characteristics between the remaining 242 patients and the 2 lost patients were observed. The mean age was 50.4 years old and male patients accounted for 64.5%. Substernal pain and featured as pressure of the pain accounted for 34.3% and 39.3%, respectively, and 36.3% and 63.7% of participants were defined as TIMI score 0 and 1, respectively (Table 2).

3.2. The HEART score evaluation

As presented in Table 3, nearly 46.3% of patients were defined as low risk and 53.7% were high risk based on the HEART score evaluation.

3.3. Incidence of MACEs and potential reduction of unnecessary cardiac testing

After 30 days' follow-up, no patient in the low-risk HEART score group and 2 patients (1.5%) in the high risk HEART score group had MACEs. All these 2 patients had non-ST segment elevation acute myocardial infarction and had percutaneous coronary intervention in our hospital. The sensitivity of HEART score to predict MACEs was 100% and the specificity was 46.7%. The potential unnecessary cardiac testing was 46.3% (Table 4).

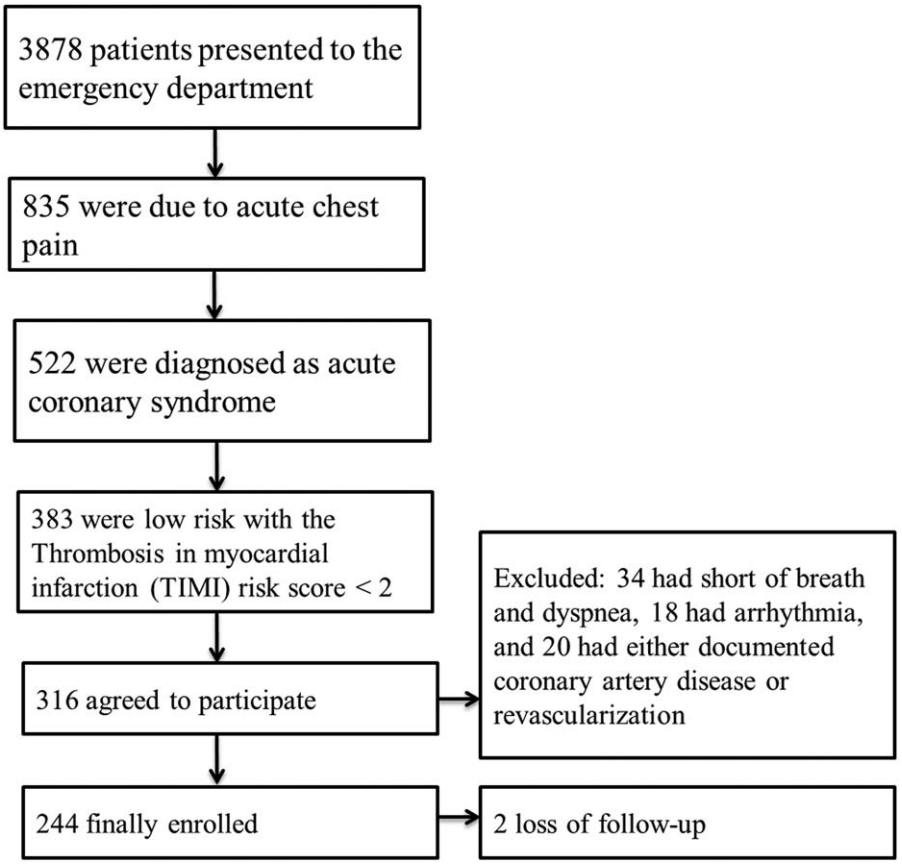

Figure 1. Schematic of patients' enrolment.

Table 2

Baseline characteristics (n = 242).

Variable	Value
Age (years)	50.4 ± 15.7
Male, n (%)	156 (64.5)
Chest pain feature	
Pressure, n (%)	95 (39.3)
Sharp, n (%)	54 (22.3)
Burning, n (%)	29 (12.0)
Ache, n (%)	12 (5.0)
Nonspecified, n (%)	52 (21.4)
Chest pain location	
Substernal, n (%)	83 (34.3)
Left chest, n (%)	42 (17.4)
Right chest, n (%)	18 (7.4)
Epigastric, n (%)	37 (15.3)
Nonspecified, n (%)	62 (25.6)
Risk factors	
Current smoker, n (%)	78 (32.2)
Hypertension, n (%)	55 (22.7)
Dyslipidemia, n (%)	43 (17.8)
Diabetes mellitus, n (%)	24 (9.9)
Family history, n (%)	35 (14.5)
TIMI Score	
0	88 (36.3)
1	154 (63.7)

TIMI = thrombosis in myocardial infarction.

Table 3

The HEART score evaluation (n = 242).

Variables		Value
History	Highly suspicious, n (%)	39 (16.1)
	Moderately suspicious, n (%)	90 (37.2)
	Slightly suspicious, n (%)	113 (46.7)
Electrocardiography	Significant ST depression, n (%)	0
	Non-specific repolarization, n (%)	75 (31.8)
	Normal, n (%)	165 (68.2)
Age, years	≥ 65, n (%)	42 (17.4)
	45–65, n (%)	116 (47.9)
	≤45, n (%)	84 (34.7)
Risk factors	3 or more, n (%)	36 (14.9)
	1–2, n (%)	120 (49.6)
	0, n (%)	86 (35.5)
Troponin I	≥ 3* normal limit, n (%)	0
	1–3* normal limit, n (%)	0
	Within normal range, n (%)	242 (100)
Total HEART score	0, n (%)	22 (9.1)
	1, n (%)	34 (14.1)
	2, n (%)	26 (10.7)
	3, n (%)	30 (12.4)
	4, n (%)	59 (24.4)
	5, n (%)	41 (16.9)
	6, n (%)	30 (12.4)
Low risk	n (%)	112 (46.3)
High risk	n (%)	130 (53.7)

high risk = HEART score ≥ 4, low risk = HEART score ≤ 3.

Table 4

Incidence of MACEs and potential reduction of cardiac testing.

HEART score	MACEs		Total
	Yes	No	
Low risk (n = 112)	0	112	112
High risk (n = 130)	2	128	130
Total (n = 242)	2	240	242
Sensitivity	2/(0+2)		
Specificity		112/(112+128)	
Potential unnecessary cardiac testing			112/(112+130)

3.4. Predictive value of the HEART score for MACEs

Cox proportional hazards regression analysis was used to evaluate the predictive value of the HEART score for studied endpoints and in the regression model, per one category increase of the HEART score was associated with nearly 1.3-fold risk of MACEs (HR 1.32 and 95% CI 1.08–1.62, $P = .042$).

4. Discussion

To our knowledge, this should be the first few studies to evaluate the value of the HEART score in prediction of the MACEs in acute chest pain patients in China. The present study indicates that the HEART score has a good sensitivity to predict MACEs within the first 30 days after discharge from emergency department. In addition, using the HEART score can help to reduce nearly 50% of unnecessary stress testing and/or cardiac imaging, which should be clinical relevant in terms of reducing health and economic burden.

Notably, acute chest pain is one of the major reasons for emergency visit and it is a challenge to physician as to distinguish cardiac and noncardiac etiologies within a limited time period.[12,13] Among the cardiac diseases, ACS is the most commonly encountered but emergency one.[14,15] Cases featured by typical clinical symptoms and signs, ST segment elevation and increased cardiac biomarkers are easily recognized. However, a substantial proportion of patients are presented with atypical symptoms, without typical electrocardiography changes and negative cardiac biomarkers within the first few hours of symptoms occurrence. Therefore, a high sensitivity screening tool is essential as to exclude low-risk patients and avoid misdiagnosis and unnecessary examinations.[16–18]

The HEART score was firstly introduced nearly decade ago in Europe and the purpose of designing the HEART score was to help physicians quickly differentiate the cardiac and noncardiac acute chest pain in the emergency department [19]; in addition, also help to identify those low-risk patients in whom the further cardiac testing can be safely forgone. The clinical values of the HEART score has been broadly tested and validated in the western countries. For example, in a cohort study, Mahler et al[9] reported that after 28 months follow-up, a HEART score > 3 was 58% sensitive and 85% specific for MACEs. The HEART score could help reduce unnecessary cardiac testing by 84.5%. In a stepped-wedge, cluster randomized trial, Poldervaart et al[20] reported that the HEART score was an accurate risk-stratification instrument and was safe to use when assessing patients with chest pain in the emergency department. In low-risk patients, incidence of MACEs was 2.0%. Consistent to prior studies, we also observed that none the low-risk patients had any MACEs and even in the high risk patient, the incidence of MACEs during the first 30 days was only 1.5%. One of the reasons that no events occurred in the low-risk patients might be due to the short duration of follow-up. The sensitivity of the HEART score in our participants was higher than that reported by Mahler, while the specificity was lower. The differences might be due to differences in the studied protocol, follow-up duration, the demographic features or the health system. Nevertheless, findings from our current study still support the hypothesis that the HEART score can be used to aid physicians in evaluating the MACEs risk in acute chest pain patients in China.

In addition, we also evaluated whether the HEART score can help avoid unnecessary testing in the low-risk patients after discharge form emergency department. We found that nearly 46.3% of these low-risk patients can be spared stress testing and/or cardiac imaging. In the study of Mahler, they reported that the HEART score can avoid 84.5% cardiac testing. Again, differences in protocol and participants should largely account for this discrepancy. Regarding the cost of cardiac testing, physical and mental stress to the patients, and workload to the radiology physicians, we strongly believe that nearly 50% reduction in unnecessary cardiac testing could translate into great clinical and economic benefits.

Our study was strengthened by its prospective design and with only 2 participants were loss of follow-up. However, there are several limitations of the present study should be addressed. First of all, the relative short duration of follow-up in current study could not allow us to observe more clinical events. However, in the truly high risk patients, the clinical events commonly occur during the first few weeks after discharge.[2,9] Secondly, this was a single center study and whether the findings from the present study could be extrapolated into other regions of China is unknown because of the heterogeneity of China's health system. Thirdly, since participants enrolled in the present study was featured by TIMI risk score < 2 and whether the HEART score was applicable to those with TIMI risk score ≥ 2 was unknown and should be further tested. Last but not the least, the HEART score is usually used to evaluate 6-weeks risk. In the present study, patients were only follow-up for 30 days which might be caused the predictive value of the risk score less accurate in terms of underestimation or overestimation. Future study is warranted to evaluate whether the HEART risk score is also useful for long-term risk prediction in the Chinese patients.

5. Conclusion

The present study indicates that in the low-risk acute chest pain patients, the HEART score is useful to physicians in evaluating the risk of MACEs within the first 30 days. In addition, the HEART score is also useful in reducing the unnecessary cardiac testing.

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