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Retrospective Cohort Study

SVEAT score outperforms HEART score in patients admitted to a chest pain observation unit

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Abstract

BACKGROUND
Timely and accurate identification of subgroup at risk for major adverse cardiovascular events among patients presenting with acute chest pain remains a challenge. Currently available risk stratification scores are suboptimal. Recently, a new scoring system called the Symptoms, history of Vascular disease, Electrocardiography, Age, and Troponin (SVEAT) score has been shown to outperform the History, Electrocardiography, Age, Risk factors and Troponin (HEART) score, one of the most used risk scores in the United States.

AIM
To assess the potential usefulness of the SVEAT score as a risk stratification tool by comparing its performance to HEART score in chest pain patients with low suspicion for acute coronary syndrome and admitted for overnight observation.

METHODS
We retrospectively reviewed medical records of 330 consecutive patients admitted to our clinical decision unit for acute chest pain between January 1st to April 17th, 2019. To avoid potential biases, investigators assigned to calculate the SVEAT, and HEART scores were blinded to the results of 30-d combined endpoint of death, acute myocardial infarction or confirmed coronary artery disease requiring revascularization or medical therapy [30-d major adverse cardiovascular event (MACE)]. An area under receiving-operator characteristic curve (AUC) for each score was then calculated. C-statistic and logistic model were used to compare

predictive performance of the two scores.

RESULTS
A 30-d MACE was observed in 11 patients (3.33% of the subjects). The AUC of SVEAT score (0.8876, 95%CI: 0.82-0.96) was significantly higher than the AUC of HEART score (0.7962, 95%CI: 0.71-0.88), P = 0.03. Using logistic model, SVEAT score with cut-off of 4 or less significantly predicts 30-d MACE (odd ratio 1.52, 95%CI: 1.19-1.95, P = 0.001) but not the HEART score (odd ratio 1.29, 95%CI: 0.78-2.14, P = 0.32).

CONCLUSION
The SVEAT score is superior to the HEART score as a risk stratification tool for acute chest pain in low to intermediate risk patients.

Key Words: Acute chest pain; Risk stratification tool; Symptoms, history of Vascular disease, Electrocardiography, Age, and Troponin score; History, Electrocardiography, Age, Risk factors and Troponin score

Core Tip: Most chest pain risk stratification scores do not use several readily available data. The Symptoms, history of Vascular disease, Electrocardiography, Age, and Troponin (SVEAT) score was shown to outperform the History, Electrocardiography, Age, Risk factors and Troponin (HEART) score in 30-d major adverse cardiovascular event. In our retrospective cohort study, we validated the performance of the SVEAT score and confirmed that the SVEAT score is superior to the HEART score as a risk stratification tool for acute chest pain in low to intermediate risk patients.

INTRODUCTION

Acute chest pain is one of the most common presenting symptoms to the emergency department[1,2]. Several non-cardiac conditions share clinical features with acute myocardial infarction and the emergency room clinician must rapidly identify those patients with chest pain who are most likely to have active coronary events from those who have chest pain due to other reasons. The key immediate task is to identify if a patient could benefit from being hospitalized for acute coronary syndrome (ACS) evaluation and those who can be safely discharged. This requires an estimation of the pretest probability of ACS. However, the accuracy of individual history, physical exam and electrocardiogram findings have been found to have limited utility for diagnosing ACS[3]. Therefore, multiple scoring systems and pathways have been proposed as risk stratification tools for these patients[4-7]. Among them, the History, Electrocardiography, Age, Risk factors and Troponin (HEART) score is arguably the most utilized particularly in the United States. Unfortunately, it has been shown in some studies to identify less than half of low-risk patients[4-6,8]. In an unselected population of chest pain patients in the emergency department, the HEART score and clinical gestalt had the same diagnostic accuracy for ACS[9]. The HEART score assigns a maximum score of 2 for chest pain deemed "highly suspicious" for ACS and suggests further inpatient evaluation for ACS for a score of 4 or more. By not clearly defining the classification of a patient's chest pain, the score introduces subjectivity and considerable inter-rater variability[10]. The score also incorporates traditional cardiac risk factors such as diabetes, hypercholesterolemia, and hypertension, which have been shown to have limited value in diagnosis ACS especially in those older than 40 years[11]. To control health care utilization and cost, it is imperative to identify low risk patients with chest pain for discharge from the emergency department. However, it is perhaps more important to not miss real cases of ACS in otherwise low risk patients. Among patients without the traditional risk factors for ACS, the HEART score may not be sensitive in identifying those who would benefit from further evaluation. Thus, there is a need for alternative risk stratification for this patient group. Recently, a new scoring system based on five sets of clinical variables; characteristics of chest pain Symptoms, history of Vascular disease, Electrocardiography, Age, and Troponin (SVEAT score, Table 1) has been reported to outperform the HEART score[8]. The objective of this study is to assess the potential usefulness of SVEAT score as a risk stratification tool by comparing its performance

Table 1 Definition of the Symptoms, History of Vascular disease, Electrocardiography, Age, and Troponin score

Component	Characteristics	Points
Symptoms	Typical unstable angina pectoris	3
	Stable angina, Canadian Cardiovascular Society Class I or II	1
	Non-cardiac chest pain	-2
Vascular disease	Recent myocardial infarction or percutaneous coronary intervention < 90 days	2
	Coronary artery bypass grafting > 5 years	2
	Prior coronary event other than above	1
	Prior revascularization for peripheral disease or carotid disease	2
EKG	Dynamic or new ischemic ST or T wave changes	3
	ST depression of unknown duration without cause	2
	ST changes with left ventricular hypertrophy, intraventricular conduction delay, digitalis, or metabolic issue	1
	Old Q wave indicating prior myocardial infarction or pre-existing ST changes	1
	No ST changes	0
	Normal EKG in the presence of severe ongoing chest pain	-2
Age (years)	> 75	2
	50-75	1
	30-49	0
	< 30	-1
Troponin I (ng/mL)	0.7 or higher	5
	> 0.12 but < 0.7	2
	> 0.04 but < or = 0.12	1
	Normal (< or = 0.004) with unclear duration of chest pain	0
	Normal after > 4 h of constant chest pain	-2

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to HEART score in chest pain patients with low suspicion for acute coronary syndrome and admitted for overnight observation.

MATERIALS AND METHODS

The registry of patients admitted to our clinical decision units between January 1st to April 17th, 2019, were retrospectively reviewed. Our clinical decision unit allows for close observation of chest pain patients who are at low risk for true major adverse cardiovascular event (MACE). Admission to this unit allows for serial monitoring of the patient's symptoms, cardiac enzymes, and electrocardiograms. To minimize any potential biases, one group of investigators was assigned to abstract relevant information necessary to calculate SVEAT score, and another was assigned to collect information for HEART score according to the published criteria[4,8]. The occurrence of MACE defined as all-cause mortality, acute myocardial infarction, confirmed coronary artery disease requiring revascularization or medical therapy at 30 d were then validated by two independent investigators who were blinded to the SVEAT and HEART score for each patient. The abstracted data were then provided to another set of investigators who were blinded to the outcome data to calculate the SVEAT and the HEART scores. Patients with ST segment elevation myocardial infraction were excluded from the study. The fourth-generation ultra-high sensitivity troponin I assay was used in all participants at our institution during the study period like the original SVEAT score study. Acute myocardial infarction was diagnosed based on standard

criteria[12]. The predictive power of the SVEAT and HEART scores for 30-d MACE were compared using c-statistic, based on area under the receiving-operator characteristic curve (AUC). Chi-squared test for equality of area under the curve was used to compare the performance of the SVEAT score to the HEART score. Categorical variables were summarized as counts (%) and between group comparisons were performed using Fisher's exact test. Continuous variables were summarized as means ± SD and difference between means by outcome compared using Student's *t*-test. All analyses were performed at a two-tailed 5% level of significance using Stata version 16.1 (Stata Corporation, College Station, TX, United States).

RESULTS

A total of 330 subjects were included in the study. Baseline patient characteristics are shown in Table 2. There were slightly more male (52.1%) than female subjects. The mean age was 59.5 ± 13.9 years. The incidence of 30-d MACE in our population was 3.33%. The subjects who suffered 30-d MACE were significantly older than those who did not (74.3 ± 13.2 years *vs* 59.0 ± 13.6 years, $P < 0.0001$). There were however no other significant differences in baseline characteristics between the two groups (Table 2).

Figure 1 illustrates the receiver-operator-characteristic curves of the SVEAT and HEART scores in predicting 30-d MACE. The AUC of the SVEAT score (0.8876, 95%CI: 0.82-0.96) is significantly higher than AUC of the HEART score (0.7962, 95%CI: 0.71-0.88), $P = 0.03$. Using logistic model, SVEAT score ≤ 4 significantly predicted 30-d MACE (odds ratio 1.52, 95%CI: 1.19-1.95, $P = 0.001$) but the HEART score ≤ 3 did not (odds ratio 1.29, 95%CI: 0.78-2.14, $P = 0.32$) (Table 3).

DISCUSSION

Currently, despite numerous risk stratification protocols, most low-risk patients presenting with acute chest pain are not being released from emergency department. The 2020 European Society of Cardiology Guideline for ACS recommends using an ultrahigh sensitivity troponin (hs-Tn) assay with 0/1-h hs-Tn protocol for ruling out acute coronary syndrome but also emphasizes the importance of incorporating clinical information into the decision-making process[12]. It additionally proposes using Global Registry of Acute Coronary Events score for prognostic purposes but does not recommend any specific clinical risk score for initial risk stratification[12]. The American College of Cardiology/American Heart Association has not updated their guideline since 2014 when they stated that none of available risk prediction tools at the time was definitively demonstrated to be superior to clinician judgement[13].

The HEART score is perhaps the most widely used risk stratification tool in the United States due to its simplicity and large amount of supporting evidence[6,14,15]. The criteria for its History and EKG component are however somewhat subjective. Consequently, inter-observer variability and scoring inconsistency have been reported[16-18]. More importantly, it has been shown to be able to identify merely less than half of low-risk patients[5,17,18]. One of the potential contributing factors for the latter issue is that the HEART score does not incorporate some of the useful clinical information readily available on initial evaluation. To circumvent some of the pitfalls of the HEART score, the SVEAT score was developed. There are a few differences between the SVEAT and HEART scores. First, larger weight (higher points) is assigned to the findings associated with higher likelihood of subsequent acute coronary event clinically and negative point for those traditionally associated with negative likelihood of the events in a stepwise manner. This approach allows wider range of potential scores, and we believe theoretically could help better discriminating among various risk group of patients. Secondly, the criteria for EKG changes and assigned point for each change are much more clearly defined. Moreover, the presence of vascular disease is included in the SVEAT score instead of risk factor which has been shown to be only a weak predictor in acute chest pain evaluation[19]. In fact, the SVEAT score has recently been shown to outperform the HEART score[8]. Like the previous study, this analysis found SVEAT score to be superior risk stratification tool to HEART score for acute chest pain evaluation in low-risk patients.

There are certainly a few limitations in our study. Firstly, the overall 30-d MACE incidence of 3.3% in this study is rather low and substantially lower than in the previous report of 19.6%[13]. This may unfavorably increase the possibility of our finding to be due to statistical chance. An extremely low event rate in this study is likely explained by our study design to include only those retrospectively identified from a low-risk chest pain registry at our institution. The incidence of MACE in our population however is in line with the recent report of real-world data in the United States where ED visit for acute chest pain exceeds 8 million annually[20]. Among these patients, < 5% of them subsequently experienced acute coronary syndrome. Second, the sample size of our study is relatively small for a retrospective design. As indicated in the methodology section, we did try to design our study to minimize potential biases. Lastly, this is a single center study and therefore future confirmation in a multicenter study in wider range of population, and larger sample size will be needed.
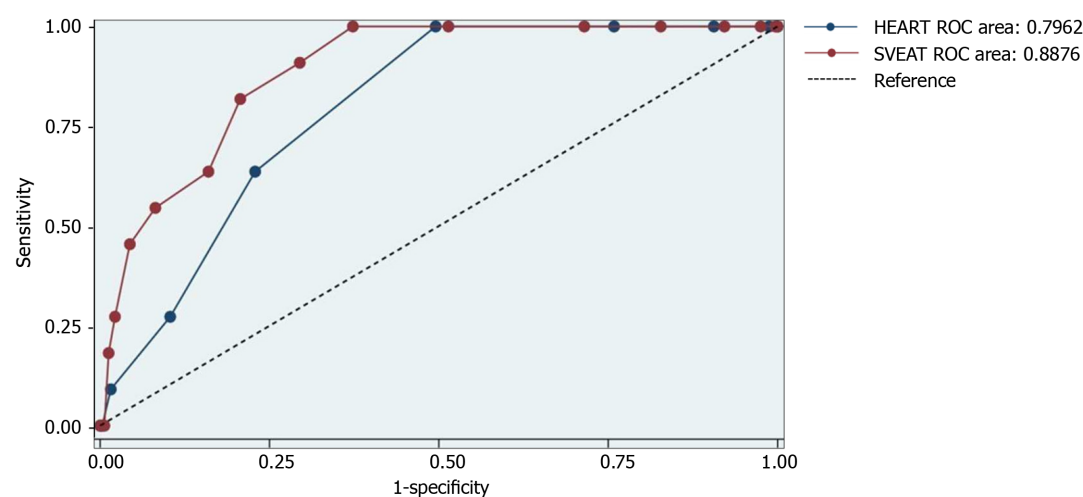
Table 2 Baseline patient characteristics

Continuous variables	Overall (*n* = 330)	30-d MACE		*P* value
		Yes, *n* = 11 (3.3%)	No, *n* = 319 (96.7%)	
Age, mean ± SD (yr)	59.5 ± 13.9	74.3 ± 13.2	59 ± 13.6	< 0.0001
BMI, mean ± SD (kg/m^2)	30.7 ± 7.8	27.8 ± 6.3	30.7 ± 7.8	0.23
Males, *n* (%)	172 (52.1)	7 (63.6)	165 (51.7)	0.55
Diabetes, *n* (%)	94 (28.5)	5 (45.5)	89 (27.9)	0.31
Dyslipidemia, *n* (%)	153 (46.4)	4 (36.4)	149 (46.7)	0.55
Hypertension, *n* (%)	206 (62.4)	10 (90.9)	196 (61.4)	0.06
Smoker, *n* (%)	177 (53.6)	9 (81.8)	168 (52.7)	0.07

Dyslipidemia: Total cholesterol > 200 mg/dL or low density lipoprotein > 130 mg/dL or non-high density lipoprotein cholesterol > 160 mg/dL. MACE: Major adverse cardiovascular events; BMI: Body mass index.

Table 3 Logistic model of major adverse cardiovascular events with HEART and SVEAT scores as covariates using cut-off of ≤ 4 points for SVEAT and ≤ 3 points for HEART for low-risk

30-d MACE	Odds ratio	*P* value	95%CI
HEART score	1.29	0.32	0.78-2.14
SVEAT score	1.52	0.001	1.19-1.95

MACE: Major adverse cardiovascular events; SVEAT: Symptoms, History of Vascular disease, Electrocardiography, Age, and Troponin; HEART: History, Electrocardiography, Age, Risk factors and Troponin.

Figure 1 Receiver operating characteristics for HEART and SVEAT scores. There area under the curve was significantly larger for SVEAT than HEART (*P* = 0.03). SVEAT: Symptoms, history of Vascular disease, Electrocardiography, Age, and Troponin; HEART: History, Electrocardiography, Age, Risk factors and Troponin; ROC: Receiver operating characteristics.

CONCLUSION

In conclusion, our study suggests potential usefulness of the newly developed SVEAT score as a risk stratification tool among low-risk patients admitted to clinical decision unit for evaluation of acute chest pain. We found that SVEAT score significantly outperforms the commonly used HEART score. Incorporating SVEAT score as part of a clinical assessment of these patients may help improve resource utilization while maintaining minimal risk of future cardiovascular events in low-risk patients presenting to emergency department with acute chest pain.

ARTICLE HIGHLIGHTS

Research background

Cardiovascular disease is the leading cause of death worldwide. Early identification of patients at risk for major cardiovascular events can expedite treatment and significantly reduce morbidity and mortality.

Research motivation

Risk stratification scoring systems used to identify patients at risk of major cardiovascular events, including the History, Electrocardiography, Age, Risk factors and Troponin (HEART) score, are often ineffective and may exclude many patients who would benefit from urgent intervention.

Research objectives

We aimed to assess the value of a new risk stratification scoring system, the Symptoms, history of Vascular disease, Electrocardiography, Age, and Troponin (SVEAT), by comparing its performance to that of the HEART score among chest pain patients with low suspicion for acute coronary syndrome.

Research methods

We retrospectively reviewed medical records of 330 consecutive patients admitted to our clinical decision unit for acute chest pain between January 1st to April 17th, 2019. To avoid potential biases, investigators assigned to calculate the SVEAT, and HEART scores were blinded to the results of 30-d combined endpoint of death, acute myocardial infarction or confirmed coronary artery disease required revascularization or medical therapy [30-d major adverse cardiovascular event (MACE)].

Research results

A 30-d MACE was observed in 11 patients (3.33% of the subjects). The area under receiving-operator characteristic curve (AUC) of SVEAT score (0.8876, 95%CI: 0.82-0.96) was significantly higher than the AUC of HEART score (0.7962, 95%CI: 0.71-0.88), $P = 0.03$. Using logistic model, SVEAT score with cut-off of 4 or less significantly predicts 30-d MACE (odd ratio 1.52, 95%CI: 1.19-1.95, $P = 0.001$) but not the HEART score (odd ratio 1.29, 95%CI: 0.78-2.14, $P = 0.32$).

Research conclusions

The SVEAT score is superior to the HEART score as a risk stratification tool for acute chest pain in low to intermediate risk patients.

Research perspectives

In our study, the SVEAT score was superior to the HEART score as a risk stratification tool for acute chest pain in low to intermediate risk patients. Future research is warranted to evaluate the SVEAT score among large, heterogeneous populations and among high-risk individuals presenting with chest pain.

FOOTNOTES

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