ORIGINAL ARTICLE

Usefulness of the HEART Score with High-Sensitivity Troponin T for the Evaluation of Patients with Chest Pain

Utilidad del score HEART con troponina T de alta sensibilidad para la evaluación de pacientes con dolor torácico

MARCIA M CORTÉS, FLORENCIA LAMBARDI, PAULA ARIZNAVARRETA, SILVANA RESI, ROSINA ARBUCCI, MAITE BORDA, MARCELO TRIVI, ALBERTO ALVES DE LIMA, JUAN PABLO COSTABEL

ABSTRACT

Background: The HEART score consists of a simple test designed to stratify patients who consult the emergency department for chest pain, according to their risk of presenting an acute coronary syndrome in the short term. It was initially created with a fourth-generation troponin, but the advent of high-sensitivity cardiac troponin T required its incorporation into the score and the re-evaluation of its behavior.
Objectives: The aim of this study was to evaluate the behavior of the HEART score with high sensitivity cardiac troponin T.
Methods: A prospective study was conducted including 1,464 patients who consulted at the emergency department due chest pain, with a non-ST-segment elevation electrocardiogram. The incidence of MACE (composite of acute myocardial infarction, death and revascularization) at 30 days was evaluated.
Results: The index classified 739 patients (50.5%) as low risk, 515 (35.2%) as intermediate risk and 210 (14.3%) as high risk patients. The composite of acute myocardial infarction, death and revascularization incidence was 1.35% in the first group, 20%, in the second group and 71%, in the third group (log-rank test $p<0.001$). The area under the global curve for the composite of acute myocardial infarction, death and revascularization was 0.91 (0.89-0.93).
Conclusions: The HEART score using high-sensitivity cardiac troponin T has a great capacity to classify patients with chest pain according to their risk of presenting cardiovascular events in the short term.

Key words: Chest pain - Acute Coronary Syndrome - Troponin T - Risk Assessment

RESUMEN

Introducción: El score HEART consiste en una prueba sencilla que fue diseñada para estratificar a los pacientes que consultan al servicio de emergencias por dolor torácico, según su riesgo de presentar un síndrome coronario agudo a corto plazo. Fue creado inicialmente con troponina de cuarta generación, pero el advenimiento de la troponina de alta sensibilidad impuso su incorporación al score y la reevaluación de su comportamiento.
Objetivo: Nos propusimos evaluar el comportamiento del score HEART con troponina de alta sensibilidad.
Material y métodos: Se realizó un estudio prospectivo que incluyó 1464 pacientes (p) que consultaron al servicio de emergencia por dolor torácico y que tenían electrocardiograma sin elevación del segmento ST. Se evaluó la incidencia de MACE (combinado de infarto agudo de miocardio, muerte y revascularización) a 30 días.
Resultados: El índice clasificó 739 pacientes (50,5 %) como de bajo riesgo, 515 pacientes (35,2%) de riesgo intermedio y 210 pacientes (14,3%) de alto riesgo. La incidencia de la combinación de infarto agudo de miocardio, muerte y revascularización fue del 1,35% en el primer grupo; del 20%, en el segundo; y del 71%, en el tercero (log rank test $p < 0,001$). El área bajo la curva global para la combinación de infarto agudo de miocardio, muerte y revascularización fue de 0,91 (0,89-0,93).
Conclusiones: El score HEART que utiliza troponina de alta sensibilidad tiene una gran capacidad para clasificar pacientes con dolor torácico de acuerdo con su riesgo de presentar eventos cardiovasculares en el corto plazo.

Palabras clave: Dolor en el pecho - Síndrome coronario agudo - troponina T - Medición de riesgo

Abbreviations

ACS	Acute coronary syndrome	**ED**	Emergency department
AMI	Acute myocardial infarction	**hs-cTnT**	High-sensitivity cardiac troponin T
MACE	Major adverse cardiac events (composite of acute myocardial infarction, death and revascularization surgery)	**CABGS**	Coronary artery bypass graft surgery
		PTCA	Percutaneous transluminal coronary angioplasty
ECG	Electrocardiogram		

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Address for reprints: Dr. Juan Pablo Costabel - Blanco Encalada 1543, 1428-CABA, Argentina - E-mail: jpcostabel@icba.com.ar

Clinical Cardiology Service, Instituto Cardiovascular de Buenos Aires

INTRODUCTION

The evaluation of chest pain has progressed in recent years with the advent of greater sensitivity markers, allowing the early diagnosis of patients with acute myocardial infarction and safe discharge of patients without the event. (1-3) The combination of these markers with the degree of clinical suspicion seems to be a good strategy for the stratification of patients who consult for chest pain. In this sense, the HEART score was developed by incorporating in its calculation data on the patient's history, age, coronary artery risk factors, electrocardiogram (ECG), and troponin on admission. This score was put into practice and validated using a fourth generation troponin which demonstrated in different publications a good discrimination capacity. (4, 5) In this work, we propose to evaluate the behavior of the HEART score in the scenario of high sensitivity cardiac troponin T (hs-cTnT).

OBJECTIVE

The aim of this study was to evaluate the behavior of the HEART risk score with the incorporation of hs-cTnT in a consecutive group of patients with suspected acute coronary syndrome (ACS).

METHODS

Study design

This was an observational, descriptive, prospective single-center study carried out in the emergency department (ED) of Instituto Cardiovascular de Buenos Aires.

Patients older than 18 years of age who consulted at the ED for acute chest pain and agreed to participate in the study by signing an informed consent form were consecutively included in the study. Patients with hemodynamic instability, signs of heart failure or arrhythmias were excluded as well as those with admission ST-segment elevation ECG, since in these disorders the value of cardiac biomarkers on admission is limited. There were no restrictions regarding the time between symptom onset and consultation.

Patients were treated according to the pain unit protocol used at that time in the ED, based on international recommendations. All patients underwent a clinical evaluation by emergency cardiologists including the preparation of a clinical history, physical examination, 12-lead ECG, continuous monitoring by telemetry, routine biochemical exams and chest x-ray. A prospective form with the baseline characteristics of the patients and the data necessary to calculate the HEART score was completed; the attending physician was blind to the result of this score.

The HEART score for risk stratification considers the following parameters: (5)

- Patient's history, classified on the basis of the interrogation in the ED: in the absence of specific elements regarding the pattern of pain, its onset and duration, the relationship with exercise, stress or cold, location, concomitant symptoms and the reaction to sublingual nitrites, "the history" is classified as "non-specific" (0 points); if it contains both uncharacteristic and suspicious elements and it is classified as "moderately suspicious" (1 point); and if it contains specific elements, as "highly suspicious" (2 points).
- Admission ECG, classified as "normal" according to the Minnesota criteria (0 points); with alterations in repolarization without significant ST-segment depression, branch block, typical changes of left ventricular hypertrophy or repolarization abnormalities probably secondary to digoxin (1 point); or with significant ST-segment depression or elevation (2 points).
- Age: Under 45 years (0 points), 45 to 65 years (1 point) and over 65 years (2 points).
- Cardiovascular risk factors (diabetes mellitus in treatment, current or recent smoking -less than one month cessation-, hypertension, hypercholesterolemia, heredofamilial history of coronary heart disease and obesity (BMI >30kg/m2): no risk factors (0 points), one or two risk factors (1 point), three or more risk factors, history of coronary bypass graft surgery (CABGS), acute myocardial infarction (AMI), stroke or peripheral vascular disease (2 points).
- Troponin levels: Below the 99th percentile for the test used (0 points), between one-to three times (1 point) or more than three times (2 points) this level.

Our laboratory works with hs-cTnT (Roche Diagnostic) whose 99th percentile for the reference healthy population is 14 ng/l.

Thus, the HEART score divides patients into low (0-3 points), intermediate (4-6 points) and high (7-10 points) risk groups of presenting cardiovascular events within 30 days of consultation.

During stay in the ED, patients were managed according to the criteria of the treating medical team.

Follow-up

All the included patients were followed-up for 30-days in the outpatient clinic or by telephone contact. Events in the index consultation and at follow-up were allocated by an independent observer not in charge of the initial management.

The following endpoints were established:

Primary: Composite MACE of AMI, coronary artery revascularization by percutaneous transluminal coronary angioplasty (PTCA) or CABGS and death at 30 days.

Acute myocardial infarction was defined according to current guideline recommendations: (6) detection of increased or decreased hs-cTnT with, at least, a value above the 99th percentile of the upper reference limit and at least one of the following: symptoms of ischemia, significant ST-T changes or new or presumably new left bundle branch block in the ECG, development of pathological Q waves, image of new or presumably new loss of myocardial viability or regional wall motion disorders, and intracoronary thrombus detected by angiography or autopsy.

Statistical analysis

Categorical variables were presented as percentages and continuous variables as means or medians with their corresponding standard deviation or interquartile range, as appropriate. The chi-square test or the Mann-Whitney test were used to compare between groups with categorical or continuous variables, respectively. The receiver operating characteristic (ROC curve) analysis was used to assess sensitivity and specificity of the different score values to predict cardiovascular events. Kaplan Meier and log-rank tests were used to analyze follow-up events, and the relationship between variables and events through Cox regression analysis. The hazard ratio was analyzed to describe the probability of events in the different populations.

Two-tailed statistical significance was used to test all the hypotheses and p <0.05 was considered as significant. Data analysis was performed with SPSS for Mac 21.0 (SPSS Inc, Chicago, Ill) statistical package.

Ethical Considerations

All study participants were asked to sign a written informed consent prior to their inclusion in the study. This consent was submitted for approval of our institutional ethics committee. The study was conducted in compliance with the National Law on the protection of personal data 25,326, and in accordance with national ethical regulations (CABA Law 3301, National Law on Clinical Research in Human Beings, Declaration of Helsinki and others).

RESULTS

A total of 1,464 patients who consecutively consulted at the ED for chest pain suggestive of ACS, and had admission non-ST-segment elevation electrocardiogram were prospectively included in the study. Sixty-two per cent were men and median age was 60 years. Cardiovascular risk factors in this population showed that 51% were hypertensive; 12%, diabetic; 13.3%, obese; 47.8% dyslipidemic; and 13.6% smokers. In 9.3% of cases heredo-familial history was reported, 19.4% had had previous AMI and 25% had undergone PTCA (Table 1).

The average time from onset of symptoms to consultation was 4 (2-7) hours and the time between admission to the ED and diagnosis was 140 (106-150) min. Thirty-day follow-up was completed in 100% of the patients with a total event rate of 19.6%. Three hundred and sixty-five patients (25%) were hospitalized at the index consultation, 289 with diagnosis of ACS (150 with AMI), 21 with pericarditis, 8 with myocarditis, 5 with pulmonary thromboembolism and the remaining 42 with non-cardiac pain. Among the total number of patients, 191 (13%) underwent urgent PTCA and 50 patients (3.4%) required CABGS. Five patients (0.3%) died within 30 days of index consultation. Among patients discharged from the ED, only 2 suffered an event at 30-days, and in both cases urgent PTCA was performed.

The HEART score classified the patients as follows: 739 patients (50.5%) as low risk, 515 (35.2%) as intermediate risk and 210 (14.3%) as high risk. The median population score was 3 (2-5). At the 30-day follow-up, the composite endpoint was 1.35% in the first subgroup; 20%, in the second; and 71%, in the third subgroup (p <0.001). The analysis of ACS revealed an incidence of 0.9%, 23.1% and 76.6%, respectively (p <0.001); and only considering AMI, the difference was sustained (0.3% vs. 5.2% vs. 57.6%, p <0.001).

The score performance was evaluated for each endpoint and ROC curves were built with the following results: for MACE, it was 0.91 (0.89-0.93); for ACS 0.926 (0.911-0.940); and for AMI 0.945 (0.929-0.961) (Figure 1).

Kaplan-Meier curves were also generated showing a hazard ratio of 0.031 (0.01-0.053) for MACE in low risk patients (Figure 2).

DISCUSSION

Our study showed that the HEART score calculated using hs-cTnT has a good capacity to stratify our patient population according to the risk of presenting short-term cardiac events.

Use of hs-cTnT has represented a great progress for the management of patients with chest pain in the ED. (7-12) Several publications have shown that low values, even within the 99th percentile for the method used, are useful to promptly exclude coronary events. (13) The new algorithms that consider serial dosage of troponin with 1 or 2 h interval have shown good stratification capacity; however, they incorporate this biochemical measurement as a single parameter, whose elevation can have other etiologies. The endpoint of

Table 1. Baseline characteristics of the population and of the different risk groups according to HEART

Variables		n 1464 %	HEART score groups 113 Low 739 50.5%	Intermediate 515 35.2%	High 210 14.3%	p
Male gender	n (%)	352 (47.6%)	352 (47.6%)	380 (74.1%)	175 (83.3%)	<0.0001
Age, years	mean (SD)	52.8 (12.2)	52.8 (12.2)	66.2 (11.2)	72.5 (10.1)	<0.0001
Troponin T	median (IQR)	6 (8-4)	6 (8-4)	10 (7-16.7)	42 (20-113)	<0.0001
Diabetes	n (%)	28 (3.8%)	28 (3.8%)	82 (15.9%)	65 (31%)	<0.0001
Smoking	n (%)	91 (12.3%)	91 (12.3%)	73 (14.2%)	35 (16.7%)	0.3449
Dyslipidemia	n (%)	196 (26.5%)	196 (26.5%)	339 (65.8%)	165 (78.6%)	<0.0001
Hypertension	n (%)	201 (27.2%)	201 (27.2%)	372 (72.2%)	172 (81.9%)	<0.0001
HFH	n (%)	59 (8%)	59 (8%)	59 (11.5%)	18 (8.6%)	0.0633
Obesity	n (%)	60 (8.1%)	60 (8.1%)	92 (17.9%)	43 (20.5%)	<0.0001
Previous AMI	n (%)	43 (5.8%)	43 (5.8%)	158 (30.7%)	83 (39.5%)	<0.0001
Previous PTCA	n (%)	64 (8.7%)	64 (8.7%)	207 (40.2%)	95 (45.2%)	<0.0001
CKF	n (%)	4 (0.5%)	4 (0.5%)	18 (3.5%)	29 (13.8 %)	<0.0001

HFH: Heredo-familial history; AMI: Acute myocardial infarction; PTCA: Percutaneous transluminal coronary angioplasty; CKF: Chronic renal failure.

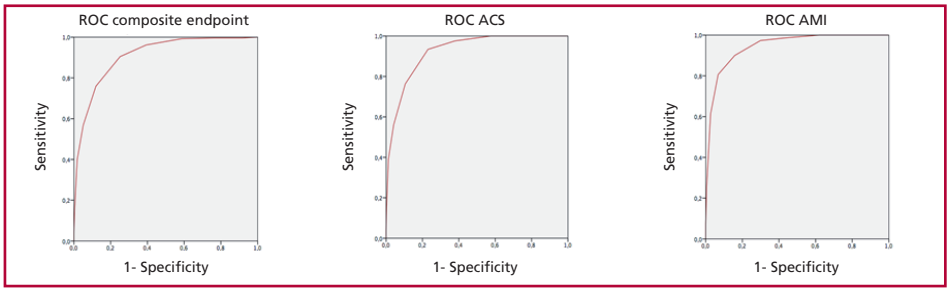

Fig. 1. ROC curves illustrating the performance of the HEART score for the different endpoints or outcomes: composite of death, AMI or revascularization (outcome 1), ACS (outcome 2) or AMI (outcome 3).

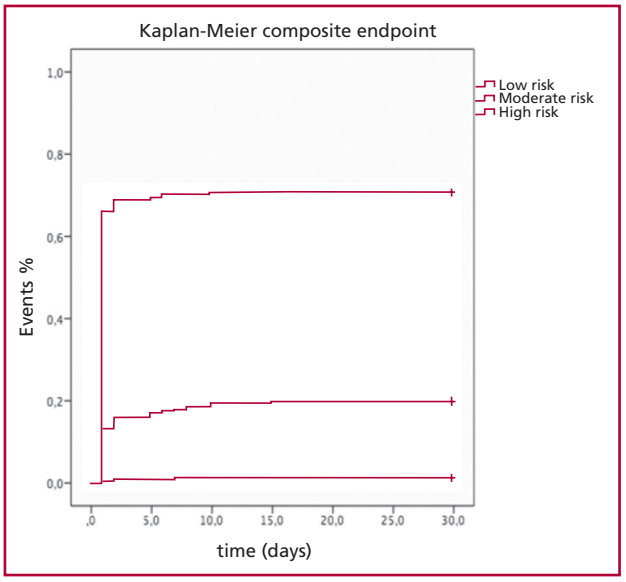

Fig. 2. Kaplan Meier curve for the composite endpoint of the different risk groups. It can be seen that the event rate is significantly different, being higher in high-risk patients.

these algorithms is the manifestation of infarctions, without assessing the need for emergency revascularization or hospitalization due to unstable angina, which are not minor facts for the patients' lives. (14) The HEART score includes, among its variables, parameters that express the characteristics of the patient's clinical condition, as well as the risk factors and age that are associated with an increased probability of undergoing an acute coronary event. (15, 16) We understand that the inclusion of these data allows us to arrive at the diagnosis of ACS even without troponin elevation, which in many cases leads to a necessary coronary revascularization.

On the other hand, the Kaplan-Meier curves illustrate very clearly the power of discrimination that the score has with hs-cTnT; it shows that the rate of events is significantly different between the different risk groups and highlights their low percentage in low risk patients. However, it is necessary to note that 36% of patients were classified as intermediate risk with a composite event rate of 20%, which would lead to high risk if these patients were mistakenly discharged.

Santi et al. published in 2016 the results of the score behavior using hs-cTnT in a cohort of 1,597 consecutive patients who consulted for chest pain at a hospital in Bologna, Italy. (4) They found that patients with low values had no events at the 30-day and 180-day follow-up periods. Unlike ours, this work had a retrospective methodology and estimated the score with data extracted from the clinical history, a fact that may impact on biases. The ROC curves that we obtained in our work were similar to those of Santi et al. In both cases, they are higher than those of the GRACE and TIMI scores. (17, 18) Finally, we believe that the main contribution of our study is to reinforce the role of the HEART score as a tool to stratify patients with chest pain, since it has a great capacity to detect low risk patients, which could be managed on an outpatient basis.

Limitations

We consider that possibly there is a selection bias because it is a single-center study carried out in a specialized cardiovascular center, where the initial evaluation is performed by cardiologists. On the other hand, we understand that we are not strictly creating a new score; however, it is true that we are applying a "modification" and, therefore, the score validation requires evaluation of its performance in a different population.

CONCLUSIONS

The HEART score with the use of high sensitivity cardiac troponin T has a great capacity to classify patients with chest pain according to the risk of presenting short-term cardiovascular events.

Conflicts of interest

None declared.

(See authors' conflicts of interest forms on the website/ Supplementary material)

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