HHS Public Access

Author manuscript

*Crit Pathw Cardiol*. Author manuscript; available in PMC 2018 September 01.

Published in final edited form as:

*Crit Pathw Cardiol*. 2017 September ; 16(3): 102–104. doi:10.1097/HPC.0000000000000119.

# Comparison of Three Symptom Classification Methods to Standardize the History Component of the HEART Score

**Michael R Marchick, MD**[1], **Michael L Setteducato, MHS**[2], **Jesse J Revenis, BS**[2], **Matthew A Robinson, MS**[3], **Emily C Weeks, MPH**[2], **Thomas F Payton, MD, MBA**[1], **David E Winchester, MD, MS**[3], and **Brandon R Allen, MD**[1]

[1]Department of Emergency Medicine, University of Florida, Gainesville

[2]College of Medicine, University of Florida, Gainesville

[3]Department of Biostatistics, Epidemiology and Research Design at CTSI, University of Florida, Gainesville

[4]Department of Medicine, Division of Cardiology, University of Florida, Gainesville

## Abstract

**Objectives—**The HEART score enables rapid risk stratification of emergency department patients presenting with chest pain. However, the subjectivity in scoring introduced by the history component has been criticized by some clinicians. We examined the association of three objective scoring models with the results of noninvasive cardiac testing.

**Methods—**Medical records for all patients evaluated in the chest pain center of an academic medical center during a one year period were reviewed retrospectively. Each patient's history component score was calculated using three models developed by the authors. Differences in the distribution of HEART scores for each model, as well as their degree of agreement with one another, as well as the results of cardiac testing were analyzed.

**Results—**749 patients were studied, 58 of which had an abnormal stress test or CTCA. The mean HEART scores for models 1, 2, and 3 were: 2.97 (SD 1.17), 2.57 (SD 1.25), and 3.30 (SD 1.35), respectively, and were significantly different ($p<0.001$). However, for each model, the likelihood of an abnormal cardiovascular test did not correlate with higher scores on the symptom component of the HEART score ($p=0.09$, 0.41 and 0.86, respectively).

**Conclusions—**While the objective scoring models produced different distributions of HEART scores, no model performed well with regards to identifying patients with abnormal advanced cardiac studies in this relatively low-risk cohort. Further studies in a broader cohort of patients, as well as comparison with the performance of subjective history scoring, is warranted prior to adoption of any of these objective models.

### Keywords

HEART score; risk stratification; history component; clinical gestalt; objectivity

**Please send correspondence to:** Michael Marchick, MD, Department of Emergency Medicine1329 SW 16th StreetPO Box 100186Gainesville, FL 32610-0186, Office: 352-265-5911, Fax: 352-265-5606, Cell: 704-968-7618, marchick@ufl.edu.

## Introduction

Chest pain is one of the most common chief complaints of emergency department (ED) patients, resulting in almost 7 million visits annually in the US alone[1]. Many of these encounters result in lengthy ED evaluations and/or subsequent inpatient admission with the performance of potentially costly and harmful studies to evaluate for acute coronary syndrome (ACS). In 2008, a study from the Netherlands first introduced the HEART Score (Table 1), a simple algorithm to rapidly stratify the risk of patients experiencing a Major Adverse Cardiac Event (MACE, defined as acute myocardial infarction, revascularization, or death) in the near term (average follow-up 423±106 days). Patients with a HEART Score ≤ 3 were classified as low risk, with a 2.5% risk of MACE during the study period, supporting early discharge without additional testing[2]. A subsequent multicenter validation study observed a <1% risk for MACE at 6 weeks in patients with a low HEART score[3]. Finally, a randomized control trial of the HEART Pathway (includes serial troponin measurements at 0 and 3 hours) done in the US showed the HEART score decreased length of stay and objective cardiac testing rate, and increased early discharge rate[4].

While the age, risk factor, ECG, and troponin aspects of the HEART score are straightforward and quantitative, the history aspect of the score is subjective[5]. We sought to minimize the subjectivity of the history component by applying three different categorization models to the symptoms reported by a cohort of patients seen in our low-risk chest pain unit. We hypothesized that the HEART scores generated by the models would vary, and sought to evaluate which model provided optimal stratification of history scores.

## Methods

### Study Population

The study population consisted of patients from a tertiary care academic center who were evaluated in the ED Chest Pain Evaluation Center (CPEC) between January 1, 2012 and December 31, 2012. To be eligible for CPEC evaluation, patients must have symptoms concerning for acute coronary syndrome, but not have evidence of ST elevation myocardial infarction or non-ST segment elevation myocardial infarction based on initial ED evaluation, as well as not have other confounding active medical issues warranting formal inpatient admission. The ultimate selection of patients for evaluation in the CPEC and the choice of the modality of advanced cardiac testing which was employed were at the discretion of ED attending physicians without knowledge of this study.

### Data Collection/Study Procedure

Retrospective chart review was performed by trained study personnel, who extracted data into a HIPPA compliant database (Research Electronic Database Capture (REDCap,) Nashville, TN)[6]. Data were extracted for each patient necessary to calculate the non-history components of the HEART score (age, ECG findings, initial troponin, and cardiovascular risk factors), as well as symptoms potentially affecting the history component, including: substernal CP, exertional CP, relief with nitroglycerin, cold sweats/diaphoresis, arm pain, jaw pain, weakness, nausea, vomiting, dyspnea, dizziness, pain under shoulders, and neck

pain. The results of any noninvasive cardiac testing performed at the index visit, including cardiac CT coronary angiography (CTCA), myocardial perfusion scan or exercise stress study were also recorded. The study team, which included a board certified cardiologist and board certified emergency physicians, created three models (Table 2) which were hypothesized to accurately categorize the history component of the HEART score. The study endpoint was the composite finding of one of the following: an abnormal stress ECG, reversible defect on myocardial perfusion scan, or presence of an obstructive (≥50%) CTCA lesion.

### Statistical Analysis

The HEART score was calculated for the entire cohort three times, using each of the three symptom models. Differences in the distribution of HEART scores generated by each model were compared by analysis of variance (ANOVA) with post-hoc Tukey's test. The test for equal proportions and test for trend in proportions were used to assess for differences in proportions of patients with abnormal advanced studies between each level of history score for a given model and for a stepwise trend in the proportion of patients with abnormal studies with respect to history score, respectively. Agreement between models was tested using Kendall's W Statistic. The relative goodness of fit for the overall HEART scores resulting from each model was compared using the Akaike Information Criterion (AIC).

## Results

749 patients from the CPEC with complete documentation allowing computation of the HEART score were included. The mean HEART scores for models 1, 2, and 3 were: 2.97 (SD 1.17), 2.57 (SD 1.25), and 3.30 (SD 1.35), respectively. The means of overall HEART scores assigned by each model were significantly different overall ($P<0.001$), and as assessed in individual comparison between each model by Tukey's test ($P<0.01$ for all possible comparisons). The number of patients with HEART score ≤3 generated by each model were: model 1: 515 (69%), model 2: 580 (77%), model 3: 407 (54%).

58 (7.7%) of patients had an abnormal result of an advanced cardiac study. The proportions of patients with low, intermediate, and high HEART score history risk values (0, 1, 2 respectively) who had an abnormal study was calculated for each model (Table 3). None of the models showed a monotonically increasing trend with higher history scores as would be ideal, with model 1 displaying a monotonically decreasing likelihood of an abnormal test with increasing history score. No significant differences in proportions of patients with abnormal testing at each level of history score within each model, or trend towards an abnormal result with each stepwise level of history score was noted using either a test for equal proportions or a test for trend in proportions (model 1: $p=0.19$ and $p=0.09$, model 2: $p=0.33$ and $p=0.41$, model 3: $p=0.09$ and 0.86, respectively).

To compare agreement between the models in assigning the same history score to the same patient, pairwise comparison was performed using Kendall's coefficient of concordance. Evidence of strong agreement was noted between Models 2 and 3 ($W = 0.821$, $p<0.001$). No evidence of agreement was noted in comparing models 1 and 2 ($W = 0.516$, $p= 0.26$), or models 1 and 3 ($W= 0.50$, $p =0.52$).

Finally, a relative goodness of fit statistic, the AIC, was performed to compare the relative performance of the total HEART score resulting from each model to predict an abnormal advanced cardiac study. AIC was 400.39, 395.46, and 397.64 for models 1, 2, and 3, respectively. As a lower AIC signifies a better fit of the data, the HEART scores generated by model 2 were the best predictor of an abnormal study.

## Conclusion

In the landmark 2008 paper which put forth the HEART score, the history section was scored by two investigators as either consisting of non-specific elements (score of 0), specific and non-specific elements (score of 1), or only specific elements (score of 2)[2]. Illustrating the importance of the history component of the score a 2013 study showed that HEART scores calculated with only history, ECG, and initial troponin had a similar association with adverse cardiac events after three months as the complete HEART score[7]. However, the history component of the HEART score introduces subjectivity into the scoring system. Given its importance, our team of cardiologists and emergency physicians sought to create and evaluate three distinct, objective models for stratifying patient histories into slightly, moderately, and highly suspicious groups (0, 1, or 2 points respectively).

Our data show that while each of the models resulted in different distributions of HEART scores in this cohort, none of the models were effective predictors of a subsequent abnormal stress testing result or obstructive CTA lesion. Of the three methods explored, model 2 resulted in a HEART score most predictive of our endpoint of an abnormal advanced cardiac study. However, based on our results, we cannot advise its widespread adoption at this time. We wish to be clear that the present study should not be taken to imply any lack of utility of the HEART score– it is quite possible that no refinement in history scoring beyond subjective evaluation by an experienced clinician is warranted.

A significant limitation of our study was the inclusion of only patients evaluated in our Chest Pain Evaluation Center. Patients deemed to be at particularly high risk of ACS by their treating emergency physician are typically formally admitted to the hospital, resulting in a relatively low risk cohort in the present study. It is certainly conceivable that these objective models may have better performance in a more general population.

Another limitation of the study was the use of the results of CTCA and stress testing as primary outcomes. While positive tests are generally useful outcomes, they are not what the HEART score was developed to predict. Using short-term occurrence of MACE (acute myocardial infarction, percutaneous cardiac intervention, coronary artery bypass grafting, or death) would have been a better primary outcome for evaluation of the scoring models. We employed CTCA and stress testing results at index visit our outcome as complete follow up data beyond the initial visit to the CPEC was not available for many patients, as is typical of retrospective ED-based studies.

Further testing of our models in a broader cohort of patients being evaluated for ACS may be considered in the future, as could formal comparison the performance of our objective

models with clinician gestalt. Prospective studies with robust follow-up to capture patients with the outcome of MACE following hospital or ED discharge are also warranted.

In conclusion, we found that none of the three distinct objective models designed to evaluate the history component of the HEART score were effective predictors of abnormal advanced cardiac studies. Further refinement of the history component of the HEART score may not be necessary.

## Acknowledgments

Sources of Support that require acknowledgment:

Research reported in this publication was supported by the University of Florida Clinical and Translational Science Institute, which is supported in part by the NIH National Center for Advancing Translational Sciences under award number UL1TR001427. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

## References

1. Centers for Disease Control and Prevention. National Hospital Ambulatory Medical Care Survey: 2011 Emergency Department Summary Tables. In: Statistics NCfH. , editor. Online: Centers for Disease Control and Prevention/ National Center for Health Statistics. 2011. p. 39
2. Six AJ, Backus BE, Kelder JC. Chest pain in the emergency room: value of the HEART score. Neth Heart J. 2008; 16(6):191–6. [PubMed: 18665203]
3. Backus BE, Six AJ, Kelder JC, Mast TP, van den Akker F, Mast EG, Monnink SH, van Tooren RM, Doevendans PA. Chest pain in the emergency room: a multicenter validation of the HEART Score. Crit Pathw Cardiol. 2010; 9:164–9. [PubMed: 20802272]
4. Mahler SA, Riley RF, Hiestand BC, Russell GB, Hoekstra JW, Lefebvre CW, Nicks BA, Cline DM, Askew KL, Elliott SB, Herrington DM, Burke GL, Miller CD. The HEART Pathway randomized trial: identifying emergency department patients with acute chest pain for early discharge. Circ Cardiovasc Qual Outcomes. 2015; 8:195–203. [PubMed: 25737484]
5. Mahler SA, Riley RF, Russell GB, Hiestand BC, Hoekstra JW, Lefebvre CW, Nicks BA, Cline DM, Askew KL, Bringolf J, Elliott SB, Herrington DM, Burke GL, Miller CD. Adherence to an accelerated diagnostic protocol for chest pain: secondary analysis of the HEART pathway randomized trial. Acad Emerg Med. 2016; 23:70–7. [PubMed: 26720295]
6. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009; 42:377–81. [PubMed: 18929686]
7. Melki D, Jernberg T. HEART score: a simple and useful tool that may lower the proportion of chest pain patients who are admitted. Crit Pathw Cardiol. 2013; 12:127–31. [PubMed: 23892942]

**Table 1**

HEART Score

| | |
|---|---|
| **History** | 0: Slightly Suspicious<br>1: Moderately Suspicious<br>2: Highly Suspicious |
| **EKG** | 0: Normal<br>1: Non-specific changes<br>2: New ischemic changes |
| **Age** | 0: <5 years old<br>1: 45-65 years old<br>2: >65 years old |
| **Risk Factors** | 0: None<br>1: 1-2 risk factors<br>2: 3 or more risk factors OR known CAD, prior stroke or PAD |
| **Troponin** | 0: 0-1× normal value<br>1: >1-3× normal value<br>2: >3× normal value |

CAD: Coronary artery disease, PAD: Peripheral artery disease

## Table 2

Three Objective Models For Scoring the History Component of the HEART Score

| Model 1 | Model 2 | Model 3 |
|---|---|---|
| **0 Points:** | **0 Points:** | **0 Points:** |
| Atypical Only | 0-2 Symptoms | 1-2 Minor Only |
| **1 Point:** | **1 Point:** | **1 Point:** |
| Typical and Atypical | 3-4 Symptoms | >1 Major or >2 Minor |
| **2 Points:** | **2 Points:** | **2 Points:** |
| Typical Only | >4 Symptoms | >1 Major or Major + Minor |
| **Typical:** | **Symptoms:** | **Major:** |
| -Substernal chest pain | -Substernal chest pain | -Dyspnea |
| -Exertional chest pain | -Exertional chest pain | -Substernal chest pain |
| -Relief with nitroglycerin | -Relief with nitroglycerin | -Exertional chest pain |
| -Cold sweats/ diaphoresis | -Weakness | -Relief with nitroglycerin |
| -Pain in L arm | -Nausea/ vomiting | **Minor:** |
| -Jaw pain | -Dyspnea | -Weakness |
| **Atypical:** | -Cold sweats/ diaphoresis | -Nausea/ vomiting |
| -Weakness | -Jaw/ teeth pain | -Cold sweats/ diaphoresis |
| -Nausea | -Neck pain | -Jaw/ teeth pain |
| -Dyspnea | -Pain in both arms | -Neck pain |
| -Dizziness | -Pain under shoulders | -Pain in both arms |
| -Pain in both arms | -Pain in L arm | -Pain under shoulders |
| -Pain under shoulders | -Dizziness | -Pain in L arm |
| -Pain in R arm/ shoulder | -Pain in R arm/ shoulder | -Dizziness |
| -Neck pain | | -Pain in R arm/ shoulder |

**Table 3**

Percentage of Patients with an Abnormal Advanced Cardiac Study at Each Level of History Score as Calculated by Each Model

| | History = 0 | History = 1 | History = 2 |
|---|---|---|---|
| **Model 1** | 9.5% | 8.1% | 3.7% |
| **Model 2** | 7.5% | 6.7% | 11.6% |
| **Model 3** | 8.8% | 2.7% | 8.6% |