

**RETROSPECTIVE INTERNAL VALIDATION OF THE HEART SCORE AS AN OBJECTIVE PREDICTOR
OF A MAJOR ADVERSE CARDIAC EVENT**

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Background: The goal of the HEART score is to provide emergency physicians with a superior risk stratification tool in the assessment of the acute chest pain patient. It is difficult to determine the severity of the chest pain complaint and many regional emergency physicians have expressed a desire to have a validated, easy, reliable, and quick predictor that will allow them to safely discharge chest pain patients with an acceptably low risk of MACE occurring in the following 6 weeks.

Objectives: This retrospective study is an internal validation in the Scottsdale, Arizona region of the HEART score as an objective predictor that a major adverse cardiac event (MACE) has a 1.7% or lower chance of occurring within six weeks in the adult patient population presenting to and discharged from the emergency department with acute chest pain.

Methods: This study included 117 patients available for review. 53 could not be contacted for follow-up, yielding 64 patients for analysis. Eligible patients were considered those with an initial chief complaint of “chest pain” upon presentation, who met the “low risk” classification of the HEART score, and who were appropriately discharged (NOT admitted) from any of the Honor Health Scottsdale Hospitals.

Results: Less than 1.7% of discharged patients (1/64, 1.57%) who met the HEART score criteria for “low-risk” patients had a MACE occurrence in the 6 weeks following discharge.

Conclusions: The HEART score is internally validated as an objective predictor of no MACE occurring in chest pain patients presenting to these emergency departments.

Introduction

Every year, millions of people present to U.S. emergency departments with the common chief complaint of chest pain. In 2012, The National Hospital Care Survey performed by the Center for Disease Control and Prevention (CDC) reported 7.1 million people arrived at U.S. emergency departments with a chief complaint of chest pain¹. The high frequency of this complaint is second only to abdominal pain and can be indicative of many potential diagnoses. The difficulty lies in determining the severity of the complaint and estimating the cardiovascular risk, which can range from a less severe diagnosis of anxiety to the life-threatening myocardial infarction and other acute coronary syndromes. Such major adverse cardiac events are what the emergency physician aims to rule out along with determining whether to discharge or admit the patient. Therefore, an initial goal is to determine if the patient requires further hospital testing in the case of acute coronary syndrome or whether they can be discharged and complete their cardiac care as an outpatient.

The HEART score predicts the 6-week risk of a Major Adverse Cardiac Event, which is defined as “acute myocardial infarction (AMI), percutaneous coronary intervention (PCI), coronary artery bypass graft surgery (CABG), coronary angiography revealing procedurally correctable stenosis managed conservatively, or death due to any cause.”⁴. These components are further defined as the following⁴:

- **AMI:** a rise and fall of troponin values with at least one value above the 99th percentile of the upper reference limit together with evidence of myocardial ischemia
- **PCI:** any therapeutic catheter intervention in the coronary arteries
- **CABG:** any cardiac surgery in which coronary arteries were operated on
- **Coronary angiography revealing procedurally correctable stenosis managed conservatively:** significant coronary stenosis thought to be the cause of the chest pain, but revascularization was withheld for reasons of co-morbidity or risk of complications

The HEART score is a prospectively studied scoring system developed by co-authors Barbara Backus, MD, PhD and Jacob Six, MD in 2008 to help emergency physicians in the Netherlands risk-stratify chest pain patients. Dr. Backus later internally validated the HEART score through a larger prospective study in 2013 utilizing 10 hospitals in the Netherlands⁴.

When a patient enters the emergency department for chest pain, the physician takes into account 5 categories: History, ECG, Age, Risk Factors, and Troponin (1 time, at presentation) with each category scored with 0, 1, or 2 points. The 5 categories are defined by Backus in “Chest pain in the emergency room: the value of the HEART score” as the following³:

- **History:** The most subjective part of the HEART score, a proper history of present illness requires physician experience and expertise. A history is classified as “non-specific” and granted zero points if the patient does not present with specific elements such as suspicious pattern of chest pain, onset and duration, localization, relation to exercise, stress, heat, or cold, and reaction to sublingual nitrates. A “moderately suspicious” score of one point is awarded if the history contains both nonspecific and suspicious

elements. Finally, a “highly suspicious” score of 2 is allocated for a history containing primarily specific elements³.

- **ECG:** A normal ECG is allocated zero points. One point was given for an ECG that indicated repolarization abnormalities, but did not contain significant ST segment elevation or depression. Two points were given for an ECG with significant ST segment elevation or depression and without a bundle branch block or left ventricular hypertrophy³.
- **Age:** Zero points for a patient < 45 years old, one point if 45-65 years old, and 2 points for a patient 65 years or older presenting with chest pain³.
- **Risk Factors:** The HEART score considers the following significant risk factors: hypertension, hypercholesterolemia, diabetes mellitus, smoking, positive family history of coronary artery disease, and obesity. If a patient does not present with any of these risk factors, zero points are apportioned. One point is given for the presence of 1-2 of these risk factors and two points for 3 or more risk factors. Two points were also given for a history of coronary revascularization, myocardial infarction, stroke or peripheral arterial disease³.
- **Troponin:** The threshold value for troponin is a score is 0.04. A troponin score equal to or below 0.04 is considered within normal limits and awarded zero points towards the HEART score. A score 1-2 times this threshold for positivity is allocated 1 point whereas a score greater than twice the threshold value was given two points³.

A score of 0,1, or 2 is allocated to each category and the categories are summed for a total score. Patients are deemed “low risk” if they have a HEART score of 0-3 and have a 0.9 - 1.7% risk of a MACE occurring³. Based on the HEART score criteria, these patients are discharged. HEART scores of 4-6 carry a 12-16.6% risk of MACE and these patients are recommended for admission. A score of 7 or greater carries a 50-65% risk of MACE and these patients are also recommended for admission and should be considered for early intervention.

When considering a means to assist emergency physicians in the care of the chest pain patient, recent literature considers the HEART score to be the superior risk stratification tool. In his 2016 study, Poldervaart and colleagues compared the HEART score to other common risk stratification tools such as the GRACE and TIMI scores in their ability to predict major adverse cardiac events in chest pain patients. He found that “the HEART score outperformed the GRACE and TIMI scores in discriminating between those with and without MACE”². Similarly, in another study assessing the diagnostic quality of TIMI versus HEART scores, the HEART score “demonstrated superior diagnostic gain in both low and moderate risk patient populations”⁵. Further research by Backus and Six provides support for the efficacy of the 5 categories that determine the HEART score. Their recent study concluded that the “previously chosen weights of the 5 elements of the HEART score are supported by multivariable statistical analyses”⁶. Based on this evidence, and its ease of use and applicability, the implementation of

the HEART score was determined to be an appropriate tool to assist Scottsdale Honor Health emergency department physicians in their assessment of the chest pain patient. An internal validation of the HEART score was therefore deemed necessary.

The HEART score was created by co-authors Backus and Six for use in Dutch hospitals and therefore the primary literature is largely European in base. While there has been a minor amount of studies performed in the U.S., such as the aforementioned study assessing the diagnostic quality of TIMI versus HEART scores which takes place in Florida⁵, the variability between hospitals of different regions must be considered. Furthermore, there has been no research into the efficacy of the HEART score in this specific Arizona patient population. This significant gap in the literature surrounding the HEART score provides a reasonable decision for internal validation.

The rationale for ascertaining an internal validation of the HEART score in the Scottsdale, Arizona region is to provide emergency physicians at these three hospitals with a superior risk stratification tool in the assessment of the acute chest pain patient. It is difficult to determine the severity of the chest pain complaint and many regional emergency physicians have expressed a desire to have a validated, easy, reliable, and quick predictor that will allow them to safely discharge chest pain patients with an acceptably low risk of MACE occurring in the following 6 weeks. Utilizing the HEART score will serve to minimize unnecessary hospital admissions, while maintaining safe medical practice. Should standardization occur, this risk tool may be able to mitigate malpractice as well. While the HEART score has been validated in other areas, there is no literature concerning this specific region, which contains a specific patient population in a unique geography.

A retrospective chart review with application of the HEART score criteria will be performed for those patients who were assessed by emergency physicians and deemed appropriate for discharge. Follow-up with these patients will occur after 6 weeks in order to determine whether a MACE occurred. We hypothesize that there will be less than a 1.7% risk of MACE occurring within this time frame. This study has the goals of internally validating the HEART score and ultimately providing Emergency Physicians with a superior risk stratification tool in the assessment of the acute chest pain patient.

Methods

Subjects: Eligible patients for retrospective chart review were those with an initial chief complaint of chest pain, who met the “low risk” classification of the HEART score, and who were appropriately discharged (NOT admitted) from any of the Honor Health Scottsdale Hospitals. Retrospective data was collected on 117 eligible patients in this study to allow for an appropriate statistical power index. Appropriate information collection was accomplished in the following methods.

Data Collection & Organization: The investigator involved in this study was granted hospital privilege to access medical records on site. Patient charts were searched for based on the chief complaint of “chest

pain”. Only those who were discharged and not admitted following initial evaluation were considered. These charts were then reviewed and assessed based on the HEART score criteria: History, ECG, Age, Risk Factors, Troponin (*table 1*). The HEART score data was compiled onto a spreadsheet and calculated for each individual patient’s risk of a 6-week MACE. This data was loaded onto a password protected computer file.

Patient Follow Up: Patient follow up was needed in order to determine if those chest pain patients discharged had a major adverse cardiac event within 6 weeks of their discharge. The investigator, accessing the on-site medical records of the eligible patients, called via phone and asked the patients this follow up question:

- “Did you have any major adverse cardiac events in the six weeks following your emergency department discharge? A major adverse cardiac event is defined as acute myocardial infarction (AMI), percutaneous coronary intervention (PCI), coronary artery bypass surgery (CABG), coronary angiography revealing procedurally correctable stenosis managed conservatively, or death due to any cause.”

Information from this question was gathered after each patient phone call follow up and recorded without using any patient identifiers. Following completion of patient follow up, the data was split into two categorical outcomes for comparison.

1. The number of chest pain patients who were discharged based upon the HEART score and DID NOT have a MACE
2. The number of chest pain patients who were discharged based upon the HEART score but DID have a MACE.

Power and Sample Size: The primary outcome for this power and sample size calculation is the difference in percentage of MACE events between our current study vs the gold standard during the 6 week follow up period among patients who were discharged.

Components of the HEART score were reported as frequencies and percentages. Furthermore, the summation of the heart score was reported as frequencies and percentages. The one sample Z-test of proportions was used to ascertain differences in the percentage of MACE between our current study population compared to the original literature guidelines. All p-values were two sided and $p < .05$ was considered statistically significant. All data analysis was conducted using STATA Version 14 (College Station, Texas).

Results

Statistical Analysis and Outcomes: Data comparison of these two categories was compared. Statistical analysis showed that out of a total of 64 chest pain patients that were discharged based upon HEART score criteria, 63 of them experienced no MACE within six weeks of discharge. While out of these same 64 patients who were discharged based upon HEART score criteria, 1 patient did experience a MACE within six weeks of discharge, a 1.57% occurrence. (*figure 1*)

The difference in percentage of MACE events between our current study (1.57%) and the gold standard (1.7%) during the 6 week follow up period among patients who were discharged is 0.13 (*figure 2*). The one sample Z-test of proportions resulted in a p-value of 0.93 which is not statistically significant. This p-value indicates there is not a statistically significant difference in results between this study and the original literature (*figure 2*).

Out of the 117 patients who were deemed eligible, (48.3% male, 51.7% female) and received a phone interview follow up, 53 were unable to be reached and were therefore lost to follow up (*figure 1*).

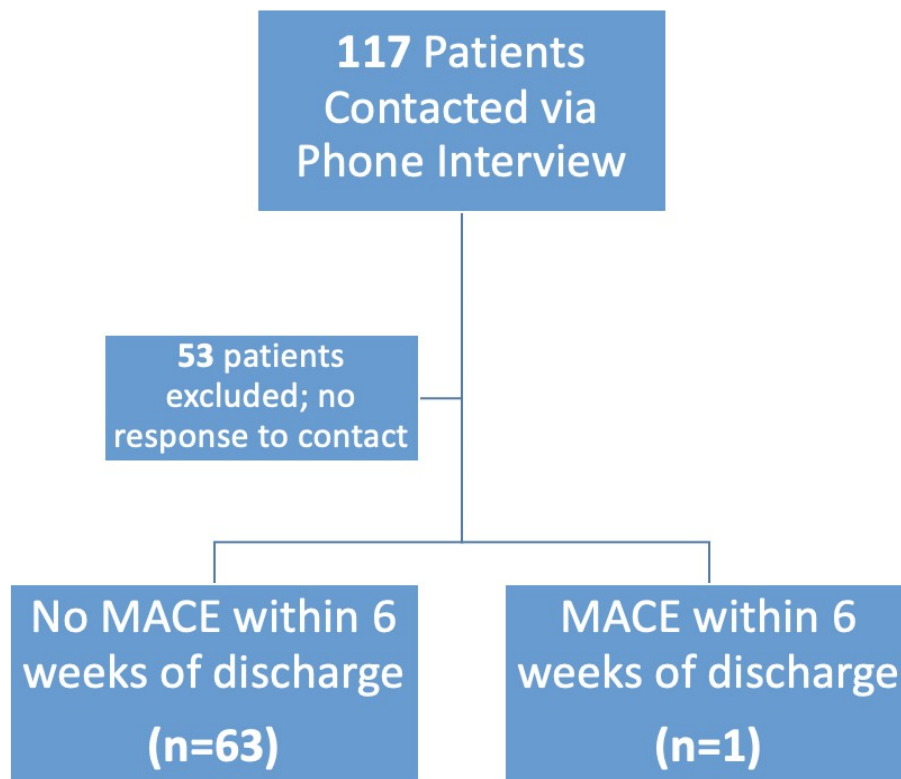


Figure 1: Flow chart of patient selection

Components of the Heart Score		Value N=64
History of Present Illness (n, %)		
0		26 (40.6)
1		38 (59.4)
ECG (n, %)		
0		57 (89.1)
1		7 (10.9)
Age (n, %)		
0		31 (48.4)
1		30 (46.9)
2		3 (4.7)
Risk Factors (n, %)		
0		24 (37.5)
1		36 (56.3)
2		4 (6.3)
Troponin (n, %)		
0		64 (100)
1		0
Heart Score (n, %)		
0		3 (4.69)
1		20 (31.3)
2		19 (29.7)
3		22 (34.4)

Table 1: Numerical Breakdown of HEART Score Components (N=64). Mean HEART score 1.94; SD 0.92.

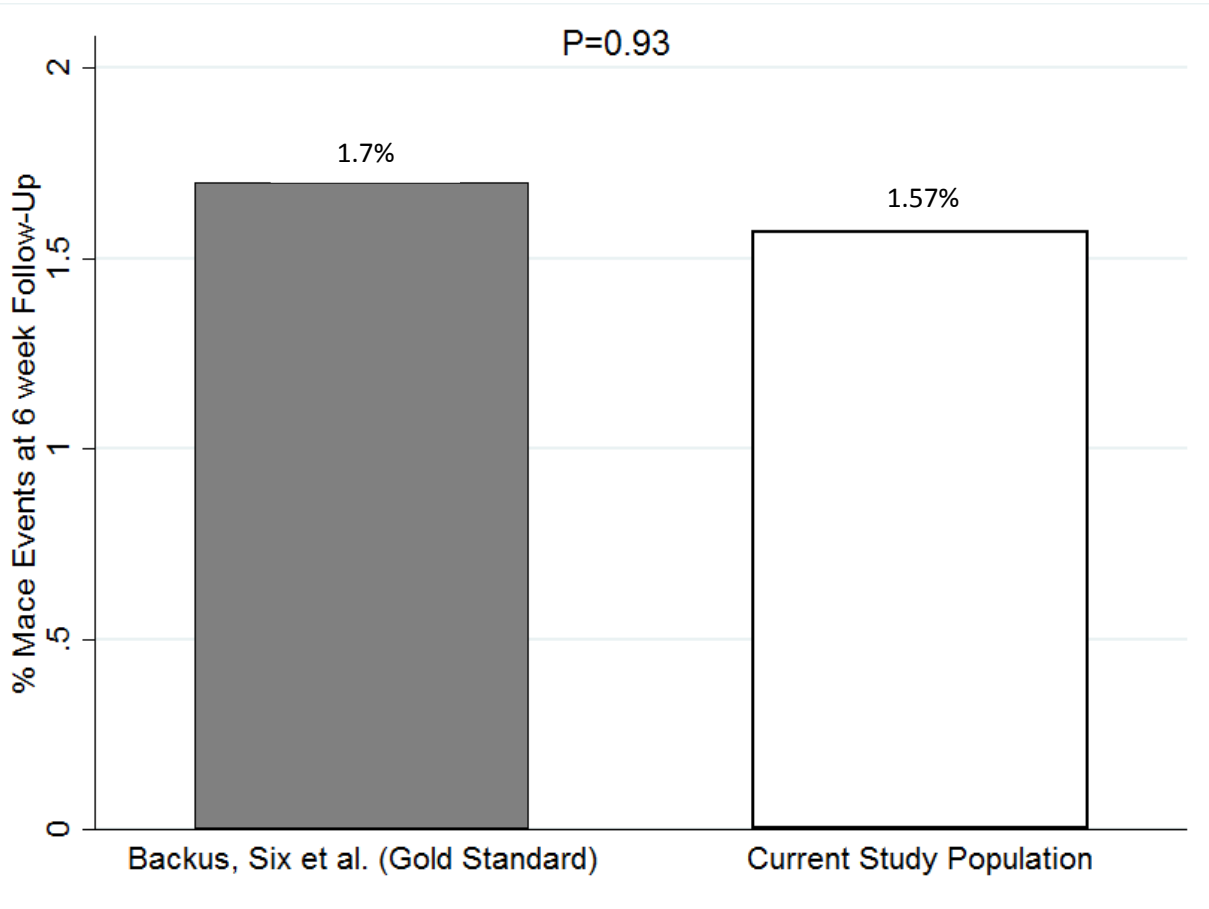


Figure 2: Comparison of MACE within 6 weeks of discharge between original literature guidelines and current study population who met low risk HEART Score criteria. P-value calculated using the One-Sample Z-test of Proportions.

Discussion

The data collected from patients who completed the follow up interview show a **1.57%** risk of MACE occurring. This value is within the predicted 1.7% put forth by the original study authors. Comparison of percentile MACE occurrence at 6 week follow up between original literature and this retrospective study did not show a statistically significant difference in study results (p-value: 0.93). These results support my hypothesis and the overall goal of this study is fulfilled. It is therefore reasonable to conclude that the HEART score is internally validated as an objective predictor of no MACE occurring within 6 weeks of discharge of a chest pain patient presenting to these Scottsdale Honor Health emergency departments. Furthermore, the HEART Score has the ability to reliably identify patients that can be discharged and not be admitted to the hospital.

Limitations:

There are certain limitations to this study to consider. A significant number of patients that met criteria for follow up based on chart review were not able to be reached via phone interview and were lost to follow up. This alone decreases statistical power. However, this also leads to a potential selection bias. If these patients lost to follow up had been discharged, experienced a MACE, and are now deceased they would not be able to provide information via the phone interview. Therefore, the study would only be selecting for those patients with favorable outcomes from the HEART score and neglecting those with a negative outcome.

Regarding the phone interview, recall bias and patient comprehension places a potential limitation on this study. Although the interviewer defines what constitutes a MACE (MI, PCI, CABG, etc), not all patients are aware of their past medical history or possess the medical comprehension to correctly identify these types of events. Patients may deny a MACE for these reasons, when in fact one did occur.

Conclusions:

The HEART score is internally validated as an objective predictor of no MACE occurring in chest pain patients presenting to these emergency departments. The results from this study do have clinical implications. The HEART score can be implemented into clinical practice, providing emergency physicians with a valuable tool for the evaluation of the chest pain patient. The HEART score allows for a quick triage for such patients, allowing physician time and hospital resources to be utilized in other areas. An additional benefit could be the minimization of unnecessary hospital admissions while maintaining safe medical practice.

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