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Original Article

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# The risk stratification of adult patients with acute chest pain and the proportion of major adverse cardiac events among the low-risk group presenting to the emergency department

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## Abstract

***Background & Aims*:** The aim of the study was to assess the safety of the HEAR Score for the early disposition of patients with chest pain presenting to the Emergency Department (ED).

***Materials & Methods*:** A total of 316 adult patients presenting with low-risk, acute-onset chest pain were included. The HEAR Score was applied to those with non-ST elevation myocardial infarction (NSTEMI), unstable angina, and other causes of chest pain, using ECG analysis and patient history.

***Results*:** Among the patients, 71.2% were male, and the majority were aged 45-65. Key findings included 21.2% with nonspecific ECG abnormalities and 19.9% with ST depression. A total of 1.9% experienced major adverse cardiovascular events (MACE). No significant associations were found between MACE and age, risk factors, or ECG scores. The average hospital stay was 4.5 hr, after which most patients were discharged for further testing.

***Conclusion*:** Our study showed that the incidence of MACE in low-risk chest pain patients was only 1.9%, and the mean hospital stay duration was only 4.5 hr with the application of the HEAR Score. Further studies are needed to validate the HEAR Score in the Indian population. It may be used by ED physicians to guide the management of low-risk chest pain patients.

***Keywords*:** Acute chest pain, Echocardiogram, HEAR score, Non-ST elevation myocardial infarction

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## Introduction

Chest pain is a common complaint among patients presenting to the emergency department (ED), estimated to account for around 10% of all ED visits (1–3). It is also the most common presentation of cardiac ischemic events. However, after investigations and clinical workup, the majority of patients with such complaints did not have a cardiac ischemic event and,

most of the time, did not require admission from the ED (3, 4).

There are several causes of chest pain, ranging from cardiovascular, respiratory, gastrointestinal, and musculoskeletal to psychological causes. Common illnesses include acute coronary syndrome, aortic dissection, pericarditis, pericardial effusion, myocarditis, acute pulmonary embolism, pneumonia, pneumothorax, tension pneumothorax, pleural effusion, gastroesophageal reflux disease (GERD), acute esophagitis, acute mediastinitis, esophageal rupture, rib fracture, costochondritis, chest wall syndromes, acute panic attacks, anxiety disorder, and hyperventilation (5).

Acute coronary syndrome (ACS) is a life-threatening condition where timely diagnosis and prompt treatment are of utmost importance. In contrast to the European population, cardiovascular death (CVD) affects Indians at least a decade earlier, during their most productive midlife years (6). In the Western population, 23% of CVD patients are below the age of 70 years, whereas this figure is 52% for Indian patients (7). The case fatality rate is higher in the low-income group than in middle- or high-income individuals in India (8).

In view of the above, in a busy ED, ACS needs to be differentiated from other causes of acute-onset chest pain. Only 8-10% of cases among all patients with chest pain involve cardiac ischemic events (3). Chest pain due to other causes, the majority of which are non-life-threatening, is much more common than ACS, and therefore these causes need to be ruled out in the ED. This differentiation is often difficult despite taking a thorough history, as the clinical examination of patients with ACS is frequently normal. Therefore, clinicians opt for a battery of tests and specialty consultations, resulting in prolonged ED observation before disposition.

The evaluations for chest pain are costly and require substantial use of resources (9). Thus, in a busy ED, an objective method is required to risk-stratify patients quickly, using minimal resources (10).

There are several scoring systems for risk-stratifying chest pain patients, such as the Thrombolysis in Myocardial Infarction (TIMI) score, Global Registry for Acute Coronary Events (GRACE) score, PURSUIT (Platelet Glycoprotein IIb/IIIa in Unstable Angina: Receptor Suppression Using Integrilin [eptifibatide] Therapy) score, Fast Revascularization in Instability in Coronary Disease (FRISC) score, The North American Chest Pain Rule (NACPR) score, and HEART score (11-15).

Among them, the HEART score is very convenient in ED settings as it requires less extensive workup and is easy to calculate. The HEART score stands for History, ECG, Age, Risk factors, and Troponin I, with each component scored from 0 to 2. Different study groups have shown it is efficient at risk-stratifying acute chest pain patients into low-risk and high-risk groups, which helps in the early ED disposition of low-risk group patients. The outcome in low-risk group patients has been impressive in terms of MACE, thus reducing the chance of missing CVD (16, 17).

The HEART score calculation can be done by emergency physicians, cardiologists, and even by nurses in the ED. It is even practiced in prehospital settings. While inter-rater variability can occur, the introduction of the HEART pathway tool can minimize decision-making in chest pain management (18, 19).

The HEART pathway is a decision aid designed to identify ED patients with acute chest pain for early discharge. In the HEART pathway, stratification of chest pain patients into high-risk and low-risk groups is done by implementing the HEART score. High-risk group (score $\geq 4$) patients are generally admitted for interventions or kept under observation, while low-risk group (score 0-3) patients are either discharged early or kept under observation if the presentation is suspicious (20–22).

Major adverse cardiac events (MACE) are defined as the development of any of the following after hospital discharge: ST elevation myocardial infarction, non-ST elevation myocardial infarction, emergency revascularization, CVD, cardiac arrest, cardiogenic

shock, high-grade atrioventricular block, or death due to any cause (23–25).

The HEAR score, derived from the HEART pathway by excluding the use of Troponin levels, has been used for early decision-making and helps in identifying low-risk patients who do not require further cardiac testing and are eligible for discharge (26).

There is a lack of data on the use of the HEAR Score among the Indian population. Therefore, the present study was conducted to assess the safety of the HEAR Score for the early disposition of patients with chest pain presenting to the ED of Sree Gokulam Medical College and Research Foundation, Trivandrum.

**Primary outcome:**

To assess the risk of MACE in low-risk group (HEAR: 0-3) patients within 30 days of ED presentation.

**Secondary outcome:**

Duration of hospital stay in low-risk group (HEAR score 0-3) patients.

## Materials & Methods

**Type of the Study:**

Prospective observational study.

**Place of the Study:**

Department of Emergency Medicine, Sree Gokulam Medical College & Research Foundation, Trivandrum.

**Study duration:**

November 2020 – February 2022.

**Study population:**

Adults with acute onset chest pain (within 24 hours), categorized as low risk chest pain based on the HEAR Score.

**Ethical consideration:**

This research study was performed in accordance with the Declaration of Helsinki. Written consent was obtained from all the included subjects (or the responsible next of kin), wherever applicable. Any details related to the study subjects, their initials, or their images have not been revealed or included anywhere in the report. Details of the study were explained to the patients. The expected benefits of the study were explained to them, and their doubts were clarified. Voluntary informed consent was taken from the patients. The privacy and confidentiality of the research participants were protected. This study protocol was approved by the Ethics Committee and the Institutional Review Board of Sree Gokulam Medical College and Research Foundation, Thiruvananthapuram, India (Ref No: 0015/2/SGMC/DNB/2020).

**Inclusion Criteria:**

1. Patients ≥ 18 years of age with acute onset chest pain in low-risk patients presenting within 24 hr of symptom onset.
2. Patients who gave informed consent for the study.

**Exclusion criteria:**

1. ST-elevation myocardial infarction (STEMI) patients with acute onset chest pain.
2. High-risk chest pain.
3. Arrhythmias.
4. Hemodynamically unstable patients.
5. Trauma patients.
6. Other causes: aortic dissection, pulmonary embolism, pneumothorax, esophageal rupture, pericarditis with tamponade, pancreatitis.

**Procedure:**

Patients who came to the ED of SGMC, Trivandrum with acute onset chest pain were examined.

Proper history-taking, 12-lead ECG, and risk factor assessment from the history at presentation were done by the treating doctors.

HEAR scoring was implemented in patients with non-ST elevation myocardial infarction (NSTEMI), unstable angina, and chest pain clinically found to be due to other causes. It was calculated by using ECG analysis and the patient's history.

The HEAR score components were used as described. Patients with a HEAR score of ≥ 4 were stratified as the high-risk group, and those with a HEAR SCORE of 0-3 as the low-risk group. Patients in the high-risk group were excluded.

Patients were initially treated with pain medications such as paracetamol or tramadol, depending on their pain severity. If the HEAR Score was 4 or above, troponin-I levels were sent, and if they were more than the reference range ( > 0.02 µg/L), a loading dose of tablet aspirin 300 mg, tablet clopidogrel 300 mg, and tablet atorvastatin 80 mg was given. These patients were either observed in the HDU area, and a cardiology consultation was taken. During the study, most of the patients who had chest pain and were suspected of having a gastrointestinal etiology (GERD, peptic ulcer disease) had pain relief after the administration of a proton pump inhibitor injection (pantoprazole 40 mg) and antiemetics (ondansetron 4 mg) intravenously. These patients were asked to follow up in the Gastroenterology OPD for further investigation. Muscular pain in young patients was common and was relieved by pain medications (27).

According to the HEAR Score, the low-risk group patients were either discharged immediately or after observation and symptomatic treatment. These patients were followed up telephonically or through the hospital database for MACE within 30 days of their hospital presentation, checking for any revisits due to acute chest pain, ECG taken, or documents available from any hospital admissions during the following 30 days, which were collected via email or phone or from the hospital database.

The duration of hospital stay in low-risk patients was obtained from the hospital database.

**HEAR Score Components**:

1. **History**:

A detailed history of chest pain and past history was obtained from the patients.

Various parameters in the history included the site, onset, character, radiation, associated factors, aggravating factors, and relieving factors of pain, any relief in pain by sublingual nitrate, and past history of coronary artery disease.

- Zero (0) points were granted if the history was not suspicious for acute coronary syndrome.
- If both nonspecific chest pain (chest pain not of the classical myocardial angina type without radiation to the jaw, neck, left arm, or right arm) and 1-2 chest pain associated factors (diaphoresis, nausea, vomiting, palpitations, dizziness, chest pain aggravating factors like pain increasing during strenuous exercise) were present, the history was considered moderately suspicious, and one (1) point was granted.
- If more than two chest pain associated factors were present and the chest pain was of the classical myocardial ischemia type, the history was considered highly suspicious, and two (2) points were granted.

2. **Electrocardiography**:

- If the ECG was 'normal', zero (0) points were given.
- In cases of repolarization abnormalities (T wave inversion, U waves, QT prolongation) but without significant ST segment depression or the presence of right bundle branch block, typical abnormalities indicative of left ventricular hypertrophy, repolarization abnormalities probably due to the use of digoxin, or in cases of unknown repolarization disturbances, one (1) point was given.

3. **Age**:

- If the patient was younger than 45 years at the time of admission, zero (0) points were given.
- One (1) point was given if the patient was between 45 and 65 years.
- Two (2) points were given if the patient was 65 years or older.

4. **Risk factors:** The following risk factors were taken into account:

- Currently on treatment or previously diagnosed with diabetes mellitus on OHA or insulin
- Current or recent smoker, or someone who had quit within 1 month
- Previously diagnosed hypertension: when the average of two or more DBP measurements on at least two subsequent visits is ≥ 90 mm Hg, or when the average of multiple SBP readings on two or more subsequent visits is consistently ≥ 140 mm Hg.

Isolated systolic hypertension is defined as SBP ≥ 140 mm Hg and DBP < 90 mm Hg.

- Previously diagnosed hypercholesterolemia: high plasma triglyceride concentration, low HDL cholesterol concentration, and increased concentration of small dense LDL-cholesterol particles.
- Family history of coronary artery disease.
- History of past coronary artery disease: characterized by atherosclerosis in coronary arteries, which may be asymptomatic.
- **Obesity**: BMI > 30 kg/m$^2$.

If the patient had no risk factors at all, zero (0) points were given.

- For one or two risk factors, one (1) point was given.
- For three or more risk factors, two (2) points were given.

The patients in the low-risk group (HEAR 0-3) were discharged from the ED with a review in the Cardiac OP for cardiac echocardiography and stress testing.

**SAMPLE SIZE:**

Proportion of patients with MACE in the low-risk group (p) = 0.67%,

Absolute precision (d) = 0.2%,

A = 5%,

Population size = 300,

$n = Z\alpha^2pq/d^2$,

n = 287,

$n\infty = n/\{1+1/(n/N)\}$

Assuming a loss to follow-up = 10%

Estimated sample size = 287 + 29 = 316

**Statistical analysis:** Data were recorded on a pre-designed proforma and managed in an Excel spread-sheet. All statistical analyses were carried out using SPSS version 20 statistical software. Qualitative (categorical) variables were represented by frequency and percentage analysis. Quantitative (continuous/score) variables were represented by mean and standard deviation. Binary logistic regression was performed to find the association between outcome/MACE and study variables. A p value less than 0.05 was considered statistically significant.

## Results

The study was conducted on a sample size of 316 (n = 316). Out of 316 patients, 225 (71.2%) were male, and 91 (28.8%) were female. The majority of patients were between 45 and 65 years of age. A total of 61 (19.3%) patients belonged to the < 45 years age group, 205 (64.9%) were between 45 and 65 years, and 50 (15.8%) were > 65 years old.

Among the 316 patients, 1 (0.3%) had a slightly suspicious history, 121 (38.3%) had a moderately suspicious history, and 194 (61.4%) had a highly suspicious history.

Among the ECG changes, 186 (58.9%) had no significant ST-T changes, 67 (21.2%) had nonspecific repolarization disturbances such as bundle branch block, without ST depression (19.9%) and left ventricular hypertrophy (58.9%), and 63 (19.9%) had significant ST depression.

In total, 209 (66.1%) patients had no risk factors, 100 (31.6%) patients had 1-2 risk factors, and 7 (2.2%) had more than 2 risk factors, with the majority of low-risk patients having no risk factors.

Out of 316 low-risk chest pain patients who were discharged to review an on OP basis for stress testing and cardiac ECHO, followed-up for 30 days was conducted telephonically or through the hospital database using their medical record number. Following ED presentation, six patients experienced MACE (1.9%).

Table 1 shows the major cardiac events experienced by a group of patients.

**Table 1.** Major adverse cardiac events

| Major adverse cardiac events | No. of patients |
|---|---|
| ST elevation myocardial infarction (STEMI) | 0 |
| Non-ST elevation myocardial infarction (NSTEMI) | 3 |

| Major adverse cardiac events | No. of patients |
|---|---|
| Emergent revascularization | 0 |
| Dysrhythmia | 2 |
| Cardiovascular death due to arrythmia | 0 |
| Cardiogenic shock | 0 |
| High degree AV block | 0 |
| Death due to any cause | 1 |

Out of 316 patients, 6 (1.9%) cases had MACE, while 310 (98.1%) patients had no MACE. MACE cases were almost the same in males (2.2%) and females (1.1%), and hence, the association between MACE and gender was not significant ($p$ = 0.485) (Table 2).

**Table 2.** Association between age, sex, history, ECG findings, risk factors and development of MACE

| | MACE | | Total | p value |
|---|---|---|---|---|
| | No | Yes | | |
| **Gender** | | | | |
| Male | 220 (97.8%) | 5 (2.2%) | 225 | |
| Female | 90 (98.9%) | 1 (1.1%) | 91 | 0.485 |
| **History** | | | | |
| Slightly Suspicious | 0 (0.0%) | 1 (100.0%) | 1 | |
| Moderately Suspicious | 119 (98.3%) | 2 (1.7%) | 121 | 0.017 |
| Highly Suspicious | 191 (98.5%) | 3 (1.5%) | 194 | |
| **ECG:** | | | | |
| 0 | 183 (98.4%) | 3 (1.6%) | 186 | |
| 1 | 66 (98.5%) | 1 (1.5%) | 67 | 0.738 |
| 2 | 61 (96.8%) | 2 (3.2%) | 63 | |
| **Age (Years):** | | | | |
| < 45 | 58 (95.1%) | 3 (4.9%) | 61 | |
| 45 - 65 | 202 (98.5%) | 3 (1.5%) | 205 | 0.121 |
| > 65 | 50 (100.0%) | 0 (0.0%) | 50 | |
| **Risk Factors:** | | | | |
| No Risk Factors | 205 (98.1%) | 4 (1.9%) | 209 | |
| 1 - 2 Risk Factors | 98 (98.0%) | 2 (2.0%) | 100 | 0.87 |
| > 2 Risk Factors | 7 (100.0%) | 0 (0.0%) | 7 | |

The association between MACE and history is significant. Only one patient belonged to the group with a slightly suspicious history who was having low risk chest pain. This was a male patient who was previously diagnosed with CAD and hypertension, with point tenderness on the chest, and an ECG showing RBBB.

The MACE cases were almost similar in patients with an ECG score of zero (1.6%), an ECG score of 1 (1.5%), and an ECG score of 2 (3.2%). It was noticed that patients aged over 65 years had no MACE because, in majority of these patients, their history, ECG, and risk factors led to their exclusion from the study.

The MACE cases were almost the same in patients aged less than 45 years (4.9%), 45-65 years (1.5%), and over 65 years (0.0%), and the association between MACE and age was not significant.

The MACE cases were almost the same in patients with no risk factors (1.9%), 1-2 risk factors (2.0%), and more than 2 risk factors (0.0%), and the association between MACE and risk factors was not significant.

The mean duration of hospital stay was 4.5 hr for patients with low-risk chest pain, after which they were discharged with instructions to review for stress testing and cardiac ECHO.

## Discussion

Chest pain is one of the most common presentations in the ED, estimated to account for around 10% of all ED visits (1-3). Chest pain may be due to life-threatening causes such as STEMI, aortic dissection, pulmonary embolism, pneumothorax, esophageal perforation, etc. These possibilities can be ruled out after clinical examination and a battery of tests. After screening, history taking, ECG readings, and a few laboratory tests in the ED, physicians must decide on the appropriate management. In a busy ED, it is difficult to determine whether a patient needs intensive investigation or can be discharged with follow-up on an outpatient department (OPD) basis. Another common question asked by patients or their attendants concerns the chances of heart attack-related events, technically termed MACE, occurring in the future.

To address these problems, physicians require a risk stratifying scale. There are many risk stratifying scores by Sakamoto et al., Reaney et al., and Cortes et al., which are used in acute chest pain cases, and among them, the HEART score outperforms most (28 ,29 ,30). The HEAR Score has been derived from the HEART Score, which helps in determining whether Troponin levels are necessary in cases of high-risk chest pain.

A study by de Otsuka et al. showed that the HEAR score performed was similarly to the HEART score in predicting MACE in low-risk group patients (31). It is easier for ED physicians to calculate and does not require many invasive investigations. History, ECG findings, age, and risk factors were the four components needed.

Most patients who developed MACE belonged to the category without any risk factors, and the most common risk factor encountered was hypertension (17).

Several comparative studies of different scoring systems for chest pain by Backus et al., Poldevaart et al., Nieuwets et al., and Sakamoto et al., showed that the HEART score is effective in identifying low-risk group patients with a minimal risk of cardiac events in the future (11, 13, 23).

Our study was a prospective observational study that assessed risk stratification of patients presenting to the ED with acute chest pain. They were categorized as low risk (0-3) and the risk of MACE in these low-risk patients, as determined by the HEAR Score, within 30 days of ED presentation.

In our study population, the total low-risk group patients (n = 316) who were discharged early had a 30-day MACE rate of 1.9%, where three patients had non-ST elevation myocardial infarction (NSTEMI) within 30 days of ED presentation. Among the remaining three patients, two developed cardiac arrhythmia – atrial fibrillation- and one patient was brought in cardiac arrest following alcohol withdrawal seizures.

The majority of patients studied had a male preponderance. The total incidence of MACE in our

study population was six patients (1.9%) out of 316. The number of MACE cases was comparable with previous studies conducted by Moumneh et al. and Todd et al. (32, 33).

Though there was no strict rule regarding the consideration of history, the examiner's decision was taken as the primary scoring criterion in this regard, as was considered by Six et al. in their pilot study on the HEART score (17).

In our study, MACE developed in two (1.7%) patients with a moderately suspicious history and three (1.5%) with a highly suspicious history. Furthermore, on assessing the collected data, the majority of MACE developed within the age group of 65 years. Patients aged > 65 years were fewer in the study sample and had a high HEAR score, leading to their exclusion from the study population.

There is no statistical significance in the association of MACE with age, ECG, and risk factors. Different age groups of people were included in this study, ranging from 18 to 81 years, with the majority of patients being under 65 years old. The p-value of 0.121 was not statistically significant. It was noted that patients over 65 years of age had no MACE, as the majority of these patients were excluded from the study, taking into account their history, ECG, and risk factors.

The MACE cases were almost the same in those with no risk factors (1.9%), 1-2 risk factors (2.0%), and no cases identified with more than two risk factors (0.0%). Thus, the association between MACE and risk factors is not significant. In our observational study, it was found that three patients without ECG changes developed MACE.

Patients without any risk factors showed a higher preopensity to develop MACE, indicating that the absence of risk factors may still lead to the development of cardiac events. A study conducted by McGinnis et al. in patients with no risk factors and those with a history of CAD showed that 1.4% (17/1207) of patients without known prior CAD developed MACE (34).

The duration of hospital stay was around 4.5 hr for the low-risk group, with our low-risk group patients having a total hospital stay duration ranging from 3.25 to 5.5 hr. The discharge time by unresolved symptoms, the unavailability of a chest x-ray technician, logistic issues, etc.

Patients who were discharged for review in the Cardiology OPD were followed up, and four patients had a positive stress cardiac test and were posted for elective CAG.

Then current study's limitations included it being a single-center study with a small sample size. Due to some logistic issues there was a delay in shifting patients for evaluation after screening. Protocol adherence and disposition were also delayed in a few cases due to overcrowding in the ED.

## Conclusion

Our study showed that the incidence of MACE in low-risk chest pain was only 1.9%, and the mean hospital stay duration was 4.5 hr with the application of the HEAR score. However, further research is needed to validate the HEAR score in the Indian population. It may be used by ED physicians to guide the management of low-risk chest pain patients.

## Acknowledgments

None declared.

## Ethical statement

Study protocol approved by Institutional Ethics Committee, Sree Gokulam Medical College and Research Foundation (Ref No: 0015/2/SGMC/DNB/2020).

## Data availability

None declared.

## Conflict of interest

The authors have no conflict of interest in this study.

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