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Original Article

Comparison of Various Clinical Risk Assessment Tools in Predicting Major Adverse Cardiac Events in Patients Presenting in Emergency Department with Undifferentiated Cardiac Chest Pain

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ABSTRACT

Objective: To compare the "HEART (History, ECG, Age, Risk factors, Troponin), GRACE (Global Registry of Acute Coronary Events), and TIMI (Thrombolysis in Myocardial Infarction)" scores in predicting major adverse cardiac events (MACE) in patients reporting with undifferentiated cardiac chest pain to the Emergency Department (ED).

Study Design: Cross-sectional validation study

Duration and place of Study: Emergency Department, Combined Military Hospital, Rawalpindi Pakistan, from Jan to Jun 2021.

Methodology: Two hundred and thirty-seven adult patients with atraumatic cardiac-like chest pain and non-diagnostic electrocardiogram (ECG) reporting to the ED were included in the study. HEART, GRACE and TIMI scores were calculated from the data. The number of patients with low risk was identified by each score and compared at a fixed safety level of minimum 95% sensitivity. The potential occurrence of MACE was confirmed using a telephonic follow-up six weeks after the presentation.

***Results*:** At an absolute safety level of minimum 95% sensitivity, the HEART score determined 101 patients as "low-risk" with 1.98% MACE missed. The GRACE score identified 49 "low-risk" patients with 4.08% MACE missed, and the TIMI score identified 66 "low-risk" patients with 3.03% MACE missed.

Conclusion: Among the three scores under comparison, the HEART score performed better than the GRACE and TIMI scores at the same safety level and surpassed them in differentiating between those with MACE and without MACE.

Keywords: HEART Score, GRACE score, Major adverse cardiac event (MACE), TIMI score

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INTRODUCTION

Chest pain is a common presentation in the Emergency Department worldwide.[1] However, it is estimated that less than one-fourth of all the patients presenting with chest pain are diagnosed with Acute Coronary Syndrome.[2] ACS is an umbrella term used to describe clinical features suggestive of myocar-dial ischemia, such as Unstable Angina, Non-ST-segment elevation myocardial infarction and ST-segment elevation myocardial infarction (STEMI).[3,4]

Although up to 60% of the patients presenting with chest pain suggestive of ACS are low-risk and could be safely managed in an outpatient setting, almost 85% are still hospitalized.[5] While patients with ST-segment elevation ACS can easily be diagnosed on ECG, patients with non-diagnostic ECG or non-cardiac chest pain are difficult to distinguish.[6] Early recognition of the latter two groups is essential to streamline appropriate and safe management, discharge, and follow-up pathways while avoiding unnecessary diagnostic and therapeutic delays.[7,8]

While several risk-assessment tools have been developed for risk stratification of chest pain, few have been validated in the ED.[9] For this study, the HEART, GRACE and TIMI scores have been selected for comparison as they have been widely used, are easily applicable to the ED setting and are non-tedious. These risk assessment scores combine and utilize various predictors to calculate the risk of ACS.[10]

While a few studies have suggested that the HEART score is the most superior of the three, significant work has yet to be done in the ED in Pakistan. This study aims to compare the HEART, GRACE and TIMI scores to predict MACE in patients reporting undifferentiated cardiac chest pain in the ED of a tertiary care hospital in Pakistan.

METHODOLOGY

This cross-sectional validation study was conducted at the ED of CMH Rawalpindi Pakistan. Informed

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written consent from patients and approval from the Ethics Committee were obtained (IERB Approval Certificate No. 246). The WHO calculator was used to calculate a sample size taking the reported prevalence of MACE of 19%.[8]

Inclusion Criteria: All patients above the age of 18 years who reported to the ED with atraumatic, undifferentiated cardiac chest pain and a non-diagnostic ECG at presentation were included in the study by using non-probability sampling technique.

Exclusion Criteria: Patients with obvious ECG changes suggestive of ACS, chest pain associated with acute Injury and chest pain with pre-hospital cardiac arrest were excluded from the study.

The GRACE, HEART and TIMI scores were calculated from the gathered data for each patient. The subjective aspects were entered by the ED doctor in real-time. The number of patients with low risk was identified by each score and was compared at a fixed safety level of at least 95% sensitivity. Telephone follow-up of patients was carried out at six weeks to assess the development of a MACE. MACE refers to "UA, NSTEMI, STEMI, percutaneous intervention, coronary artery bypass grafting, stenosis managed conservatively, cardiovascular and non-cardiovascular death, and death of unknown cause". Electronic emergency clinical records were checked for all the patients with a plausible MACE or status unknown at six weeks.

Statistical analysis was carried out using SPSS-20.0. Quantitative variables were expressed as Mean± SD and qualitative variables were expressed as frequency and percentages. The three scores were compared by analyzing their Receiver Operating Characteristic ROC curves followed by the area under the curve (AUCs) calculation and the corresponding 95% confidence intervals (CI).

RESULTS

In total, 237 patients were enrolled in the study, of which.[11] were lost to follow-up, leaving 226 for the final analysis. The risk of developing MACE within six weeks was used to assess the safety of the three risk stratification scores. In total, 77 MACEs were developed by 52(23.0%) patients. Head-on comp-arison of the HEART, TIMI and GRACE scores in 226 patients presenting to the ED with undifferentiated cardiac chest pain showed that at the same safety level of all patients with ACS, the number of patients with low risk recognized by the HEART score 101(44.6%) was greater tha GRACE 49(21.6%) and TIMI 66(29.2%), Table-I. The baseline characteristics of the patients with and without MACE, were represented in Table-II. The Figure showed the HEART score leading with the highest AUC of 0.76(95% CI:0.74-0.78). It was followed by the TIMI score with an AUC of 0.66(95% CI:0.64-0.68) and the GRACE score trailing behind with an AUC of 0.62 (95% CI:0.60-0.68). All differences in AUC were significant statistically.

Table-I: Safety and Efficiency of HEART, GRACE and TIMI Scores (n=226)

Sensitivity 95%	Heart Score n(%)	Grace Score n(%)	Timi Score n(%)
"low risk" cut off value	Score 1-3	Score 0-88	Score 0
low risk patients	101(44.6%)	49(21.6%)	66(29.2%)
Low risk patients with MACE	2(1.9%)	2(4.1%)	2(3.0%)
Negative predictive value/Low risk patients without MACE	99(98.0%)	47(96.9%)	64(96.9%)

Table-II: Baseline Characteristics the Patients (n=226)

Baseline Characteristics	All Patients (n=226)	Patients Who Developed Mace (n=52)	Patients who Had no Mace (n=174)
	Mean±SD	Mean±SD	Mean±SD
Age in years	64.0±13.6	68.0±13.7	62.0±13.3
Mean SBP in mmHg	144.0±23.0	147.0±23.0	143.0±23.0
Mean heart rate per minute	75.0±18.0	76.0±18.5	75.0±18.1
Variables	**n (%)**	**n(%)**	**n(%)**
Male	151(66.8%)	39(75.0%)	112(64.4%)
Risk factors Diabetes Mellitus	51(22.5%)	18(34.0%)	33(18.9%)
Hypercholesterolemia	68 (30.0%)	22(42.3%)	46(26.4%)
Hypertension	114(50.4%)	41(78.8%)	73(41.9%)
Positive family history	64(28.3%)	20(38.4%)	44(25.2%)
Current smoking	63(27.8%)	17(32.7%)	46(26.4%)
History of cardiovascular disease	72(31.8%)	24(46.15%)	48(27.5%)
History of acute myocardial infarction	40(17.7%)	11(21.1%)	29(16.6%)
History of primary PCI	39(17.2%)	15(28.8%)	24(13.8%)
History of coronary arterial bypass grafting	19(8.4%)	7(13.4%)	12(6.8%)
History of cerebrovascular attack	16(7.1%)	5(9.6%)	11(6.3%)
History of peripheral artery disease	8(3.5%)	3(5.7%)	5(2.8%)

SD: standard deviation, SBP (Systolic Blood Pressure), mmHg: millimetres mercury

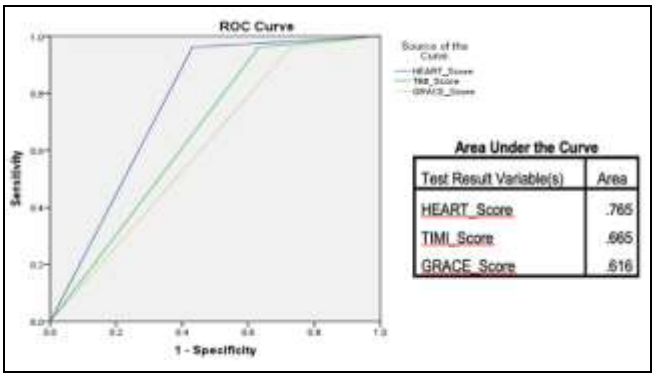

Figure: GRACE, HEART and TIMI Scores to predict MACE within 6 weeks (ROC curves and corresponding Areas under the curve) (n=226)

DISCUSSION

It is obvious from the results of our study that the HEART score is the safest and most efficient in identifying a higher proportion of low-risk ACS patients while missing an insignificantly low number of MACE. A literature review of the last decade shows several studies comparing these risk stratification tools with similar results. One study which compares all three scoring systems showed that the AUC for HEART score was 0.86 (95% CI 0.84–0.88), followed by the AUC for TIMI score of 0.80 (95% CI: 0.78–0.83) and GRACE Score (0.73, 95% CI: 0.70–0.76) 8. In several other studies where the HEART score has been compared to any other scoring system, the HEART score has always proven to be the superior risk stratification tool.[9,10]

The superior performance of HEART over GRACE and TIMI may be attributed to its origin as it was designed specifically for patients with chest pain reporting to the ED with diagnostic uncertainty.[11] In contrast, GRACE and TIMI scores were developed for high-risk patients with previously diagnosed ACS.[12,13] Thus, despite being popular and well-supported by current clinical guidelines, the GRACE and TIMI scores appear more appropriate as prognostic tools for high-risk patients with a previous history of ACS.[14] The HEART score, on the other hand, is more valuable in risk assessment of low-risk ACS patients with atypical presentation and non-diagnostic ECG.[15]

To efficiently manage patients presenting to the ED, it is necessary to design a tool with a high sensitivity for identifying low-risk ACS patients and a low probability of missing MACE. Traditionally, most chest pain guidelines and pathways depend on troponin, cardiac enzymes, other laboratory investigations.[16] However, even with the introduction of point-of-care (PoCT) troponin, decision-making is delayed as at least two samples are required 2-hours apart to calculate delta troponin. Besides, PoCT troponin is only readily available in some countries.[17] Thus, the pragmatic choice is the HEART score as it contains only five variables derived from clinical practice that are quick and easy to calculate at the bedside.[18]

In comparison, the GRACE score is tedious, time-consuming and needs to be calculated electronically. Similarly, although not too hard to calculate, the TIMI score recognizes a small proportion of low-risk patients. Thus, its safety could be better. The safety and accuracy of the ideal risk-stratification tool are determined by its ability to identify the highest proportion of low-risk ACS patients and the minimum risk of missing a MACE. At an absolute level of safety of 5% of total patients for missed MACE, the HEART score predicts the highest number of "low risk" patients, 101 (44.6%), with only 2(1.98%) MACE missed. Thus, the HEART score is most suitable for the undifferentiated chest pain presenting to the ED as it is quick, easy, efficient, and safe.

STUDY LIMITATIONS

We acknowledge that our study only compares three of the many available risk stratification tools for chest pain assessment. However, the possibility of a stratification tool superior to the HEART score must be considered. Furthermore, given the versatility of culture, socio-economic discrepancies and healthcare inequality in Pakistan, the sample size of this study may be a partial representation of the entire population.

CONCLUSION

Among the scores used to identify the patients with low risk, the HEART score performed better than GRACE and TIMI scores at the same level of safety and surpassed them both in discriminating between those with and without MACE.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

KB & TP: Data acquisition, data analysis, drafting the manuscript, approval of the final version to be published.

MNA & MHR: Study design, data interpretation, critical review, approval of the final version to be published.

NC & MSH: Conception, drafting the manuscript, approval of the final version to be published. Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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