Research Article

A Quick New Score to Predict In-hospital Mortality, Cardiac Arrest and Cardiogenic Shock in Acute Myocardial Infarction

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Background: Acute Myocardial infarction is one of the most important components of the burden of cardiovascular diseases. A total of 5–10% of patients with anterior wall AMI develop cardiogenic shock(CS) & 8–10 % had a cardiac arrest. This study aims to provide a new assessment score using parameters like age, sex, heart rate, systolic blood pressure, and investigations like ECG, Killip class, hemoglobin, random blood sugar (RBS), and serum creatinine, for these complications and could identify high-risk patients.

Methods: An observational study was performed in Medicine Department at R. D. Gardi Medical College, Ujjain (M.P.).All cases of AMI aged between 30 to 70 years are included in this study. We use the following factors to calculate the new score- male gender, age >50 years, ECG [ST-T abnormalities], Killip class >1, HR<40 or ≥ 100 bpm, SBP<100 mmHg, RBS >200 mg/dL, serum creatinine>1.3 mg/dL, Hb<11 gm%. The data which was collected was analysed with IBM.SPSS statistics software 23.0 version To find the efficacy of the risk score, sensitivity, specificity, PPV and NPV were used, and the probability value 0.05 is considered significant.

Results: In our study, a total of 87 patients with AMI were assessed. On the basis of the data which was collected, on taking a score cut off of 8, specificity & sensitivity of 78 and 72% for CS while Specificity & sensitivity of 69 and 100% for cardiac arrest And for mortality, specificity & sensitivity of 81 and 70%.

Interpretation & conclusion: Patients with score ≥ 8 are more likely to have complications such as CS, cardiac arrest and mortality and may be managed aggressively and those with lower scores have less risk of complications.

Access this article online

Website: www.cijmr.com

Keywords: Acute myocardial infarction, Cardiovascular diseases, Electrocardiogram, Killip class, Hemoglobin

10.58999/cijmr.v2i01.36

Introduction

Acute Myocardial infarction is one of the most important components of the burden of cardiovascular diseases. Cardiogenic shock is the most severe complication of Myocardial Infarction, and it is the initial presentation of at least 1 in 15 patients admitted to ICCU.[1] Around 5–10% of patients with myocardial infarction develop cardiogenic shock; about 2/3rd of these may not survive in the next 2–3 weeks.[2] Cardiogenic shock is thus characterized by low systolic blood pressure in combination with poor end organ perfusion like cold, clammy extremities, decreased urine output, and acidosis. Sudden cardiac death [SCD] is a public health problem of significant importance, afflicting an estimated 300,000 persons per year in the US. In hospital cardiac arrest [IHCA] is described as cessation of cardiac activity as evidenced by no sign of circulation in a hospitalized patient who had a pulse when he was admitted.[3] Cardiac arrest occurs in 8 to 10% of AMI patients. The risk stratification and prognostication of AMI have been successfully assessed using TIMI and GRACE scores for a long time. Early diagnosis and prompt revascularisation has indeed reduced the incidence of death due to cardiogenic shock and cardiac arrest to a great extent, still the number of patients presenting with cardiogenic shock and cardiac arrest remains stable. This study aims to provide a new assessment score using clinical parameters like age, heart rate, systolic blood pressure, and basic investigations like ECG abnormalities, random blood sugar, serum creatinine, and hemoglobin for these complications and could identify high-risk patients.

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Submitted: 09/05/2022 Revision: 12/10/2022

Accepted: 05/03/2023 Published: 20/05/2023

How to cite this article: Patidar A, Garg V. A Quick New Score to Predict In-hospital Mortality, Cardiac Arrest and Cardiogenic Shock in Acute Myocardial Infarction. Central India Journal of Medical Research. 2023;2(1):3-7.

Material and Methods

Ethics: An observational study was conducted during a 18 month period from November 2018 to May 2020 at R.D. Gardi Medical College Ujjain, MP. Written informed consent from all study subjects was taken.

Inclusion Criteria: Any patients between 30 to 70 years of age with AMI were included in the study.

Exclusion Criteria: Patients with previous myocardial infarction and cardiac arrest prior to admission and cardiogenic shock prior to admission were excluded.

Study Design: Longitudinal Observational study.

Variables

The WHO European Myocardial Infarction registry criteria were based on clinical findings and ECG, blood enzymes and postmortem findings. The following factors were used to calculate the new score- Male gender, Age >50 years, ECG [ST-T abnormalities], Killip class >1, (2 points), heart rate <40 or ≥100 bpm (2 points), systolic blood pressure <100 mmHg (4 points), RBS >200 mg/dL (2 points), S. creatinine >1.3 mg/dL (2 points) hemoglobin <11 gm% (2 points).

The data which was collected was analyzed with IBM. SPSS statistics software 23.0 Version. To describe the data, descriptive statistics frequency analysis and percentage analysis were used for categorical variables and the mean and S.D were used for continuous variables. To find the risk score's efficacy, sensitivity, specificity, PPV and NPV and diagnostic accuracy with operating receiver curve (ROC) was used. In the above statistical tool the probability value 0.05 is considered as significant level.

Results

Out of 87 subjects , 18 subjects had cardiogenic shock making 20.7% of total study population, 3 subjects had ventricular tachycardia following AMI, accounting for 3.4% of the study population, while two patients had sudden cardiac arrest accounting for 2.3% of the total study population which shown in tables below (Table 1).

Sensitivity and specificity were found out for each score as cut off for cardiogenic shock and are tabulated below:

Sensitivity and specificity calculated for each score as cut off for cardiac arrest is shown in Table 4.

The ROC curve has been plotted with the above values (true positive and false positive) as coordinates for each score as cut off and the ROC curve was obtained as Table 5.

The sensitivity and specificity calculated for each score as cut off for mortality is shown in Table 6.

Table 1: Frequency distribution for complications

		Frequency	*Percent*
Cardiogenic shock	yes	18	20.7
	no	69	79.3
Ventricular tachycardia	yes	3	3.4
	no	84	96.6
Cardiac arrest	yes	2	2.3
	no	85	97.7

Table 2: Cut off value for sensitivity and specificity for cardiogenic shock

Positive if greater than or equal To[a]	*Sensitivity*	*Specificity*
2.0000	1.000	1.000
3.5000	1.000	.855
4.5000	1.000	.739
5.5000	1.000	.638
6.5000	.944	.493
7.5000	.833	.406
8.5000	.722	.217
9.5000	.667	.174
10.5000	.556	.130
11.5000	.333	.101
13.0000	.278	.058
14.5000	.167	.014
15.5000	.056	.014
17.0000	0.000	0.000

Area under ROC curve - 0.820
Standard error - 0.049
Confidence interval - 99.5% [*p-value* = 0.005]

Table 3: Area under ROC for cardiogenic shock

Area	*Std. Error*[a]	*Asymptotic sig.*[B]	*Asymptotic 95% confidence interval*	
			Lower bound	*Upper bound*
.820	.049	.000	.723	.917

The ROC curve has been plotted with the above values [true positive and false positive] as coordinates for each score as cut off and the ROC curve was obtained as shown in Table 7.

The Area Under the ROC Curve is 0.791 and the standard error is 0.057, determined with a confidence interval of 99.5% (p-value =0.005), shown in Table 7.

On the basis of the collected data in the study, score of 8 was taken as a cut-off [so <8 Low scores and >8 high score] , specificity was 78% and sensitivity of 72% for cardiogenic shock while specificity was found to be 69% and sensitivity of 100% for cardiac arrest And for in-hospital mortality, specificity was found to be 81% and sensitivity of 70%. Of the 87 subjects studied, 59 had low and 28 had high scores. (Table 8)

Table 4: Cut off value for sensitivity and specificity for cardiac arrest

Positive if greater than or equal To[a]	*Sensitivity*	*Specificity*
2.0000	1.000	1.000
3.5000	1.000	.882
4.5000	1.000	.788
5.5000	1.000	.706
6.5000	1.000	.576
7.5000	1.000	.482
8.5000	1.000	.306
9.5000	.500	.271
10.5000	.500	.212
11.5000	.500	.141
13.0000	.500	.094
14.5000	0.000	.047
15.5000	0.000	.024
17.0000	0.000	0.000

Table 5: Area under ROC for cardiac arrest

Area	*Std. error*[a]	*Asymptotic sig.*[b]	*Asymptotic 95% confidence interval*	
			Lower bound	*Upper bound*
.821	.086	.123	.653	.988

Table 6: Cut off value for sensitivity and specificity for mortality

Positive if greater than or equal To[a]	*Sensitivity*	*1 - Specificity*
2.0000	1.000	1.000
3.5000	.957	.859
4.5000	.957	.734
5.5000	.913	.641
6.5000	.870	.484
7.5000	.783	.391
8.5000	.696	.188
9.5000	.609	.156
10.5000	.522	.109
11.5000	.348	.078
13.0000	.304	.031
14.5000	.130	.016
15.5000	.043	.016
17.0000	0.000	0.000

Table 7: Area under ROC for mortality

Area	*Std. error*[a]	*Asymptotic sig.*[b]	*Asymptotic 95% confidence interval*	
			Lower bound	*Upper bound*
.791	.057	.000	.679	.903

Table 8: Prediction of cardiogenic shock, cardiac arrest and mortality on the basis of new score (cut-off >8)

Measures	*Cardiogenic shock*	*Cardiac arrest*	*Mortality*
Sensitivity	72	100	70
Specificity	78	69	81
PPV	46	7	57
NPV	92	100	88
FPR	22	31	19
FNR	28	0	30
ACCURACY	77	70	78

For the above cut off limit of score, positive predictive value for cardiogenic shock , cardiac arrest and in hospital mortality are 46, 7, 57%, respectively and negative predictive value are 92, 100, 88%, respectively and the accuracy is 77, 70, 78%, respectively as shown in bar diagram below.

Discussion

Acute myocardial infarction usually leads to significant short term and long term mortality. In the first 24 hours, it is associated with a high death rate , with most of them occurring in the 1st hour of symptoms onset. Hence, risk stratification plays an important role in its management. Hence risk stratification plays an important role in its management. Age, gender, heart rate, blood pressure, ECG changes, Killip class, serum creatinine, random blood sugar levels and hemoglobin are some variables useful in risk stratification and mortality estimation in ICU.

As pointed out previously, advanced age is a strong predictor of mortality in cardiogenic shock. Older patients have more age-related generalized atherosclerosis and comorbidities. In the large SHOCK registry (1993–1997), which included 277 elderly patients, in-hospital mortality for patients aged >75 years was 48% within 18 hours of myocardial infarction compared with 81% in the late group.[4] In a large comparative study between TIMI score, GRACE score and PURSUIT score, 67% of subjects older than 65 years had MACE within 30 days.[5] Blood pressure is a strong and most important predictor for cardiogenic shock, and cardiac arrest and is associated with mortality. In human cardiac arrest survivors and cardiogenic shock patients, good functional recovery was independently and positively associated with arterial blood pressure during the first 2 hours after human cardiac arrest or cardiogenic shock but not with hypertensive reperfusion within the first minutes after return of spontaneous circulation in cardiac arrest.[6] A large comparative

study between TIMI score, GRACE score and PURSUIT score also suggests that blood pressure on admission is major predictor of adverse outcome.[5] Mortality in acute coronary syndrome can be estimated on the bedside by Killip Classification. It has 4 classes in which class III and IV have higher mortality than class I and II. Compared with all-cause mortality rates among patients in class I (3 at 30 days and 5% at 6 months), rates were significantly higher among patients in class II (9 and 15%, respectively) and patients in classes III-IV (14 and 23%, respectively).[7]

In the prediction of outcome in a large cohort of patients with cardiac arrest and cardiogenic shock, changes in serum creatinine may also have a contributory role. Good prognosis is indicated by fall in creatinine levels in the first 24 hours [>0.2 mg/dL] , whereas a constant or increasing creatinine indicates poor prognosis.[8] Many retrospective studies have shown that hyperglycemia is commonly seen in patients following out of hospital cardiac arrest [OOHCA] and In-hospital Cardiac arrest [IHCA]. Also, many other studies have shown that hyperglycemia may worsen the prognosis in many critical patients having acute coronary syndrome and cardiogenic shock.[9] Studies of OOHCA and IHCA have also demonstrated that glucose measurements immediately following spontaneous circulation (ROSC) return and during the first few days following ROSC (e.g., 12, 24, or 72 hours) may be independently correlated with patient outcomes.[10] Hemoglobin levels are more associated with cardiac arrest outcomes than cardiogenic shock. Anemia is associated with increased sudden cardiac arrest (SCA) in several cardiovascular diseases. The Korean National Health Insurance Database Cohort (NHID-Cohort) concluded that In general population, anemia was associated with an increased risk of SCD. Hence it should be considered an important prognostic marker, and therapeutic strategies aimed to increase hemoglobin levels in the general population should be investigated.[11]

A recent scientific statement from the American Heart Association underlines that current risk adjustment models are inadequate in the setting of out-of-hospital cardiac arrest or AMI complicated by CS.[12] However, risk scores may contribute to better interpreting the patient's setting, behaviors and decision-making. We propose a model of risk assessment score that predicts major adverse outcomes following AMI.

There are 3 major strengths of the proposed score. First,it was based on simple variables and thus can be rapidly and easily calculated in clinical routine. Second, it included variables that are readily available directly in the laboratory after hospital admission and does not require an elaborate assessment of variables. Third, Variables has been validated in the IABP-SHOCK II registry as well as in an external CS cohort.

However, these available scoring systems have several limitations. Some scores were developed based on clinical trials performed in the pre-PCI era, including the aforementioned GUSTO-I and SHOCK trial scores.[13-15] Other scores are complex and impracticable in clinical routine, especially in an acute setting. Notably, most of the scores are not validated. So we developed a quick assessment score to consolidate all the characteristics to a cumulative score that can identify adverse cardiac event such as CS, SCA or in-hospital mortality following acute myocardial infarction.

Based on area under ROC curve of 0.821,0.791,0.820 for cardiac arrest, in hospital mortality and cardiogenic shock, respectively, it is shown that The score is an efficient test with a cut-off of 8 and below as low score And more than 8 as high score. This scoring system reliably segregates patients who are likely to have major adverse cardiac events such as CS, SCA following acute myocardial infarction.

Conclusion

This risk assessment score is a simple tool that can be rapidly calculated in the laboratory setting and applied in clinical routine. It might therefore serve for identifying patients for future clinical trials and, more importantly, it might help stratify patients according to their risk for short-term mortality.

We use the following variables to calculate the new score

- Age≥50 years (1 point),
- Male sex (1 point),
- St-t abnormalities (2 points),
- Killip class>1 (2 points),
- Heart rate<40 or ≥100 bpm (2 points),
- Systolic blood pressure <100 mmHg (4 points),
- Rbs >200 mg/dL (2 points),
- S. Creatinine >1.3 mg/dL (2 points)
- Hemoglobin < 11 gm% (2 points)

On the basis of these variables, patients with score of more than 8 are more likely to have Complications such as cardiogenic shock, cardiac arrest and mortality and may be managed aggressively in Coronary Care Unit and those with lower scores have lower risk of complications; hence, facilitating the clinical decision making for aggressive monitoring and management.

Limitations

- The population included in the study were small.
- TIMI flow grade was not included in the study.
- Short follow-up period, we have followed patients during their hospital stay only.
- This study has observed for major adverse cardiac events (MACE) occurring upto 7 days following AMI. Though this is the time period wherein there is a maximum risk of MACE occurrence following AMI, 30 day MACE incidence should be studied.
- With echocardiographic imaging being available and physicians being made to train in rapid echo screening, the presence of Regional Wall Motion Abnormality can be incorporated into the score to improve the score's sensitivity.

Acknowledgement

Thanks to all who participated in this study.

Conflict of Interest

None

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