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Original Article

# Evaluation of $CHA_2DS_2$-VASc Score to Predict Cardiogenic Shock in ST Elevation Myocardial Infarction (STEMI)

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## ABSTRACT

**Objective:** To evaluate the ability of the $CHA_2DS_2$-VASc score to predict the likelihood of cardiogenic shock in patients diagnosed with ST-elevation myocardial infarction (STEMI).

**Methodology:** The research was conducted at the Department of Cardiology, NICVD, Karachi, over the period from February 2023 and February 2024. A descriptive study design was employed. The study population included 531 patients diagnosed with STEMI, aged between 18 and 70 years, who presented within 24 hours of symptom onset. Participants were recruited using non-probability consecutive sampling. On clinical symptoms and ECG diagnosed STEMI[12] and patients who had past myocardial infarction, chronic kidney diseases, chronic liver diseases, heart failure and arrhythmias were excluded. Before PCI, we collected baseline demographic and clinical information and determined $CHA_2DS_2$-VASc scores. SPSS version 26.0 was used for data analysis.

**Results:** The mean±SD age of the individuals were found to be 57.05±11.283. Out of 531 participants 82.3% were male while 17.7% accounted for female. The $CHA_2DS_2$-VASc score effectively forecast cardiogenic shock in STEMI cases, alongside an AUC of 0.761 (p=0.0001). Cases with greater scores faced worse in-hospital outcomes, including a significantly higher mortality rate (9.6% compared to 1.5%, p=0.0001) and more frequent major cardiovascular events (14.4% vs. 5.4%, p=0.001). Their average ejection fraction was also lower (41.43% vs. 46.06%, p=0.0001).

**Conclusion:** It is to be concluded that $CHA_2DS_2$-VASc score offers practical insights into risk assessment for STEMI patients, especially in predicting the likelihood of cardiogenic shock. Patients with higher scores tended to have more severe health conditions and poorer outcomes during hospitalization. Using this score in clinical settings helps identify those who may benefit from closer observation and timely interventions.


**Keywords:** Area under the curve, Cardiogenic shock, $CHA_2DS_2$-VASc score, Hemodynamic complications, ST-segment elevation myocardial infarction,

## INTRODUCTION

The $CHA_2DS_2$-VASc score is a recognised tool utilised to assess stroke risk in patients with atrial fibrillation. However, recent studies have demonstrated its applicability in predicting the clinical outcomes of patients with ST-elevation myocardial infarction (STEMI), particularly in assessing the risk of cardiogenic shock. This research is to evaluate the prediction accuracy and clinical relevance of the $CHA_2DS_2$-VASc score in the prediction of cardiogenic shock with cases having STEMI which is an important threat to the burden of disease worldwide.

High score $CHA_2DS_2$-VASc increase of cardiovascular event risk in patient STEMI on evidence-derived. For example, Sun et al. found that the $CHA_2DS_2$-VASc score was strongly predictive of in-hospital prognosis in primary PCI cases[1]. Huang et al. also observed that the $CHA_2DS_2$-VASc score is a reliable indicator of coronary artery disease and prognosis in individuals with acute STEMI[2].

Several studies reported the impact of the $CHA_2DS_2$-VASc score on cardiogenic shock. Fang et al. pointed out that cases with high $CHA_2DS_2$-VASc scores experienced a greater frequency of cardiovascular adverse events while in hospital[3]. This is crucial, since early recognition of at-risk individuals may provide timely therapies and enhance survival rates.


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Furthermore, as shown by Ashoori et al., $CHA_2DS_2$-VASc serves as an autonomous indicator of post-reperfusion and short-term fatalities subsequent to initial PCI[4]. These results highlight the potential utility of the score in the threat of STEMI patients possibly in need of more aggressive management approaches.

The $CHA_2DS_2$-VASc-HSF score represents important progress in risk stratification and has demonstrated a more accurate prediction of angiographic blood flow than having STEMI[5,6]. Such enhanced predictive capacity may be useful to clinicians to help guide appropriate treatment decisions in those patients at high risk of immediate shock during or following acute coronary events[7,8].

Modified versions of $CHA_2DS_2$-VASc score have also been used to predict hospital mortality and post-PCI complications after acute coronary syndrome[9,10]. More generally, the reliability of the $CHA_2DS_2$-VASc score extends beyond evaluating the risk of contrast nephropathy and hemorrhagic stroke associated with enhanced therapy[11,12]. These results indicate that in the clinical management of STEMI patients, the $CHA_2DS_2$-VASc score may have broader applicability.

$CHA_2DS_2$-VASc score appears to be an effective instrument in forecasting cardiogenic shock risk within STEMI cases that reaffirm their use as more than merely a tool for anticoagulation management[13,14]. The implementation of this score within healthcare settings may enhance decision-making processes and improve outcomes in individuals with STEMI[15,16].

## METHODOLOGY

The research was carried out in the Cardiology department of National Institute of Cardiovascular Diseases (NICVD), Karachi, since February 2023 till February 2024. The study was carried out in the form of comparative descriptive cross-sectional design enrolling 531 patients, and the sample size

was determined through WHO sample size calculator, based on 5.87% frequency of cardiogenic shock in STEMI patients, margin of error (d)=2%, and confidence level (C.I)=95%. Patients with either gender aged 20–70 years with STEMI (attended within 3 hours of onset or less) and planned for primary percutaneous coronary intervention (PPCI) without any mechanical or surgical interventions (All patients treated with aspiration during PPCI after balloon dilatation) were enrolled using non-probability purposive sampling. In STEMI cases, acute myocardial infarction (AMI) was diagnosed according to clinical presentation and ECG findings, with classical chest pain lasting > 20 min (retrosternal pain radiating to the left arm or shoulder, aggravated by exertion or emotional stress) concurrent with ST segment elevation in two or more contiguous leads or new left bundle branch block. ST-segment elevation was defined as a J-point elevation of greater than 2 mm in leads V2 and V3, and ≥1 mm in other leads.

Patients with recurrent myocardial infarction were excluded, as were patients with chronic kidney disease or liver disease (defined as either chronic kidney disease or liver disease), and those with heart failure or who had arrhythmias (atrial fibrillation, ventricular tachycardia, ventricular fibrillation, or supraventricular tachycardia). Patients were stabilized and initial treatment provided upon their arrival in the Emergency Department (ED). Once stable, the study's purpose, risks, and benefits were explained, and written informed consent was obtained. Baseline demographic and clinical data, including age, gender, diabetes, hypertension and smoking status were obtained using a pre-designed proforma. STEMI was confirmed via ECG, and the $CHA_2DS_2$-VASc score was calculated before the PCI procedure.

All PCI procedures were performed by interventional cardiologists with more than five years of experience, and study covariates were meticulously recorded. The patients were all evaluated for cardiogenic shock depending on surviving hypotension (systolic blood pressure >18 mm Hg or RV end-diastolic pressure >10-15 mm Hg). Statistical data was assessed by SPSS version 26.0.

## RESULTS

The baseline characteristics of the study participants are shown in **Table I**. Comparisons of characteristics between low and high $CHA_2$ $DS_2$ -VASc groups revealed significant differences in age, sex, and multiple comorbidities ($p < 0.05$ for all). The older (64.60 ± 9.79 years versus 54.72 ± 10.68 years; p=0.0001) high $CHA_2DS_2$-VASc (0-1 versus ≥ 2) group The low score group had a higher percentage of males (91.1% vs 53.6%, p=0.0001) and less congestive heart failure, hypertension, diabetes mellitus, stroke, peripheral artery disease, CABG surgery history, MI history, and PCI history compared with the high score group ($p<0.05$ for each). A higher number of current smokers were observed in the low score group (80.8% vs. 39.2%, p=0.0001); however, hyperlipidemia was much higher in the high score group (36.0% vs 20.9%, p=0.001). A much greater Killip Score I was also present in the high $CHA_2DS_2$-VASc group (16.8% vs. 5.9%, p=0.0001). The door-to-balloon time was significantly longer in the high score group (35.54 ± 6.28 hours vs. 32.56 ± 5.91 hours, p=0.0001); however, the pain-to-balloon time, systolic blood pressure, heart rate, and length of hospital stay showed no significant differences between both groups ($p>0.05$). The $CHA_2DS_2$-VASc score was found to be significantly elevated for the high score group (3.528 ± 0.963 vs. 0.815 ± 0.732, p=0.0001).

**Table II**: In-hospital outcomes of the low and high $CHA_2DS_2$-VASc score groups (low: n=406, high: n=125). In the high $CHA_2DS_2$-VASc group, in-hospital mortality was significantly higher (9.6% vs. 1.5%, p=0.0001). Those with high scores also experienced significantly more major adverse cardiovascular events (MACE) (14.4% vs. 5.4%, p=0.001). We noted a higher rate of hemodialysis (4.0% vs. 0.7%, p=0.020) and transient pacemaker use (9.6% vs. 1.5%, p=0.0001) in the high-score group. In terms of red cell transfusion, the low-score group had a higher rate (5.6% vs. 1.5%, p=0.009). No differences were found in reinfarction, target vessel revascularization (TVR), cardiopulmonary resuscitation, intra-aortic balloon pump (IABP) use, cardiogenic shock, atrial fibrillation and femoral artery pseudoaneurysm between the groups ($p>0.05$ for all) In addition, the mean ejection fraction was also significantly lower in the high $CHA_2DS_2$-VASc group (41.43 ± 4.60% vs. 46.06 ± 7.71%, p=0.0001).

The $CHA_2DS_2$-VASc score is predictive of cardiogenic shock (AUC 0.761), as shown in **Figure I**. An AUC value of this level suggests that it has good discriminatory ability such that the $CHA_2DS_2$-VASc score effectively separates patients at high vs low risk for cardiogenic shock. In addition, a very low p-value of < 0.0001 supports the statistical significance of the association and suggests that the $CHA_2DS_2$-VASc score may be a valid predictor of cardiogenic shock in patients with ST-elevation myocardial infarction (STEMI).

In-hospital mortality predicted by $CHA_2DS_2$-VASc score in **Figure II**. An AUC of 0.874 reflects excellent discriminatory ability, suggesting that the $CHA_2DS_2$-VASc score is a very good predictor of in-hospital mortality. The p-value of 0.0001 further confirms that this is a highly statistically significant result and highlights the strength of the $CHA_2DS_2$-VASc score in predictive mortality. The score can discriminate between patients at risk of in-hospital death and those not in need of intensive monitoring and care with an AUC of 0.874.

| Table I: Baseline Characteristics of Study Participants (n=531) | | | | |
|---|---|---|---|---|
| **Variables** | | **$CHA_2DS_2$-VASc** | | **P-Value** |
| | | **Low** (n=406) | **High** (n=125) | |
| Age in years, Mean ± SD | | 54.72 ± 10.68 | 64.60 ± 9.79 | 0.0001 |
| Gender | Male, *n* (%) | 370 (91.1) | 67 (53.6) | 0.0001 |
| | Female, *n* (%) | 36 (8.9) | 58 (46.4) | |
| Congestive Heart Failure, *n* (%) | | 3 (0.7) | 9 (7.2) | 0.0001 |
| Hypertension, *n* (%) | | 120 (29.6) | 110 (88.0) | 0.0001 |
| Diabetes Mellitus, *n* (%) | | 66 (16.3) | 68 (54.4) | 0.0001 |
| Stroke, *n* (%) | | 3 (0.7) | 10 (8.0) | 0.0001 |
| Peripheral Artery Disease, *n* (%) | | 6 (1.5) | 12 (9.6) | 0.0001 |
| CABG Surgery History, *n* (%) | | 9 (2.2) | 12 (9.6) | 0.0001 |
| MI History, *n* (%) | | 34 (8.4) | 27 (21.6) | 0.0001 |
| PCI History, *n* (%) | | 36 (8.9) | 31 (24.8) | 0.0001 |
| Anterior MI, *n* (%) | | 189 (46.6) | 60 (48.0) | 0.777 |
| Current Smoker, *n* (%) | | 328 (80.8) | 49 (39.2) | 0.0001 |
| Hyperlipidemia, *n* (%) | | 85 (20.9) | 45 (36.0) | 0.001 |
| Killip Score I, *n* (%) | | 24 (5.9) | 21 (16.8) | 0.0001 |
| Door-to-Balloon Time (hours), Mean ± SD | | 32.56 ± 5.91 | 35.54 ± 6.28 | 0.0001 |
| Pain-to-Balloon Time (hours), Mean ± SD | | 212.18 ± 90.36 | 221.97 ± 83.07 | 0.281 |
| Systolic Blood Pressure (mm Hg), Mean ± SD | | 125.57 ± 15.79 | 122.30 ± 20.60 | 0.061 |
| Heart Rate (bpm), Mean ± SD | | 78.48 ± 6.45 | 77.42 ± 9.37 | 0.153 |
| Length of Hospital Stay (day), Mean ± SD | | 7.35 ± 4.53 | 8.04 ± 4.07 | 0.127 |
| $CHA_2DS_2$-VASc, Mean ± SD | | 0.815 ± 0.732 | 3.528 ± 0.963 | 0.0001 |

***CABG**: Coronary Artery Bypass Graft; **MI**: Myocardial Infarction, **PCI**: Percutaneous Coronary Intervention*

| Table II: Comparison of In-Hospital Outcomes Between Low and High $CHA_2DS_2$-VASc Score (n=531) | | | | |
|---|---|---|---|---|
| **Variables** | **$CHA_2DS_2$-VASc** | | | **P-Value** |
| | **Low** (n=406) | **High** (n=125) | **95% C. I** | |
| In-Hospital Mortality, *n* (%) | 6 (1.5) | 12 (9.6) | 0.052 --- 0.385 | 0.0001 |
| Reinfarction, *n* (%) | 9 (2.2) | 4 (3.2) | 0.208 --- 2.266 | 0.366 |
| TVR, *n* (%) | 14 (3.4) | 4 (3.2) | 0.349 --- 3.344 | 0.577 |
| MACE, *n* (%) | 22 (5.4) | 18 (14.4) | 0.176 --- 0.658 | 0.001 |
| Hemodialysis, *n* (%) | 3 (0.7) | 5 (4.0) | 0.042 --- 0.758 | 0.020 |
| Cardiopulmonary Resuscitation, *n* (%) | 21 (5.2) | 10 (8.0) | 0.287 --- 1.370 | 0.238 |
| IABP, *n* (%) | 9 (2.2) | 6 (4.8) | 0.157 --- 1.289 | 0.127 |
| Cardiogenic Shock, *n* (%) | 18 (4.4) | 11 (8.8) | 0.221 --- 1.047 | 0.060 |
| Atrial Fibrillation, *n* (%) | 9 (2.2) | 6 (4.8) | 0.157 --- 1.289 | 0.127 |
| Transient Pacemaker, *n* (%) | 6 (1.5) | 12 (9.6) | 0.052 --- 0.385 | 0.0001 |
| Femoral Artery Pseudoaneurysm, *n* (%) | 15 (3.7) | 7 (5.6) | 0.258--- 1.623 | 0.350 |
| Red Cell Transfusion, *n* (%) | 6 (1.5) | 7 (5.6) | 0.083 --- 0.767 | 0.009 |
| Ejection Fraction (%), Mean ± SD | 46.06 ± 7.71 | 41.43 ± 4.601 | 3.201 --- 6.058 | 0.0001 |

***CV**: Cardiovascular, **IABP**: Intra-Aortic Balloon Pump, **MACE**: Major Advanced Cardiac Events, **TVR**: Target Vessel Revascularization*

**Figure 1:** Predictive Value of the $CHA_2DS_2$-VASc Score for Cardiogenic Shock

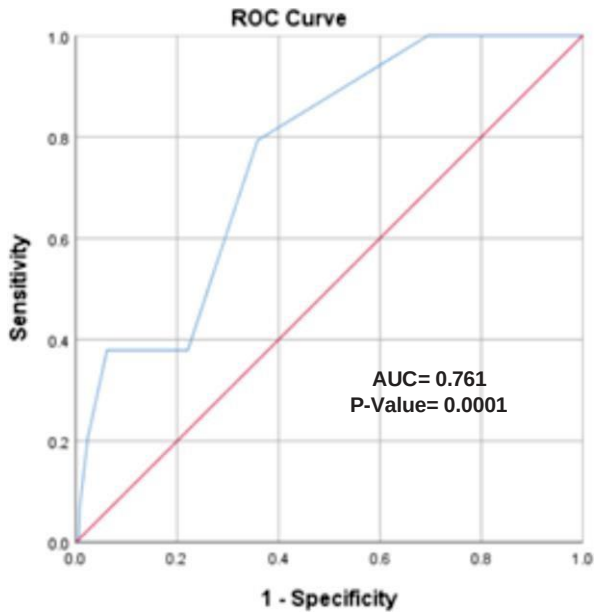
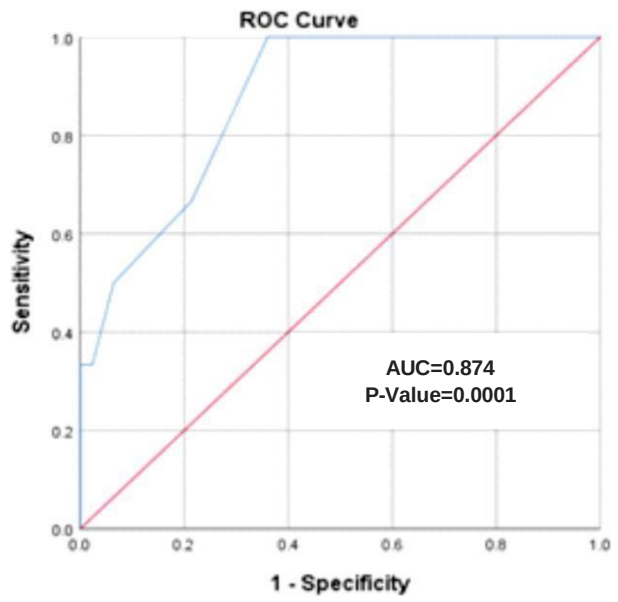



**Figure 2:** Predictive Value of the $CHA_2DS_2$-VASc Score for In-Hospital Mortality




## DISCUSSION

The $CHA_2DS_2$-VASc score is a validated measure for thromboembolic risk stratification in atrial fibrillation patients; however, its effectiveness in predicting cardiogenic shock in STEMI patients has not been well investigated[17]. The present investigation indicated a robust correlation between elevated $CHA_2DS_2$-VASc scores and incidences of cardiogenic shock. The score has a moderate ability to identify at risk patients as shown by AUC 0.761. Additionally, those with high scores had worse clinical outcomes, such as lower ejection fractions and a higher Killip Class. These results underscore the impact of systemic comorbidities, including older age, diabetes, and hypertension, on the development of cardiogenic shock during acute myocardial ischemia.

The current study expands on prior work demonstrating that the $CHA_2DS_2$-VASc score also predicts a range of cardiovascular events beyond stroke[4,5]. A research performed by Fang et al. achieved an AUC of 0.744 in the prediction of major adverse cardiovascular events (MACE) with a 3.5 cut-off score[3]. Similarly, Huang et al. found a higher cut-off of 4.5 with an AUC of 0.947 for MACE[2]. Additionally, Bozbay et al. $CHA_2DS_2$-VASc score effectively predicted long-term mortality in STEMI populations[18], with AUC=0.821. Although these studies mainly associated the score with MACE and mortality, our study contributes new insights about the association between this score and cardiogenic shock after STEMI, a less commonly examined complication. This study highlights the $CHA_2DS_2$-VASc score as a simple risk stratification tool that could be applied in more widely clinical settings.

However, there are limitations of applying the $CHA_2DS_2$-VASc score in the prediction of cardiogenic shock[19,20]. Essential differences exist between this diagnostic tool and STEMI-specific tools, it does not consider important aspects including infarct size, reperfusion status and left ventricular function[21]. This may be the reason the score provides only moderate predicting power in this setting, with these components are crucial in determining the risk of cardiogenic shock for the patient. Incorporating these STEMI-specific variables into the $CHA_2DS_2$-VASc may improve its accuracy and clinical applicability and should be the aim of future work.

A significant feature of this research is its emphasis on the applicability of the $CHA_2DS_2$-VASc score. Its dependence on routinely collected experimental data renders it feasible and transferrable into practice, including resource-limited healthcare settings. This study also uses the score to identify STEMI patients who may be at risk of developing cardiogenic shock and thereby extends its utility beyond thromboembolism risk evaluation. Enabling doctors to detect high-risk people sooner and act more effectively and promptly, clinicians will be able to influence outcomes with greater success than is possible today in more vulnerable patients.

Nevertheless, some limitations must be considered. The lack of any STEMI–specific factors limits the usefulness of the score in cardiogenic shock. The generalizability of these findings should be confirmed in larger and more diverse populations including non-STEMI. The $CHA_2DS_2$-VASc score more effectively forecasts ischaemic stroke in patients with STEMI and should be adjusted by adding specific parameters to further enhance its goodness of fit and its prediction ability in future studies, which might include external validation in low-income settings.

The $CHA_2DS_2$-VASc score is a useful predictive tool of STEMI risk stratification, especially for identifying patients who are at risk for developing post-STEMI cardiogenic shock. Although its simplicity and practicality are important advantages, the addition of other clinical variables would improve its performance and accuracy. These advancements would help healthcare workers better identify high-risk patients and provide more precise, impactful care.

## CONCLUSION

It is to be concluded that the $CHA_2DS_2$-VASc score offers practical insights into risk assessment for STEMI patients, especially in predicting the likelihood of cardiogenic shock. Patients with higher scores tended to have more severe health conditions and poorer outcomes during hospitalization. Using this score in clinical settings helps identify those who may benefit from closer observation and timely interventions.

**Conflict of Interest:** Authors declare that there is no conflict of interest.

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**Authors' Contributions:** All authors took part in this study to an equal extent. **Juned H:** Contributed to the conception of the study, data collection, and initial manuscript drafting. **Parveen A:** Supervised the entire study, provided critical revisions, and offered expert guidance throughout the research process. **M Farhan A:** Was responsible for data analysis, interpretation of results, and the final review of the manuscript to ensure its accuracy and completeness.

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