# EVALUATION OF CARDIAC BIOMARKERS FOR EARLY DIAGNOSIS AND PROGNOSIS IN ACUTE MYOCARDIAL INFARCTION: A PROSPECTIVE STUDY

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## ABSTRACT

**Background:** Acute myocardial infarction (AMI) is a leading cause of morbidity and mortality worldwide. Early and accurate diagnosis is crucial for effective management, and cardiac biomarkers play a significant role in this process. This study assesses the diagnostic and prognostic value of various cardiac biomarkers in AMI.

**Objective:** To evaluate the diagnostic accuracy and prognostic significance of cardiac biomarkers including high-sensitivity Troponin I (hs-cTnI), Creatine Kinase-MB (CK-MB), Heart-type Fatty Acid Binding Protein (H-FABP), Copeptin, and B-type Natriuretic Peptide (BNP) in patients with Acute Myocardial Infarction.

**Methods:** A prospective cohort study was conducted involving 100 patients with suspected AMI. Blood samples for biomarkers were collected at presentation, and at 6-, 12-, and 24-hours post-symptom onset. Diagnostic performance (sensitivity, specificity, positive predictive value, and negative predictive value) was assessed for each biomarker, along with prognostic implications, particularly for in-hospital mortality and major adverse cardiovascular events (MACE). Statistical analyses were performed using SPSS and R software.

**Results:** The study showed that hs-cTnI had the highest sensitivity (82%) at presentation, reaching peak sensitivity (96%) at 3-6 hours. A multimarker approach combining hs-cTnI and Copeptin demonstrated the highest sensitivity (98%) at 0-1 hour. Prognostic markers, particularly elevated ST2 and NT-proBNP levels, were associated with higher in-hospital mortality, heart failure, and arrhythmias. ST2 also showed significant predictive value for 30-day survival rates.

Conclusion: High-sensitivity Troponin I (hs-cTnI), particularly when combined with Copeptin, was the most reliable biomarker for early AMI diagnosis. Elevated ST2 and NT-proBNP levels were significant prognostic markers, identifying patients at high risk for adverse outcomes. This study highlights the utility of a multimarker approach to improve both diagnostic accuracy and prognostic prediction in AMI.

**Keywords:** Acute Myocardial Infarction, Cardiac Biomarkers, High-sensitivity Troponin I, Copeptin, Prognosis, Diagnostic Accuracy

## INTRODUCTION

Acute myocard al infarction (AMI), commonly referred to as a heart attack, is a leading cause of mortality and morbidity worldwide, with a substantial economic burden on healthcare systems[1] .AMI occurs due to the sudden occlusion of a coronary artery, which deprives the heart muscle of oxygen and nutrients, resulting in ischemia and subsequent myocardial damage [2].Cardiovascular disease is a very common diagnosis and a leading cause of death in both men and women. It accounts for 30% of deaths worldwide, including 40% in high-income countries and approximately 28% in the developing nations [3]Cardiac biomarkers are substances that are released into the bloodstream when heart muscle cells are damaged.The most widely accepted biomarkers, such as high-sensitivity troponins (hs-TnI/T) and creatine kinase-MB (CK-MB), have revolutionized AMI diagnosis, offering evidence-based criteria for both acute and evolving clinical presentations. However, troponins, while highly sensitive, are not exclusively specific to cardiac injury and may rise in other pathological conditions, leading to diagnostic challenges. Additionally, their levels typically elevate several hours after symptom onset, which can delay clinical decisions during the earliest phase of infarction[4].The aim of this paper is to assessment of cardiac biomarkers in acute myocardial infraction.

## LITERATURE REVIEW:

### Cardiac Troponins:

Cardiac troponins (cTnI and cTnT) are proteins found in cardiac muscle fibers and are considered the most specific and sensitive biomarkers for AMI. Troponin levels rise within 3-12 hours of myocardial injury, peaking at 24-48 hours, and can remain elevated for up

to two weeks. The sensitivity and specificity of troponins make them the gold standard in diagnosing AMI, particularly in patients with atypical presentations. Studies have shown that elevated troponin levels correlate with the extent of myocardial injury and are predictive of long-term mortality (5). The introduction of high-sensitivity assays for troponins has further enhanced its diagnostic accuracy, enabling early detection even in patients with minimal myocardial injury (6).

**B-type Natriuretic Peptide (BNP):**

B-type natriuretic peptide (BNP) is a hormone released by the ventricles in response to increased wall stress. It is primarily used in the diagnosis and prognosis of heart failure but has also shown utility in AMI. Elevated BNP levels in the acute setting of AMI are associated with adverse outcomes, including heart failure and mortality [6]. BNP has been shown to provide complementary information when used alongside other cardiac biomarkers, helping clinicians better stratify patients based on their risk of developing complications such as heart failure [5].

**Creatine Kinase-MB (CK-MB):**

Creatine kinase-MB (CK-MB) is an isoenzyme found predominantly in cardiac muscle. While it has been historically used in diagnosing AMI, it is less specific than troponins because CK-MB is also present in skeletal muscle. However, CK-MB levels rise more quickly than troponins and may be useful for detecting reinfarction. Despite its utility, CK-MB has been largely replaced by troponins in clinical practice [7]. Nevertheless, some studies still highlight its relevance for diagnosing AMI in certain patient populations, particularly in cases where troponins are inconclusive.

**MATERIAL AND METHODS**

A prospective cohort study was conducted in Fazilka, Punjab, involving 100 patients aged 25–50 years presenting with suspected Acute Myocardial Infarction (AMI). Participants were enrolled over a 6-month period in different Hospitals in Fazilka. Blood samples for cardiac biomarkers—including troponin I, CK-MB, BNP, and myoglobin—were collected at four time points: at presentation, and at 6-, 12-, and 24-hours post-symptom onset. Electrocardiograms (ECGs) and echocardiographic assessments were performed to evaluate cardiac function. The study aimed to determine the diagnostic accuracy (sensitivity, specificity, positive predictive value, and negative predictive value) and prognostic significance of these biomarkers concerning in-hospital mortality and major adverse cardiovascular events (MACE). Statistical analyses were performed using SPSS and R software, employing Kaplan-Meier survival analysis, with a significance threshold set at $p<0.05$.

**RESULT**

This prospective study was conducted on 100 patients who is suffering from acute myocardial infraction. their demographic detail and other biomarkers are predicted in table 1,2,3& 4 respectively

| Characteristic | Total (n=100) | STEMI (n=64) | NSTEMI (n=36) | p-value |
|---|---|---|---|---|
| Age (years, mean ± SD) | 58.4 ± 10.6 | 57.8 ± 9.8 | 59.4 ± 11.8 | 0.48 |
| Male sex (%) | 68 | 71.9 | 61.1 | 0.28 |
| Hypertension (%) | 54 | 53.1 | 55.6 | 0.81 |
| Diabetes mellitus (%) | 38 | 37.5 | 38.9 | 0.89 |
| Dyslipidemia (%) | 42 | 40.6 | 44.4 | 0.73 |
| Current smoker (%) | 40 | 42.2 | 36.1 | 0.56 |
| Family history of CAD (%) | 20 | 20 | 19.4 | 0.91 |

**Table 1. Baseline Characteristics of Study Population (n = 100)**

The study population consisted of 100 patients, with 64 in the STEMI group and 36 in the NSTEMI group. There were no significant differences between the groups in terms of age, gender, comorbidities (hypertension, diabetes, dyslipidemia), smoking, or family history of coronary artery disease (CAD), with p-values all > 0.05. This suggests that both STEMI and NSTEMI patients had similar baseline characteristics, which may imply that these factors do not significantly influence the classification of AMI type in this cohort.

| Biomarker | Positive at 0 h (%) | Peak Sensitivity | Time to Peak (h) |
|---|---|---|---|
| hs-cTnI | 82 | 96 | 3–6 |
| CK-MB | 60 | 71.9 | 6–9 |
| H-FABP | 74 | 85 | 1–3 |
| Copeptin | 79 | 80 | 0–1 |
| hs-cTnI + Copeptin | 98 | 98 | 0–1 |

**Table 2. Biomarker Positivity at Presentation (0 h) and Peak Sensitivity**

Table 2 illustrates that ,hs-cTnI had the highest positivity (82%) and reached peak sensitivity (96%) between 3-6 hours, making it the most reliable early biomarker. CK-MB and H-FABP had lower sensitivity but showed peak sensitivity at 6-9 hours and 1-3 hours, respectively. Copeptin reached a peak sensitivity of 80% at 0-1 hour, demonstrating its utility in the first hours of AMI diagnosis. The combination of hs-cTnI and Copeptin showed the highest sensitivity (98%) at 0-1 hour, confirming the efficacy of a multimarker approach.

| Biomarker | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | AUC (95% CI) |
|---|---|---|---|---|---|
| hs-cTnI | 82 | 90 | 94 | 72 | 0.92 (0.86–0.98) |
| CK-MB | 60 | 88 | 90 | 55 | 0.78 (0.69–0.87) |
| H-FABP | 74 | 84 | 88 | 66 | 0.86 (0.79–0.93) |
| Copeptin | 79 | 80 | 85 | 71 | 0.85 (0.77–0.92) |
| hs-cTnI + Copeptin | 98 | 84 | 92 | 71 | 0.95 (0.91–0.99) |

**Table 3. Diagnostic Performance of Biomarkers at 0 h**

Table 3 shows,hs-cTnI demonstrated the highest sensitivity (82%) and specificity (90%), with an AUC of 0.92, indicating its robust diagnostic capability. CK-MB had lower sensitivity (60%) but higher specificity (88%), making it useful for confirming AMI. H-FABP and Copeptin also showed promising diagnostic performance, with hs-cTnI + Copeptin achieving the highest AUC (0.95), emphasizing the advantage of combining biomarkers in improving diagnostic accuracy.

| Outcome / Variable | Frequency (%) | p-value (vs lower biomarker group) |
|---|---|---|
| Heart failure | 15 | 0.02 (ST2 > 90th percentile) |
| Ventricular arrhythmias | 8 | 0.04 (NT-proBNP> 1800 pg/mL) |
| Reinfarction | 4 | NS |
| In-hospital mortality | 3 | 0.03 (ST2 > 90th percentile) |
| 30-day survival (high ST2) | 78 | Log-rank p = 0.004 |
| 30-day survival (low ST2) | 96 | — |

**Table 4. In-Hospital Outcomes and Prognostic Biomarker Associations**

Table 4 shows that Elevated ST2 levels were associated with higher rates of heart failure (p=0.02) and in-hospital mortality (p=0.03), underscoring ST2's prognostic value. NT-proBNP> 1800 pg/mL was linked to a higher incidence of ventricular arrhythmias (p=0.04). The 30-day survival rate was significantly lower in patients with high ST2 (78%) compared to those with low levels (96%), highlighting ST2's predictive value for long-term outcomes.

| Subgroup Comparison | Biomarker | Peak Value Higher in | p-value |
|---|---|---|---|
| STEMI vs NSTEMI | STEMI vs NSTEMI | STEMI | <0.01 |
| STEMI vs NSTEMI | Copeptin, H-FABP | No significant difference | >0.05 |
| Diabetic vs Non-diabetic | hs-cTnI, H-FABP | Slightly lower specificity | 0.04 |

**Table 5. Subgroup Analysis**

Table 5 shows that **hs-cTnI** and **CK-MB** levels were significantly higher in STEMI patients compared to NSTEMI patients (p<0.01), suggesting these biomarkers are more elevated in STEMI. However, no significant differences were found between the two groups for **Copeptin** and **H-FABP,** indicating that these biomarkers may not be useful in differentiating STEMI from NSTEMI. In diabetic patients, hs-cTnI and H-FABP showed slightly lower specificity, suggesting the need for adjusted diagnostic thresholds in this population (p=0.04).

## DISCUSSION

Our findings reaffirm the results of this study are consistent with previous research on the diagnostic and prognostic value of cardiac biomarkers in Acute Myocardial Infarction (AMI). High-sensitivity Troponin I (hs-cTnI) demonstrated high sensitivity (82%) at presentation, and a peak sensitivity of 96%, supporting findings from Mueller et al. (2016) [8], who reported that hs-cTnI remains the gold standard for early AMI detection. Similarly, Schönfeld et al. (2018)[9] highlighted the added value of combining hs-cTnI with Copeptin, which reached 98% sensitivity at presentation in our study, reinforcing the role of multimarker strategies for improving early diagnosis.

The CK-MB biomarker, with lower sensitivity but higher specificity (88%), aligns with González et al. (2019) [10], who noted its role as a confirmatory marker in AMI diagnosis. The results also corroborate Turer et al. (2016) [11], who demonstrated the utility of H-FABP in early AMI detection, showing peak sensitivity at 1-3 hours post-symptom onset in our study as well.

Regarding prognosis, elevated ST2 levels were significantly associated with in-hospital mortality and heart failure, which is consistent with Tavil et al. (2019) [12], who identified ST2 as a strong prognostic marker for adverse outcomes in AMI. Similarly, NT-proBNP levels above 1800 pg/mL were linked to ventricular arrhythmias, confirming the prognostic value of this biomarker as reported by Lee et al. (2015) [13].

## CONCLUSION

Our study highlights the significant diagnostic and prognostic roles of cardiac biomarkers in the early detection and outcome prediction of Acute Myocardial Infarction (AMI). **High-sensitivity Troponin I (hs-cTnI),** especially when combined with **Copeptin**, demonstrated superior sensitivity and diagnostic accuracy, confirming its critical role in the early phase of AMI diagnosis.**CK-MB, H-FABP**, and **Copeptin** also contributed valuable information, with **hs-cTnI + Copeptin** showing the highest performance. Prognostic biomarkers like **ST2** and **NT-proBNP** proved essential for predicting in-hospital outcomes, including heart failure and mortality, emphasizing their importance in risk stratification. Furthermore, **STEMI** patients exhibited higher biomarker levels than **NSTEMI** patients, indicating more extensive myocardial injury. The study also identified the need for adjusted diagnostic thresholds in diabetic patients, where biomarkers showed slightly reduced specificity. Overall, a multimarker approach is essential for improving both

diagnostic accuracy and prognostic prediction in AMI management.

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