

A Comparative Diagnostic Efficacy of High-Sensitivity versus Rapid Troponin Testing in Acute Myocardial Infarction

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ABSTRACT

Background: Rapid and accurate diagnosis of acute myocardial infarction (AMI) is critical. While high-sensitivity cardiac troponin (hs-cTn) assays are the contemporary standard, rapid qualitative troponin tests offer speed and simplicity, though their diagnostic performance in direct comparison remains a key clinical question. **Objective:** This study aimed to compare the diagnostic efficacy of a contemporary hs-cTn assay with a qualitative rapid troponin test in patients presenting with suspected acute coronary syndrome (ACS). **Materials and Methods:** A cross-sectional study was conducted on 100 patients with suspected ACS. All patients underwent simultaneous testing with a quantitative hs-cTnI assay (gold standard) and a qualitative rapid troponin test (detection threshold: 0.5 ng/mL). Diagnostic performance, including sensitivity, specificity, and predictive values, was calculated for the rapid test against the hs-cTn reference. **Results:** The hs-cTn assay demonstrated 100% sensitivity and specificity. In contrast, the rapid troponin test showed perfect specificity (100%) and positive predictive value (100%), but a critically low sensitivity of 32.8%. It produced 43 false-negative results, yielding a negative predictive value of 46% and an overall diagnostic efficiency of only 57%. **Conclusion:** The high-sensitivity troponin assay is vastly superior for the early diagnosis of AMI, enabling reliable rule-in and rule-out protocols. The rapid troponin test's poor sensitivity renders it unsuitable as a standalone diagnostic tool in the emergency evaluation of suspected AMI, due to an unacceptably high rate of missed diagnoses. **Keywords:** Troponin I; Myocardial Infarction; Diagnostic Tests, Routine; Point-of-Care Testing; Sensitivity and Specificity.

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INTRODUCTION

Acute coronary syndromes (ACS) represent a spectrum of conditions characterized by a sudden reduction in blood flow to the heart muscle, encompassing ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina. The most common presenting symptom is chest pain at rest, affecting approximately 79% of men and 74% of women with ACS. However, a

significant proportion of patients, nearly 40% of men and 48% of women, present with non-specific symptoms such as dyspnea, either alone or in combination with chest pain [1]. Rapid and accurate diagnosis is critical for guiding management and improving outcomes. The initial evaluation of a patient with suspected ACS involves an electrocardiogram (ECG), which is essential for distinguishing between STEMI, requiring immediate reperfusion therapy, and NSTEMI [2].

While ECG and clinical presentation are foundational, cardiac biomarkers are indispensable for confirming myocardial injury. Historically, biomarkers like creatine kinase lacked sensitivity, often requiring serial testing over 6-12 hours, leading to critical delays in diagnosis and treatment [3].

The advent of cardiac troponin (cTn) assays marked a significant advancement, as troponin is a highly specific marker for myocardial necrosis. The latest generation, high-sensitivity cardiac troponin (hs-cTn) assays, have further revolutionized the diagnostic approach. These assays can detect very low circulating levels of troponin with high precision, enabling the earlier diagnosis of myocardial infarction [4, 5]. This enhanced sensitivity facilitates rapid "rule-out" protocols for low-risk patients and a more reliable "rule-in" for high-risk patients, thereby streamlining emergency department workflows and guiding timely therapeutic interventions [6]. In contrast, qualitative rapid troponin tests provide results quickly without the need for automated laboratory equipment, making them potentially useful in resource-limited settings [7]. However, their lower analytical sensitivity compared to hs-cTn assays may limit their diagnostic accuracy, particularly in the early hours of symptom onset [8]. Therefore, this study aims to compare the diagnostic efficacy of a contemporary hs-cTn assay with a qualitative rapid troponin test in patients presenting with suspected ACS, to evaluate their respective roles in the modern diagnostic paradigm.

MATERIALS AND METHODS

Study Design and Population

A cross-sectional study was conducted at the Emergency Room and Cardiac Care Unit of Al Qurna General Hospital in Basrah. The study enrolled 100 patients (48 males and 52 females) presenting with symptoms suggestive of an acute coronary syndrome (ACS), such as unstable angina or myocardial infarction.

Participants' ages ranged from 41 to 70 years. The diagnosis of acute myocardial infarction (AMI) was established according to World Health Organization (WHO) criteria [9], which integrate clinical features, electrocardiographic (ECG) findings, and elevated levels of cardiac biomarkers.

Exclusion Criteria

To ensure the accuracy of troponin measurements and minimize false-positive results, patients with the following conditions were excluded from the study:

- Presentation too early (2-3 hours) or too late (>12 hours) after the onset of chest pain.
- Sepsis
- Cardiac arrhythmias
- Recent percutaneous coronary intervention (PCI)
- Chronic kidney disease (CKD)
- Rheumatoid arthritis (RA)
- Suspected pulmonary embolism

Sample Collection and Processing

For each participant, two venous blood samples (3 ml each) were drawn using vacuum tubes. The first sample was collected in an EDTA K3 anticoagulant tube (model FV01003), and the second in a gel & clot activator tube (model G1326331). The samples in the clot activator tubes were centrifuged at 2000 RPM for 10 minutes to separate the serum. The resulting serum aliquots were stored at -20°C to -80°C until analysis.

Biochemical Assays

1. High-Sensitivity Troponin I (hs-cTnI) Assay

Serum concentrations of hs-cTnI were quantitatively measured using a commercially available immunoassay kit (Vidas, BioMérieux, France) according to the manufacturer's instructions. This assay served as the gold-standard reference test for the study.

2. Rapid Troponin I Test

A qualitative, membrane-based immunoassay device (One Step Troponin I Test) was used for the rapid detection of cTnI. The test was performed using serum, as per the manufacturer's protocol. The appearance of a colored line in the test region within the specified time indicated a positive result, while its absence indicated a negative result. The test's detection threshold, as provided by the manufacturer, is 0.5 ng/ml.

Statistical Analysis

Statistical analysis was performed using Microsoft Excel 2019. Diagnostic performance of the rapid troponin test was evaluated against the gold-standard hs-cTnI assay by calculating

sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall efficiency using standard formulas (e.g., **Efficiency = (True Positives + True Negatives) / Total Patients × 100%**).

RESULTS

The demographic characteristics of the study population are summarized in **Table 1** and **Figure 1**. The cohort consisted of 100 patients, with a nearly equal gender distribution: 48 (48%) males and 52 (52%) females. The mean age was 57 years for males and 56 years for females, indicating a comparable age profile between the two groups.

Table 1: Demographic Distribution of the Study Population.

Gender	Number of Patients (n)	Minimum Age	Maximum Age	Mean Age	Standard Deviation (SD)
Male	48 (48%)	41	70	57	7.8
Female	52 (52%)	42	69	56	7.7

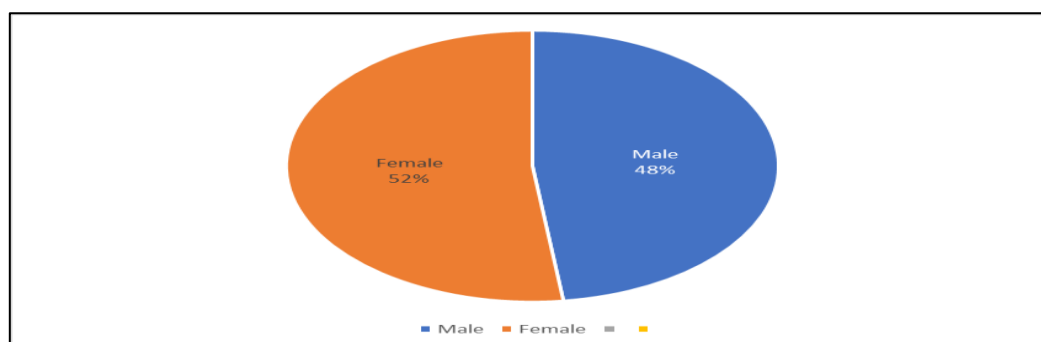


Figure (1): Distribution of Patients by Sex.

Based on the gold-standard WHO criteria (incorporating hs-cTn results, ECG findings, and clinical presentation), 64 patients (64%) were diagnosed with Acute Coronary Syndrome (ACS). The remaining 36 patients (36%) were ruled out for ACS. The performance of the rapid troponin test was evaluated against the high-sensitivity troponin assay. The results, detailed in **Table 2**, reveal a significant difference in sensitivity. The high-sensitivity troponin assay, used as the reference standard, demonstrated 100% sensitivity and specificity in this study context. The rapid

$$= (21 + 36) / 100 \times 100 = 57\%$$

troponin test showed perfect specificity (100%) and Positive Predictive Value (PPV), meaning all positive results were true positives. However, its sensitivity was low at 32.8%. It failed to detect ACS in 43 out of the 64 confirmed patients (False Negatives). This resulted in a Negative Predictive Value (NPV) of 46%.

The overall diagnostic efficiency of the rapid troponin test was calculated as follows:

Efficiency = (True Positives + True Negatives) / Total Patients × 100

Table 2: Diagnostic Performance of Rapid Troponin Test vs. High-Sensitivity Troponin.

Test Metric	High-Sensitivity Troponin (Gold Standard)	Rapid Troponin Test
True Positive (TP)	64	21
True Negative (TN)	36	36
False Positive (FP)	0	0
False Negative (FN)	0	43
Sensitivity	100%	32.8%
Specificity	100%	100%
Positive Predictive Value (PPV)	-	100%
Negative Predictive Value (NPV)	-	46%

DISCUSSION

This study compared the diagnostic utility of a rapid troponin test against a high-sensitivity cardiac troponin (hs-cTn) assay in patients with suspected acute myocardial infarction (AMI). The findings demonstrate a marked superiority of the hs-cTn assay, which served as the gold standard in this investigation, exhibiting 100% sensitivity and specificity. In contrast, the rapid troponin test showed significantly lower sensitivity (32.8%), despite a high specificity (100%) and a negative predictive value (NPV) of only 46%. The overall diagnostic efficiency of the rapid test was calculated at 57% [10,11].

The primary objective in managing patients presenting with acute chest pain is the rapid and accurate triage to either rule-in or rule-out AMI. The principle that "time is muscle" underscores the critical importance of early intervention to salvage myocardium and improve clinical outcomes [12]. In this context, point-of-care rapid troponin tests offer the theoretical advantage of providing results within minutes, which could be particularly valuable in resource-limited settings or overcrowded emergency departments. However, our data indicate that this speed comes at a substantial cost to diagnostic accuracy.

The low sensitivity (32.8%) of the rapid test observed in our study indicates that it fails to detect a substantial proportion of true AMI cases, as evidenced by the 43 false-negative results among the 64 confirmed AMI patients.

This high false-negative rate is likely attributable to the inferior analytical sensitivity of rapid tests, which are typically unable to detect troponin concentrations below 0.5 ng/mL [13]. Consequently, a negative rapid troponin result cannot reliably exclude AMI, especially in patients presenting early after symptom onset or with minor myocardial injury. This limitation renders it unsuitable as a standalone rule-out tool and poses a significant risk if used in isolation.

Conversely, the high-sensitivity troponin assay enables the quantification of very low circulating troponin concentrations, facilitating a more precise and earlier diagnosis. The implementation of hs-cTn aligns with contemporary guidelines, such as those from the European Society of Cardiology, which endorse specific 0h/1h algorithms for the rapid rule-in and rule-out of non-ST-elevation MI (NSTEMI) [17]. The use of hs-cTn has been associated with reduced time to diagnosis, shorter emergency department stays, and more efficient patient flow [18, 19]. Furthermore, while hs-cTn may identify patients with troponin elevation from non-ischemic causes, such elevations remain prognostically significant, being associated with higher rates of mortality and major adverse cardiac events (MACE) [20, 21].

The high specificity (100%) of the rapid test in our cohort suggests that a positive result is a reliable indicator of myocardial injury. However, its clinical utility is severely constrained by its poor sensitivity. The high

NPV of hs-cTn protocols makes them not only clinically effective but also cost-effective by safely allowing the early discharge of low-risk patients and directing resources toward high-risk individuals [22, 23].

CONCLUSION

In conclusion, high-sensitivity cardiac troponin (hs-cTn) assays remain the preferred biomarker over rapid troponin tests for the evaluation of suspected acute myocardial infarction, due to their superior diagnostic sensitivity and precision, which facilitate rapid rule-in and rule-out protocols. The use of hs-cTn not only enables more expedient and accurate diagnosis, thereby reducing emergency department stay durations and guiding timely intervention, but also provides significant prognostic value by identifying patients at higher risk for adverse cardiovascular events. Future efforts should focus on standardizing assay-specific cut-offs and optimizing diagnostic algorithms to fully integrate high-sensitivity troponin testing into routine emergency care for patients presenting with chest pain.

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