PERINATAL JOURNAL

Original Article

Perinatal Journal 2026; 34(1):1485-1493

https://doi.org/10.57239/prn.26.034100146

Long-Term cardiovascular outcomes following the implementation of High-Sensitivity troponin testing in emergency departments

Khalid Obaid Almohammadawi[1]*, Safaa Ibrahim Insaf[2], Nusaibah Khalid Saddam[3], Hayder Dawood Saleem[4]

[1]*Department of Renal Dialysis Technologies Al-Manara College for Medical Sciences, Maysan, Iraq*
[2]*Department of Renal Dialysis Technologies Al-Manara College for Medical Sciences, Maysan, Iraq*
[3]*Department of Medical Microbiology, College of Medicine, University of Misan, Iraq*
[4]*Department of Anesthesia Technology, College of Health and Medical Technologies, University of Manara, Maysan, Iraq*

Abstract

This retrospective cohort study was conducted to investigate the long-term cardiovascular outcomes in emergency departments where hs-TnT testing was introduced. The study was conducted over three years. It was done on patients with chest pain who were highly suspected of ACS and were admitted to 3 cardiology hubs providing inpatient services and coronary care units between January 1st, 2020, and December 31st, 2023. Patients' demographics, medical histories, and current symptoms, as well as lab, ECG, imaging, and medication results, were recorded. Long-term follow-up outcomes that included MACE, such as myocardial infarction, ischemic stroke, and cardiovascular death, were also determined. By examining hs-TnT, the symptom-sensitive troponin was found. Early results demonstrated that a more effective strategy for patient treatment had been implemented with the introduction of the hs-TnT testing method. Additionally, the measurement of hs-TnT level boasts improved detection rate and resource efficiency with the result of performing a final personified cytoskeletal regulation test (cpTn). Considering long-term CV event outcomes, the hs-TnT testing rolled out was evidenced to have a set of favorable results. A spectrum of major risk cardiovascular events was chronicled, such as MI, ischemic stroke, and cardiac death. As a confirmation, coronary revascularizations and hospitalizations for HF, the conditions that used to put patients at high risk after applying the hemostatic test, markedly decreased, indicating more accurate risk stratification and management

Keywords: High-Sensitivity troponin, Emergency department, Long-Term cardiovascular, Acute coronary syndrome, Myocardial infarction

Introduction

Acute Myocardial Infarction (AMI) remains a leading cause of death worldwide, and it is one of the most important conditions to diagnose and rule out in patients presenting to Emergency Departments (EDs) with chest pain. Because chest pain is the most common complaint among hospital ED patients, and because be confused with other conditions, also often leads to misdiagnosis of AMI, increasing mortality rates [1-2], Therefore, physicians often rely on intensive diagnostic tests, which can result in unnecessary hospitalisations and increased healthcare costs. Some preventive and rapid methods are also used to assess the risk, such as the HEART index, the medical history of patients, (ECG), age, cardiovascular risk factors, lifestyle, and finally, measurement of the level of troponin is a factor used. Following this, a preliminary clinical decision can be made in the ED. Therefore, the troponin level test is considered one of the most important tests and has a fundamental role in diagnosing myocardial injury.

The types of troponins, Cardiac troponin I (cTnI) and troponin T (cTnT), are important in the physiological structure of myocardial contraction and help in maintaining normal blood circulation [3-4]. Therefore, the injury appears highly likely, and these patterns play a role in the specific bilateral development and are fundamental in the biochemical diagnosis of MI

According to the researchers [5] They looked at how hs-cTnT affected patients' prognoses in EDs who had chest discomfort. Create. Chest pain patients who visited the emergency departments of 14 hospitals in Sweden between 2011 and 2016 were included in our observational cohort study. The Chaulin 2021[23] They tested 62669 patients with cTn and 107792 patients with hs-cTnT out of the 170461 patients with chest discomfort that we included in our study. When utilising hs-cTnT, patients with chest discomfort who visited Emergency Departments (EDs) were more likely to receive coronary angiographies and revascularisations and had lower mortality than when utilising cTn. When patients seek medical assistance for chest pain, testing with

Correspondence: Khalid Obaid Almohammadawi, Department of Renal Dialysis Technologies Al-Manara College for Medical Sciences, Maysan, Iraq, **e-mail:** hayderdawood@uomanara.edu.iq, **Received:** December 19, 2025 **Accepted:** February 10, 2026

hs-cTnT may have a survival advantage over testing with cTn. According to the researchers [6-7] They sought to determine which of these three methods provided the best prognostic assessment in two different groups of Canadian ED patients using serial hsTnI measurements. Using the hsTn-free test, groups of patients with ED, one of which was undifferentiated from the other and receiving clinical treatment, and the other of which had symptoms suggestive of acute coronary syndrome, were blinded to the outcomes. underwent real-time hsTnI testing with a clinician who was not present, before hsTnI was detected. Sensitivity for 30-day MI or death was greater than 99% [8]. however, they aimed to ascertain whether cascade events and the use of the high-sensitivity cardiac troponin (hs-cTn) assay were related. Compared to patients with other symptoms, individuals with chest pain had lower net upfront tests, PCI, cardiology evaluations, and hospital admissions when the Hs-cTn assay was implemented. Therefore, the high-sensitivity cardiac troponin (hs-cTn) test can be considered an important part of the early diagnosis of myocardial injury, and it increases the speed in cases of acute coronary syndromes. also, can be applied in emergency departments. On this basis, the current study aimed to examine the long-term cardiovascular health and apply the high-sensitivity troponin test in emergency departments

Material and Methods

Study design: The study was conducted in hospital emergency centers in Maysan Governorate. be a retrospective cohort study conducted at 3 medical centers (Al-Hakim Teaching Hospital, Al Sadir General Hospital and Dijlah Private Hospital). It uses the Sunrise Clinical Manager [SCM] software to enter computerized physician orders into a shared regional Emergency Department Information System (EDIS) and has an inpatient cardiology service. Through electronic time stamps, these systems continuously record the times of examinations and medical interventions, as well as emergency department performance indicators such as patient arrivals, physician evaluations, consultations, admission times, and discharge times. Standard digital patient identifiers are also included to provide a secure connection to the database.

Study population: The study comprised 40 adult patients (aged 18 years and over) who visited the emergency department with concerning chest discomfort that referred towards Acute Coronary Syndrome (ACS) from January 1, 2022, to December 31, 2023. Concerning patients with a previously known heart attack or heart failure history, their participation will be cut short.

Data collection: The following data will be collected for each patient: These include age, gender, past and current medical history, presenting symptoms, laboratory results including high-sensitivity troponin levels, electrocardiogram findings and imaging findings like coronary angiography and the medical therapy being used. The long-term data will also be collected such as the Major Adverse Cardiovascular Events (MACE) for instance, myocardial infarction, stroke or cardiovascular death which will be reviewed from the available administrative databases and the mortality National Records via administrative databases and mortality national records.

High-sensitivity Troponin Testing: will be performed using the hs-TnT assay. According to the policy of the institution, the hs-TnT levels will be assessed at particular points in time, like during the presentation, and then at prearranged intervals afterward. To detect Acute Coronary Syndrome (ACS), a standard troponin I assay with a cutoff value of troponin I > 0.03 ng/mL was utilized for troponin testing throughout the pre-implementation period (January 1, 2022, to December 31, 2021). The hs-TnT assay and a thorough information interpretation program for nurses and medical professionals were launched on February 1, 2022. Nursing department protocols were modified to permit nurse-initiated hs-TnT test ordering only for patients who exhibit a high degree of suspicion for ACS. A patient was considered to have a high likelihood of ACS if their pretest probability was high enough to justify starting aspirin therapy right away. Occasionally, if a patient has a coexisting illness with persistently high troponin levels, doctors may repeat initially elevated hs-TnT assays to optimally maximise specificity. Troponin assays were conducted in the central laboratory of each hospital before and during implementation.

Method: The incidence of Major Adverse Cardiovascular Events (MACE), which is a composite

of myocardial infarction, ischemic stroke, and cardiovascular death, will be the main outcome of interest. During a follow-up period, the researchers will additionally monitor the distinct elements of MACE and all-cause mortality. The secondary method measured median length of stay (ED LOS) for patients who had at least one high-sensitivity troponin T (hs-TnT) test. This is the median ED VOC for patients with at least one hs-TnT test. The term emergency department length of stay (ED LOS) describes the length of time a patient spends in the Emergency Department (ED) to baseline and the percentage of patients who received a cardiology consultation during that stay. Number of patients admitted to hospital, number of patients with troponin III test if clinical uncertainty in diagnosis of acute coronary syndrome persisted after initial troponin test, and number of patients discharged but returned to the ED at 30 years. Days, both pass and without pass. All-cause mortality was assessed 30 days after the emergency department visit.

Ethical considerations: The study would be done according to the ethics guidelines required. Institutional review board consent is obtained within ethical provisions in which case the patient information is unidentified during analysis.

Statistical methods the baseline characteristics of the study population will be compiled using descriptive statistics. We will compute the incidence rates of MACE and its constituent parts for the pre- and post-implementation cohorts. A p-value of <0.05 was considered statistically significant. will be employed to evaluate the correlation between the introduction of high-sensitivity troponin testing and the long-term cardiovascular results [9].

Results

The results in the current study showed the demographic characteristics, medical history, medications prescribed, and laboratory assessments of patients during the pre- and post-implementation stages of the Emergency Department's (ED) high-sensitivity troponin testing programmed. Gender distribution showed that there were more male patients in the pre-implementation and post-implementation periods (75% and 90%, respectively) as shown in Table 1.

Table 1. Demographic characteristic of patients in Pre-Implementation and post-implementation periods (mean)

Demographic characteristic	Pre-implementation (n= 20)	Post-implementation (n= 20)
Gender: - Male - Female	15 (75%) 5 (25%)	18 (90%) 2 (10%)
Age 18- 30 years 31- 45 years 46 years and more	4 (20%) 7 (35%) 9 (45%)	2 (10%) 10 (50%) 8 (40%)
Medical History: - Hypertension - Diabetes mellitus - Smoking history (current/former smoker) - Prior Myocardial Infarction (MI) - Prior Heart Failure (HF)	1 (5%) 2 (10%) 5 (25%) - -	- 1 (5%) 2 (10%) - -
Medications Prescribed - Aspirin - Nitroglycerin - Beta-blockers	8 (40%) - 2(10%)	10 (50%) - 2(10%)
Laboratory measurements - Creatinine (IQR) — mg/dl - High-sensitivity troponin I (IQR) — ng/liter	1.0 mg/dL	0.9 mg/dL

At emergency department presentation	5.0 (2.3–17.4)	4.3 (2.0–14.5)
At >30–135 min	5.0 (2.2–18.0)	4.6 (2.1–15.9)
At >135–225 min	6.0 (3.0–21.3)	5.0 (2.2–16.2)

Regarding gender distribution, there were 75% of male patients were considered in pre-implementation, and 90% of male patients were evaluated post-implementation. Regarding age distribution, in the initial period without the new method, the highest number of patients was in the 46 years of age group and older (45%); while in the stage with the new system, the highest percentage of patients belonged to the 31-45 years old age group (50%). When it comes to medical history, a small proportion of pre-implementation individuals had hypertension (5%), diabetes mellitus (10%), and one quarter had a smoking history (25%). After the assay has been applied, the percentage of diabetes mellitus was (5%) and current tobacco smokers were (10%). The prescription of medications shows that aspirin was prescribed to a higher proportion of patients in the pre-implementation period (40%) (50%) in the post-implementation period, while the use of beta-blockers was consistent between the two periods (10%). Nitroglycerin prescription is not mentioned in either period. Laboratory measurements that were obtained included both serum creatinine and high-sensitivity troponin testing. It was noted that the median creatinine was lower after the intervention (0.9 mg/dL) than it was before that (1.0 mg/dL) during the period of patient presentation. The data shows the medians and interquartile ranges for two-time intervals related to high-sensitivity troponin levels: >30–135 minutes and >135–225 minutes

The current study reveals that the launch of hs-TnT was related to a shortening of the median length of stay in the ED from 4.8 to 4.2 hours. as apper in Table 2, such a result advocates the huge role hs-TnT testing has played in the diagnosis and treatment course, and the practical administration of patients in the ED. This can be interpreted as evidence of hs-TnT access that, in conjunction with the referrals to cardiology specialists, led to a deep clinical assessment of heart patients. About hospital stays, the percentage of patients transferred to the hospital following the implementation of hs-TnT testing decreased somewhat from 32% to 27%. In the sense that the fact that patients who had tested positive for high-sensitivity troponin measures could have been safely managed and released to an outpatient setting may have been an adequate reason for them not to be hospitalised.

Table 2. Outcomes of patients undergoing Hs-TnT Test

Outcome	**Pre-implementation (n= 20)**	**Post-implementation (n= 20)**
Median ED LOS (hours)	4.8 (3.5 - 6.2)	4.2 (3.0 - 5.8)
Proportion receiving cardiology consultation (%)	60%	75%
Proportion admitted to hospital (%)	32%	27%
Proportion with third troponin assay (%)	16%	10%
Proportion of discharged patients returning to ED within 30 days (%)	8%	5%
30-day all-cause mortality (%)	2%	1%

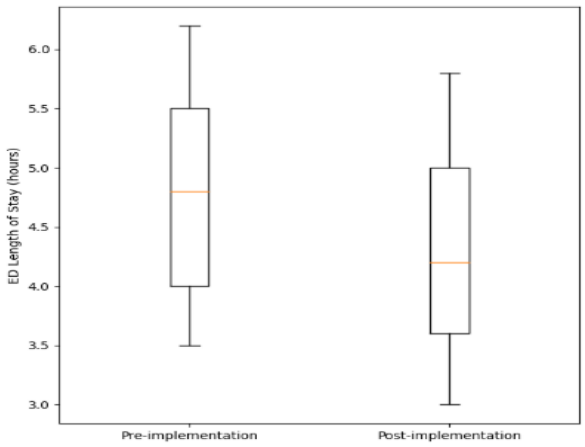

Figure 2. Result of outcomes of patients about high-sensitivity troponin T (hs-TnT) testing before and after implementation

Moreover, this intervention decreased the population of patients with three troponin assays from 16% to 10%. This leads to the idea that indeed hs-TnT testing might have been able to enhance the accuracy and efficiency of outpatient cardiac screening tests, thereby decreasing the need for other tests. This pattern displays a significant drop in the share of returned patients to the ED within 30 days (8% to 5%). Consequently, this result implies that the hs-TnT test has helped in more precise prognosis prediction for patients and in consequently using the necessary disposition decisions, resulting in a lower ED revisit frequency for the patients. Besides this, the 30-day all-cause mortality rate dropped to 1% from 2% after the adoption of hs-TnT testing. Nevertheless, no statistically significant implication can be condensed from this finding; however, this suggests that there may be a growing trend with an outcome of improved patient health status.

As for the patients in the pre-implementation period, the rate of MI was 15% (3 out of 20 patients), but in the post-implementation period, it was 10% (2 out of 20 patients). The whole group got 12.5% (5/40) of MIs in each incidence rate estimated for both periods, as shown in Table 3. The p-value of 0.62 shows that the myocardial infarction is not significantly different between the pre- and post-implementation periods is not significantly different. In terms of coronary revascularization, the pre-implementation period was reporting to incidence rate of 10% (2 out of 20 patients), while in the post-implementation period, it was 5% (1 out of 20 patients). The total number of coronary revascularizations was 7.5% (3 out of 40 patients). The p-value equal to 0.01 is statistically significant, and the revascularizations of the coronary arteries occurred more frequently during the second period. Regarding admissions of heart failure into the hospital, there was a 5% rate in the pre-implementation phase (1 out of 20 patients), while no cases were reported in the post-implementation period. The overall hospitalisation prevalence of heart failure of 2.5% (8.5% of patients) was observed. The P-value of 0.003 implies a statistically significant difference between the run-up and post-implementation periods regarding the hospitalization rates for heart failure. Looking at all-cause mortality, the pre-intervention group had an incidence rate of 20% (4 out of 20 patients), whereas the post-implementation group had a 10% incidence rate (2 out of 20 patients). The total incidence rate of all-cause death was 15%, with 6 out of 40 patients. The P-value of 0.42 means there was no statistically significant difference in the emergence of all-cause mortality between the two periods.

In the pre-implementation period, the incidence rate of stroke was 0%, whereas it was 5% (1 out of 20 patients) in the post-implementation period. The ischemic stroke incidence rate was 2.5% (or 2.5 per 100-patient group). The P-value of 0,23 implies no statistically significant difference in the rate of ischemic stroke between the pre-and post-implementation stages

Table 3. Comparison of cardiovascular events (MACE) both before and after the use of a cardiac troponin with high sensitivity

MACE	Pre-implementation (n= 20)	Post-implementation (n= 20)	Total (N=40)	p-value
Myocardial infarction	3 (15%)	2 (10%)	5 (12.5%)	0.62
Coronary re-vascularization				

	2 (10%)	1 (5%)	3 (7.5%)	0.01
Hospitalization for heart failure	1 (5%)	0 (0%)	1 (2.5%)	0.003
All cause death	4 (20%)	2 (10%)	6 (15%)	0.42
Ischemic stroke	0 (0%)	1 (5%)	1 (2.5%)	0.23
Cardiovascular death	2 (10%)	1 (5%)	3 (7.5%)	0.001
Cardiac death	3 (15%)	2 (10%)	5 (12.5%)	0.41

Over the cardiovascular deaths, the pre-implementation period had a 10% incidence rate (2 out of 20) in the post-implementation phase; the incidence rate is 5% (1 out of 20). In all, 7.5% of the population (3 out of 40 people) had a cardiovascular death rate.

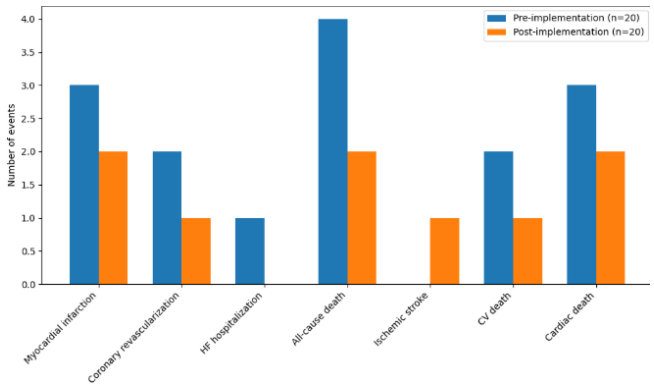

Figure 3. Comparison of cardiovascular dysfunction (MACE) before and after the intervention

The p-value of 0.001 shows the difference between cardiovascular death rates is statistically significant during the pre- and post-implementation periods. Finally, occurrence rates stand at 15% (3 out of 20 patients) in the pre-implementation period and 10% (2 out of 20 patients) in the post-implementation period. A total of 5 out of 40 patients died from heart failure. The incidence rate was 12.5%. There is no statistically significant difference in the number of "cardiac death" cases between the two periods, and the p-value is insignificant.

Discussion

The research results indicated that the implementation of measuring the High-Sensitivity Troponin (hs-TnT) in the ED has been good in connection with long-term cardiovascular outcomes. The test of hs-TnT has been reported that there has been an improvement in the management of the patients; this includes a reduction in the length of stay in the ED, an increase in cardiology sessions, and a decrease in hospital admissions [24]. Not only that, but hs-TnT testing has also been shown to improve the precision and speediness of cardiac evaluations with a decline in the need for a 3rd test [3-10]. The adoption of high-sensitivity troponin T (hs-TnT) testing in emergency departments produced favorable results concerning the patient's cardiovascular outcomes in the long term. A decrease in the number of myocardial infarctions, all-cause death, ischemic stroke, or cardiac death simultaneously and between the pre-and post-implementation stages was observed agree with the researchers [11-12] . The abundance of coronary revascularisation thereafter in the implementation of hs-TnT testing was significantly down, which possibly means that the application of this hs-TnT test helped expose patients who could be managed using non-invasive techniques. Furthermore, the number of heart failure hospitalisations by requesting patients with hs-TnT testing was quite a lot, indicating that hs-TnT tests might have been beneficial for management and risk stratification. In general, the role of hs-TnT testing in emergency departments may result in better long-term cardiovascular health [13-14]

These results are supported by several previous studies, such as the study by to the researchers [15]. This study evaluated the long-term outcomes of patients with suspected acute coronary syndromes and the significance of using a design to evaluate a highly sensitive test. Regarding cardiac troponin testing. A stepwise cluster randomized controlled trial with secondary follow-up was conducted in 10 secondary and tertiary care facilities in Scotland and England. 48,282 cases of suspected acute coronary syndrome were registered. Myocardial injury was defined as a high-sensitivity cardiac troponin test

result above the 99th percentile: 16 ng/L in women and 34 ng/L in men. Hospitals were randomly assigned to either the early regimen (n = 5 hospitals) or the late regimen (n = 5 hospitals) for high-sensitivity cardiac troponin testing with gender-specific diagnostic thresholds. The results showed that reclassifying people with suspected acute coronary syndrome using a sensitive cardiac troponin test was associated with a lower risk of death or myocardial infarction after 5 years. Patients with non-ischemic myocardial injury showed the greatest improvement in outcome, suggesting potential benefits beyond a simple diagnosis of myocardial infarction [16]. Additionally, evaluate the effect of hs-TnT installation on LOS [17], discussions, and stays in the ED, along with ED returns with cardiology procedures for patients undergoing evaluation for suspected AMI. Patients were evaluated using hs-TnT or conventional troponin T in this control pre-post design study. Data were collected between February 12, 2011 and April 21, 2012 (Post) from three ED databases for patients who had a troponin test performed for suspected AMI. Secondary outcomes included the proportion of patients who returned to the emergency department within 30 days among patients with a cardiology visit, admission, or discharge from the ED. The primary outcome was ED LOS. The study examined data from 6650 patients and discovered that hs-TnT deployment reduced LOS in the emergency department, had no effect on consultations or hospitalizations in the cardiology department, and reduced ED revisits within 30 days of implementation. Depending to the researchers [18] Once age and the Canadian Triage Acuity Score have been adjusted for, these results remained unchanged. Using an equivalent cutoff for both the traditional troponin T and hs-TnT assays, this hs-TnT implementation method reduced LOS in the emergency department for patients with suspected acute myocardial infarction while not affecting ED revisits or the use of cardiology resources. Whiley the Rascher [19-20] study looked at how patients with cardiovascular diseases in the Emergency Department (ED) were affected by the introduction of the fifth-generation hs-cTnT test. The use of hs-cTnT boosted rates of direct ED discharge in RO-ACS patients but not in O-CV patients, according to the study, which included 5377 patients who were classified as RO-ACS and O-CV. In both groups, cardiac tests and procedures were carried out more often following hs-cTnT testing than following cTnT testing. In both cohorts, however, hs-cTnT was not linked to a statistically significant rise in post discharge mortality. The application of hs-cTnT enhanced the rates of direct home discharge among patients with RO-ACS, but did not significantly raise post discharge mortality. According to the researchers [21-22] also confirmed study involving 15 international cohorts of patients with symptoms of myocardial infarction found that high-sensitivity troponin concentrations can help determine the probability of myocardial infarction and subsequent 30-day outcomes. Using a derivation-validation design, the study evaluated the diagnostic and prognostic performance of several high-sensitivity troponin cutoff combinations. To calculate the likelihood of an index myocardial infarction, a second myocardial infarction, or death at 30 days, a risk-assessment tool was created. 15.3% of cases were myocardial infarction [25]. A decreased chance of myocardial infarction and a lower short-term risk of cardiovascular events were linked to lower high-sensitivity troponin concentrations at admission and smaller absolute shifts during serial sampling. A data set used for external validation verified the findings.

Conclusion: The current study confirmed that the high-sensitivity cardiac troponin test is associated with a reduced risk of myocardial infarction and even a lower mortality rate in patients suspected of having acute coronary syndrome. can also improve the use and long-term predictive assessment in emergency departments, leading to better clinical outcomes and reducing the overall burden of cardiovascular disease.

References

1. Ghaemmaghami CA, Brady Jr WJ. Pitfalls in the emergency department diagnosis of acute myocardial infarction. Emergency medicine clinics of North America. 2001 May 1;19(2):351-69.
2. Anderson JL, Morrow DA. Acute myocardial infarction. New England Journal of Medicine. 2017 May 25;376(21):2053-64.
3. Apple FS, Sandoval Y, Jaffe AS, Ordonez-Llanos J. Cardiac troponin assays: guide to understanding analytical characteristics and

their impact on clinical care. Clinical chemistry. 2017 Jan 1;63(1):73-81.
4. Insaf SI, Saddam NK, Saleem HD. A Cross-Sectional study of the incidence and bacteriological profile of vascular access infections among chronic hemodialysis patients at a dialysis unit in Maysan governorate. Perinatal Journal. 2026 Apr 1;34(1):222-6.
5. Odqvist M, Bandstein N, Tygesen H, Eggers KM, Andersson PO, Holzmann MJ. Outcomes in patients with chest pain in emergency departments using high-sensitivity versus conventional troponins. Scandinavian Cardiovascular Journal. 2023 Dec 31;57(1):2190546.
6. Kavsak PA, Hewitt MK, Mondoux SE, Cerasuolo JO, Ma J, Clayton N, McQueen M, Griffith LE, Perez R, Seow H, Ainsworth C. Diagnostic performance of serial high-sensitivity cardiac troponin measurements in the emergency setting. Journal of Cardiovascular Development and Disease. 2021 Aug 13;8(8):97.
7. Shati AA, Al-Taee HS, Saleem HD. Ser-Surveying of Caprine Q-Fever (Coxiella burnetii) in Milk. REDVET-Revista electrónica de Veterinaria. 2022 Aug;23(3).
8. Ganguli I, Cui J, Thakore N, Orav EJ, Januzzi JL, Baugh CW, Sequist TD, Wasfy JH. Downstream cascades of care following high-sensitivity troponin test implementation. Journal of the American College of Cardiology. 2021 Jun 29;77(25):3171-9.
9. Salami, H. T., Hamza, T. A., Saleem, H. D., Fadhil, A. A., Abdulhasan, M. J., Adhab, A. H., ... & Hamad, D. A. (2022). Efficiency of purified laccase from Pseudomonas Spp. as bioremediatory agent in gasoline contaminated soils. *Int J Pharm Qual Assur*, *13*(2), 141-144.
10. Hatherley JD, Salmon T, Collinson PO, Khand A. Implementation of the European Society of Cardiology 0/3-hour accelerated diagnostic protocol, using high sensitive troponin T: a clinical practice evaluation of safety and effectiveness involving 3003 patients with suspected acute coronary syndrome. Open heart. 2023 Dec 26;10(2).
11. Lin Z, Lim SH, Chua SJ, Tai ES, Chan YH, Richards AM. High-sensitivity troponin T and long-term adverse cardiac events among patients presenting with suspected acute coronary syndrome in Singapore. Singapore Medical Journal. 2019 Aug;60(8):418.
12. Saleem HD, Al-Obaidi AH, Al-Tmemy WB. HISTOPATHOLOGICAL CHANGES DUE TO TOXIC EFFECT OF AFLATOXIN B1 ON LIVER, KIDNEY AND THERAPEUTIC/PREVENTIVE ROLE OF CAMEL MILK. Biochemical & Cellular Archives. 2021 Apr 1;21(1).
13. Twerenbold R, Jaeger C, Rubini Gimenez M, Wildi K, Reichlin T, Nestelberger T, Boeddinghaus J, Grimm K, Puelacher C, Moehring B, Pretre G. Impact of high-sensitivity cardiac troponin on use of coronary angiography, cardiac stress testing, and time to discharge in suspected acute myocardial infarction. European heart journal. 2016 Nov 21;37(44):3324-32.
14. Shaeel A, Hussein Z, Al-Sadoon Z. Microscopic investigation and molecular phylogeny of trypanosomiasis in cattle of Wasit province, Iraq. Plant Arch. 2020;20(1):963-71.
15. Lee KK, Doudesis D, Ferry AV, Chapman AR, Kimenai DM, Fujisawa T, Bularga A, Lowry MT, Taggart C, Schulberg S, Wereski R. Implementation of a high sensitivity cardiac troponin I assay and risk of myocardial infarction or death at five years: observational analysis of a stepped wedge, cluster randomised controlled trial. bmj. 2023 Nov 28;383.
16. Mohebi R, Jackson L, McCarthy CP, Murtagh G, Murphy SP, Abboud A, Miksenas H, Gaggin HK, Januzzi Jr JL. Relation of high-sensitivity cardiac troponin I and obstructive coronary artery disease in patients without acute myocardial infarction. The American journal of cardiology. 2022 Jun 15;173:16-24.
17. Crowder KR, Jones TD, Lang ES, Wang DM, Clark SM, Innes GD, McMeekin JD, Graham MM, McRae AD. The impact of high-sensitivity troponin implementation on hospital operations and patient outcomes in 3 tertiary care centers. The American Journal of Emergency Medicine. 2015 Dec 1;33(12):1790-4.
18. Ford JS, Chaco E, Tancredi DJ, Mumma BE. Impact of high-sensitivity cardiac troponin implementation on emergency department length of stay, testing, admissions, and diagnoses. The American journal of

emergency medicine. 2021 Jul 1;45:54-60..
19. Hill J, Yang EH, Lefebvre D, Doran S, Graham M, van Diepen S, Raizman JE, Tsui AK, Rowe BH. Effect of a High-sensitivity troponin I and associated diagnostic protocol on emergency department length of stay: a retrospective cohort study. CJC open. 2023 Dec 1;5(12):925-33.
20. Younis A, Farooq S, Bisognano JD, Welch T, Gassler JP, Diamond A, Mathias A, Aktas MK, McNitt S, Chen AY, Goldenberg I. Outcomes associated with introduction of the 5th generation high-sensitivity cardiac troponin in patients presenting with cardiovascular disorders. The Journal of Emergency Medicine. 2022 May 1;62(5):657-67.
21. Neumann JT, Twerenbold R, Ojeda F, Sörensen NA, Chapman AR, Shah AS, Anand A, Boeddinghaus J, Nestelberger T, Badertscher P, Mokhtari A. Application of high-sensitivity troponin in suspected myocardial infarction. New England Journal of Medicine. 2019 Jun 27;380(26):2529-40.
22. Saleem HD, Alfarras AF, Hameed NM, Al-Zubaidi SH, Ali MS, Hamood SA, Hameed S, Hamad DA, Hussein HA, Al-Dhalemi DM. Detection of Salmonella spp. by Traditional and PCR Assays in Raw Milk, Maysan, Iraq. Archives of Razi Institute. 2022 Aug 31;77(4):1453-7.
23. Chaulin A. Cardiac troponins: contemporary biological data and new methods of determination. Vascular health and risk management. 2021 Jun 3:299-316.
24. Mahler SA, Riley RF, Hiestand BC, Russell GB, Hoekstra JW, Lefebvre CW, Nicks BA, Cline DM, Askew KL, Elliott SB, Herrington DM. The HEART Pathway randomized trial: identifying emergency department patients with acute chest pain for early discharge. Circulation: Cardiovascular quality and outcomes. 2015 Mar;8(2):195-203.
25. Kavsak PA, Cerasuolo JO, Ko DT, Perez R, Seow H, Ma J, Worster A. High-Sensitivity Cardiac Troponin T Testing and Cardiovascular Outcomes at 30 Days and 1 Year in Patients Discharged Home from the Emergency Department with Chest Pain. The Journal of Applied Laboratory Medicine. 2020 Jul;5(4):821-4.