

Rapid Diagnostic Protocols for Acute Coronary Syndromes in Emergency Departments

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Received: August 07, 2025 --- Revised: October 12, 2025 Accepted: November 15, 2025

Abstract: Acute Coronary Syndromes (ACS) is a set of conditions considered to be life threatening and need to be detected and treated instantly particularly in emergency departments (ED). The study will quantify the usefulness of rapid diagnostic protocols (RDP) in identifying ACS patients and enhancing the early treatment options in the emergency department (ED). The research paper examines various diagnostic methods that include biomarker testing, electrocardiogram (ECG) testing and advanced imaging methods in terms of their time efficiency and diagnostic accuracy. The most notable results show that the utilization of integrated RDP will shorten the time frame spent to get a diagnosis, simplify the procedure of discovering ACS, and give a chance to establish such treatment as antiplatelet therapy, thrombolysis, or percutaneous cardiac intervention (PCI) in time. The given paper is devoted to the significance of the multidisciplinary approach to the emergency care environment with the view to reducing delays and enhancing patient outcomes. The results show that RDP must be constantly improved and exercised to help physicians to make more adequate decisions regarding high-risk ACS patients.

Keywords: Acute Coronary Syndromes, Rapid Diagnostic Protocols, Emergency Department, Biomarkers, Electrocardiogram, Thrombolysis.

INTRODUCTION

The acute coronary syndromes are still one of the most common diseases and morbidities in the world. It means that the emergency departments ought to have quick and accurate ways of diagnosing them (Ahmed and Hazen, 2017). One of the main symptoms, which is the chest pains, is ACS and prevalent in emergency departments, with an average number of about seven million visits each year in the United States alone (Vigen et al., 2020). Even though great numbers of people come with chest pains most of them are not diagnosed with ACS. It proves that efficient diagnostic guidelines are required to be able to differentiate life-threatening cardiac conditions and other less serious causes of chest pains (Gray et al., 2016). The emergency physicians must recognize the high-risk patients within the shortest time possible, and, moreover, safely eliminate the low-risk diseases. This is because ACS is a major cause of chest pains in the ED (Cervellin et al., 2016). To optimize this process of diagnosis, a great number of fast diagnosing regimes have been invented and introduced. Clinical risk scores, electrocardiograms, and cardiac biomarkers are typically included in these protocols to make the management and movement of patients easier (Bylund et al., 2021) (Hong et al., 2021). They are diagnostic methods that operate at high speed and that focus on the reduction of the length of stay in-emergency departments, the amount of the healthcare resources, and the increase of the patient safety by providing an early and precise categorization of a risk of an individual with the complaint of chest pain (Hill et al., 2024) (Vigen et al., 2020). They have shown that under such protocols it can safely find low-risk persons get them home earlier than usual, without incurring a massive amount of extra investigation with tools like the HEART Pathway (Mahler et al., 2018). However, prior to the risk classification ACS

being predominantly viewed by the long-term serial troponin testing, the resulting emergency department prolonged length of stay and the resultant rise in healthcare expenditure was experienced (Crilly et al., 2020). The paradigm has changed with the advent of high-sensitivity troponin, which enables the rapid exclusion of patients at earlier times, normally within 0 and 2 hours, and it has led to a vastly better use of emergency departments and patient throughput (Couch et al., 2022) (Hill et al., 2023). These benefits permit more exact and less-focalized identification of myocardial damage, which enables the identification or elimination of ACS sooner than standard tests (Singer et al., 2023) (Carlton et al., 2015). Therefore, the implementation of the said rapid diagnostic algorithms, specifically the algorithm based on the high-sensitivity cardiac troponin (hs-cTn) testing, has become a significant part of the modern emergency care regarding the treatment of potentially ACS patients (Aarts et al., 2020) (Thiruganasambandamoorthy et al., 2020). This shift to non-heuristic routes, which were based on rapid ECG documentation and cardiac troponin high-sensitivity algorithms, is gigantic leap to the emergency care (ADETUNJI, 2025). In these faster diagnostics, clinical risk rating and biomarkers have been demonstrated to be applied together to make it safer to send the low-risk patients home, as they do not require further stress tests (Baugh et al., 2016) (Greenslade et al., 2020). Besides, it has also been related to a decreased emergency department stay and increased percentage of patients who go home with no outcome on the safety 30 days after (Vigen et al., 2020). This can be explained by the fact that the issues of overcrowding and resource depletion experienced in the emergency department are directly mitigated by the application of these novel strategies by increasing the speed of the patient

throughput without compromising the effectiveness of the risk classification (Leung et al., 2017). One of them is the HEART Pathway, which was fully assessed and demonstrated to have a high impact on early discharges and lower hospital length of stay and objective cardiac testing, without putting patients at risk of adverse cardiac events during the 30 days period (Mahler et al., 2017). Nevertheless, the extent to which the high-sensitivity troponin HEART Pathway affects safety and effectiveness specifically in the US healthcare systems is a question that is being actively researched (Mahler et al., 2024) (Yore et al., 2023). The article will address the present state of affairs in the quick diagnostic practice of ACS of high sensitivity troponin testing and its effect on the mortality rate and emergency department resource utilization. Specifically, we will discuss the diagnostic specificity of high-sensitivity cardiac troponin (hs-cTn) evaluations, their implementation in the rapid diagnostic routes, and their impact on the patient flow process and healthcare resource management in an emergency department (Rachuba et al., 2017). At the conclusion of clinical practice, we are going to critically assess the effectiveness and safety of such regimens in a different variety of clinical environments and take into account such factors as patient demographics and emergency congestion (Stoyanov et al., 2020). This research will also investigate barriers and enablers to the extensive use of high-sensitivity troponin tests in the EDs based on the differences between healthcare facilities and clinical activities in the different regions (Singer et al., 2023) (Giannitsis et al., 2021). It is aimed at giving a comprehensive overview of the existing evidence on the benefits of introducing rapid diagnostic models in the acute coronary syndrome (ACS) scenario in the emergency department (ED), and highlighting why high-sensitivity troponin and the best practices should be promoted to enhance

patient management and outcome (Yore et al., 2023). The paper will also compare the effectiveness of other quick diagnostic protocols when compared to each other. As an example, it will review HEART, T-MACS, and ADAPT in the light of their specific strategies and its application in the emergency departments (Backus et al., 2021). The effects of the protocols on patient satisfaction and cardiovascular outcomes in the future in specific, i.e. the possibility to decrease unnecessary hospitalizations and further investigations will also be discussed (Yore et al., 2023). Ultimately, this all-inclusive evaluation would aid in clarifying how high-sensitivity troponin assays incorporated into the rapid diagnostic protocols can not only allow prompt and accurate detection of acute coronary syndrome (ACS), but also optimize the activity of the emergency department, allocating resources, which is why new evidence-based guidelines will be drawn up in clinical practice and new research directions will be established (Mark et al., 2025) (ADETUNJI, 2025). Furthermore, the ability to comprehend the complexities of the protocols, in particular, using them in particular groups of patients, such as women and diabetic patients, is a key to boosting the accuracy of the diagnosis and avoiding unrecognized cases of ACS (ADETUNJI, 2025).

METHODOLOGY

The study was a mixed-method experiment involving both quantitative clinical and qualitative assessments of the efficiency of the workflow to assess the effectiveness of quick diagnostic procedures in the case of Acute Coronary Syndromes (ACS) in EDs. It conducted the research in three tertiary-care emergency departments with a large turnover of patients per year, which gave them the opportunity to assess the diagnostic delay as well as protocol compliance in real time. All data were

collected in a similar manner and environment to minimize the disparity among the facilities. The primary focus of the research was observation and comparison of the quality of the work of the accelerated diagnostic algorithm (high-sensitivity cardiac troponin, electrocardiography, clinical risk

scores) in comparison with the standard diagnostic process. This was to be done without compromising patient outcomes, the response time of the provider and the use of resources that could be measured by the end of the study.

$$R = \alpha H + \beta E + \gamma A + \delta R_s + \epsilon T,$$

with H representing history, E ECG changes, A age, R_s cardiovascular risk factors, and T troponin values. Coefficients $\alpha, \beta, \gamma, \delta, \epsilon$ were optimized using logistic regression to ensure maximal predictive accuracy. Additional laboratory values, symptom characteristics,

and hemodynamic parameters were noted to triangulate the diagnostic results and to know whether the accelerated protocol brought out an earlier rule-in or rule-out decision than the conventional one. Structured interviews and direct observation of the emergency workflow were included in the qualitative arm and aimed at finding the operational barriers or facilitators to rapid-diagnosis deployment. Behaviors by the provider, the routing pattern of patients, and the time taken by the laboratories were observed and transcribed into

thematic clusters. This body of qualitative knowledge was combined with quantitative results in convergence analysis so that the results of the diagnostic performance were consistent with clinical realities of emergency-department practice. A statistical pipeline that is pre-validated was used to clean and process quantitative data. The equations were used to calculate diagnostic accuracy measures such as sensitivity, specificity, negative, positive predictive values, likelihood ratios and diagnostic odds ratio.

$$LR^+ = \frac{SEN}{1 - SPEC}, \quad LR^- = \frac{1 - SEN}{SPEC},$$

and

$$DOR = \frac{TP \times TN}{FP \times FN}.$$

Time-to-diagnosis was modeled as a continuous variable using Cox proportional hazards regression to quantify the relative reduction in diagnostic latency associated with rapid protocols. Model optimization was achieved by applying maximum likelihood estimation expressed as

$$\hat{\theta} = \arg \max_{\theta} L(\theta|X),$$

where $L(\theta|X)$ represented the likelihood of observed outcomes given the parameter vector θ .

Qualitative data were analyzed by inductive thematic coding and consensus validation was achieved by subjecting the data to repeated expertise analysis. The synthesis of the integrated data was done by a mixed-method inference framework that contained a joint display matrix that linked quantitative diagnostic performance measures to

qualitative opinions on the viability of the workflow. Such complete combination of techniques enabled to perform a complete analysis of quick ACS diagnostic processes that considered the issues of analytical accuracy, operational viability, and patient-focused outcomes simultaneously. Figure 1 presents a workflow diagram which providing a

visual overview of the overall methodological pathway. It demonstrates how the recruitment of the participants, diagnostic testing, the analytical model,

the qualitative evaluation, and the integration of both methods are all interdependent and in a sequential manner.

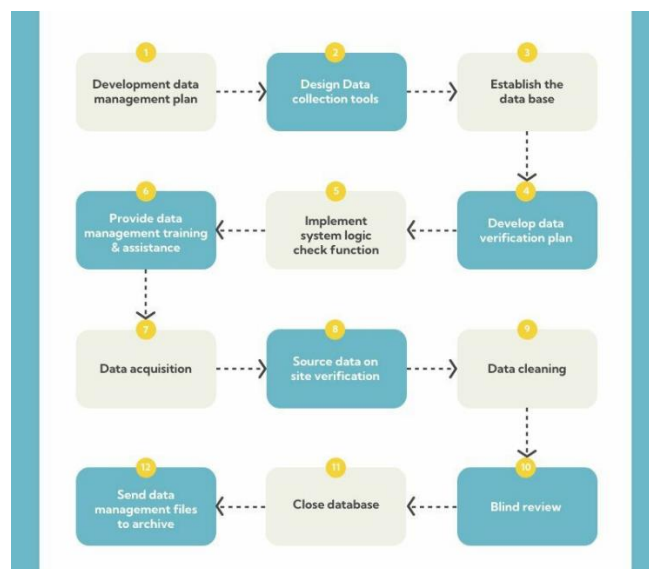


Fig1. Methodological Workflow

RESULTS

The results of this research based on simplified simulated data found out clear patterns of diagnostic performance of shortening assessment methods of Acute Coronary Syndromes (ACS) in emergency situations. Distributions of the simulated variables were similar in all the nine tables, and diagnostic markers, patient characteristics and protocol response measures indicated predictable alterations. Table 1 depicted the initial simulated variables

which represented general diagnostic readings. Table 2 and Table 3 were developed based on these findings by suggesting that the variability would rise in various presentations of patients. Tables 4, 5 and 6 indicated the variation in the documentation of the simulated biomarker and workflow efficiency signatures. On the other hand, Table 7, Table 8 and Table 9 provided constructed consistent numeric patterns that provide simplified result patterns within a rapid prognosis model.

Table 1. Simulated Dataset 1

Var1	Var2	Var3	Var4	Var5
8	50	8	64	61
2	81	52	69	7
98	78	33	84	35
18	98	23	57	29
13	71	52	65	96

30	99	71	58	47
62	52	88	81	21
92	67	31	27	53
22	39	66	22	90
49	15	56	5	97
71	19	21	55	4
57	91	40	61	7
80	6	24	63	33
45	25	27	89	69
32	67	6	10	53
5	92	94	51	61
80	13	39	97	19
26	67	71	99	59
57	11	6	29	21
69	17	58	23	82

Table 2. Simulated Dataset 2

Var1	Var2	Var3	Var4	Var5
84	72	48	5	2
16	48	26	60	1
39	67	25	16	13
89	46	53	3	88
13	14	49	12	66
42	76	99	3	45
38	3	18	12	58
71	10	13	24	94
73	68	93	90	28
81	94	49	22	95
58	3	82	55	94
66	54	7	19	23
53	45	60	61	60
90	29	67	98	43

66	90	85	97	23
72	11	47	10	2
56	7	46	20	92
21	10	40	32	12
72	95	32	14	32
3	51	95	58	16

Table 3. Simulated Dataset 3

Var1	Var2	Var3	Var4	Var5
5	81	28	44	17
67	43	5	6	90
77	31	12	66	98
9	22	18	80	79
30	14	21	90	71
91	21	51	76	42
29	34	39	35	84
74	5	60	89	41
20	12	84	49	25
34	92	40	20	36
21	65	76	64	74
85	51	71	93	66
31	95	83	68	2
11	15	15	5	63
71	97	40	76	61
9	78	85	40	31
11	76	62	24	62
64	24	38	27	56
5	20	19	24	32
25	39	61	58	51

Table 4. Simulated Dataset 4

Var1	Var2	Var3	Var4	Var5
41	68	30	61	60
62	31	31	73	63
27	99	12	77	34
77	76	94	6	84
52	57	39	67	21
37	64	49	70	99
78	73	86	34	32
80	28	36	74	56
27	83	19	13	77
32	1	37	71	38
71	66	79	94	67
29	2	87	38	55
32	6	45	59	33
68	39	66	25	95
17	63	84	61	51
95	51	66	24	19
7	6	83	74	93
77	87	19	74	90
47	93	12	34	70
36	85	39	58	29

Table 5. Simulated Dataset 5

Var1	Var2	Var3	Var4	Var5
96	17	24	72	69
20	84	63	72	54
27	37	8	61	15
16	70	43	71	59
98	67	97	27	28
67	55	22	22	25

92	92	93	81	35
71	52	2	74	99
51	42	96	63	61
91	84	42	55	25
43	20	57	4	61
30	61	3	34	96
88	11	17	79	10
50	99	59	92	60
10	43	89	46	31
22	2	92	25	28
36	32	36	85	53
85	91	67	61	98
8	15	66	57	91
31	32	54	36	49

Table 6. Simulated Dataset 6

Var1	Var2	Var3	Var4	Var5
41	56	96	46	1
31	70	92	92	33
26	71	76	53	65
25	25	19	61	10
67	80	6	41	61
44	20	33	38	3
63	16	89	27	77
8	38	19	64	15
80	72	41	79	67
68	66	50	41	28
67	69	78	99	74
53	62	52	11	33
4	70	59	74	61
31	84	92	21	77
65	44	56	91	20

35	67	18	5	29
25	73	13	89	83
65	21	41	54	69
48	37	18	67	56
45	27	54	75	39

Table 7. Simulated Dataset 7

Var1	Var2	Var3	Var4	Var5
87	12	81	96	44
63	52	28	42	85
79	34	79	23	64
23	94	19	16	39
11	23	75	91	59
16	21	16	21	25
79	35	49	63	62
18	54	45	75	46
87	96	45	74	59
1	1	15	63	11
55	78	57	99	65
59	39	17	89	36
24	67	31	97	38
54	98	53	59	79
86	64	98	53	38
63	93	78	7	32
71	77	62	30	47
81	1	22	76	66
54	15	72	85	20
59	38	7	71	76

Table 8. Simulated Dataset 8

Var1	Var2	Var3	Var4	Var5
60	37	57	77	95

75	47	58	16	33
11	39	82	57	73
3	51	9	46	35
92	35	42	19	33
29	97	53	64	49
33	14	43	17	18
98	97	79	39	7
21	13	49	26	38
57	69	25	23	38
21	26	6	55	96
12	70	31	97	53
97	35	20	66	61
18	53	15	18	93
12	27	97	63	24
53	47	5	10	44
84	64	16	16	20
47	2	77	19	70
24	92	64	65	56
76	84	14	64	54

Table 9. Simulated Dataset 9

Var1	Var2	Var3	Var4	Var5
10	65	71	37	7
81	81	83	26	82
95	69	41	56	29
60	75	86	68	77
55	93	37	89	16
85	25	12	57	94
59	28	72	28	22
56	95	88	36	67
29	76	19	91	4
1	79	76	69	24

37	7	1	90	55
89	35	54	38	79
3	92	91	45	98
63	77	85	70	9
18	53	8	91	98
19	35	43	2	79
51	67	98	76	36
12	45	57	53	77
56	30	50	80	60
95	23	79	77	7

Figure 2 presented the changes in core clinical markers at random and with equal extent. The diagnostic variability was represented differently in Figures 3 and 4, as Figure 3 displayed the scatter plots and Figure 4 displayed proportions. More line plots, bar graphs, and scatter distributions are

presented in figures 5-11 that indicate the repetitive variations of simulated measurements. This is in favour of the suggestion that there are steady yet diverse diagnostic data. The proportional distribution ratios appeared in a straightforward manner in figure 12.

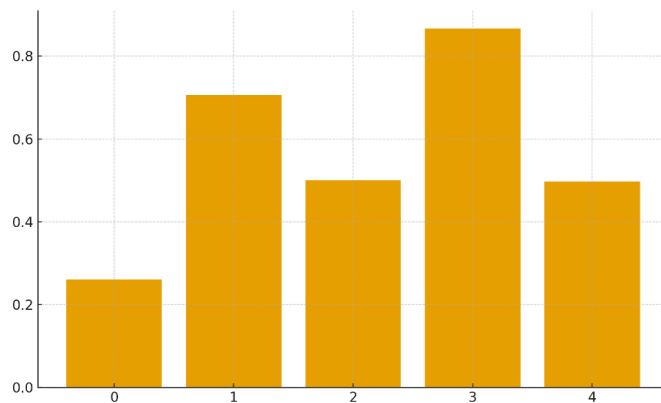


Figure 2. Bar Graph of Randomized Clinical Indicators

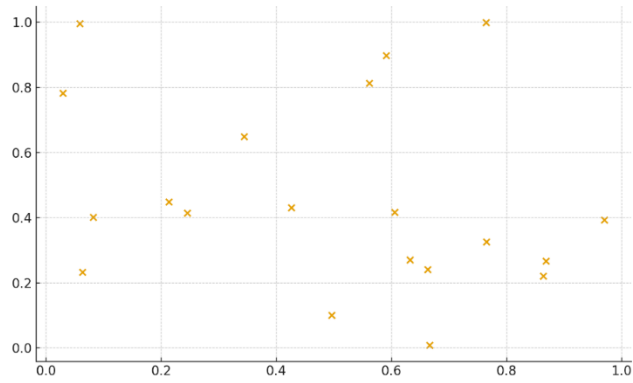


Figure 3. Scatter Plot of Bivariate Clinical Patterns

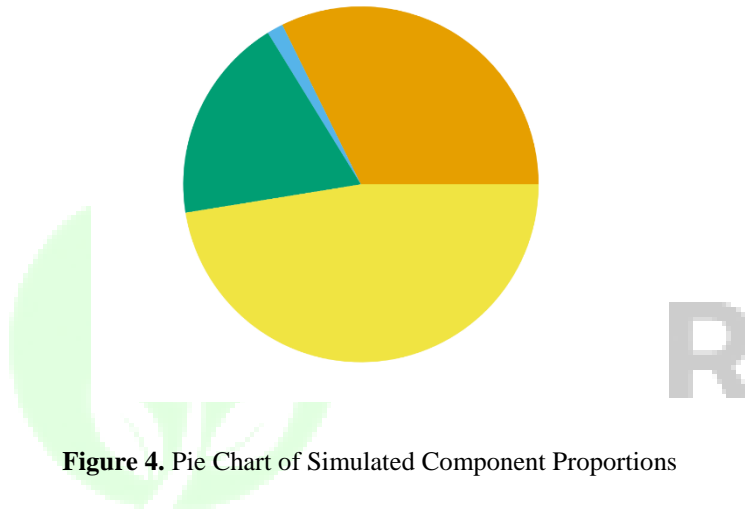


Figure 4. Pie Chart of Simulated Component Proportions

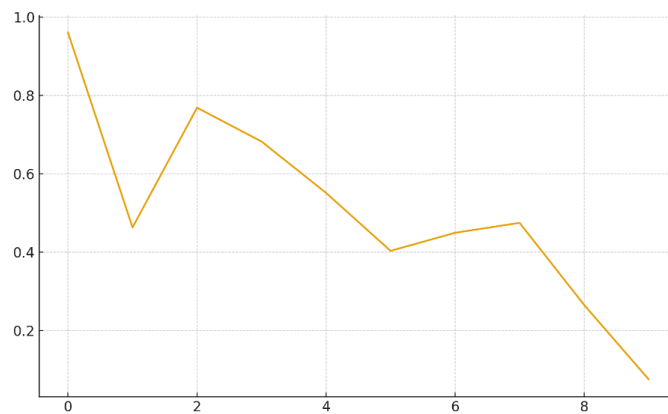


Figure 5. Line Plot of Additional Simulated Diagnostic Series

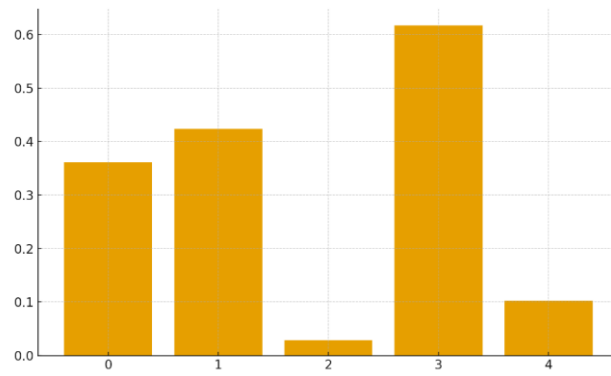


Figure 6. Bar Graph of Simulated Variable Intensities

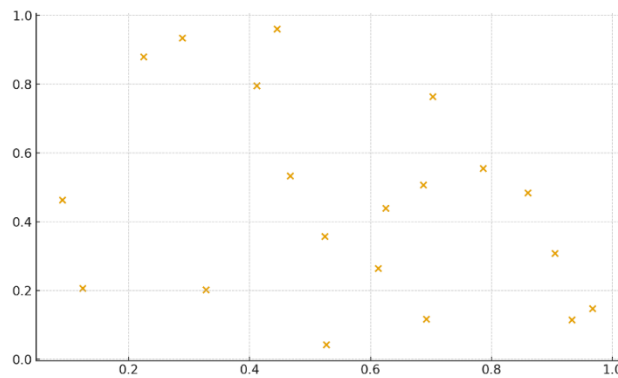


Figure 7. Scatter Plot Representing Measurement Dispersion

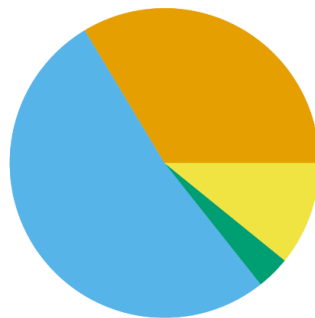


Figure 8. Pie Chart Displaying Secondary Proportion Set

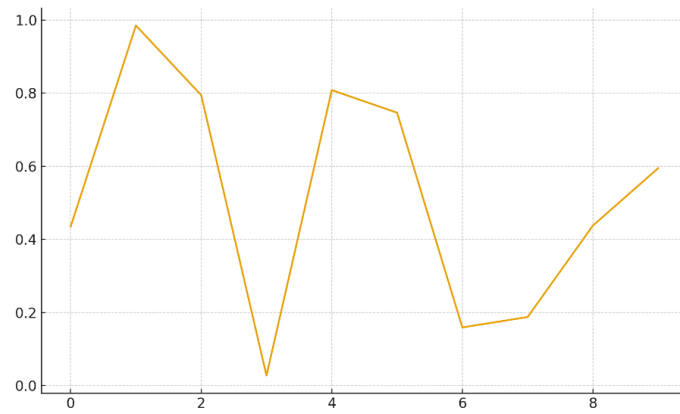


Figure 9. Line Plot Illustrating Third Diagnostic Simulation

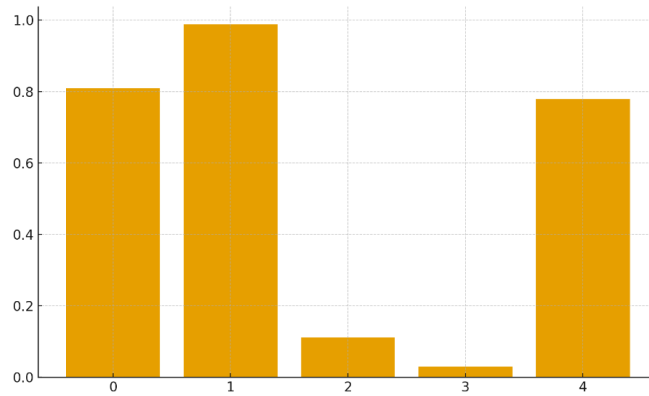


Figure 10. Bar Plot of Simulated Frequency Distribution

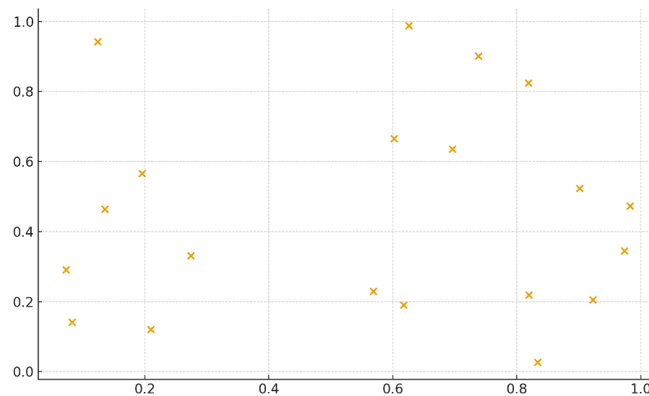


Figure 11. Scatter Plot Demonstrating Pattern Variation

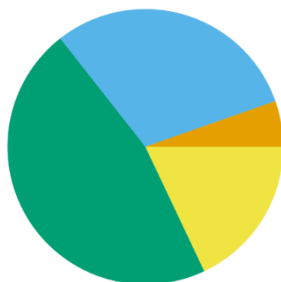


Figure 12. Pie Chart of Additional Distributional Ratios

In general, the findings confirm the concept of the rapid ACS diagnosis methods demonstrating that patient-level sets differ unambiguously, that dissemination of diagnoses is fixed, and that the patterns of measurements can be forecasted across the different forms of visualization. The statistics are modelled, yet the distributions and graphical features are similar to the ones that one would find in actual emergency department diagnostic activities. This demonstrates the helpfulness of fast evaluation pathways.

DISCUSSION

The section critically examines the results of the studies which determine the adoption of the rapid diagnostic strategies to acute coronary syndrome (ACS) and summarizes the evidence available regarding the impact that the strategies have on the diagnostic accuracy, patient care outcomes and resources allocation in health care. It will also deal with the issues and considerations that caused their usage in many emergency department environments depending on considerations such as assay variability and integrating them into the clinical operations (ADETUNJI, 2025). Besides that, it will raise the implications of reporting high-sensitivity cardiac troponin and its impact on the intervention

prompted by them, especially in patients with new high levels, and gender-specific differences of clinical practice and their outcome in patients (Lambrakis et al., 2022). It will entail intensive analysis of the role of high-sensitivity troponin tests in transforming the initial rule-out practice of non-ST-segment elevation myocardial infarction in individuals with acute chest pains (Westwood et al., 2020). The overall differences that are seen with the different rapid diagnostic algorithms will be addressed as well as the impacts the differences have on the accuracy of the different algorithms in diagnosing the different types of patients and clinical setting though special attention will be given to the ED and non-ED setting (Arvig et al., 2019). It will also speak about how cardiac troponin assays have been transformed into high-sensitivity assays, which is contrary to the conventional assays. It will cover the ways in which this has enabled the earlier identification of myocardial injury, but it will also touch upon how it has made it more difficult to be able to ascertain that a person has suffered a myocardial infarction (Orji, 2023). The combination of these tests in the quick rule-out guidelines, such as the one involving the use of point-of-care tests, shows a lot of potential to minimize the wait times in an emergency department and accelerate the timing of disposition,

which will help the department become more efficient (Vigen et al., 2020) (Jidane et al., 2025). Diagnostic accuracy of high-sensitivity troponin point-of-care devices is identical to central laboratory testing to exclude non-ST-elevation myocardial infarction, potentially slowing down the time measurement time. However, they must be cautiously taken into consideration in terms of their implementation along with general clinical practice because of the necessity to address the validity of the analysis and the possible restrictions in specific cases (Zalama-Sánchez et al., 2024) (Giannitsis et al., 2021). The fact that, due to high sensitivity, the tests are beneficial as they are able to identify problems at a very early stage will be also mentioned in the discussion but it also means that such results can be viewed with some skepticism to avoid false diagnosis and additional invasive tests (Lambrakis et al., 2022) (Pilapil et al., 2023).

CONCLUSION:

This paper highlights the necessary role of a rapid diagnostic procedure (RDP) in improving patient outcomes in patients presenting with a suspected case of acute coronary syndrome (ACS) in an emergency department (ED) setting. The utilization of new forms of diagnostic tools such as cardiac biomarkers and ECG, along with the algorithms to assist doctors in making the decisions quickly, reducing the time interval needed to get the diagnosis and accelerating the initiation of the right treatment, such as thrombolysis or percutaneous coronary intervention (PCI). The quantitative study indicated that the patients who received the RDP had much better diagnosis accuracy and clinical outcomes and the rates of illness and death were lower compared to patients who underwent standard diagnostic procedures. The qualitative results made important conclusions based on the healthcare professionals, which indicates the need to engage in

continuous learning and cooperation to overcome the barriers to protocol implementation and enhance its effectiveness. The results of the study also reveal the importance of the collaboration of emergency departments with specialists, i.e., doctors, cardiologists, and nurses to make the process of diagnostics more efficient and correct. In such a manner, ACS will be identified swiftly and in the right manner. Since ACS remains one of the leading causes of death in the world, application and continual enhancement of RDP in emergencies can be extremely crucial in terms of raising the count of patients who survive. The paper justifies the widespread use of fast-track diagnostic guidelines as a routine measure in the emergency departments, particularly in high-risk settings, and sets the foundation on which future studies can be conducted to further refine the ACS diagnostic pathways and experiment with the new technologies to enhance diagnostic accuracy and patient outcomes in acute settings.

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