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A CROSS-SECTIONAL STUDY TO EVALUATE DOOR-TO-ECG TIME IN PATIENTS PRESENTING WITH CHEST PAIN IN EMERGENCY DEPARTMENT OF A TERTIARY CARE HOSPITAL OF PAKISTAN

Original Research

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ABSTRACT

Background: Prompt diagnosis and management of acute coronary syndrome (ACS) is vital to reducing morbidity and mortality. The American College of Cardiology (ACC) and American Heart Association (AHA) recommend that patients presenting with chest pain suggestive of ACS should undergo an electrocardiogram (ECG) within 10 minutes of arrival at the Emergency Department (ED). While this benchmark is crucial for ST-elevation myocardial infarction (STEMI), limited data exist on its impact for non-ST-elevation myocardial infarction (NSTEMI). Timely ECG acquisition remains a cornerstone of early ACS care.

Objective: To assess compliance with the ACC/AHA recommended door-to-ECG (D2E) time of ≤10 minutes among patients presenting with chest pain suggestive of ACS in a tertiary care emergency department.

Methods: This was a prospective, cross-sectional, non-interventional, observational analytical study conducted at the ED of Combined Military Hospital (CMH) Rawalpindi from July to December 2023. A total of 139 adult patients (aged ≥18 years) presenting with acute, atraumatic chest pain suspected to be cardiac in origin were included through consecutive non-probability sampling. Patients with pre-arrival ECG or trauma-related chest pain were excluded. Data were recorded in real time by attending physicians using a structured proforma. Door-to-ECG time was calculated in minutes, and data were analyzed using SPSS v20.

Results: The mean D2E time was 15 minutes, with a range of 3–59 minutes. Only 32% (n=45) of patients met the ≤10-minute target. Specifically, 12.23% (n=16) had D2E <5 minutes, 19.42% (n=27) between 6–10 minutes, 25.89% (n=36) between 11–15 minutes, 23.02% (n=32) between 16–20 minutes, and 16.54% (n=22) had D2E >20 minutes. The most common causes of delay were ED overcrowding, triage prioritization issues, and lack of awareness among healthcare staff.

Conclusion: Only one-third of patients achieved the recommended D2E benchmark of 10 minutes. The primary contributors to delay were systemic and operational challenges, emphasizing the need for structured interventions to improve timely ECG acquisition in suspected ACS cases.

Keywords: Acute Coronary Syndrome, Cardiac Chest Pain, Diagnosis, Door-to-ECG Time, Electrocardiography, Emergency Medical Services, Time-to-Treatment.

INTRODUCTION

Cardiovascular disease (CVD) remains the leading global cause of mortality, accounting for approximately 17.3 million deaths in 2013, with projections estimating this number will rise to 23.6 million by 2030 (1). Among the clinical manifestations of CVD, chest pain is one of the most frequent reasons for presentation to the Emergency Department (ED). Yet, fewer than 25% of these patients are ultimately diagnosed with acute coronary syndrome (ACS), suggesting a significant proportion of evaluations are non-cardiac in origin (2). ACS encompasses a spectrum of conditions associated with myocardial ischemia, including unstable angina, non-ST elevation myocardial infarction (NSTEMI), and ST elevation myocardial infarction (STEMI). While STEMI often presents with clear electrocardiographic findings, the diagnosis of NSTEMI or other non-specific cardiac chest pain can be considerably more complex, particularly in patients with non-diagnostic ECG findings or chronic symptoms not clearly suggestive of ACS (3). Despite the fact that 30–60% of patients presenting with chest pain from outpatient settings are at low risk and may be suitable for outpatient management, up to 85% are admitted, often due to medicolegal concerns, diagnostic uncertainty, or institutional protocols (4). Timely identification and management of ACS, especially STEMI, is critical and has a profound impact on patient outcomes. The American College of Cardiology (ACC) and the American Heart Association (AHA) jointly recommend that patients presenting with symptoms suggestive of ACS undergo a 12-lead electrocardiogram (ECG) within 10 minutes of arrival to the ED (5). Furthermore, to limit myocardial damage and improve survival, the ACC/AHA Guidelines and Joint Commission Core Measures emphasize that STEMI patients should receive reperfusion therapy in a cardiac catheterization lab within 90 minutes of presentation—commonly referred to as the "door-to-balloon" time (6).

However, delays in diagnosis and treatment of STEMI continue to contribute to increased morbidity, mortality, and medicolegal liability globally (7). Failure to meet the recommended 10-minute window for initial ECG acquisition, known as door-to-ECG (D2E) time, compromises the rapid triage and treatment processes essential for favorable outcomes. Timely ECGs not only facilitate rapid identification of high-risk patients but also expedite transfer to definitive care, especially in settings where cardiac catheterization capabilities are available. Given that both STEMI and NSTEMI rely on prompt ECG interpretation and clinical history, early ECG performance remains a cornerstone of optimal ACS management (8). Despite these established guidelines, real-world adherence varies widely due to environmental constraints, staffing limitations, patient load, and institutional protocols (9). Understanding the extent to which these factors influence D2E time is crucial for developing targeted interventions that enhance care delivery. To date, limited data exist on how such variables impact ECG timing and outcomes within specific institutional contexts, particularly in resource-variable emergency settings (10). This study therefore seeks to evaluate the current ECG acquisition practices within the Emergency Department of our institution and determine how well they align with ACC/AHA guideline-recommended standards. It aims to quantify the proportion of patients receiving an ECG within the 10-minute window, assess factors contributing to delays, and explore whether extended D2E times are associated with significantly worse clinical outcomes. Through this investigation, the objective is to provide evidence-based insights that can inform process improvement strategies for early ECG implementation in patients presenting with chest pain suggestive of ACS.

METHODS

This was a non-interventional, non-randomized, prospective observational analytical study conducted over a six-month period, from July to December 2023, at the Emergency Department (ED) of Combined Military Hospital (CMH) Rawalpindi. CMH Rawalpindi is a 1100-bed tertiary care teaching hospital, and its ED comprises 47 beds with an annual patient load exceeding 200,000. The study was approved by the Institutional Ethics Review Board (IERB Approval Certificate No. 581), and written informed consent was obtained from all participants prior to inclusion in the study. A total of 139 patients were enrolled, with the sample size calculated using the World Health Organization (WHO) sample size calculator. Parameters included a 95% confidence interval, a 5% margin of error, and an anticipated population proportion of 10%. Consecutive non-probability convenience sampling was employed, and all patients meeting the eligibility criteria during the study period were included. Inclusion criteria comprised patients aged 18 years and above presenting with acute, atraumatic chest pain of less than 24 hours' duration, a pain score greater than one on the Visual Analogue Scale (VAS), triage categorization of 1 to 3, and classified as high-risk based on either a HEART (History, ECG, Age, Risk Factors, Troponin) score

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>3 or TIMI (Thrombolysis in Myocardial Infarction) score >1. Patients with both typical and atypical chest pain, as well as those with a history of ischemic heart disease (IHD) or diabetes mellitus (DM), were eligible (11).

Patients were excluded if they presented with out-of-hospital cardiac arrest (OHCA), had chest wall deformities, were referred with a pre-confirmed non-cardiac diagnosis such as spontaneous pneumothorax or empyema thoracis, arrived with a diagnostic ECG performed elsewhere, or declined to provide consent. Triage categories were defined as follows: Category 1 for immediate life-threatening conditions, Category 2 for imminent threats requiring urgent attention, and Category 3 for potentially serious but stable presentations. These classifications guided prioritization of clinical assessment and management. High-risk patient profiles included those with chest discomfort accompanied by symptoms such as dyspnea, diaphoresis, or chest tightness, particularly in individuals with a history of IHD, DM, or anginal equivalents. Typical chest pain was characterized as central or retrosternal, pressure-like discomfort radiating to the left arm, jaw, shoulder, or back, and often provoked by exertion or stress and relieved by rest or nitroglycerin. In contrast, atypical chest pain lacked these classic features and could present in locations such as the epigastrium, back, or as isolated arm/jaw discomfort, often accompanied by nonspecific symptoms like nausea, dizziness, or fatigue (12).

Data were collected prospectively using a structured, self-designed proforma by attending emergency physicians at the time of patient presentation. Any missing information was supplemented through review of medical records. Given the absence of a standardized ECG archiving system—where ECGs are routinely handed over to patients for continued care—photographs of the ECGs were retained for the purposes of study documentation and analysis. The key variable, door-to-ECG (D2E) time, was calculated by subtracting the time of ED arrival (T0) from the time the initial ECG was performed (T2), expressed in minutes (D2E = T2 - T0). Descriptive statistics, including mean, median, and mode, were computed to summarize baseline characteristics and D2E times. Data were entered and preliminarily analyzed using Microsoft Excel (Office 365), which was used for tabular and graphical representation. Further statistical analysis, particularly for quantitative variables such as time intervals, was performed using the Statistical Package for Social Sciences (SPSS), version 20.0. Visual tools such as histograms and bar charts were employed to illustrate distributional patterns and support data interpretation.

RESULTS

During the six-month study period, a total of 139 patients who presented to the Emergency Department with symptoms suggestive of acute coronary syndrome (ACS), including chest pain, pressure, or discomfort, were evaluated. Of these, 60% (n=83) were male and 40% (n=56) were female. The mean age of the study population was 51 years, with a median age of 53 years and a mode of 46 years. Age distribution showed that 7% (n=10) were aged 18–30 years, 14% (n=20) were 31–40 years, 21% (n=30) were 41–50 years, 35% (n=49) were 51–60 years, and 22% (n=30) were over 60 years of age. In terms of symptom presentation, 32% (n=44) of patients experienced typical chest pain, while 68% (n=95) presented with atypical chest pain. The prevalence of key comorbidities included hypertension in 25% (n=34), diabetes mellitus in 15% (n=21), and ischemic heart disease in 15% (n=21). Among the full cohort, the mean door-to-ECG (D2E) time was 15 minutes, with a range of 3 to 59 minutes. The median D2E time was 15 minutes, and the mode was 10 minutes. The mean triage-to-ECG (T2E) time was 11 minutes, while the mean ECG-to-interpretation (E2R) time was 2 minutes. Evaluation of D2E intervals revealed that 12.23% (n=16) of patients received an ECG within 5 minutes, 19.42% (n=27) within 6–10 minutes, 25.89% (n=36) within 10–15 minutes, 23.02% (n=32) within 15–20 minutes, and 16.54% (n=22) after more than 20 minutes. Among patients with D2E times under 10 minutes (n=45), 6.7% (n=3) had electrocardiographic findings consistent with STEMI, and 15.6% (n=7) showed changes suggestive of ACS but not STEMI. A total of 22% (n=10) in this group were admitted or transferred for interventional cardiology.

In contrast, among those with D2E times exceeding 10 minutes (n=94), 8.5% (n=8) had ECG findings suggestive of STEMI, and 17% (n=16) showed changes compatible with ACS. Of these, 17% (n=16) were admitted or transferred for cardiology intervention. Notably, there was no reported mortality within 24 hours of presentation in any patient. Additional analysis of clinical risk factors showed that among patients with D2E <10 minutes, 15.6% (n=7) had more than two cardiac risk factors (such as smoking, obesity, family history, or recent anginal symptoms), and 13.3% (n=6) had one or more high-risk comorbidities (hypertension, hypercholesterolemia, diabetes, or obesity). Additionally, 11.1% (n=5) had a known history of coronary artery disease. Among patients with D2E >10 minutes, 20.2% (n=19) had more than two risk factors, 13.8% (n=13) had high-risk comorbidities, and 8.5% (n=8) had a history of coronary artery disease. Statistical analysis using the chi-square test was performed to evaluate whether delays in door-to-ECG (D2E) times were significantly associated with adverse clinical indicators, such as STEMI detection, ACS-related changes on ECG, or the presence of high-risk cardiac risk factors. The results demonstrated no statistically significant association between D2E time and the likelihood of

presenting with STEMI (p = 0.9672), non-STEMI ACS (p = 1.0000), or having more than two cardiac risk factors (p = 0.6698). Similarly, the presence of high-risk comorbidities (p = 1.0000) and known coronary artery disease (p = 0.8561) also did not show a statistically significant difference between patients with D2E times below or above 10 minutes. These findings indicate that, within the studied cohort, prolonged D2E times were not significantly correlated with worse immediate clinical presentations or risk profiles.

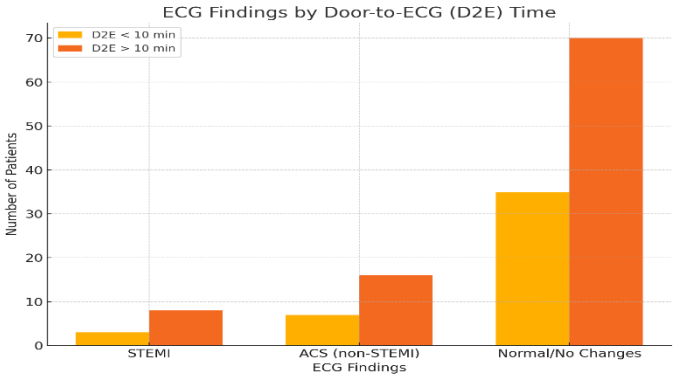

Figure 1 ECG Findings by Door- to-ECG(D2E) Time

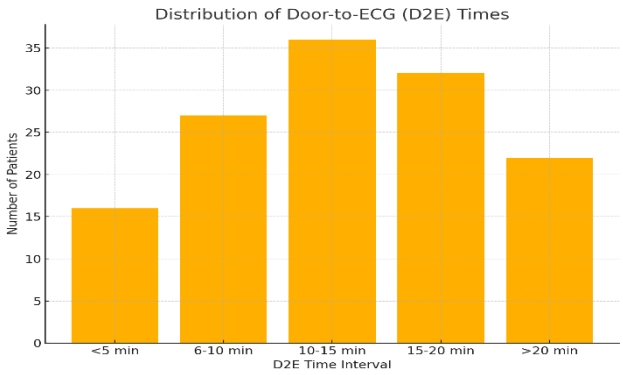

Figure 2 Distribution of Door-to-ECG (D2E) Times

Table 1: Baselines Characteristics of patients included in the study

Baselines Characteristics		**Study Population (n=139)**
Age Range		
Mean: 51 years	Age (18-40) years	21% (n=30)
Median: 53 years	Age (41-60) years	57% (n=79)
Mode: 46 years	Age > 60 years	22% (n=30)
Gender	Male	43% (n=60)
	Female	57% (n=79)
Chest Pain Characteristics	Typical chest pain	32% (n=44)
	Atypical chest pain	68% (n=95)
Co-Morbidities / Risk Factors	Diabetes Mellitus	15% (n=21)
	Hypertension	25% (n=34)
	Ischemic heart Disease	15% (n=21)

Table 2: Table showing assessment and findings in patients presenting to the ED

	D2E < 10 min	**D2E > 10 min**
Total number of patients	45	94
More than 2 cardiac risk factors (Obesity, Smoker, Family History, recent angina symptoms in last 7 days)	n= 7	n= 19
One or more of high-risk co-morbidities (Hypertension, Hypercholesterolemia, Diabetes, Obesity)	n= 6	n= 13
Previously known coronary artery disease	n= 5	n= 8
STEMI on ECG	n= 3	n=8
Non-specific changes suggestive of ACS	n=7	n=16
No ECG changes / Normal ECG	n=35	n=70

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Table 3: Chi-square Analysis of Outcomes vs D2E Time

Variable	Chi-square	p-value	Significant (p<0.05)
More than 2 cardiac risk factors	0.182	0.6698	No
High-risk comorbidities	0	1	No
Known CAD	0.033	0.8561	No
STEMI on ECG	0.002	0.9672	No
ACS (non-STEMI)	0	1	No
Normal ECG	0.046	0.8306	No

DISCUSSION

Acute coronary syndrome (ACS) remains a critical and time-sensitive medical condition, with missed or delayed diagnoses frequently leading to adverse outcomes and legal repercussions in clinical practice. In response, the American College of Cardiology (ACC) and the American Heart Association (AHA) have updated chest pain management guidelines, advocating for the acquisition of an electrocardiogram (ECG) within 10 minutes of a patient's arrival to the emergency department (ED) in cases of suspected ACS. This benchmark, though primarily emphasized for ST-elevation myocardial infarction (STEMI), serves as a general standard for all patients with ongoing chest discomfort suggestive of cardiac ischemia (13). While literature supports this timeframe for STEMI due to its association with timely reperfusion therapy and improved outcomes, there remains limited evidence specifically linking early ECG in non-ST-elevation myocardial infarction (NSTEMI) to clinical prognosis (13,14). However, early risk stratification and timely revascularization in high-risk NSTEMI cases have shown promising clinical value. The current study demonstrated a median door-to-ECG (D2E) time of 15 minutes, with only 32% of patients receiving an ECG within the recommended 10-minute window. These findings are in line with previously reported median D2E times ranging between 15 and 25 minutes in similar emergency settings. Importantly, the present study did not observe a statistically significant association between delayed ECG acquisition and worse immediate clinical outcomes, such as STEMI diagnosis or admission for interventional cardiology (15). Nonetheless, the absence of adverse outcomes in this cohort should be interpreted cautiously, as delays exceeding 59 minutes were uncommon, and other studies have associated more prolonged delays (e.g., >120 minutes) with increased mortality and morbidity. Furthermore, most patients, regardless of D2E time, had no ECG changes suggestive of acute ischemia, highlighting the need for more nuanced risk stratification strategies beyond time-based targets alone. A key finding of this study was the predominance of atypical chest pain presentations (68%), which has been similarly reported in other regional studies (16). Despite presenting atypically, these patients had comparable rates of STEMI and ACS-related ECG changes to those with typical symptoms, reinforcing the importance of maintaining a high index of suspicion and prioritizing ECG acquisition regardless of symptom pattern. This underscores the risk of diagnostic delay in patients with less classical presentations, a phenomenon widely recognized in emergency medicine. The primary bottleneck identified in achieving timely ECGs was not the interpretation or decision-making process but rather the execution of the ECG itself (17). Factors contributing to this delay included ED overcrowding, high patient volumes, and variable awareness among healthcare workers (HCWs) about the urgency of ECGs in chest pain evaluation. Operational practices, such as deprioritizing ECGs for patients perceived to be lower risk—either due to younger age or transient symptom resolution—also contributed to the lag. Although these are context-specific challenges, they reflect common systemic barriers observed globally, especially in resource-limited healthcare environments (18).

From a quality improvement perspective, targeted interventions to reduce prescription-to-ECG time (T2E) are warranted. Potential strategies include assigning dedicated personnel for rapid ECG acquisition, periodic HCW refresher training, and deploying visual or digital prompts to reinforce early ECG as a high-priority task. Such approaches have demonstrated measurable improvements in time-sensitive care metrics in other healthcare systems and could be adapted to local workflows. Furthermore, integrating early risk assessment tools into triage systems may help prioritize ECGs for patients with high-risk features, even in the absence of typical symptomatology (19). A major strength of this study lies in its prospective design and real-time data collection in a high-volume tertiary care ED, which enhances the reliability of the findings within this context. However, several limitations must be acknowledged. The single-center design and relatively small sample size limit the generalizability of the results. The lack of long-term outcome data, such as 30-day mortality or readmission rates, restricts the ability to fully assess the impact of ECG delays. Additionally, although statistical testing was performed, the study may have been underpowered to detect subtle differences in clinical outcomes associated with D2E time. Overall, while this study reinforces international trends regarding the challenges in achieving guideline-recommended ECG

timings, it also highlights that, modest delays may not necessarily translate into immediate adverse outcomes in all patients. However, this should not justify complacency, as the stakes in ACS management are high, and each minute of delay can have implications, particularly in high-risk populations (20). Future research should include multicenter trials with larger sample sizes and incorporate follow-up data to better assess the prognostic significance of ECG timing in both STEMI and NSTEMI populations. Implementing system-wide quality improvement projects may further aid in bridging the gap between guidelines and real-world practice, ultimately enhancing timely and effective care for patients with suspected ACS.

CONCLUSION

This study reinforces the critical role of early ECG acquisition in the effective management of patients presenting with suspected acute coronary syndrome. Although a modest delay beyond guideline-recommended timeframes did not correspond with increased morbidity in this cohort, the findings emphasize the importance of maintaining a high level of clinical vigilance—particularly in cases with atypical presentations. Delays were most often related to operational challenges, highlighting the need for institutional strategies that streamline ECG workflows and promote timely assessment. Ultimately, this research contributes to the growing body of evidence supporting structure, prompt ECG practices in emergency settings and underscores the value of ongoing quality improvement and multicenter collaboration to enhance early ACS recognition and intervention.

Author Contribution

Author	Contribution
Zeeshan Munir*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Tamkeen Pervez	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Aqsa Sajjad Bhatti	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Iqra Janjua	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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