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Original Research Article

Patient Characteristics and Outcomes in ST-Segment Elevation Myocardial Infarction (STEMI) Cases Managed by Emergency Medical Services (EMS)

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Abstract

Background: Myocardial infarction (MI) remains a leading cause of morbidity and mortality worldwide. Early recognition of ST-elevation MI (STEMI) and prompt activation of pre-hospital percutaneous coronary intervention (PCI) are critical for improving patient outcomes. The World Health Organization defines MI based on the presence of chest discomfort, elevated troponin levels, and ECG changes. This study aimed to assess the impact of early STEMI recognition and pre-hospital PCI activation on mortality rates.

Methods: A retrospective cohort study was conducted involving patients diagnosed with STEMI by emergency medical services (EMS), Emergency medicine unit of SKMCH, Muzaffarpur, and Bihar from April 2024 to September 2024. Data were collected from hospital records, electronic patient care reports, and patient contact. Key variables included demographic data, medical history, pre-hospital interventions, time intervals (call-to-balloon [C2B], first medical contact-to-balloon [FMC2B], the time from when treatment by a healthcare provider begins to balloon time, and door-to-balloon [D2B]), and patient outcomes. Statistical analysis was performed using SPPS statistical software version 24.

Results: A total of 76 patients were analyzed, predominantly male (88%), with a mean age of 57 years. Early STEMI recognition and pre-hospital PCI activation resulted in a mean C2B time of 90 minutes, FMC2B time of 68 minutes, and D2B time of 33 minutes. Most patients (93%) underwent PCI upon arrival. Outcomes showed that 76% of patients recovered without complications, 16% recovered with complications, 4% worsened, and 4% died.

Conclusion: Early recognition of STEMI and pre-hospital PCI activation significantly improved patient outcomes, in adherence to international time benchmarks. These findings highlight the need for continued efforts to optimize emergency medical services (EMS) protocols and public awareness to further reduce mortality rates.

Keywords: STEMI, MI, early recognition, outcome, C2B, FMC2B, D2B pre-hospital PCI activation, mortality, EMS, time-to-treatment.

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Introduction

Cardiovascular diseases (CVDs) remain the leading cause of global mortality, with acute coronary syndrome (ACS) representing a major subset of these conditions [1]. ACS encompasses unstable angina, non-ST-elevation myocardial infarction (NSTEMI), and ST-elevation myocardial infarction (STEMI) — with STEMI being a critical emergency characterized by complete coronary artery occlusion, typically due to thrombus formation over a ruptured or eroded atherosclerotic plaque. Notably, coronary artery occlusion exceeding 70% is strongly associated with STEMI pathophysiology, leading to extensive myocardial ischemia and necrosis if reperfusion is delayed [2].

STEMI management revolves around restoring coronary perfusion as swiftly as possible [3]. Current international guidelines — including those from the American Heart Association (AHA), European Society of Cardiology (ESC), European Resuscitation Council (ERC), and Saudi Heart Association (SHA) — recommend primary percutaneous coronary intervention (PCI) as the gold standard for reperfusion therapy, provided it is performed within recommended timeframes [1,4]. Optimal outcomes are associated with achieving door-to-balloon (D2B) times of ≤90 minutes and first medical contact-toballoon (FMC2B) times of ≤120 minutes [5].

However, in resource-limited settings or areas lacking timely access to catheterization laboratories, thrombolytic therapy remains a crucial alternative.

Studies comparing PCI and tissue plasminogen activator (tPA) administration demonstrate that PCI yields superior outcomes — including lower mortality, reduced reinfarction rates, and improved long-term prognosis [6].

Material and Methods

This descriptive retrospective cohort study was conducted in Emergency medicine unit of SKMCH, Muzaffarpur, and Bihar from April 2024 to September 2024.

The protocol mandates the performance of a 12-lead electrocardiogram (ECG) for any patient presenting with chest pain, epigastric discomfort, or suspected ACS.

Paramedics, trained in ECG interpretation and STEMI recognition, perform these ECGs either at the scene or in the ambulance. The results are transmitted to the medical director at the cardiac center for confirmation before hospital arrival. In cases of confirmed STEMI, prehospital activation of the catheterization laboratory is initiated to minimize delays in reperfusion therapy.

The protocol includes oxygen administration to maintain oxygen saturation levels above 94% and the administration of 300 mg of aspirin unless contraindicated. Intravenous (IV) access is established before administering nitroglycerin, which is given sublingually at 0.4 mg every five minutes, up to three doses, provided systolic blood pressure remains above 120 mmHg. If chest pain persists despite nitroglycerin, fentanyl (1 mcg/kg), or morphine (4 mg initially, followed by 2 mg increments to a maximum of 10 mg) is administered. Hypotensive patients (systolic blood pressure < 90 mmHg) are treated with fluid boluses and placed in a shock position. These measures aim to stabilize patients before they arrive at the receiving facility.

Inclusion criteria required patients to be aged 18 years or older, have STEMI confirmed by Cardiac Center, and have complete documentation of demographic, clinical, and outcome data. Exclusion criteria included cases deactivated by the cardiac center due to diagnostic uncertainty or alternative diagnoses, as well as incomplete records with missing critical variables.

Data were retrospectively collected from Cardiac Center medical records, and follow up telephone interviews with patients or their families.

Informed consent was obtained before conducting follow-ups. Diagnosis data were verified against the cardiac center's records. Priority Dispatch System through the ProQA application, where paramedics manually input diagnoses for EMS cases. The dataset encompassed detailed information on demographics, prehospital care, and patient outcomes.

To ensure confidentiality, all data were anonymized and securely stored.

Independent variables included demographic information (age, gender, nationality), medical history (prior cardiac conditions, comorbidities, smoking status), presenting symptoms (e.g., chest pain, dyspnea), and prehospital interventions (e.g., medications administered, oxygen therapy, and ECG transmission). Dependent variables included mortality rates (in-hospital and 30-day mortality), critical time intervals such as call-to-balloon (C2B), first medical contact-to-balloon (FMC2B), and door-toballoon (D2B), and patient outcomes. Patient outcomes were categorized as "improved without complications," "improved with complications," "worsened," or "death."

Improvement without complications referred to full recovery with no adverse events, while improvement with complications included specific adverse outcomes such as cardiac arrest, arrhythmias, re-occlusion, coronary artery dissection, or aneurysm formation. Worsening referred to clinical deterioration requiring extended care.

Patient confidentiality was maintained throughout, and all data were anonymized before analysis.

The dataset was analyzed using SPPS statistical discovery software (Version 24 for Windows).

Descriptive statistics were employed to summarize demographic and clinical characteristics. Continuous variables such as time intervals were reported as means and standard deviations, while categorical variables such as outcomes were expressed as frequencies and percentages. Rigorous cross-verification of data was conducted to ensure accuracy and reliability in reporting.

Results

This retrospective study analyzed 96 patients transported directly to the catheterization lab by EMS. After excluding 20 patients who did not meet the inclusion criteria, 76 patients were included in the final analysis (N = 76). The patients' ages ranged from 33 to 88 years, with a mean age of 57 years. The most common age was 50 years, with nine patients falling into this category. The cohort was predominantly male, with 67 males (88%) and nine females (12%). Male patients had a mean age of 56 years, with the youngest being 33 and the oldest being 88 years old, while female patients had a mean age of 63 years, with ages ranging from 45 to 86 years. These demographic details are summarized in Table 1, which highlights the distribution of age and gender across the study cohort.

Table 1: Patient demographics and clinical characteristics

Characteristics	Total (n=78)
Mean Age (years)	57±12
Age Range (years)	33-88
Most common age (years)	50 (9 cases)
Male patients (%)	67 (88%)
Female patients (%)	9 (12%)

Regarding the clinical history of the cohort, the majority of patients (54 or 71%) had no prior documented cardiac conditions. Among those with a history of cardiac disease, the most common condition was ACS, reported in 14 patients (18%), followed by congestive heart failure (CHF) in five patients (6%), valvular heart disease (VHD) in three patients (4%), and cardiomyopathy in one patient (1%).

Three patients had unspecified cardiac conditions. Male patients had a higher prevalence of prior cardiac diseases than females, with 20 males having a history of cardiac conditions compared to only two females. Smoking status was also assessed, revealing that 41 patients (54%) had never smoked, while 34 patients (45%) were current smokers, and only one patient (1%) was a former smoker.

The distribution of cardiac history and smoking status is illustrated in Table 2, showing no significant association between smoking and the prevalence of cardiac disease in this cohort.

Table 2: Gender wise distribution of cardiac history and smoking status

Sex	ACS	CHF	VHD	Cardiomyopathy	Cardiac	No
Male	12	3	3	1	3	47
Female	2	2	0	0	0	7

Prehospital interventions were a critical aspect of this study. EMS providers administered aspirin to 79% of patients, while an additional 5% had already taken aspirin before EMS arrival. Another 3% took aspirin as directed by EMS dispatchers during the emergency call, and 7% received partial doses completed by EMS providers. Four percent of patients did not receive aspirin at any stage, and one patient (1%) received aspirin only upon arrival at the catheterization lab. Additionally, 25% of patients received medications other than aspirin, while 62% received oxygen therapy during transport. Pain assessments during transport revealed that 42% of patients showed improvement, 24% remained stable, and 4% deteriorated. However, for 30% of patients, pain levels were not assessed. These prehospital interventions are detailed in Table 3, which provides a comprehensive view of aspirin administration patterns. Upon arrival at the catheterization lab, 71 patients (93%) underwent PCI, while three patients (4%) received coronary angiography (CAG), and two patients (3%) required coronary artery bypass grafting (CABG). The mean admission period across all patients was 3.64 days.

Table 3: Prehospital aspirin administration

	No aspirin	EMD	Cath. Lab	Before calling+ Ambulance	Before calling	Ambulance+ cath. Lab	Ambulance
No.	3	2	1	5	4	1	60

Admission durations varied significantly based on the intervention type: CABG patients stayed between 13 and 22 days, CAG patients had admission periods ranging from 3 to 11 days, and PCI patients stayed between 1 and 20 days. These results clarify the earlier discrepancy between the mean and most common admission periods, highlighting the variability across treatment groups. Transport time intervals were another critical focus of this study. The call-to-balloon (C2B) interval ranged from 47 to 154 minutes, with a mean of 90 minutes. The first medical contact-to-balloon

(FMC2B) interval ranged from 46 to 113 minutes, with a mean of 68 minutes, while the door-to-balloon (D2B) interval ranged from 12 to 74 minutes, with a mean of 33 minutes. These time intervals underscore the importance of timely interventions in improving STEMI outcomes.

The study also evaluated patient outcomes, revealing that 58 patients (76%) improved without complications, 12 patients (16%) improved but experienced complications, three patients (4%) worsened, and three patients (4%) died. Among PCI patients, 79% improved without complications, 13% improved with complications, 4% worsened, and 4% died.

All CABG patients improved without complications, while two CAG patients improved without complications, and one patient improved with complications. These outcome distributions are presented in Table 4, which compares procedural outcomes across the intervention types.

Table 4: Procedural outcomes by intervention type

Intervention type	Improved	Improved with complications	Worse	Die
PCI	56	9	3	3
CAG	2	1	0	0
CABG	0	2	0	0

While this analysis primarily describes the demographic and clinical characteristics of the cohort, it also highlights areas for future investigation. Delays in transportation, particularly extended C2B and FMC2B intervals, could be further examined to identify modifiable factors.

Similarly, the potential association between prehospital aspirin administration and improved outcomes warrants further exploration to enhance prehospital care protocols for STEMI patients.

Discussion

The mean C2B time observed in this study was 90 minutes, consistent with international benchmarks such as those established by the AHA and ESC, which recommend C2B times of 90 to 120 minutes for optimal outcomes.

Similarly, the FMC2B and D2B times of 68 and 33 minutes, respectively, align with prehospital standards of <90 minutes for FMC2B and <60 minutes for D2B [7].

These timeframes reflect strong system performance in recognizing STEMI, initiating prehospital care, and rapidly transferring patients for intervention.

However, when compared to international EMS systems, certain gaps emerge. For example, a European registry demonstrated an FMC2B time of 55 minutes and a D2B time of 30 minutes [8]. The need to further reduce these time intervals is evident, particularly when considering that delays of even a few minutes have been shown to significantly impact mortality rates and long-term outcomes [2014].

The overall mortality rate of 4% in this study aligns with international findings [9].

The 93% utilization of PCI as the primary intervention in this study highlights its dominant role in STEMI management, consistent with global trends favoring PCI over thrombolytics due to superior outcomes [11].

The complication rate of 16% in this study, largely due to bleeding and arrhythmias, is consistent with findings from global registries. CABG patients showed higher rates of complications and longer hospital stays compared to PCI patients, reflecting the greater complexity and risk associated with surgical interventions. This observation aligns with findings from the FREEDOM trial, which demonstrated that CABG was associated with higher early risks but better long-term outcomes in diabetic and high-risk patients [2014].

When comparing outcomes, this study’s findings are similar to results from neighboring regions. For instance, in the Middle East, studies report PCI-related mortality rates of 3.5% to 4.5%, which are comparable to those observed in this study [10]. However, integrated STEMI care pathways in high-income countries such as Sweden and Japan have achieved even lower mortality rates, often below 3%, by emphasizing prehospital thrombolysis and reducing symptom-to-balloon times [8].

This study has several limitations that should be acknowledged. First, it is descriptive and retrospective, limiting its ability to establish causal relationships or identify significant associations between early recognition and outcomes. Second, mortality was recorded only during the hospital stay, without tracking longer-term outcomes such as 30-day or 1-year survival.

This limits the ability to assess the sustained benefits of interventions. Additionally, the relatively small sample size may not fully capture the variability in STEMI presentations, particularly given the exclusion of patients with incomplete data. Confounding factors, such as socioeconomic status, pre-existing comorbidities, and genetic predispositions, were not controlled for, further limiting the generalizability of the findings. Lastly, the study did not include a comparative group, such as patients receiving thrombolytic therapy, which would have allowed for a more nuanced analysis of outcomes across different treatment modalities.

Conclusion

Efforts to improve public awareness, EMS utilization, and system efficiencies are crucial for further reducing STEMI-related mortality. There are several limitations to consider in this study. Relying on retrospective records and the possibility of incomplete data poses challenges to the validity of our findings. Additionally, focusing on a single geographic location and a specific population may limit the generalizability of the results to other locations or populations with different healthcare infrastructures.

Moreover, the influence of confounding factors such as comorbidities, patient characteristics, and variations in treatment protocols could not be fully controlled. Future research should consider prospective study designs and larger sample sizes across multiple centers to validate and expand upon these findings. Including a control group would also allow for more effective comparisons of mortality rates and complication outcomes between intervention types.

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