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Factors Associated with Delays in Pre-Hospital Arrival for Patients experiencing Myocardial Infarction – A Prospective Observational Study

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KEYWORDS

Myocardial Infarction, Prehospital delay, cardiovascular disease, mortality, Early treatment, cardiac pathophysiology

ABSTRACT:

Cardiovascular disease ranks among the foremost causes of mortality globally, with over 75% of these fatalities occurring in low- and middle-income nations. Myocardial infarction (MI) stands out as one of the most prevalent cardiovascular conditions, characterized by a significant mortality rate. This study was initiated to investigate the factors contributing to prehospital delays in the northern region of India and their correlation with in-hospital mortality rates. The objective was to analyze the primary variables that lead to prolonged prehospital delays and to assess the impact of these delays on mortality following hospital admission. Conducted as a prospective observational study at the Sri Ramachandra Institute of Higher Education and Research from May 2023 to July 2023, our research sheds light on the various factors affecting prehospital delays in patients experiencing MI. Notably, patient behavior and health-related actions emerged as critical contributors to extended prehospital wait times. A lack of awareness regarding the common symptoms of MI was recognized as a potential factor, underscoring the necessity for enhanced public education on these symptoms.

Introduction

Myocardial infarction is classified as a form of acute coronary syndrome resulting from a pathological event associated with myocardial ischemia, leading to significant cardiac damage and injury. The diagnosis is confirmed by observing a rise and/or fall in cardiac troponin levels, accompanied by corroborative evidence such as characteristic symptoms, indicative electrocardiographic alterations, or imaging findings that reveal new loss of viable myocardium or newly developed regional wall motion abnormalities.(1) The goal of early rehabilitation after an acute MI is to restore perfusion as soon as possible in order to preserve as much of the damaged myocardium as is practical. Medical or mechanical interventions, such as coronary artery bypass graft surgery or percutaneous coronary intervention, can accomplish this. Reducing morbidity and avoiding complications are the main objectives of medical treatment for MI. Small intramural foci of coagulative necrosis and perinuclear edema within cardiac myocytes, along with enlarged mitochondria and an enlarged sarcoplasmic reticulum, are the pathological hallmarks of MI.(2) The clinical outcomes for patients experiencing MI have seen significant improvements over the last two decades.(2) Nevertheless, the mortality rate associated with MI continues to be alarmingly high. Given that delayed intervention can lead to more severe short- and long-term effects, there has been a growing interest in timely treatment strategies for individuals with acute coronary syndrome. However, there is a lack of robust evidence to substantiate the proposed explanations for this phenomenon.(2)

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Prehospital delay in the context of MI is defined as the duration from the onset of symptoms until the patient reaches the hospital. This interval is crucial, as every minute is vital in the management of MI. Prolonged delays can lead to increased damage to the cardiac muscle and elevate the risk of serious complications or mortality. Efforts to minimize prehospital delays should focus on enhancing public awareness regarding MI symptoms, ensuring prompt access to emergency medical services, and improving the overall efficiency of healthcare systems.(3)

In cases of acute MI, the time frame between the onset of symptoms and reperfusion is a key factor influencing treatment outcomes. Early studies from the thrombolysis era indicated that the time consumed by the technical aspects of treatment is relatively minor. Various sources of delay have been identified and addressed individually to shorten these timeframes.(4) However, it is noteworthy that a substantial portion up to 75% of the prehospital delay is attributed to the patient's own decision-making time. Even when emergency medical services operate at an optimal technical level, the subjective experience of the onset of symptoms remains the predominant factor affecting the time until treatment is initiated. Contributing factors to this delay include advanced age, female gender, rural residency, diabetes, atypical pain presentations, and a lack of awareness regarding the importance of pain.(5)

The prolonged interval between the onset of MI symptoms and the provision of emergency medical care adversely impacts patient outcomes.(6) Research indicates that approximately two-thirds of patients who succumb within 28 days of the onset of MI symptoms do so prior to receiving care at a healthcare facility. Reperfusion therapy for ST segment elevation MI can be delayed by as little as 30 minutes, which can drastically raise mortality risks and shorten life expectancy by an average of one year. Regardless of age, gender, or race, the American College of Cardiology and the American Heart Association recommend that reperfusion therapy be given to all patients displaying MI-like symptoms as well as those displaying electrocardiographic abnormalities like ST segment elevation or left bundle branch block, if there are no contraindications.(7)

The growing body of research underscores the critical nature of prompt treatment initiation for MI. Studies examining the efficacy of various reperfusion therapies have demonstrated that timely interventions are essential for minimizing mortality and morbidity. While treatment preferences may lean towards one reperfusion method over another (such as coronary angioplasty versus thrombolytic therapy), the reduction of time to intervention remains a pivotal factor in achieving the benefits of reperfusion, irrespective of the specific modality employed.(7)

Pre-hospital delay and in-hospital delay are the two main stages of delays in the start of treatment for acute MI. While in-hospital delay, also known as door-to-treatment time, is the time between hospital admission and the start of reperfusion therapy, pre-hospital delay is the amount of time between the onset of symptoms and the patient's arrival at the hospital. Pre-hospital delay can further be subdivided into decision delay and transportation delay.(8, 9) Decision delay encompasses the time from symptom onset to the initial decision to seek medical assistance, whereas transportation delay is the period from that decision to the actual arrival at a healthcare facility.(10, 11) This article examines the contemporary elements influencing the predictors of pre-hospital delays in patients experiencing MI.

Against this background, the objectives were to investigate the primary factors that lead to prolonged pre-hospital delays and the subsequent impact of these delays on mortality rates following hospital admission for individuals experiencing MI; and to identify the time interval between the onset of chest pain and the patient's arrival at the hospital, as well as to analyze the differences in outcomes between patients who arrived within four hours and those who arrived after four hours, assessing the implications for patient health.

Materials and Methods

This investigation employed a prospective observational design, a methodology in which a cohort initially free of the outcome of interest is followed forward in time so that temporal relationships between exposures and subsequent events can be established, thereby minimizing recall bias and strengthening causal inference. The study was conducted at Sri Ramachandra Institute of Higher Education and Research, Chennai, over a three-month period from May 2023 to July 2023. Its principal aim was to quantify pre-hospital delays in the management of acute MI and to identify the factors

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influencing such delays. A preliminary review indicated a median interval of 3.0 hours from symptom onset to initiation of medical care (interquartile range [IQR] 11.0 hours). Using the formula $n=(1.96)^2\sigma^2/(\mu\times0.20)^2$ with an estimated standard deviation of 5 and a mean delay of 3 hours, the required sample size was calculated to be 266 participants.

Eligible participants were adults (≥18 years) diagnosed with acute MI who received thrombolytic therapy at the study centre and provided written informed consent; those with additional cardiac complications, those treated with thrombolysis elsewhere, or those who declined participation were excluded. After departmental authorization, the investigator explained the study objectives to potential participants and obtained consent. Interns and nurses documented each enrollee's demographic characteristics, hospital admission diagnoses, comorbidities, systolic and diastolic blood pressures, respiratory rate, and Glasgow Coma Scale score within 24 hours of the MI diagnosis on a structured proforma; laboratory results were added as they became available. Participants themselves verified demographic details and clinical history, while the principal investigator determined each patient's pre-hospital delay on the basis of the recorded timelines.

The primary dataset comprised the completed proforma and the corresponding emergency-department documentation. Data were first collated in Microsoft Excel, checked for transcription errors, and then exported to SPSS (version 20.0) for descriptive statistical analysis. The study protocol raised no ethical concerns and was approved by the Institutional Ethics Committee of Sri Ramachandra Institute of Higher Education and Research (Deemed University). All participants received a comprehensive written explanation of study aims, procedures, duration, and follow-up requirements prior to enrolment, and a purpose-built questionnaire—designed to capture all variables relevant to the study objectives—was administered to ensure systematic and reliable data collection.

Results

Among the 266 participants, the gender distribution revealed a predominance of males, with 189 (71%) male participants and 77 (29%) females, indicating a male-to-female ratio of approximately 2.5:1. The resident-wise distribution showed a nearly even split, with 137 participants (51.5%) residing in rural areas and 129 (48.5%) in urban settings. This balanced distribution enabled the examination of potential geographical disparities in health-seeking behaviours and clinical outcomes. The distance from the participants' primary residence to a major healthcare centre was assessed to determine access to care. Out of 266 patients, 160 individuals (60.2%) resided at distances greater than 5 kilometres from the emergency facility, while the remaining 106 (39.8%) lived within 5 kilometres.

In evaluating behaviour following the onset of symptoms, various misconceptions were identified. Of the total participants, 51 (19.2%) misinterpreted the nature of their pain, attributing it to non-cardiac causes. Another 76 individuals (28.6%) did not consider the symptoms severe enough to warrant urgent medical evaluation. A total of 68 (25.6%) adopted a wait-and-watch approach, expecting the symptoms to resolve spontaneously. Meanwhile, 49 patients (18.4%) suspected an MI, but delays still occurred, and 22 individuals (8.3%) reported being neglected or dismissed by initial healthcare contact points.

Regarding initial medical action following symptom onset, 198 participants (74.4%) sought care from trained medical professionals, whereas 68 (25.6%) resorted to self-medication. In terms of hospital admittance patterns, 206 participants (77.4%) presented directly to the emergency department, while 60 (22.6%) were referred from private healthcare facilities. This finding underscores the importance of strengthening the referral system and promoting timely direct access to tertiary care centres. Analysis of transport mode revealed that only 77 participants (28.9%) arrived via ambulance, whereas the majority, 189 patients (71.1%), used alternative or general means of transport. The low utilization of ambulance services, despite the urgency of MI, suggests logistical and systemic gaps in pre-hospital emergency care.

Of the 266 patients, 185 (69.5%) did not experience delays in reaching medical care, while 81 (30.5%) presented after a delay, defined based on the study criteria. The significant proportion of delayed presentations emphasizes the relevance of identifying the contributing factors and implementing targeted interventions. An analysis of the relationship between patient residency and delay revealed that among rural

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residents, 50 experienced delays and 87 did not. Among urban residents, 31 experienced delays while 98 did not. While the majority of urban participants presented without delay, delays were more frequent among rural patients. This geographic disparity suggests the influence of infrastructure, transportation access, and awareness on time-to-treatment. However, statistical analysis ($P = 0.027$; $p > 0.5$) did not confirm a significant correlation between residence and delay duration, supporting the null hypothesis.

The association between behaviour following symptom onset and delay duration was examined further. Of the 51 individuals who misinterpreted their pain, 22 experienced delays and 29 did not. Among the 76 patients who perceived their symptoms as insignificant, 29 had delays and 47 did not. For those who waited for symptoms to subside ($n = 68$), 17 had delays while 51 did not. Among the 22 who felt neglected by staff, 5 experienced delays, and 17 did not. Among 49 who suspected an MI, only 8 experienced delays and 41 did not. Statistical analysis indicated a significant association between patient behaviour and delay duration ($p = 0.016$), suggesting that misinterpretation and underestimation of symptoms directly contribute to pre-hospital delays.

When analyzing the association between the first medical intervention and delay duration, 198 individuals sought care from trained medical personnel, among whom 48 experienced delays and 150 did not. Of the 68 participants who self-medicated, 33 experienced delays and 35 did not. The in-hospital outcome was also examined in relation to patient residency. Among rural residents ($n = 137$), 35 patients died while 102 recovered. In contrast, among urban residents ($n = 129$), 17 patients died while 112 recovered. The mortality rate was notably higher among rural patients, suggesting that residence may be an indirect predictor of adverse in-hospital outcomes due to the interplay of delay, access, and early medical response. In assessing the relationship between delay duration and in-hospital outcomes, rural patients with delays accounted for 34 deaths, and only one death occurred among those without delay. Additionally, 16 rural patients with delays recovered, while 86 recovered without delay. Among urban patients, there were 15 deaths in the delay group and 2 deaths in the no-delay group, with 16 recoveries in the delay group and 96 recoveries without delay. The initial medical response also influenced in-hospital outcomes. Among the 68 patients who self-medicated, 27 died and 41 recovered. Of the 198 patients who consulted a medical professional, 25 died while 173 recovered. The mortality rate was disproportionately higher among those who opted for self-medication, reinforcing the importance of timely medical intervention by qualified personnel. The correlation between first medical action and in-hospital outcome was found to be statistically significant.

The mode of transportation similarly influenced clinical outcomes. Among the 77 patients who arrived by ambulance, 21 died and 56 recovered. In comparison, among the 189 who used general transport, 31 died while 158 recovered. The higher mortality observed in ambulance users may reflect the severity of their condition at presentation rather than the effect of transport mode per se. Nonetheless, the analysis demonstrated a statistically significant association between transport mode and in-hospital outcomes. Lastly, the relationship between delay duration and in-hospital outcomes revealed that among the 81 patients who experienced delays, 49 died while 32 recovered. In contrast, among the 185 patients who presented without delay, only 3 died, while 182 recovered.

Discussion

The aim of our research is to identify the factors that contribute to pre-hospital delays in patients experiencing MI. By gaining insights into the variables that influence the duration of time spent outside the hospital following the onset of MI, we can devise strategies to minimize these delays and enhance life-saving interventions for this condition. In our study cohort, the median pre-hospital delay was recorded at seven hours (IQR nine hours), while the median decision-making time was three hours (IQR four and a half hours). Notably, only 69.5% of the patients were admitted to SRMC within four hours of symptom onset. Those patients who exhibited typical clinical signs recognized their symptoms as cardiac-related, consulted healthcare professionals, and sought care directly at SRMC were more likely to be admitted within the four-hour window.

A study conducted in Dhaka, Bangladesh, revealed that the average waiting time for MI patients to be admitted to a hospital was such that 80% of patients arrived within six hours. This investigation took place in a private tertiary care facility, predominantly serving patients

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from affluent backgrounds. In our findings, patients from high-income families similarly experienced shorter pre-hospital delays compared to those from lower- and middle-income backgrounds. Another study indicated that only 17.2% of patients presented within six hours at a government tertiary care hospital in Chittagong, located in southern Bangladesh. The consistent infrastructure and services across government tertiary care hospitals in Tamil Nadu suggest that variations in socioeconomic demographics and healthcare utilization patterns across different regions are likely responsible for these discrepancies. Age was also identified as a risk factor for pre-hospital delay,(12, 13) and this might be because of a lack of resources or a transportation issue. Our analysis found no statistically significant difference in pre-hospital delay between males and females, which aligns with the vast majority of studies from developed and developing nations. However, other research found that one of the determinants of pre-hospital delay was female gender.(14)

Patients from rural areas and lower-income backgrounds exhibited a tendency for delayed hospital admissions, regardless of their educational attainment. Previous studies have indicated that individuals residing in rural settings and those from economically disadvantaged backgrounds were more susceptible to delays in hospital admission due to insufficient financial resources and limited access to transportation. Moreover, individuals living within a 5.0 km radius of a primary healthcare facility were more likely to reach the hospital within four hours following the onset of MI symptoms. Similar findings have been reported, highlighting that patients often present late when they are situated far from their primary care facilities. Additionally, research conducted in our country revealed that patients who utilized ambulances experienced shorter waiting times compared to those who opted for alternative transportation methods. Conversely, our study identified a correlation between the mode of transportation—whether by ambulance or private vehicle—and pre-hospital delays.

We also recognized the significance of clinical symptoms in forecasting delays in hospital admission during MI events. According to earlier research, patients who experienced chest pain were more likely to be admitted for treatment within four hours of the onset of MI compared to those who reported pain in other areas or exhibited ambiguous symptoms. Many patients tend to attribute atypical symptoms to non-cardiac issues, which hinders their ability to seek prompt medical care. Nonetheless, these factors did influence the pre-hospital delay experienced by our patients.

Long-standing co-morbidities continue to exert a significant influence on prehospital delays. Our research indicates that individuals with diabetes mellitus or a history of coronary artery disease tend to be hospitalized sooner than their counterparts; however, no correlation was found between hypertension and earlier admissions. Certain studies suggest that individuals with diabetes and a history of cardiovascular disease may present later in life.(15) Conversely, our findings align with previous research,(16) indicating that a positive family history of cardiovascular disease is associated with earlier hospital presentations. It is possible that individuals with chronic conditions and their families are generally more health-conscious and informed about available healthcare options, prompting them to seek medical attention sooner.

Our study sheds light on the various factors affecting pre-hospital delays for patients experiencing MI. Patient behavior and health-related activities emerged as significant contributors to extended pre-hospital waiting times. A lack of awareness regarding the common symptoms of MI was identified as a potential factor, highlighting the necessity for increased public education on these symptoms. To prevent patients from making critical diagnostic errors, it is essential to encourage prompt medical assistance. Reducing referral times, particularly from private primary care facilities, could lead to substantial improvements. The implementation of diagnostic tools such as ECG and cardiac troponin testing has the potential to decrease pre-hospital delays.

The research sample was primarily sourced from the southern region of Tamil Nadu, which constitutes a significant portion of the national demographic. Additionally, the use of medical records to gather information on patients' symptoms, recommendations, and other clinical data helped mitigate the risk of memory bias. However, a notable limitation of the study is its inability to accurately reflect the entire population of the country. This prospective, single-center study did not encompass the full spectrum of the national population. There was a potential for recall bias when participants were asked to report the onset of symptoms

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and key activities during the interviews. Moreover, the convenience sampling method may have introduced sample bias. Individuals who did not arrive at the hospital alive or who had died prior to being interviewed were excluded from the study, which may have limited our understanding of other relevant factors. Additionally, patients who sought care at different primary health facilities may originate from areas distinct from those who chose SRMC, making comparisons of pre-hospital delays between these groups potentially inaccurate. Delay, as a measure of time, could be utilized to explore the factors influencing pre-hospital delays and in-hospital mortality. Furthermore, the study did not examine other morbidities associated with MI or its treatment, which represents another significant limitation beyond mortality during hospitalization. It is recommended that further research be conducted on additional factors to gain a more comprehensive understanding of how pre-hospital delays impact adverse outcomes.

Conclusion

Observational studies that are prospective in nature hold significant importance in elucidating the natural progression of diseases, pinpointing risk factors, and formulating hypotheses for subsequent investigations. They play a crucial role in areas where ethical or practical constraints hinder experimental interventions. In this study concerning patients with MI, the overall pre-hospital delay was notably longer compared to findings in other health research literature. Factors such as the patients' behavioral responses post-onset, their interactions with primary care providers, referrals from private healthcare facilities, and the distance from their residences to hospitals all contributed to the delays in hospital admission. Misinterpretation of pain symptoms has been identified as a variable that exacerbates pre-hospital delays, consequently leading to increased mortality rates within the hospital setting. Enhancing the referral processes within the existing healthcare framework and improving patient awareness regarding cardiovascular conditions may help mitigate unforeseen delays. To advance the treatment of MI patients in our country, it is imperative to establish a more cohesive and integrated healthcare system, which includes public education on critical health issues, particularly for individuals in high-risk groups. Reducing pre-hospital delays for MI patients is essential for improving clinical outcomes and lowering mortality rates. Various interventions can aid in achieving this objective, such as public awareness initiatives, enhanced ambulance services, and effective emergency response mechanisms. Timely recognition of symptoms, prompt activation of emergency medical services, and strict adherence to established protocols are vital for minimizing delays. By emphasizing timely interventions and refining the pre-hospital care phase, healthcare systems can significantly improve patient outcomes and contribute to the overall enhancement of MI management.

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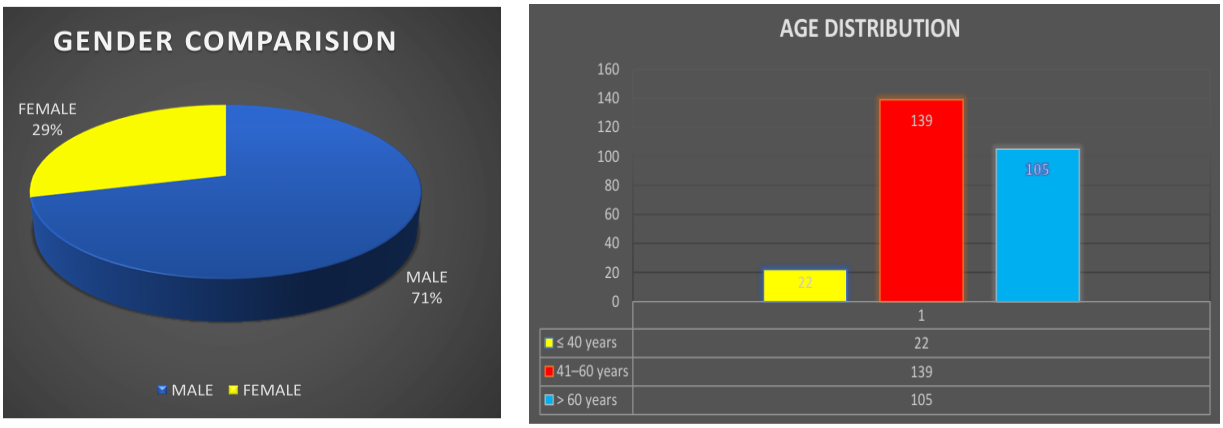

Figure 1: Gender and age wise distribution

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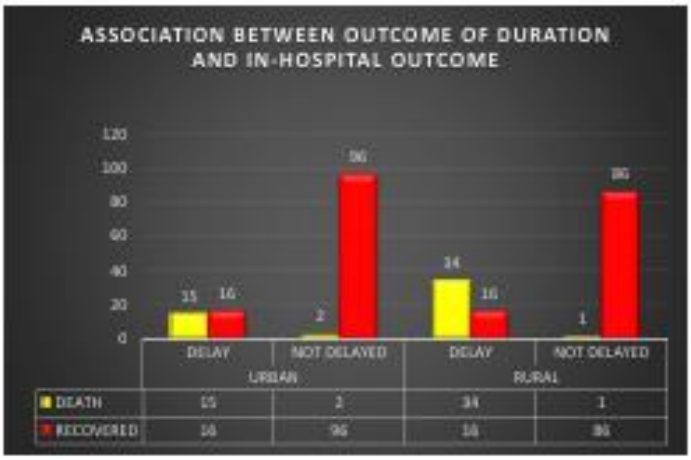

Figure 2: Association between outcome of duration and in-hospital outcome

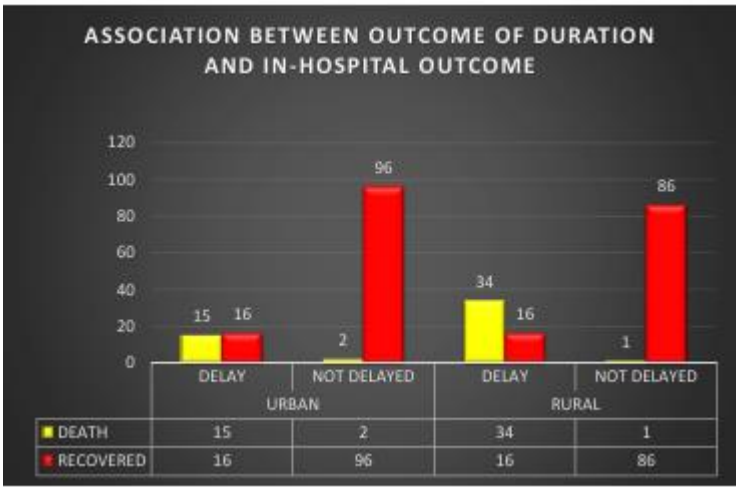

Figure 3: Association between outcome of duration and in-hospital outcome