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ASSOCIATION BETWEEN DOOR-TO-BALLOON TIME AND IN-HOSPITAL MORTALITY IN PATIENTS WITH ST-ELEVATION MYOCARDIAL INFARCTION UNDERGOING PRIMARY PERCUTANEOUS CORONARY INTERVENTION

DR AHSAN ALI*[1], DR MUHAMMAD SAQIB[2], DR WASEEM BARKHURDAR[3], DR BUSHRA SAHBA[4], DR MUHAMMAD ADIL RAMZAN[5], MUHAMMAD TAYYAB[6]

[1] MEDICAL OFFICER, DHQ NANKANA SAHB, EMAIL: ahsansial37@gmail.com
[2] MEDICAL OFFICER CARDIOLOGY, DHQ HOSPITAL SOUTH CITY, OKARA
[3]CONSULTANT CARDIOLOGIST, DHQ HOSPITAL, BHAKKAR
[4] ASISSTANT PROFESSOR CARDIOLOGY, ISRA UNIVERSITY HOSPITAL, HYDERABAD, EMAIL:- Fantasyvirgoen@gmail.com
[5] ABBASI SHAHEED HOSPITAL, KARACHI MEDICAL AND DENTAL COLLEGE, KARACHI, EMAIL: Dradilxyz@gmail.com
[6] ASSISTANT PROFESSOR CARDIOLOGY, AZRA NAHEED MEDICAL COLLEGE, LAHORE, EMAIL: Tayyabrana@hotmail.com

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ABSTRACT

Background: ST-Elevation Myocardial Infarction (STEMI) is a potentially fatal emergency involving the heart, and it requires immediate reperfusion therapy to deliver blood to the heart and minimize the amount of damage to the heart. The most appropriate form of treatment of STEMI when prompt is Primary Percutaneous Coronary Intervention (PPCI). One such quality measure used in the management of STEMI is Door to Balloon (D2B) time, the time between the arrival of the patient at the hospital and the first balloon inflation during PPCI. The prolonged D2B time is also associated with the poor clinical prognosis and mortality. The aim of this paper was to determine the correlation between the in-hospital mortality and the door-to-balloon time of patients with STEMI who underwent primary PCI.

Study Design: Descriptive cross-sectional study.

Place and Duration of Study: The research was carried out in Punjab Institute of Cardiology, Lahore from January 2023 to July 2023.

Methodology: Non-probability consecutive sampling resulted in the determination of 250 patients who had been diagnosed with STEMI and were receiving primary PCI. Patients who were already thrombolysed previously, patients who presented with cardiogenic shock and those who did not have complete records were excluded. The door-to-balloon time involved in the calculation was calculated through the period between the arrival of the hospital and first balloon inflation and the categorization of the patients made it to include two groups; 90 minutes or less and above 90 minutes. WHO formula calculator, sample size was employed in the calculation of sample size, keeping in mind a level of confidence of 95 percent, and projected proportion which is based on past studies. Analysis of data was performed using SPSS version 26 and Chi-square test was applied.

Results: Out of 250 patients, 155 (62% to 95) patients in the cohort had a D2B time of 90 minutes or less and 95 (38) patients of time above 90 minutes, respectively. The overall in-hospital mortality stood at 20 (8%). There was greater mortality in the patients with D2B time greater than 90 minutes than those with D2B time less than 90 minutes ($p<0.05$).

Conclusion: Conclusion Long door-to-balloon time is linked significantly with in-hospital mortality in STEMI patients who receive primary PCI. Keywords Primary Keywords STEMI, Door-to-Balloon Time, Primary PCI, In-Hospital Mortality, Acute Myocardial Infarction, Reperfusion Therapy, Cardiology, Emergency Care.

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INTRODUCTION

The cardiovascular diseases are the morbidity and mortality leading causes in the world with a significant percentage of deaths globally every year. ST-Elevation Myocardial Infarction (STEMI) is one of the deadliest acute coronary syndrome forms, which cannot be treated without urgent medical care (Choi et al., 2022). STEMI is caused by the total blockage of a coronary artery, which causes a long-lasting myocardial ischemia and irreversible damages to the cardiac tissue unless there is timely reperfusion. Coronary blood flow restoration is thus required at an early stage to maintain myocardial functioning, decrease complications and enhance patient survival (Inoue et al., 2023).

Primary Percutaneous Coronary Intervention (PPCI) has now been recommended as the reperfusion intervention of choice in the patient with STEMI, especially when timely provided by well trained cardiology services. PPCI includes mechanical reopening of the blocked coronary artery by balloon angioplasty and in most cases, stenting which ultimately restores blood flow to the affected myocardium (Maimaitiming et al., 2024). Much clinical research has shown that PPCI is superior to thrombolytic therapy in that it reduces mortality, reinfarction and stroke when conducted in a short time after a patient has been presented (Bujak et al., 2023).

Door-to-Balloon (D2B) time is one of the most significant indicators of the quality and efficiency of the STEMI management**Error! Reference source not found.Error! Reference source not found.**. Time Door-to-balloon Time: This is the parameter that indicates the time gap between the arrival of a patient to the hospital and initial balloon inflation during PPCI (Tseng et al., 2024).The guidelines of the international cardiology (as well as the guidelines of such huge cardiovascular societies) state that the time interval between D2B is preferably 90 minutes or lower in case of patients walking directly to the hospital that can do the PCI. A decrease in D2B times correlates with a better myocardial salvage, smaller infarct size and better clinical outcomes (Yan et al., 2023).

Nevertheless, even with improved healthcare system and standardized STEMI protocols, delays in door-to-balloon time are still experienced within most hospitals, especially in the developing nations where the healthcare infrastructure and emergency responses systems might be insufficient (Thrane et al., 2023). The causes of long D2B time may be linked to some factors, such as the delay in the diagnosis, ineffective process of the hospital, the delay of the catheterization laboratory team activation, and the logistical impediments in emergency departments **Error! Reference source not found.**. Such delays may have high impact on patient outcomes, including extending myocardial ischemia and exposing patients to additional complications, including heart failure, arrhythmias, cardiogenic shock, and death (Fukui et al., 2023).

The in-hospital mortality is one of the critical outcomes measures in STEMI patients who require PPCI. Several studies have revealed that there is a high association between the long door-to-balloon time and high mortality rate (Alghamdi et al., 2023). Minimizing the waiting time of treatment has thus emerged as one of the primary targets of quality improvement efforts in cardiovascular care (Gibson et al., 2022). Constant control over D2B time and identification of factors related to delays can assist healthcare organizations in increasing the efficiency of treatment and patient outcomes**Error! Reference source not found.**.

In Pakistan and other least developed nations, there is little local data available about the correlation between door-to-balloon time and clinical outcome of STEMI patients who have undergone primary PCI (Movahed & Irilouzadian, 2023)**Error! Reference source not found.**. This association is vital in the local healthcare environment to understand how to enhance hospital practices and optimize the emergency care of the heart. Thus, the given research was carried out to assess the correlation of the door-to-balloon time with in-hospital mortality in patients who had ST-Elevation Myocardial Infarction and primary percutaneous coronary intervention in a tertiary care facility. The results of the given study can be used to define the role of delays in treatment and emphasize the role of quick reperfusion therapy in enhancing patient survival outcomes in the case of STEMI (Movahed & Irilouzadian, 2025).

OBJECTIVE

To establish the relationship between door-to-balloon time and in-hospital mortality in patients with STEMI receiving primary percutaneous coronary intervention.

METHODOLOGY

The research is descriptive cross-sectional research, which will be conducted in Punjab Institute of Cardiology, Lahore from January 2023 to July 2023. A total of 250 patients with ST-Elevation Myocardial Infarction (STEMI) and who were undergoing primary Percutaneous Coronary Intervention (PCI) were sampled in the study by non-probability consecutive sampling. The study had excluded the patients who had been given thrombolytic therapy before admission to the hospital, patients who had cardiogenic shock at the time of being taken to the hospital as well as patients with incomplete medical history. D2B time was the interval of duration between patient arrival to the emergency department of the hospital and the time-span of first inflating a balloon during PCI. D2B time was used to categorize patients as two groups: 90 minutes and above. The sample size was calculated using the formula

of the WHO sample size calculator of the level of confidence of 95 percent and the estimate proportion of the past studies. A structured proforma was used to collect the demography and clinical data to the study.

Inclusion and Exclusion Criteria

Inclusion Criteria**:** Included were patients who were aged 18 years and older with known ST-Elevation Myocardial Infarction (STEMI) and receiving primary percutaneous coronary intervention (PCI). Both sexes were recruited and full clinical logs, such as door-to-balloon time and in-hospital outcomes, were in the research environment.

Exclusion Criteria**:** Patients receiving prior thrombolysis, presenting with cardiogenic shock, or having previous coronary artery bypass grafting or PCI were excluded. Those with incomplete records, missing door-to-balloon time, unclear outcomes, or transferred after initial treatment elsewhere were also excluded from the study.

Data Collection

The information was collected depending on the patients who were identified with a confirmed diagnosis of ST-Elevation Myocardial Infarction and were administered primary PCI. The fact that administrative consent and ethical approval had been obtained assisted in the entering of patient information using a structured data collection form. Such demographic items as age, gender, and suitable clinical characteristics were noted. The clinical data was comprised of the time of arrival of the patient to the hospital, the time of inflation of the balloon, door balloon, comorbid and in-hospital outcomes. Patient follow-up was done when they were in the hospital to ascertain their survival. The door to balloon time was calculated by the hospital records and catheterization laboratory records. Patient files and hospital electronic records to verify the correctness and completeness to all the data collected were checked. The research was conducted in patient information confidentiality.

Data Analysis

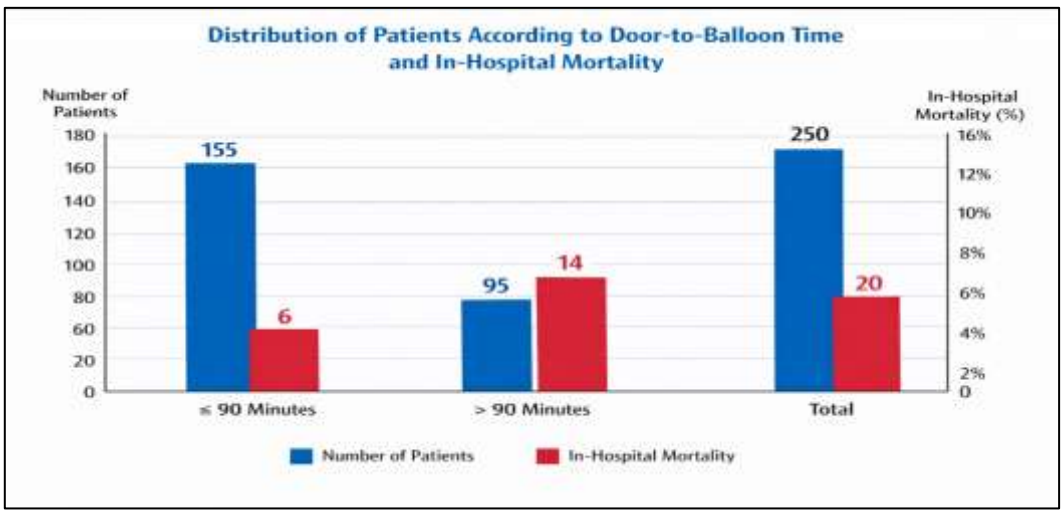
Data were analysed using Statistical Package of Social Sciences (SPSS) version 26. The quantitative variables such as age were reported in the form of standard deviation and mean. those variables that were categorical such as gender, categories of door to balloon times and mortality outcomes were reported as frequency and percentages. The classification of patients was based on the door to balloon time which was divided into less than 90 and above 90. Chi-square test was the method of establishing the relationship between door-to-balloon time and the in-hospital mortality. The p-value of below 0.05 was considered significant. The results have been presented in tables and percentages to enable easy interpretation of results. The possible confounding factors such as age and gender were also stratified to observe their effect on the mortality outcome of the patients suffering from STEMI and receiving primary PCI.

RESULTS

The study included 250 ST-Elevation Myocardial Infarction patients who are receiving primary PCI. The average age of the patients was 57.9112 years with most of them being males. Out of the participants, the door-to-balloon time of 155 patients allowed the door to balloon time of 62% and 95 patients with door to balloon time of 38%. The total in-hospital mortality was noted in 20 patients (8%). There was a high mortality of patients with door-to-balloon time exceeding 90 minutes in comparison to patients that were treated in a period of 90 minutes or less.

Table 1: Distribution of Patients According to Door-to-Balloon Time and In-Hospital Mortality

Door-to-Balloon Time	Number of Patients (n)	In-Hospital Mortality (n)	Mortality (%)
≤90 minutes	155	6	3.9%
>90 minutes	95	14	14.7%
Total	250	20	8%



The bar chart reveals that patients with the highest mortality (6) had a door-to-balloon 90 minutes and above (155). Patients with D2B time more than 90 minutes mortality was higher (14 deaths) and this emphasizes the risk of delayed treatment.

Table 2: Association Between Door-to-Balloon Time and In-Hospital Mortality (Chi-Square Test)

Door-to-Balloon Time	Mortality (Yes)	Mortality (No)	Total	p-value
≤90 minutes	6	149	155	
>90 minutes	14	81	95	
Total	20	230	250	**0.01**

reveals a very high mortality in patients with door to balloon time above 90 minutes than in 90 minutes and statistically significant correlation (p=0.01) is obtained, showing that delay in treatment predisposes the patient to mortality.

Table 3: Stratification of In-Hospital Mortality with Respect to Age Groups

Age Group (Years)	Mortality (Yes)	Mortality (No)	Total	p-value
≤60	8	142	150	
>60	12	88	100	
Total	20	230	250	**0.04**

indicates that in-hospital mortality was less in 60 years and above relative to 60 years and below, and the difference is significant (p=0.04), which indicates the role of age as a risk factor.

Table 4: Stratification of In-Hospital Mortality with Respect to Gender

Gender	Mortality (Yes)	Mortality (No)	Total	p-value
Male	15	165	180	
Female	5	65	70	
Total	20	230	250	**0.62**

According to, there was no significant difference in the in-hospital mortality between male and female patients (p=0.62), which means that gender did not have significant effects on mortality outcomes among STEMI patients receiving PCI.

Table 5: Stratification of In-Hospital Mortality with Respect to Diabetes Mellitus

Diabetes Mellitus	Mortality (Yes)	Mortality (No)	Total	p-value
Yes	11	79	90	
No	9	151	160	
Total	20	230	250	**0.03**

shows that diabetic patients and non-diabetic patients differ in the mortality rate in hospital and the relationship is significant (p=0.03), which means that diabetes is a significant risk factor of poor outcomes.

DISCUSSION

The current paper examined the correlation between door-to-balloon (D2B) period and in-hospital death in patients with ST-Elevation Myocardial Infarction (STEMI) undergoing primary percutaneous coronary intervention (PCI) (Furmento et al., 2023). The results indicated that the longer D2B time, the higher the prospects of in-hospital mortality, which argues the paramount role of timely reperfusion as one of the factors to enhance clinical outcomes.

In this investigation, 62 percent of patients had a D2B time of 90minutes and below, which is equal to the international suggestions on optimality of STEMI management. Nevertheless, there were significant numbers of patients (38%) who had delays that exceeded 90 minutes. The total in hospital mortality rate was 8% and it is comparable with other related studies and reports in the regions and internationally. Notably, the mortality rate in patients with long D2B time (>90 minutes) was much more important, which also supports the long-term known idea that time is myocardium (Emami et al., 2023).

These results agree with the earlier research which has revealed that the longer the delay in reperfusion therapy then the more the infarct size, less myocardial salvage and increased chances of cardiac failures, arrhythmias as well as death. Primary PCI restoration of coronary blood flow in the early phases is an important factor in the preservation of left ventricular function and survival. Thus, the reduction of delays during D2B time is one of the priorities of the STEMI care (Guo et al., 2022).

There might be several reasons behind high D2B time in our environment. These can be delayed presentation of patients, ignorance on cardiac symptoms, transportation, overcrowding of the emergency department, and lags in the activation of catheterization laboratory team. Also, treatment delays may be caused by the presence of

administrative and logistical inefficiencies in hospitals as well **Error! Reference source not found.**(Bawamia et al., 2023). The challenge of these factors can be handled through a multidisciplinary approach, which includes the publicity, better emergency health care, and the simplification of hospital procedures.

Stratification analysis in the given study also brought out significant results. The older patients were more likely to die with increased age, and this observation can be explained by the fact that multiple comorbidities were present, and older patients had less physiological reserve. Even though the largest part of the study population was male patients, gender was not a significant mortality factor (Yiadom et al., 2024). In addition, diabetes mellitus also demonstrated strong relationship with higher mortality rates, which is aligned with the current literature of diabetic patients having worse cardiovascular outcome because of endothelial injuries and faster atherosclerosis.

Strengths of this study are that the sample size is relatively good, and the standardized definitions of D2B time and clinical outcomes are used. Nevertheless, it has some limitations that are to be admitted. The study is a single-centre study; thus, it may not be applicable to other healthcare setting. As well, the cross-sectional design does not allow developing causality. The possible confounding variables like size of infarcts, differences in treatments and knowledge of the operator were not exhaustively investigated (Cervantes-Nieto et al., 2023). The study highlights the need to decrease the door-to-balloon time to increase the survival rates among STEMI patients despite these limitations The introduction of standard protocols, early diagnosis, fast triage, and activation of PCI teams at the right time can greatly decrease time delays in treatment**Error! Reference source not found.** (Jollis et al., 2022).

This paper confirms the available information that long D2B time is linked to the elevated rate of in-hospital mortality. The optimization of the processes in hospitals and delays in reperfusion therapy are the key factors that need to be worked on to improve the quality of care and outcomes of patients with ST-Elevation Myocardial Infarction (Kobayashi et al., 2022).

CONCLUSION

As the conclusion of this paper is, long door-to-balloon (D2B) time is highly correlated with in-hospital mortality in patients reporting ST-Elevation Myocardial Infarction (STEMI) and undergo primary percutaneous coronary intervention (PCI). Timely patients ones who were intervened within 90 minutes had a better survival consequence as compared to those with delays. The findings confirm the importance of the timely decision-making, the quick diagnosis, and the proper organization of the healthcare services in STEMI treatment. Despite the fact that there has been improvement in interventional cardiology, delays in D2B time still exist and have been a major problem particularly in regions of low resources. The means of solving this kind of delays is to streamline emergency response equipment, hospital services, and increase the awareness of people regarding early symptoms and early hospitalization. The quality indicator of D2B time can be tracked carefully to enable the healthcare institution to identify any gaps and use certain interventions. Overall, door-to-balloon optimization is the most important process to reduce mortality and improve the clinical outcomes of the STEMI patients receiving primary PCI.

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