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Original Article

Impact of Routine Case Volume on Door-to-Device Time for Primary PCI Patients: The Concept of a Designated Primary PCI Cath Lab at a Large Volume Cardiac Center

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Abstract

Background: Timely management of acute ST-elevation myocardial infarction (STEMI) is crucial, as prolonged door-to-device (DTD) time is directly related to worse cardiac outcomes. Institutions aim to achieve optimal DTD times as a measure of quality improvement.

Objective: This study aimed to evaluate the impact of a higher number of routine cases on the DTD time of acute STEMI patients presenting to a tertiary care cardiac center.

Methods: This retrospective observational study was conducted at the Peshawar Institute of Cardiology (PIC) in Peshawar. A total of 371 patients presented with acute STEMI over a three-month period, of whom 258 were included in the detailed analysis. Patient data, including baseline characteristics, arrival time, and device time, were obtained from the hospital database. Patients were divided into three groups based on their presentation timing: Morning (08:00 am to 02:00 pm), Evening (02:00 pm to 08:00 pm), and Night (08:00 pm to 08:00 am). The primary endpoint was to calculate and compare DTD time between these groups and evaluate the impact of routine case volume, especially during daytime hours.

Results: Out of the 258 patients studied, 194 (75.4%) were male, with a mean age of 58.2 ± 11.2 years. Hypertension was the most common risk factor, affecting 131 patients (50.7%). A higher number of cases presented during the night shift (n=99), followed by the evening (n=81) and morning shifts (n=78). The use of conventional right radial artery access (RRAA) was prevalent (n=239, 92.6%, p=0.032). The total mean DTD time was 90.78 ± 39.9 minutes, with shift-wise DTD times of 74.0 ± 29.6 minutes for the night shift, 98.97 ± 40.0 minutes for the evening shift, and 103.5 ± 44.0 minutes for the morning shift. Post-procedural TIMI-III flow was achieved in 90.9% of night shift patients, 86.4% of evening shift patients, and 82.0% of morning shift patients.

Conclusion: A higher number of routine cases resulted in prolonged DTD time. Establishing a designated catheterization lab exclusively for primary PCIs could improve DTD times and patient outcomes.

1 Introduction

In the treatment of ST-elevation myocardial infarction (STEMI), rapid reperfusion is paramount for improving patient outcomes, with percutaneous coronary intervention (PCI) being the preferred method of reperfusion (1). The American Heart Association (AHA) endorses a door-to-balloon/device time of less than 90 minutes, giving it a class 1 recommendation (2, 3). Achieving this time frame is a critical quality metric for healthcare institutions, and various programs have been implemented at institutional and national levels to meet this goal. In 2006, the American College of Cardiology (ACC), in collaboration with national partners, launched the Door-to-Balloon (D2B) Alliance, a campaign to improve D2B times, and in 2007, they introduced the Mission: Lifeline project to enhance door-to-device (D2D) times for STEMI patients (4, 5).

The D2D time is defined as the period from the patient's arrival at a PCI-capable hospital to the reperfusion of the culprit vessel through either balloon inflation or stent deployment (6). Several factors can delay D2D time, including the time taken to perform an ECG, obtain a brief medical history, conduct a prompt physical examination, activate the cardiac catheterization laboratory, and complete the procedure. In busy catheterization laboratories, especially in low- to middle-income countries with limited PCI facilities, the high volume of routine cases can significantly impact D2D times.

This study aims to evaluate the influence of routine case volume on D2D time by comparing times during different shifts: morning and evening shifts, which have higher routine case volumes, and night shifts, which have fewer routine cases. This research highlights the need for dedicated catheterization laboratories and teams exclusively for primary PCI to reduce D2D times and improve patient outcomes. By emphasizing the importance of a dedicated infrastructure for primary PCI, this study seeks to contribute to the ongoing efforts to optimize reperfusion strategies for STEMI patients.

2 Material and methods

This observational, retrospective study was conducted at the cardiology department of Peshawar Institute of Cardiology (PIC) after obtaining approval from the institutional ethical review committee (ERC). The study adhered to the principles of the Declaration of Helsinki to ensure ethical conduct. The primary aim was to assess the impact of routine case volume on door-to-device (DTD) time in patients presenting with acute ST-elevation myocardial infarction (STEMI) who underwent primary percutaneous coronary intervention (PCI).

The study population consisted of patients who presented to the hospital with acute STEMI and underwent primary PCI between March and May 2024. Inclusion criteria were patients who received primary PCI for STEMI, while those who underwent rescue PCI or received pharmacoinvasive therapy were excluded. A total of 371 patients were initially identified, but detailed analysis was conducted on 258 patients who met the study criteria.

Data collection involved the extraction of patient demographics, baseline characteristics, and clinical presentation from the hospital database using a preformed proforma. Arrival time was defined by the medical record number generation, while catheterization laboratory transfer time was noted from patient notes in the Health Management Information System (HMIS). Device time, defined as the time of balloon inflation or stent deployment, was retrieved from the DICOM® system. Patients were categorized into three groups based on their presentation timing: Morning (08:00 am to 02:00 pm), Evening (02:00 pm to 08:00 pm), and Night (08:00 pm to 08:00 am).

The primary PCI team was available round the clock and comprised a consultant interventional cardiologist, an instructor, an interventional cardiology fellow, a cardiology resident, a catheterization lab technician, a radiographer, nursing and support staff, and a cardiac surgeon for backup.

Statistical analysis was performed using SPSS version 25.0. Descriptive statistics were used to summarize categorical variables, reported as frequencies and percentages. Continuous variables were presented as means with standard deviations or medians with interquartile ranges, depending on the normality of distribution. The Chi-square test or Fisher's Exact test, where appropriate, was used to assess the statistical significance of categorical variables. Independent Student's t-tests were employed to evaluate differences in continuous variables between groups. A p-value of ≤0.05 was considered statistically significant.

This study sought to determine the relationship between the volume of routine cases and the DTD time across different shifts, thereby assessing the potential benefits of a designated catheterization laboratory for primary PCI procedures.

3 Results

In this study, a total of 258 patients with acute ST-elevation myocardial infarction (STEMI) underwent primary percutaneous coronary intervention (PCI). The cohort comprised predominantly male patients (n=194, 75.4%), with a mean age of 58.2 ± 11.2 years. Hypertension was identified as the most common risk factor (n=131, 50.7%), followed by diabetes mellitus (n=84, 32.5%).

The distribution of patients across different shifts was as follows: the night shift had the highest number of cases (n=99), followed by the evening shift (n=81), and the morning shift (n=78). The majority of patients presented with chest pain as the chief complaint (n=208, 80.6%), while other presentations included shortness of breath and apprehension. Acute anterior wall myocardial infarction (AWMI) was the most frequent diagnosis (n=108, 41.8%), followed closely by inferior wall myocardial infarction (IWMI) (n=107, 41.4%).

Table 1: Baseline Characteristics and Presentation

Variable	Morning Shift (N=78)	Evening Shift (N=81)	Night Shift (N=99)	Total (N=258)	P-Value
Age (years)	58.8 ± 9.8	58.9 ± 10.6	57.1 ± 12.4	58.2 ± 11.2	
Male, n (%)	53 (68.8%)	64 (79.0%)	77 (77.8%)	194 (75.5%)	0.263
Female, n (%)	24 (31.2%)	17 (21.0%)	22 (22.2%)	63 (24.5%)	
Hypertension, n (%)	37 (47.4%)	41 (50.6%)	53 (53.5%)	131 (50.8%)	
Diabetes, n (%)	27 (34.6%)	29 (35.8%)	28 (28.3%)	84 (32.6%)	
Smoker (current), n (%)	8 (10.3%)	7 (8.6%)	13 (13.1%)	28 (10.9%)	0.871
Ex-Smoker, n (%)	1 (1.3%)	1 (1.2%)	2 (2.0%)	4 (1.6%)	

Dyslipidemia, n (%)	12 (15.4%)	15 (18.5%)	22 (22.2%)	49 (19.0%)	0.820

The conventional right radial artery access (RRAA) was predominantly used as the default access route (n=239, 92.6%, p=0.032), with the highest number of cases (n=97, 97.9%) utilizing RRAA during the night shift. The angiographic findings indicated that the left main disease was present in 16 patients, with the left anterior descending (LAD) artery identified as the culprit artery in 131 patients. A total thrombotic occlusion with pre-procedural TIMI-0 flow was observed in 129 patients.

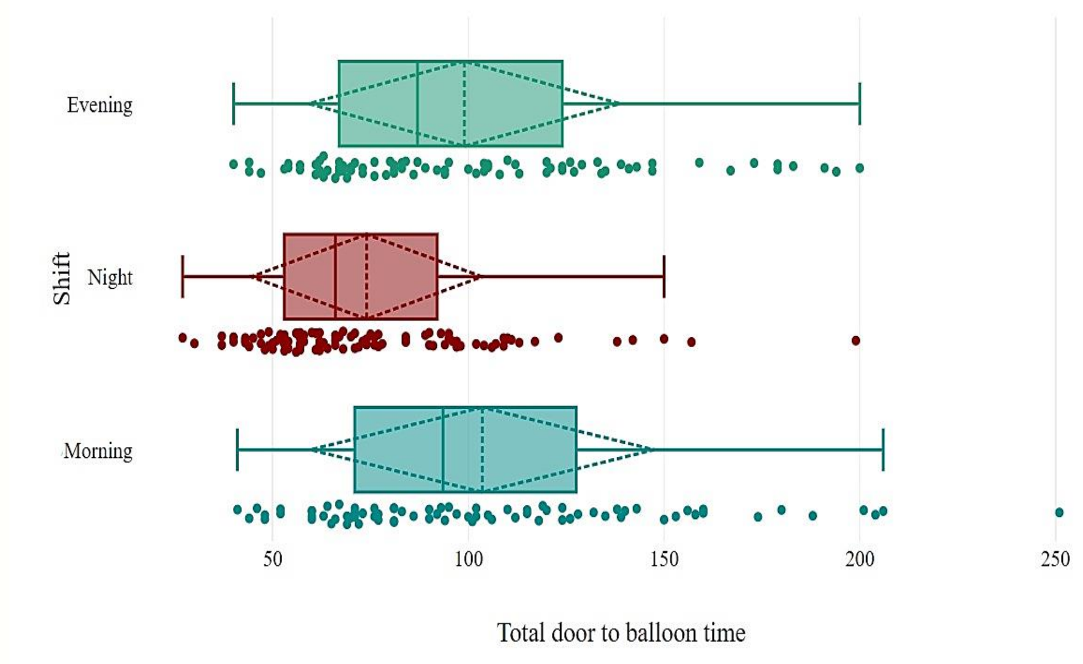

Figure 1: Shift vs Total door to balloon time.

Table 2: Angiographic Features

Feature	Morning Shift (N=78)	Evening Shift (N=81)	Night Shift (N=99)	Total (N=258)	P-Value
Radial Access, n (%)	69 (88.5%)	73 (90.1%)	97 (98.0%)	239 (92.6%)	0.032
Femoral Access, n (%)	9 (11.5%)	8 (9.9%)	2 (2.0%)	19 (7.4%)	
Left Main Disease, n (%)	4 (5.1%)	5 (6.2%)	7 (7.1%)	16 (6.2%)	
SVCAD, n (%)	33 (42.9%)	32 (39.5%)	51 (51.5%)	116 (45.1%)	0.111
DVCAD, n (%)	24 (31.2%)	36 (44.4%)	27 (27.3%)	87 (33.9%)	
TVCAD, n (%)	20 (26.0%)	13 (16.0%)	21 (21.2%)	54 (21.0%)	
Culprit Vessel: LAD, n (%)	36 (46.2%)	42 (51.9%)	53 (53.5%)	131 (51.0%)	0.622
LCX, n (%)	12 (15.6%)	10 (12.3%)	8 (8.1%)	30 (11.6%)	
RCA, n (%)	29 (37.7%)	29 (35.8%)	38 (38.4%)	96 (37.4%)	

The overall mean door-to-device time was 90.78 ± 39.9 minutes. DTD times differed significantly between shifts: 74.0 ± 29.6 minutes during the night, 98.97 ± 40.0 minutes in the evening, and 103.5 ± 44.0 minutes in the morning. Post-procedural TIMI-III flow was achieved in 90.9% of patients in the night shift, 86.4% in the evening shift, and 82.0% in the morning shift.

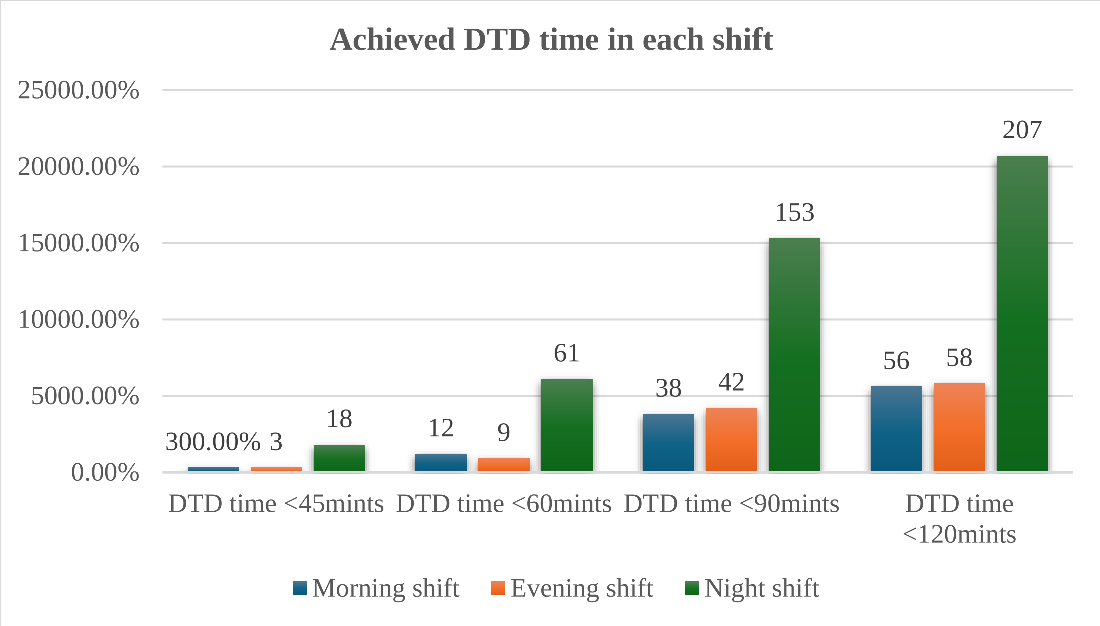

Figure 2: Achieved DTD time in each shift

Table 3: Door-to-Device Time and TIMI Flow

Parameter	Morning Shift (N=78)	Evening Shift (N=81)	Night Shift (N=99)	Total (N=258)	P-Value
Door-to-Device Time (minutes)	103.5 ± 44.0	98.97 ± 40.0	74.0 ± 29.6	90.78 ± 39.9	
TIMI-III Flow, n (%)	64 (82.1%)	70 (86.4%)	90 (90.9%)	224 (86.8%)	
No Flow or Slow Flow, n (%)	13 (16.7%)	10 (12.3%)	8 (8.1%)	31 (12.0%)	

In terms of complications, the morning shift experienced higher rates of in-hospital mortality (2.56%) and no-reflow or slow flow (16.7%) compared to the evening and night shifts.

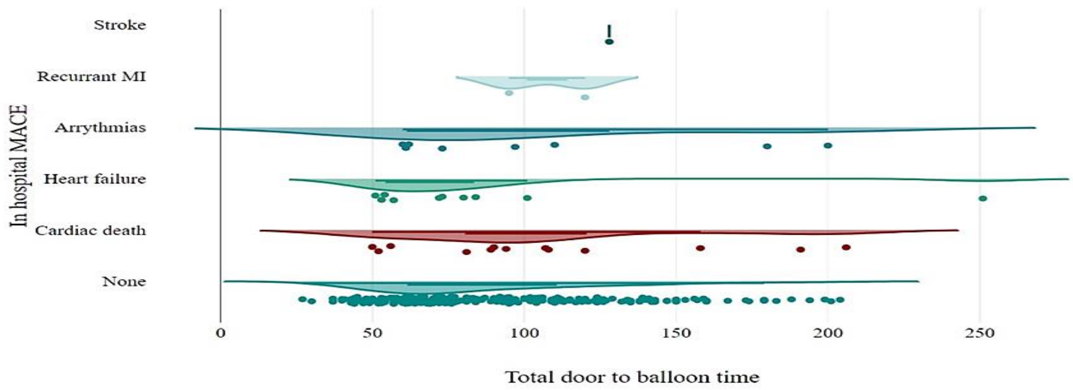

Figure 3: In hospital MACE vs Total door to balloon time

Total major adverse cardiac events (MACE) were higher in the morning shift (37.1%) than in the evening (25.9%) and night shifts (20.2%), though not statistically significant.

Table 4: Complications and MACE

Complication / MACE	Morning Shift (N=78)	Evening Shift (N=81)	Night Shift (N=99)	Total (N=258)	P-Value
Mortality, n (%)	2 (2.6%)	0 (0.0%)	0 (0.0%)	2 (0.8%)	0.098
Arrhythmias, n (%)	1 (1.3%)	0 (0.0%)	1 (1.0%)	2 (0.8%)	0.398
Perforation, n (%)	0 (0.0%)	1 (1.2%)	0 (0.0%)	1 (0.4%)	
No Flow or Slow Flow, n (%)	13 (16.7%)	10 (12.3%)	8 (8.1%)	31 (12.0%)	
Recurrent MI, n (%)	0 (0.0%)	1 (1.2%)	1 (1.0%)	2 (0.8%)	

4 Discussion

This study demonstrated that the volume of routine cases significantly impacted door-to-device (DTD) times in patients undergoing primary percutaneous coronary intervention (PCI) for ST-elevation myocardial infarction (STEMI). The findings showed that the night shift, which had a lower volume of routine cases, achieved significantly shorter DTD times compared to the morning and evening shifts. These results align with previous studies that have emphasized the importance of minimizing DTD time to improve patient outcomes (7, 9). The association between shorter DTD times and better outcomes, such as achieving post-procedural TIMI-III flow, underscores the critical role of timely intervention in STEMI management.

The study's strengths include its focus on a high-volume cardiac center and its assessment of the relationship between routine case volume and DTD time. This provides valuable insights into how operational factors can affect clinical outcomes in resource-constrained settings. The use of the right radial artery access as the default approach in most cases is noteworthy, as it aligns with current guidelines advocating radial access over femoral access due to its association with lower complication rates and improved outcomes (13, 15).

However, the study also had several limitations. Its retrospective and observational design may introduce selection bias and limit the ability to infer causality. Additionally, the study was conducted at a single center, which may limit the generalizability of the findings to other settings or populations. A multicenter, prospective study with a larger sample size would provide more robust evidence and help validate these findings.

Despite these limitations, the study highlights the need for dedicated catheterization laboratories and teams focused exclusively on primary PCI to reduce DTD times and improve patient outcomes. Implementing such changes could be particularly beneficial in high-volume centers where routine case burden affects the availability of resources for emergent cases. Additionally, further research is needed to explore other operational strategies that can enhance the efficiency and effectiveness of STEMI care.

The study also found that the total incidence of major adverse cardiac events (MACE) was higher in the morning shift, potentially due to the increased complexity and instability of cases presenting during this time. This observation suggests that patient complexity and clinical presentation variability could contribute to longer DTD times and poorer outcomes, emphasizing the need for tailored approaches to managing high-risk patients.

The findings of this study underscore the importance of operational strategies in optimizing DTD times and improving outcomes in STEMI patients. The implementation of a designated catheterization lab and dedicated teams for primary PCI could enhance the efficiency of care delivery, particularly in high-volume centers. By addressing the operational challenges associated with routine case volumes, healthcare institutions can achieve better patient outcomes and adhere more closely to established guidelines for STEMI management.

5 Conclusion

In conclusion, this study demonstrated a significant prevalence of gestational diabetes mellitus (GDM) among obese pregnant women, highlighting the strong association between higher BMI and increased GDM risk. These findings underscore the critical need for targeted screening, prevention, and management strategies to address obesity as a modifiable risk factor. By focusing on these interventions, healthcare providers can improve maternal and fetal outcomes, reducing the incidence of complications such as preeclampsia and cesarean delivery. Furthermore, addressing GDM effectively has long-term healthcare implications, potentially decreasing the risk of type 2 diabetes and cardiovascular diseases in mothers, and mitigating the intergenerational transmission of metabolic disorders to their offspring.

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Disclaimers	
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Trial Registration	NA
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