

Analysis of Door-to-Balloon (D2B) Time in STEMI Patients at EHCC Hospital

Introduction

ST-Elevation Myocardial Infarction (STEMI) is a severe cardiac event where timely intervention is critical to patient survival and outcomes. The internationally accepted benchmark for treatment is the Door-to-Balloon (D2B) time—the interval from a patient's arrival at the hospital to the restoration of blood flow via Primary Percutaneous Coronary Intervention (PCI). The guideline set by the American Heart Association (AHA) and European Society of Cardiology (ESC) is a D2B time of 90 minutes or less. Delays beyond this benchmark are strongly associated with increased mortality and morbidity. While this is a global standard, many hospitals, particularly in the Indian context, face significant systemic and operational challenges in consistently meeting this target. These challenges include infrastructural limitations, interdepartmental communication gaps, and a lack of uniform protocols. This study addresses the urgent need to analyze and optimize the D2B process within a specific Indian hospital setting, EHCC Hospital, Jaipur. The research aims to identify the root causes of delays and develop evidence-based recommendations to improve the STEMI care pathway.

Review of Literature

The literature review establishes the critical importance of D2B time, citing landmark studies such as **De Luca et al. (2004)**, which found that every 30-minute delay increases the mortality risk by 7.5%, and **McNamara et al. (2006)**, which confirmed better outcomes for patients treated within the 90-minute window. Key factors influencing D2B time are identified, including pre-hospital delays, patient-side barriers (**Mehta et al., 2015**), and in-hospital systemic issues like poor communication and inefficient workflows (**Bradley et al., 2006; Nallamotheu et al., 2007**). The review also examines proven strategies for D2B time reduction, such as empowering the Emergency Department (ED) to activate the Cath Lab and using single-call activation systems, as highlighted by the D2B Alliance campaign (**Krumholz et al., 2008**). Studies specific to the Indian context (**Gupta et al., 2019**) highlight a unique set of challenges that justify a localized investigation.

Theoretical/Conceptual Framework

This study is conceptually grounded in the principles of **Quality Improvement and Process Optimization** within healthcare systems. The central framework posits that Door-to-Balloon (D2B) time is a critical process metric that serves as a proxy for the overall efficiency and coordination of a hospital's emergency cardiac care system.

The framework is based on the following premises:

1. **D2B as a System Output:** D2B time is not the result of a single action but the cumulative output of a complex, multi-step process involving multiple departments (Emergency, Cardiology, Cath Lab).
2. **Process Variables as Key Determinants:** The primary determinants of D2B time are systemic and process-related variables (e.g., communication protocols, role clarity, workflow standardization, real-time feedback) rather than solely clinical skill.
3. **The PDSA Cycle (Plan-Do-Study-Act):** The study implicitly follows this quality improvement model by analyzing baseline performance (Plan), observing the effects of interventions (Do), evaluating the results (Study), and proposing recommendations for standardization (Act).

This framework allows the research to move beyond simply measuring D2B time to diagnosing the underlying systemic health of the STEMI care pathway and prescribing targeted management interventions.

Research Gap

Despite a global consensus on the importance of D2B time, the literature reveals a significant gap concerning localized, real-time performance data from the Indian healthcare context. While broad challenges in India are acknowledged, there is a scarcity of granular evidence detailing month-to-month variations in D2B times and the specific impact of process interventions within a single institution. This study aims to fill this gap by providing an in-depth analysis of D2B performance dynamics at EHCC Hospital, offering empirical data that is currently lacking.

Research Questions

1. What is the average Door-to-Balloon time for STEMI patients at EHCC Hospital?

2. Are there observable trends or variations in D2B times based on the patient's date of visit?
3. What are the specific, quantifiable reasons contributing to delays in D2B time at EHCC Hospital, and what qualitative insights explain these reasons?
4. How do EHCC Hospital's D2B times compare against established national and international benchmarks (e.g., the 90-minute target)?
5. What evidence-based recommendations can be proposed to optimize D2B times and improve STEMI patient care at EHCC Hospital?

Research Objectives

1. **To Quantify and Analyze D2B Performance:** To retrospectively calculate and analyze the mean, median, and variability of Door-to-Balloon (D2B) times for all STEMI patients who underwent primary PCI at EHCC Hospital between March and May 2025.
2. **To Identify Temporal Trends and Correlates of Delay:** To examine the monthly variations in D2B performance to identify trends and investigate the primary reasons for delays.
3. **To Benchmark Performance Against Established Standards:** To compare EHCC Hospital's monthly D2B time performance against the internationally recognized ≤ 90 -minute benchmark.
4. **To Evaluate the Impact of Process Interventions:** To assess the effectiveness of interventions implemented in April, such as early ECG protocols and direct ER-to-Cath Lab alerts.
5. **To Develop Actionable Recommendations for Sustained Improvement:** To formulate a set of specific, practical, and sustainable recommendations for process optimization and protocol institutionalization.

Methodology

This study will employ a **mixed-methods research design**. The quantitative component will be a **retrospective observational study** analyzing de-identified data from **35 STEMI patients** treated at **EHCC Hospital, Jaipur**, between March and May 2025. Key variables will include timestamps for patient arrival, ECG completion, and balloon inflation. The qualitative component will involve structured questionnaires and interviews with key personnel in the

Emergency Department and Cath Lab to provide context for the quantitative findings. This dual approach will allow for a comprehensive analysis of both the performance metrics and their underlying causes.

Plan of Analysis

The quantitative data will be analyzed using statistical methods. **Descriptive statistics** (mean, median, standard deviation) will be used to summarize D2B times and sub-intervals. **Frequency distributions** will be calculated to determine the percentage of cases meeting the 90-minute benchmark. **Trend analysis** will be performed to examine monthly variations in D2B times. Qualitative data from interviews will be thematically analyzed to identify recurring themes related to process bottlenecks and facilitators. The quantitative and qualitative findings will be integrated to provide a holistic interpretation of the results.

Tentative Chapter Plan

- **Chapter 1: Introduction:** Background of the Study, Problem Statement, Purpose of the Research, Aims and Objectives.
- **Chapter 2: Review of Literature:** Criticality of D2B Time, Factors Influencing D2B, Global Strategies, and Research Gaps.
- **Chapter 3: Methodology:** Research Design, Study Setting and Population, Research Procedures, Operational Definitions, Statistical Methods, and Ethical Considerations.
- **Chapter 4: Results:** Presentation of quantitative findings, including patient volume, monthly D2B performance, and trend analysis.
- **Chapter 5: Discussion:** Interpretation of results, comparison with other studies, system-level factors, limitations, and policy implications.
- **Chapter 6: Conclusion and Recommendations:** Summary of findings structured by research objectives and a list of actionable recommendations.
- **Chapter 7: References**
- **Appendices**