Original Article

Optimizing Door-to-Balloon Time in STEMI Care through Structured Quality Improvement at a Tertiary Centre

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Abstract

Background: Door-to-balloon (DTB) time is a key performance metric in the management of ST-elevation myocardial infarction, with shorter times strongly associated with improved myocardial salvage and reduced mortality. International cardiology guidelines recommend achieving DTB within 90 minutes for patients undergoing primary percutaneous coronary intervention. This quality improvement (QI) initiative aimed to identify determinants of delayed DTB time in a tertiary care hospital and implement structured system-level interventions. **Methods:** Root-cause analysis revealed delays related to financial clearance processes, off-hour Cath lab staffing, concurrent laboratory use, and delayed arrival of consultants and anesthesiologists. Interventions included workflow standardization, staff duty rosters, night supervision protocols, and real-time communication channels linking emergency, cardiology, Cath lab, and administrative teams. Monthly DTB times were monitored from September 2022 to December 2025. **Results:** Median DTB times exceeded 100 min during the baseline period (101–111 min) but decreased to 69–84.6 min following implementation of the QI interventions. Achievement of the recommended DTB target (<90 min) became more consistent throughout the postintervention period. **Conclusion:** A structured multidisciplinary QI strategy focusing on financial workflow reform, staffing readiness, and real-time interdepartmental communication was associated with substantial and sustained reductions in DTB time at a tertiary care center. Continuous monitoring, protocol reinforcement, and adaptive process refinement were essential to maintaining performance near internationally recommended targets.

Keywords: Emergency, quality, turn over time

Résumé

Contexte: Le délai entre l'arrivée à l'hôpital et le gonflage du ballonnet (« door-to-balloon », DTB) constitue un indicateur clé de performance dans la prise en charge de l'infarctus du myocarde avec sus-décalage du segment ST (STEMI). Des délais plus courts sont fortement associés à une meilleure préservation du myocarde et à une réduction de la mortalité. Les recommandations internationales de cardiologie préconisent d'atteindre un délai DTB inférieur ou égal à 90 minutes chez les patients bénéficiant d'une intervention coronarienne percutanée primaire. Cette initiative d'amélioration de la qualité (AQ) visait à identifier les déterminants des délais DTB prolongés dans un centre hospitalier de soins tertiaires et à mettre en œuvre des interventions structurées à l'échelle du système. **Méthodes:** L'analyse des causes profondes a mis en évidence plusieurs facteurs responsables des retards, notamment les procédures d'autorisation financière, la disponibilité du personnel du laboratoire de cathétérisme cardiaque (« Cath lab ») en dehors des heures ouvrables, l'utilisation simultanée du laboratoire pour d'autres procédures, ainsi que l'arrivée tardive des cardiologues consultants et des anesthésistes. Les interventions comprenaient la standardisation des flux de travail, l'établissement de tableaux de garde du personnel, la mise en place de protocoles de supervision nocturne et l'instauration de canaux de communication en temps réel reliant les services des urgences, de cardiologie, le laboratoire de cathétérisme cardiaque et les équipes administratives. Les délais DTB mensuels ont été suivis de septembre 2022 à décembre 2025. **Résultats:** Pendant la période de référence, les délais DTB médians dépassaient 100 minutes (101–111 minutes), mais ont diminué pour atteindre 69–84,6 minutes après la mise en œuvre des interventions d'AQ. L'atteinte de l'objectif DTB

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recommandé (< 90 minutes) est devenue plus constante tout au long de la période post-interventionnelle. **Conclusion:** Une stratégie structurée et multidisciplinaire d'amélioration de la qualité, axée sur la réforme des processus d'autorisation financière, la préparation des effectifs et la communication interdépartementale en temps réel, a été associée à une réduction substantielle et durable du délai DTB dans un centre de soins tertiaires. Un suivi continu, le renforcement des protocoles et l'adaptation progressive des processus se sont révélés essentiels au maintien des performances à des niveaux proches des objectifs recommandés au niveau international.

Mots-clés: Urgences ; qualité ; délai de prise en charge

Introduction

Cardiovascular disease remains the leading cause of death globally, and ST-elevation myocardial infarction (STEMI) represents one of the most time-sensitive manifestations of coronary artery disease.[1] Early restoration of coronary blood flow through primary percutaneous coronary intervention (PCI) is the preferred reperfusion strategy because it limits infarct size, preserves ventricular function, and improves survival.[2] The benefit of PCI is highly time-dependent, and the literature reports that there is a continuous relationship between treatment delay and mortality, even within the recommended timeframe.[3] For this reason, door-to-balloon (DTB) time, defined as the interval between hospital arrival and first balloon inflation, has become an internationally accepted quality metric.[4] Professional societies, including the American Heart Association, recommend a DTB time of 90 min or less.[5] Despite widespread acceptance of this target, on-ground performance is varied due to inefficiencies with operations, limitations of staff, and a fragmented healthcare system.[6] Factors that are nonclinical in nature, such as administrative processes and interdepartmental communication gaps, can further prolong DTB time, particularly in complex hospital environments.[7] Numerous quality improvement (QI) initiatives have demonstrated that structured process redesign, rapid team activation, and coordinated communication.[8] However, sustaining improvements remains challenging because delays often arise from multiple interacting system components. This study describes a multidisciplinary QI initiative undertaken at a tertiary care center to identify local determinants of DTB delay, implement targeted operational interventions, and evaluate longitudinal DTB trends relative to international benchmarks.

Methods

This manuscript was prepared in accordance with the Standards for QI Reporting Excellence (SQUIRE 2.0) guidelines. This QI initiative was conducted in a tertiary care hospital with round-the-clock emergency and interventional cardiology services, and involved a multidisciplinary task force comprising cardiologists, emergency physicians, anesthesiologists, Cath lab technologists, nursing staff, and hospital administrators. A structured root-cause analysis was performed to map the patient pathway from emergency department (ED) arrival to balloon inflation, with attention to time stamps for triage, electrocardiogram (ECG) acquisition, STEMI diagnosis, Cath lab activation, patient transfer, and procedural initiation. Key contributors to delay were categorized into administrative, logistical, and clinical domains. Administrative delays primarily involved financial clearance processes required before procedural initiation. Logistical delays included Cath lab team mobilization during off-hours, laboratory occupancy due to ongoing procedures, and transport coordination. Clinical team-related delays involved consultant cardiologist and anesthesiologist availability during emergency activations. Interventions were designed to address each domain systematically. Financial workflow optimization was implemented through predefined emergency clearance pathways and close coordination with the billing department. Prior to the intervention, patients undergoing primary PCI were routinely required to complete financial registration and obtain payment authorization before transfer to the Cath lab. During emergency presentations, this process frequently resulted in delays due to documentation requirements, insurance verification, payment processing, and communication between clinical and administrative departments. To address this barrier, an emergency financial clearance pathway was established, allowing immediate activation of the Cath lab and commencement of PCI while financial formalities were completed in parallel. Dedicated coordination between the emergency department, admissions office, billing services, and cardiology team was instituted to facilitate uninterrupted patient flow.

Staffing interventions included formalized on-call duty rosters for anesthesiology and Cath lab personnel, as well as strengthened night supervision to monitor response intervals. A real-time communication strategy was introduced using secure messaging groups linking ED physicians, cardiologists, Cath lab staff, admissions, and billing personnel to share Code Cardiac alerts and timestamp updates. As part of routine quality monitoring, only aggregate monthly DTB performance metrics were available for analysis. Patient-level demographic, procedural, and outcome data were not collected within the scope of this QI initiative. The primary outcome measure was median DTB time per month in minutes, with secondary observation of the proportion of months achieving ≤90-min performance. The following is the Plan-Do-Study-Act cycle for the study plan and execution-

Root cause analysis done, DTB was 101-111 minutes, plan formulated (September 2022–December 2022).

Results

Root-cause analysis identified financial authorization procedures as one of the most significant non-clinical

contributors to delayed reperfusion. Prior to implementation of the QI initiative, activation of the Cath lab was frequently deferred until completion of administrative and payment-related formalities. Following introduction of an emergency clearance pathway, financial processing was shifted from a prerequisite to a parallel process, enabling earlier patient transfer and procedural initiation. This change, together with staffing and communication interventions, was temporally associated with the marked reduction in DTB times observed during the postintervention period.

Baseline performance and intervention initiation

Prior to the implementation of targeted QI measures in late 2022, DTB times consistently exceeded the established 90-minute clinical benchmark. The median DTB times during the baseline period reached a peak of 111 min (October 2022), reflecting a significant deviation from international guidelines.

Following the initiation of operational reforms in early 2023, a prompt downward trajectory in DTB intervals was observed. By January 2023, the median time improved to 78 min, marking the first instance within the study period where the facility met the <90-min goal.

Longitudinal trends and sustainability

The improvements observed in early 2023 were largely sustained throughout the following 18 months. While periodic variability was noted – often correlating with high procedural volume or acute staffing constraints – the overall performance demonstrated greater stability near or below the recommended threshold. Notable performance peaks occurred in April 2023 (69 min) and April 2024 (66.1 min). The comparative data between the baseline and postintervention phases are summarized in Table 1.

Figure 1 shows the run chart demonstrating monthly median DTB times before and after implementation of QI interventions. The dotted vertical line indicates initiation of the QI program in January 2023. The dashed horizontal line represents the internationally recommended DTB target of <90 min.

Throughout 2023 and the first half of 2024, the temporal association between implemented system changes and improved DTB performance suggests that these operational reforms contributed meaningfully to observed clinical efficiencies. Despite intermittent increases, the median DTB time across the latter half of the study period remained consistently and significantly lower than baseline levels.

Discussion

Principal findings and systemic barriers

This QI initiative demonstrates that DTB delays are frequently driven by modifiable system-level inefficiencies rather than inherent clinical complexity.[9] Our findings suggest that targeted operational interventions can yield sustained performance improvements, even in resource-constrained environments.[10] A salient finding in this study was the role of financial clearance processes as a primary driver of delay.

Table 1: Median door-to-balloon times: Baseline versus postintervention

Study phase	Time period	Median DTB time (min)	Target achievement (<90 min)
Baseline	September 2022	101	No
	October 2022	111	No
	December 2022	102	No
Postintervention	January 2023	78	Yes
	April 2023	69	Yes
	June 2023	77	Yes
	December 2023	70.5	Yes
	2023 annual range	69–103	Variable
	April 2024	66.1	Yes
	July 2024	76.4	Yes
	December 2024	78.6	Yes
	2024 annual range	76–89	Yes
	January 2025	84.6	Yes
	April 2025	80.5	Yes
	July 2025	73.7	Yes
	December 2025	81.6	Yes
	2025 annual range	73–88	Yes

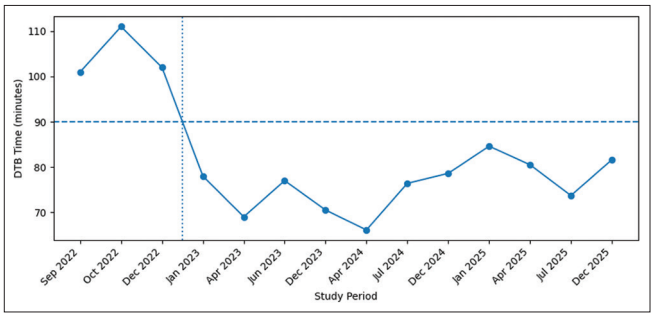


Figure 1: Run chart of monthly median door-to-balloon (DTB) times

This aligns with existing literature regarding health systems where administrative and insurance-related hurdles precede procedural authorization, creating a non-clinical bottleneck that compromises the "time is muscle" paradigm.[11]

A noteworthy finding of this study was the substantial contribution of financial authorization processes to treatment delay. Unlike many publicly funded healthcare systems where emergency reperfusion pathways are activated immediately upon diagnosis, healthcare delivery in several low- and middle-income countries often requires concurrent administrative and financial processing before high-cost interventions can proceed.[12] Consequently, delays may arise not from clinical decision-making but from operational requirements related to payment authorization, insurance verification, or admission formalities.[13] Recognizing this challenge, our institution introduced an emergency financial clearance pathway that enabled reperfusion therapy to proceed while administrative processes were completed simultaneously. This intervention addressed a locally relevant barrier that is seldom described in Western literature but may

be highly applicable across resource-constrained healthcare settings. The findings highlight the importance of considering financial workflow redesign as an integral component of STEMI quality-improvement programs in developing health systems.[14]

Impact of operational interventions

The observed improvements correlate strongly with the mitigation of off-hour staffing constraints. The implementation of structured on-call rosters and defined activation pathways likely neutralized the delays typically associated with nights and weekends, where team mobilization is historically protracted.[15,16] By protocolizing team activation, we reduced the "decision-to-action" lag, a result consistent with global benchmarks for high-performing primary PCI centers.[17,18] Furthermore, the introduction of real-time communication channels served as a catalyst for interdepartmental coordination. By replacing fragmented communication with a centralized, transparent platform, we fostered a culture of accountability and reduced the "interdepartmental friction" often cited as a barrier to rapid reperfusion.[19,20]

Sustainability and clinical implications

Despite the clear downward trend in DTB times, residual variability persisted. This highlights the inherent challenges of maintaining peak performance in dynamic hospital environments where fluctuating case volumes and resource constraints can occasionally disrupt even optimized pathways.[9] While this study was not powered to measure patient-level outcomes (e.g., mortality or infarct size), the reduction in DTB times carries significant clinical weight.[10,21,22] Our 30–40 min reduction in DTB time is comparable to the 22–35 min reductions reported by Namdar *et al*.[16] and Salarifar *et al*.,[19] suggesting that structured activation pathways remain effective across diverse healthcare settings.

Limitations and future directions

This was a single-center QI initiative, and the findings may not be generalizable to other healthcare settings. Only aggregate monthly DTB metrics were available for evaluation, and patient-level demographic, procedural, and outcome data were unavailable. Consequently, formal statistical comparisons between study periods could not be performed, and the impact of the interventions on clinical outcomes could not be assessed. Furthermore, because multiple interventions were implemented as part of a bundled QI strategy, the individual contribution of each intervention cannot be determined. Nevertheless, the sustained reduction in DTB times over an extended observation period provides practical evidence supporting the value of coordinated system-level process improvements.

Conclusion

A structured multidisciplinary QI strategy focusing on financial workflow reform, staffing readiness, and real-time interdepartmental communication was associated with consistent reductions in DTB time at a tertiary care center. Continuous monitoring, protocol reinforcement, and adaptive process refinement were essential to maintaining performance near internationally recommended targets. These findings emphasize that timely STEMI reperfusion depends not only on clinical expertise but also on coordinated hospital-wide operational efficiency.

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Conflicts of interest

There are no conflicts of interest.

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