

Six Sigma Approach to Reduce Door-to-Balloon Time for Patients With STEMI

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Each year, more than 300,000 patients worldwide experience an ST-segment elevation myocardial infarction (STEMI). Primary percutaneous coronary intervention (PPCI) is the gold standard for these patients, with a recommended door-to-balloon time (DTBT) of less than 90 minutes.¹ In a community-based hospital, we observed that only 76% of patients had a DTBT of less than 90 minutes despite CMS reporting a national average of 96%.² Subsequently, several individual steps from the emergency department arrival of a patient to deployment of the balloon in the catheterization lab were identified. Interventions were then designed based on the Six Sigma ideology to improve performance at each step by reducing SD. Here, we report the specific interventions and their impact on the DTBTs specific to the community setting.

We collected data on 243 consecutive adult patients (≥ 18 years) who presented with out-of-hospital STEMI between October 1, 2013, and December 31, 2017. In addition to the total DTBT, data were collected on time durations for several steps as outlined in the [Table](#). These data were collected using the CathPCI registry of the National Cardiovascular Data Registry after approval by the Institutional Review Board at Sinai Hospital of Baltimore in Baltimore, Maryland.³ The patients were divided into 3 groups: group 1 (preintervention group; n = 63; October 1, 2013, to September 30, 2014), group 2 (transition group; n = 14; October 1, 2014, to December 31, 2014; excluded from analysis), and group 3 (postintervention group; n = 166; January 1, 2015, to December 31, 2017). A Six Sigma approach was used for the primary end point of reduction in DTBT and the proportion of patients with DTBT less than 90 minutes and secondary end points of improvement in the time duration of each of the 7 steps mentioned in the [Table](#). All analyses were conducted using IBM SPSS Statistics for Windows version 22.0 (IBM Corp; Armonk, New York).

The mean age of patients was 63 years; 69% were male and 50% were black. Overall, the baseline demographics, comorbidities (including cardiovascular risk factors), and cardiac catheterization data were similar in group 1 and group 3. The individual steps, specific interventions targeting them, and their impact

TAKEAWAY POINTS

- ▶ Guidelines recommend a door-to-balloon time (DTBT) of less than 90 minutes for patients with ST-segment elevation myocardial infarction.
- ▶ We identified specific interventions using a Six Sigma approach that led to reduction in the overall mean (SD) DTBT (from 79 [52] to 57 [19] minutes; $P < .001$), with 99.4% (from 76.2%) of patients having a DTBT of less than 90 minutes. The reduction was sustained 3 years post interventions.
- ▶ The results now exceed the national and state average of 94% to 96% of patients having a DTBT of less than 90 minutes.
- ▶ Institutions in a community setting struggling to reduce their DTBT can adopt community hospital-specific interventions from this study to improve compliance.

with reductions in mean and SD are noted in the [Table](#). These interventions led to an overall reduction in DTBT from a mean (SD) of 79 (52) minutes in group 1 to 57 (19) minutes in group 3 ($P < .0001$), with 99.4% of patients in group 3 (vs 76.2% in group 1; $P < .0001$) achieving a DTBT of less than 90 minutes. No differences were observed in 48-hour postprocedure mortality or need for intra-aortic balloon pump.

DTBT has 3 key intervals—time from door to electrocardiogram (ECG), time from ECG to catheterization laboratory, and time from laboratory arrival to device—all of which are dependent on system factors that vary across institutions.⁴ In this study, we demonstrate successful customization of the generalized recommendations for STEMI DTBT reduction in the community setting using a Six Sigma approach. Although the change did not translate to decreases in postprocedural 48-hour mortality, the results now exceed the national and state average of 94% to 96% of patients receiving PPCI within 90 minutes. We anticipate that specific measures implemented at our institution will help other struggling community-based centers improve their DTBT and increase the percentage of patients receiving angiography within 90 minutes of arrival. ■

TABLE. Overview of the Individual Steps Involved From Patient Arrival in the ED to Balloon Deployment, Specific Interventions for Individual Steps, and the Effect of the Interventions on Time Spent at Each Step^a

| Individual Steps From Identification of STEMI to Balloon Deployment | Time in Minutes, Mean (SD) | | | P | Interventions |
|---|----------------------------|------------------|-------------------|------------------|---|
| | Group 1 (n = 63) | Group 2 (n = 14) | Group 3 (n = 166) | | |
| Patient arrival to ECG | 14 (27) | 13 (25) | 3 (5) | <.0001 | 1. Education to ED staff: total of 7 presentations done at the time of change of shift with mandatory attendance, focusing on identification of STEMI, importance of early intervention, and awareness about atypical presentations 2. Education handouts provided to all ED staff for early identification of acute STEMI |
| ECG to catheterization laboratory notification | 19 (32) | 13 (10) | 5 (8) | <.0001 | |
| Notification to arrival of catheterization laboratory staff | 11 (13) | 8 (13) | 9 (11) | .24 | 3. Parking spots for laboratory MD and nurse reserved near catheterization laboratory 4. Enforcement of MD response time to within 30 minutes of notification; in-house calls mandatory for MDs living more than 30 minutes away 5. Call schedule to include only the interventionalists with good response times |
| Notification to arrival of MD | 26 (19) | 23 (20) | 19 (14) | .002 | |
| Preparation of catheterization laboratory to arrival of patient in the catheterization laboratory | 15 (10) | 12 (7) | 14 (9) | .46 | |
| Arrival of patient and MD at catheterization laboratory to beginning of PCI | 9 (7) | 10 (6) | 10 (5) | .22 | 6. ED staff to transport identified cases with or without catheterization laboratory staff and to stay in laboratory until laboratory staff arrive |
| Beginning of PCI to balloon deployment | 15 (7) | 13 (5) | 16 (8) | .37 | |
| Total door-to-balloon time | 79 (52) | 65 (36) | 57 (19) | <.0001 | 7. Immediate feedback on every case with next-day emails regarding timings and outcomes, with immediate assessment of cases that failed to meet the cutoff times |

ECG indicates electrocardiogram; ED, emergency department; MD, medical doctor; PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction.

^aSignificant P values (P <.05) are in bold.

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Source of Funding: None.

Author Disclosures: The authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (TS, RoC, JG, AK, DM, RaC); acquisition of data (TS, RaC); analysis and interpretation of data (RoC, JG, DM, RaC); drafting of the manuscript (TS); critical revision of the manuscript for important intellectual content (JG, AK, DM, RaC); statistical analysis (RoC, RaC); provision of patients or study materials (TS); and supervision (JG, AK, RaC).

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