

Optimizing Door-to-Balloon Times

A useful measure of STEMI for hospitals of all levels.

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Reperfusion therapy improves survival in patients with ST-segment elevation myocardial infarction (STEMI). Improving the time to reperfusion decreases mortality rates for both fibrinolytic therapy and percutaneous coronary intervention (PCI).¹⁻³ PCI is the preferred method of reperfusion if it can be performed in a timely manner at high-volume centers.⁴⁻⁷ The benefits of PCI may decline with treatment delays,^{8,9} and therefore, the American Heart Association/American College of Cardiology (AHA/ACC) guidelines recommend a door-to-balloon time of ≤ 90 minutes for primary PCI.⁵

To improve the quality of STEMI care, there has been increased focus on strategies that both increase access to primary PCI and improve time to treatment, with particular emphasis on door-to-balloon time.¹⁰⁻¹³ The Health Quality Alliance program, a combined effort of the Centers for Medicare and Medicaid Services and the Joint Commission, has included door-to-balloon time as one of its core measures regarding quality of care in STEMI.¹⁴ The issue of time to treatment in STEMI is also being addressed by the ACC with the D2B Alliance (www.d2balliance.org) and the AHA with Mission: Lifeline.

THE IMPORTANCE OF TIME TO TREATMENT

The current AHA/ACC STEMI guidelines are based on preclinical and clinical data, which support the adage "time is myocardium." The time-dependent nature of myocardial necrosis after a coronary occlusion was first described in a canine model in the 1970s.¹⁵ This was

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confirmed clinically by the early fibrinolytic trials, which demonstrated that a delay in time to treatment translated directly to an increase in mortality.¹⁶ It is important to note that the degree of reperfusion plays a key role as well. The ability to re-establish normal coronary flow (TIMI grade 3 flow) has a direct effect on 30-day mortality rates, with a 3.7% mortality rate in patients with TIMI grade 3 flow, a 6.1% mortality rate in patients with TIMI grade 2 flow, and a 9.3% mortality rate in patients with a persistently occluded or minimal-flow artery (TIMI grade 0 or 1 flow).¹⁷ It is also clear that there is a time-dependent nature to time to treatment. In other words, the benefits of reperfusion are more pronounced in the first few hours after a coronary occlusion.¹⁸

Although time to treatment is important for both fibrinolytics and primary PCI, it may be less critical with primary PCI. Stenestrand et al showed that after a 2-hour time delay, the observed mortality reductions with prehospital fibrinolysis tended to decrease, whereas the benefits with primary PCI seemed to remain regardless of the time delay.¹⁹ In addition, the Swedish registry

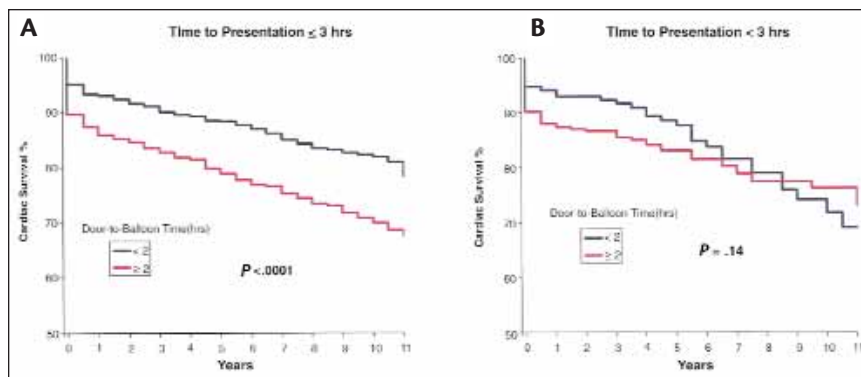


Figure 1. A comparison of door-to-balloon times based on when the patient presents to medical care in relation to symptom onset (A). Notice how door-to-balloon time becomes less important when presentation time is >3 hours (B).²⁰

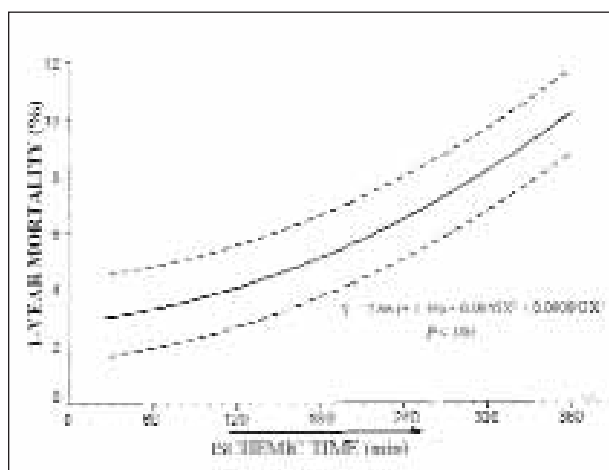


Figure 2. The relative risk of mortality in STEMI patients at 1 year increases 7.5% per 30-minute delay in time to treatment.²¹

data confirmed that primary PCI is a superior reperfusion strategy compared with fibrinolytics, whether performed in the prehospital or in-hospital setting at all time points. Brodie et al meanwhile showed that a >2-hour door-to-balloon time was associated with higher long-term mortality rates in high-risk patients (32.5% [≥2 hours] vs 21.5% [<2 hours]; hazard ratio, 1.53 [1.22–1.9]; $P=.0002$; median, 83-month follow-up) and in patients who present within 3 hours of symptom onset (24.7% [≥2 hours] vs 15% [<2 hours]; hazard ratio, 1.54 [1.24–1.9]; $P=.0001$). The door-to-balloon time appears to be less critical in low-risk patients or those who present after 3 hours of symptom onset (21.1% [≥2 hours] vs 18.5% [<2 hours]; $P=.8$) (Figure 1).²⁰

The overall time to treatment (total ischemic time) is the most critical factor in reperfusion therapy, but the time from symptom onset to hospital arrival is often difficult to quantitate. It has been challenging from a

system-improvement standpoint because it is so dependent on the patient. Therefore, it is not surprising that the focus has been on door-to-needle and door-to-balloon times.

Although the door-to-balloon time may be less critical in primary PCI compared to fibrinolytic therapy, it has been clearly related to mortality rates.^{2,3,21} Data from the National Registry of Myocardial Infarction (NORMI) suggest a near-linear relationship between door-to-balloon time and in-

hospital mortality rates, showing the relative risk of mortality from STEMI increases from 1 to 1.15 after a door-to-balloon time of 60 minutes to 1.41 after 120 minutes. Once the door-to-balloon time exceeds 150 minutes, the odds of in-hospital mortality increase to >1.6.² De Luca et al noted the relative risk of 1-year mortality from STEMI increases 7.5% per 30-minute delay in time to treatment (Figure 2).²¹ As previously noted, the door-to-balloon time is especially important in patients who present early or are high risk, such as patients with anterior myocardial infarction and the elderly.^{18,20}

The door-to-balloon time has become an important and effective tool to measure the quality of care of STEMI patients. Not only has it become one of the core measures for JCAHO, but it is the focus of the ACC D2B Alliance. Door-to-balloon time is a reasonable surrogate for mortality and is an excellent measure of a hospital's "system of care" for STEMI patients. Door-to-balloon time is a measure that is easy to determine and relatively reproducible for a specific hospital and, therefore, is a reasonable measure of the quality of STEMI care in a region, state, or country. In particular, it is an excellent tool to measure the quality of STEMI care over time.¹⁴ Therefore, it has become a key measure for pay-for-performance programs.

IS DOOR-TO-BALLOON TIME THE RIGHT MEASURE?

Door-to-balloon times may be a reasonable measure reflecting quality of care for STEMI patients, but there are potential pitfalls. Controversy remains regarding the appropriate definitions. A case can be made for using alternatives such as door-to-first angiogram, door-to-wire, or door-to-first device. Many cardiologists believe the best measure would be door-to-reperfusion (TIMI

TABLE 1. DOOR-TO-BALLOON TIME ACCORDING TO THE NUMBER OF KEY STRATEGIES USED*

No. of Strategies	Hospitals (N=362) With the No. of Key Strategies (No. [%])	Average of Key Median Door-to-Balloon Times† (min)
0	137 (37.8)	110
1	130 (35.9)	100
2	56 (15.5)	88
3	31 (8.6)	88
4	8 (2.2)	79

*Because the number of hospitals using three or four strategies was small, the precision of the estimates may be limited.

†P<.001.

grade 3 flow). If the infarct is patent with normal flow, is there a need to “race” to inflate the balloon? If you have TIMI grade 1 flow after inflation, is that really successful? Excessive emphasis on rapid door-to-balloon times may have the unintended consequence of inadequate evaluation of a complex patient or a higher prevalence of “false-positive” cardiac catheterization laboratory activations.²²

It is also important to remember the initiatives to improve door-to-balloon times provide information only on patients who undergo PCI. The definitions for which STEMI patients are reported have also changed, and a considerable number of STEMI patients are currently excluded, including transferred patients. These patients represent a large share of STEMI patients in the US.²³ There are a number of other important measures that should be considered in the quality of a hospital's STEMI program, such as “eligible but untreated patients,” false-positive catheterization lab activation, and clinical outcomes. These are important factors to consider as we enter the pay-for-performance era.

STRATEGIES AND REAL-WORLD MODELS TO OPTIMIZE DOOR-TO-BALLOON TIMES

Recent data from NRMI, a prospective registry reflecting current practice in the US, indicates that for hospitals with PCI capability, only 40% of STEMI patients undergo PCI within the recommended 90-minute door-to-balloon time. In STEMI patients who require interhospital transfer to a PCI center, only 4% have door-to-balloon times <90 minutes and 15% <120 minutes.²⁴ Moreover, door-to-balloon times have improved only modestly over time.²⁵ Recently, Bradley et al published

TABLE 2. EVIDENCE-BASED STRATEGIES: CORE OF ACC D2B ALLIANCE

- Emergency department physician activates the catheterization lab
- One call activates the catheterization lab
- Catheterization lab team ready in 20 to 30 minutes
- Prompt data feedback
- Senior management commitment
- Team-based approach

data from a cross-sectional study of 365 acute-care hospitals in the US. Using multivariate analysis, they identified six key strategies associated with significantly faster door-to-balloon times: (1) an emergency department physician activating the catheterization lab; (2) a single call to a central page operator activate the lab; (3) the emergency department activating the lab while the patient is en route to the hospital; (4) the lab team becoming available within 20 minutes of being paged; (5) an attending cardiologist always on site; and (6) the emergency department and catheterization lab staff giving real-time feedback.¹⁰ The median door-to-balloon time decreased as the number of key strategies used increased (Table 1). Based in part on these results, the ACC's D2B Alliance has provided recommendations to improve door-to-balloon times (Table 2).

Results from several regional transfer programs have recently demonstrated the real-world viability of these strategies to increase both access to PCI and improve time to treatment. For example, the Minneapolis Heart Institute at Abbott Northwestern Hospital initiated a region-wide standardized, organized rapid-transfer program for STEMI patients in 2003 that serves 31 community hospitals without PCI capability.^{26,27} The STEMI program utilized all six key strategies later determined by Bradley et al, and the results indicate that a standardized protocol can significantly improve door-to-balloon time, even for long-distance transfer patients.²⁷ For patients presenting directly to the PCI center, door-to-balloon times were well within guidelines, with a median of 65 minutes (n=297; interquartile range [IQR], 47–84). For patients transferred from distances ≤60 miles, median door-to-balloon times were 95 minutes (n=620; IQR, 82–116), and 120 minutes for patients transferred from 60 to as far as 210 miles from the PCI center (n=396; IQR, 100–145).²⁷ These results translated into excellent outcomes even for patients <210 miles from the PCI center. Similarly, the Reperfusion of Acute Myocardial Infarctions in North Carolina Emergency

Departments (RACE) investigators reported the success of a statewide system to improve the quality of care and increase access to timely reperfusion for STEMI patients.²⁸

CONCLUSION

Door-to-balloon times are an excellent measure of STEMI care for an individual hospital, state, region, or country. Current strategies to improve access to PCI and decrease door-to-balloon times should result in short- and long-term outcome improvements in STEMI patients in the US. ■

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