Reducing door-to-balloon time in ST-segment elevation myocardial infarction: are we missing the forest for the trees?

"...it is time to broaden the focus beyond a single metric of care. The 'door-to-balloon' time success story encourages further extrapolation and expansion to system-wide strategies that optimize community and hospital evidence-based ST-segment elevation myocardial infarction care."

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ST-segment elevation myocardial infarction (STEMI) remains a significant global health problem. In the USA alone, approximately half a million STEMI patients are admitted for treatment annually, which translates approximately to almost one STEMI per minute [1]. Up to a third of these patients do not survive the first 24 h after onset of ischemia [2].

Nevertheless, in-hospital STEMI mortality has declined over time with the introduction of reperfusion therapies and specialized coronary care systems. Initial pharmacotherapies proved effective in establishing early patency of the occluded infarct artery [3]. More recently, catheter-based interventions are able to achieve rapid and more consistent reperfusion [4]. While initially a topic of intense debate, evidence to date favors primary percutaneous coronary intervention (PPCI), when achievable in a timely manner, over fibrinolytic therapy as the mode of reperfusion, the former being associated with significant reductions in death, reinfarction and stroke. There is general consensus, however, that timing of reperfusion has a greater impact on patient outcomes than the mode of reperfusion.

Why should earlier reperfusion matter?

Coronary artery occlusion diminishes perfusion of downstream myocardium initially leading to myocyte ischemia, and ultimately to myonecrosis. After as little as 20 to 30 min, myocyte death occurs with an expanding 'wavefront' of ischemic cell death that is in proportion to total occlusion time [5]. While effect size is modifiable by factors such as the presence of coronary collaterals or ischemic preconditioning, most infarcts are complete and irreversible by 6 h from onset of vessel occlusion. Thus, from a mechanistic perspective, achieving early vessel patency limits the extent of myocardial injury.

The term 'door-to-balloon (DTB) time', defined as the time from first medical contact to the time of first coronary device deployment, has become a mantra of STEMI management. First medical contact, often poorly characterized in the field, is usually defined by time of hospital door arrival. Clinical trial and observational data have shown that shorter DTB times correlate with improved outcomes [6–8]. In the GUSTO-IIb clinical trial, 30-day mortality was 1.0% for PPCI performed within 60 min of study enrollment, 3.7% for PPCI between 61 and 75 min, 4.0% for PPCI between 76 and 90 min and 6.4% for PPCI performed after 90 min, the odds of death increasing 1.6-fold for each increasing time interval. A recent large registry study analyzed data from 43,801 patients in the American College of Cardiology (ACC) National Cardiovascular Data Registry (NCDR) and showed that adjusted in-hospital mortality was 3.5, 4.3, 5.6 and 7.0% for DTB times of 30, 60, 90 and 120 min, respectively [9]. Current ACC/American Heart Association (AHA) and European Society of Cardiology guidelines both recommend that PPCI be performed within 90 min of the patient's first contact with medical personnel [1,10].

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These guidelines have in turn been incorporated in quality improvement programs for STEMI care. DTB time fulfills many of the requirements of a good quality indicator, insofar as it correlates with relevant and important clinical outcomes, is easily measurable and can be influenced by specific interventions [11]. As such,

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the US Health Quality Alliance Program, a combined effort of the Centers for Medicare and Medicaid Services and the Joint Commission, includes DTB time among its core measures to assess the quality of STEMI care. Furthermore, pay-for-performance programs also use this metric to drive optimal care.

What is being done to reduce DTB time?

Early data from 1999 to 2002 among hospitals participating in the National Registry of Myocardial Infarction showed that only 35% of STEMI patients were treated within 90 min of hospital arrival, and less than 15% of hospitals had a median DTB time of less than 90 min [12]. With guideline updates and greater awareness of the need to shorten DTB times, subsequent data from the AHA Get-With-The-Guidelines (GWTG) registry showed an improvement in DTB times from 2002 to 2006. Yet despite this improvement, the proportion of patients treated within 90 min only increased from 36.2 to 58.8% (p = 0.003) [13].

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Regional and national initiatives have been designed to bridge this gap in performance. The ACC D2B: An Alliance for Quality™ (D2B Alliance) initiative, started in November 2006, is a network of almost 1000 US hospitals committed to achieving the DTB goal via a system of specific evidence-based targeted interventions [11]. These interventions included direct activation of the PPCI team by the emergency department (ED) physician, a single-call system to activate the PPCI team, the use of prehospital arrival electrocardiograms (ECG), the expectation that the PPCI team will arrive and be ready within 30 min from time of activation, having an onsite attending cardiologist and real-time data feedback to the ED and the catheterization laboratory. Follow-up data from the GWTG registry showed that between 2006 and 2008, the proportion of patients with DTB times less than 90 min increased significantly from 54.1 to 74.1% [14]. Interestingly, this improvement was seen even in hospitals not formally enrolled in the D2B Alliance, suggesting a 'spill-over' effect beyond participating hospitals. Globally, the message to reduce DTB times appears to have been well disseminated, and other successful initiatives to reduce DTB times have been reported in the literature [15–18].

What next?

Thus, the DTB story seems to be a fantastic example of evidence-based medicine in practice – a concept that was formulated based on pathophysiology, validated by clinical data and finally a target of successful quality improvement interventions leading to improvements in clinical outcomes. The increasing proportion over time of patients with a DTB times of less than 90 min underscores the fact that it is achievable. But why stop at 90 min – would not aiming for DTB times less than 60 min further improve outcomes?

The issue, of course, is feasibility; greater effort is required to reduce DTB time from 90 to 60 min than is required to go from 120 to 90 min. In the assessment by the D2B Alliance, prehospital processes such as use of prehospital ECGs were thought to be too challenging to implement as it would involve more complex interactions between hospital EDs and ambulance services, as well as restructuring of emergency medical training and equipment; all of this would require a large, upfront commitment of finances and resources. Even if all these challenges were tackled, would the effort and investment required to obtain incremental reductions in DTB times translate to substantial improvements in outcomes? The relationship between DTB times and mortality is not a linear one. In the ACC NCDR study, reductions of DTB times from 120 to 90 min, 90 to 60 min and 60 to 30 min were associated with a 1.3, 0.8 and 0.5% absolute reduction in adjusted in-hospital mortality, respectively [9]. There appears to be a diminution of absolute mortality reduction as DTB times became shorter and conceivably a point of diminishing return exists.

There is also a concern that too much emphasis on a single objective may lead to other important care processes being neglected. Data from the GWTG program show that while hospital DTB times have decreased significantly since implementation of initiatives such as the D2B Alliance, there was no correlation with improvement of other performance indices, and furthermore, no correlation with hospital-level mortality reduction [19]. These findings argue that quality improvement interventions need to be tailored to individual performance metrics.

Although some targets are complementary, extensive focus on changing the performance of a single measure may 'crowd out' institutional awareness and resources for other important care processes. In the face of finite healthcare resources, a more comprehensive and inclusive strategy looking at improvements in a variety of quality measures across the board would be more advisable than focusing on a single care process.

The AHA Mission: Lifeline program offers an example of a nationwide initiative directed towards improving several aspects of STEMI quality of care in the USA. It brings many of the stakeholders – patients, hospitals, emergency medical systems, payors and healthcare administration – to the table in an effort to improve overall healthcare system readiness and response [20]. Taking a step beyond hospital DTB times, this initiative strives to reduce symptom onset to balloon time, arguably a metric that more accurately reflects total ischemic time. As the majority of hospitals in the USA do not have 24/7 PPCI capabilities, many STEMI patients require interhospital transfer for reperfusion that further delays DTB time. This initiative also focuses on upfront triage and transportation logistics that can expedite treatment for patients without close access to PPCI.

Perhaps even more important than the emphasis on time to reperfusion is the sobering fact that up to a third of eligible STEMI patients currently still do not receive any reperfusion therapy [21]. System-wide improvements in reperfusion involve several facets of care. On the community end, public education programs highlighting symptom recognition and the importance of early presentation need to be expanded, particularly to high-risk patient populations. Resource reallocation to improve ambulance response and transportation times is necessary, especially to improve access to care in communities with known healthcare disparities. In geographically remote areas, primary reperfusion at pre-existing medical facilities merits consideration in suitable patients in light of emerging data showing that PPCI carried out without cardiac surgery support do not necessarily have higher rates of complications compared with PPCI performed at sites with on-site cardiac surgical capability [22].

In conclusion, DTB time is an important metric in the management of patients with STEMI. It has been and continues to be the target of quality improvement interventions, and has visibly shortened with associated improvement in patient outcomes. But it is time to broaden the focus beyond a single metric of care. The DTB success story encourages further extrapolation and expansion to system-wide strategies that optimize community and hospital evidence-based STEMI care.

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