

Optimizing Door-to-Balloon Time

How an academic teaching hospital system addressed the door-to-balloon time initiative.

BY AMAN ALI, MD; RYAN CUNNANE, MD; HANNAH WHITNEY, RN;
AND TIMOTHY A. SANBORN, MD, FSCAI

It is now widely recognized that the main goal in treating ST-elevation myocardial infarction (STEMI) is to restore perfusion in the affected coronary artery in less than 90 minutes to minimize the total ischemic time. The 1999 American College of Cardiology/American Heart Association (ACC/AHA) Guidelines for the Management of Acute Myocardial Infarction were the first to call attention to the use of primary percutaneous coronary intervention (PCI) in “a timely fashion.”¹ Later, the landmark study by Cannon in 2000,² used the National Registry of Myocardial Infarction (NRMI-2) database to show an improvement in in-hospital mortality if primary PCI was performed within 2 hours and a trend toward even greater improvement if it was performed within 90 minutes (Figure 1). The follow-up ACC/AHA recommendations in 2004 specifically recommended a “door-to-balloon time of within 90 minutes.”³ Despite these guidelines, a review of the NRMI-3 and NRMI-4 database registries (from 1999–2002) showed that 65% of patients were still experiencing delays in primary PCI beyond 90 minutes.⁴ In subsequent years, the AHA’s large national quality improvement effort, the Get With The Guidelines registry, showed an improvement in the percentage of door-to-balloon (D2B) times of less than 90 minutes—from 36.2% to 58.8% of all presenting STEMI patients.⁵ In November 2006, the ACC stepped up the effort to reinforce the guidelines with the ACC D2B: An Alliance for Quality (D2B Alliance) initiative.⁶ The D2B Alliance is a network of almost 1,000 hospitals in the United States that began with a goal to treat 75% of their nontransfer STEMI patients with primary PCI within 90 minutes. A follow-up study of the Get With The Guidelines registry between 2006 and 2008 demonstrated an increase in the percentage of patients with D2B

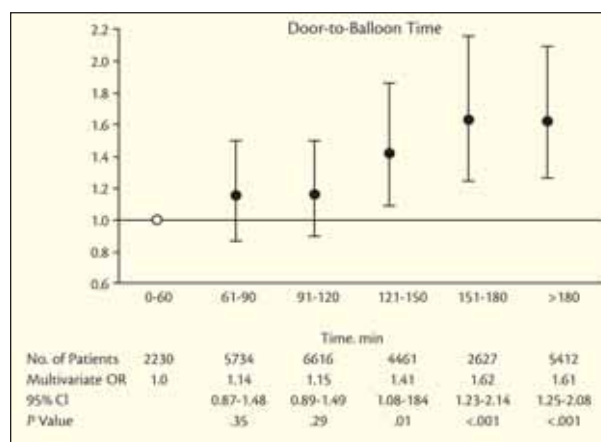


Figure 1. Relationship between time intervals and mortality. Reproduced with permission from Cannon et al. Relationship of symptom-onset-to-balloon time and door-to-balloon time with mortality in patients undergoing angioplasty for acute myocardial infarction. *JAMA*. 2000;283:2941-2947.²

times of less than 90 minutes—from 54.1% to 74.1%.⁷ This improvement was seen even in hospitals not enrolled in the D2B Alliance, possibly related to requirements in the Centers for Medicare & Medicaid Services core measures reporting. In this article, we review how we addressed the D2B initiative at each step in the process.

HOW NORTHSORE ADDRESSED D2B

NorthShore University HealthSystem is a group of four hospitals located in Chicago’s northern suburbs, consisting of Evanston Hospital (a 350-bed teaching hospital with two catheterization laboratories [cath labs]), Highland Park Hospital (a 239-bed hospital with one cath lab), Skokie Hospital (a 175-bed hospital with

two cath labs), and Glenbrook Hospital (a 143-bed hospital with one cath lab). Three of the hospitals have cardiac surgery available onsite (Evanston, Highland Park, and Skokie). Despite an awareness of the need for rapid reperfusion in patients with acute STEMI, we observed that the percentage of STEMI patients undergoing PCI at our institutions within 90 minutes was only 36% in late 2005. Because many individuals are involved in the care of STEMI patients from their arrival in the emergency department to reperfusion in the cardiac cath lab (CCL), we recognized that a team approach with the support of senior management was needed to improve our D2B results.

In January 2006, a team consisting of physicians, nurses, hospital administration, the quality improvement department, the communications department, and staff from the emergency department and CCL met together to prepare a plan. One of the first observations was that although we all had a common goal, each individual or department was seeing it from a different point of view and bringing a wide variety of interests to the table. The emergency department staff was concerned about focusing too much effort on a small percentage of patients moving through their busy department every day. On the other hand, the internists and cardiologists, who were accustomed to being responsible for determining the appropriateness of a cardiac procedure, were suddenly being asked to relinquish this decision making to someone else. Despite these multiple viewpoints, there was a common understanding that something needed to be done. Reviewing all of the D2B evidence-based strategies, the committee set out to evaluate each of them and to adopt those deemed most feasible. The first task was to divide each step in the care of a STEMI patient into preset time frames (Figure 2). This allowed separate consideration of the various points of care, development of specific process changes, and a format to implement and evaluate those changes. In the following sections of this article, we outline how our hospital system addressed the D2B initiative goals at each step of the STEMI treatment process, as well as our plans for future improvements.

DOOR TO ECG (5 MINUTES)

Currently, 42% of our STEMI patients do not enter our emergency department via emergency medical systems (EMS). These non-EMS, or “walk-in,” patients are particularly difficult because of the wide array of possible presenting complaints and the difficulty in moving them through the busy triage process. Our committee found that we were often missing patients presenting with atypical STEMI symptoms. Through the review

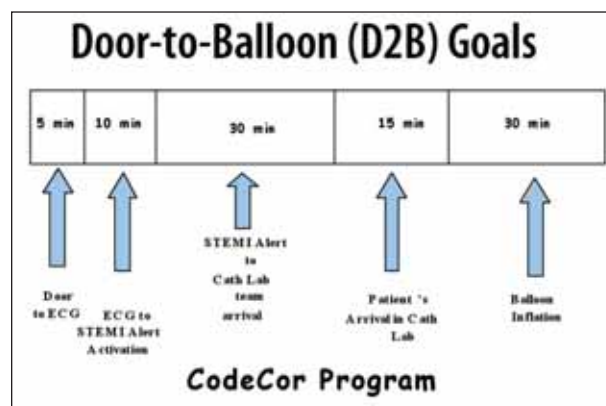


Figure 2. D2B goals.

process, we were able to see that the primary delay was in the time to first electrocardiogram (ECG) beyond the 5-minute goal. To address this deficiency, a protocol requiring ECGs for all non-EMS patients complaining of pain “from the waist up” was implemented (Figure 3F). We also found that we needed a way to identify STEMI patients rapidly when the emergency department was full. The triage room was not enclosed, and the performance of a 12-lead ECG was not feasible. In an effort to maintain a door-to-ECG time within 5 minutes, an extra small private room was appropriated near each triage area to assist in obtaining the ECG more rapidly (Figure 3E). This took more than a year to secure at each hospital. In addition, one emergency department staff member on the committee noted that a considerable amount of time was spent looking for an ECG machine, so another one was purchased. All of these efforts helped to improve our triage of non-EMS patients and minimize delays in the first step of the D2B goals.

An additional way to reduce door-to-ECG time is to perform the ECG at first contact with EMS. Because 85% of our EMS ambulances have 12-lead ECG capabilities, we investigated the use of various ECG transmission systems. However, due to the multiple EMS groups that service our hospitals, the cost was ultimately prohibitive. Other hospital systems have succeeded in activating STEMI teams based on the EMS assessment of the ECG; therefore, we are encouraging activation of our STEMI alert based on an EMS call to the emergency department whenever possible (Figure 3G). With activation by EMS, the alert can go out before patient arrival to the emergency department, allowing the team extra time to come in while the patient is being brought to the emergency department for evaluation and preparation for transfer to the CCL. This process was validated in a recent study from Denmark in which field triage

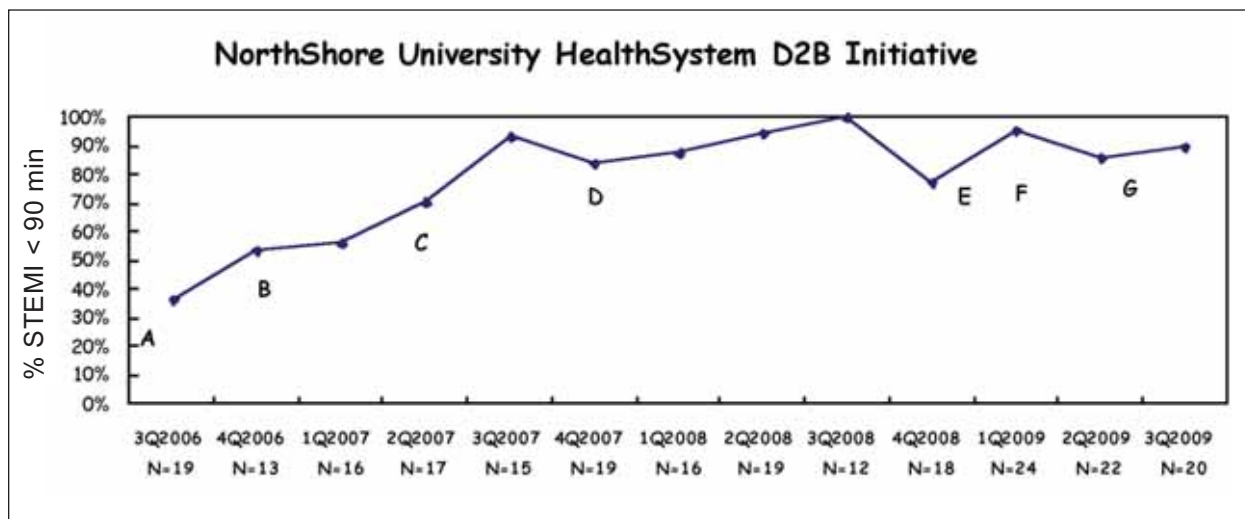


Figure 3. The NorthShore University HealthSystem D2B initiative: initial patient percentage (36%) (A); single-pager system (B); increase CCL team from 2 to 3 (C); concurrent reviews (D); ECG room near triage set-up (E); ECG with pain from waist to ear (F); and team activated by EMS call of STEMI (G).

not only reduced the time to treatment but also improved all-cause mortality or nonfatal MI.⁸ Furthermore, the recent 2009 ACC/AHA focused update for STEMI made a new class 1 recommendation for following standards developed by the AHA's national initiative (Mission: Lifeline), including a process for prehospital identification and activation.⁹

Future Plans

We are currently exploring whether streamlining the ECG test itself would improve times by testing an ECG glove (PhysioGlove ET, Commwell Medical, Evanston, IL) that fits on the patient's left arm, lies across his chest, and takes less than 1 minute to record a 12-lead ECG. We are also continuing to investigate ways to actively review these cases directly with EMS.

ECG TO STEMI ALERT (10 MINUTES)

Historically, the first and most difficult hurdle we found was cutting the time from STEMI identification to notification of the team. Previously, if an emergency department physician believed a patient needed to be treated for STEMI, he or she would first call the patient's internist, who would then ask the emergency physician to contact a clinical cardiologist, who would then, if treatment was indicated, ask the emergency physician to call an interventional cardiologist. Often, multiple fax transmissions of ECGs were involved, which delayed activation of the CCL team considerably. There were also different interventional cardiology groups on call at the same time, further complicating the decision as to which interventional car-

diologist to call. This method was obviously quite cumbersome and, given the multiple parties involved, required quite a few meetings to work out a solution. The first meetings were not easy and required strong leadership and extended negotiations. Eventually, relationships developed among the interventional cardiologists and the emergency department that first led to a single, shared on-call system and later allowed for direct emergency physician activation of the STEMI alert system.

With the CCL team already available 24 hours per day, 7 days a week, we just needed a method of contacting them more rapidly. To achieve this, a single-pager system was initiated to contact all the CCL staff and the interventional cardiologist at the same time (Figure 3B). Once this was put into place, we tried various ways of activating the single-paging system. At first, we had the emergency department secretary place the page and track the callbacks so they could place follow-up calls to nonresponders. After many trials, we found that operators having access to a dedicated phone line for all in-house emergencies was the fastest, and CodeCoronary (CodeCor) was born. In this system, the emergency department staff places a call to the code operator, who then activates pagers for the entire team from Smart Web (Amcom Software, Inc., Eden Prairie, MN) where the schedules of the on-call staff are posted. As the staff call in with their estimated time of arrival, the data are entered into the system. If someone does not call back within 5 minutes, the system triggers an alert that notifies the code operator, who then calls that staff member at home.

Future Plans

We are investigating the use of secure transmission of ECGs directly to the interventional cardiologist via cell phone.

STEMI ALERT TO CCL TEAM ARRIVAL (30 MINUTES)

To ensure CCL team arrival within 30 minutes of CodeCor activation, our present policy is to only hire staff that can arrive at the hospital within 30 minutes. In addition, the emergency department prepares the patient for transport as the team is on its way in. Preparation involves undressing patients, changing them into a snap-on gown, and connecting oxygen and a portable monitor with defibrillator pads.

“Historically, the first and most difficult hurdle we found was cutting the time from STEMI identification to notification of the team.”

We also found that staff parking was far away from the emergency department entrance and further contributed to the time it took for the team to be fully assembled. Surprisingly, we were unprepared for the many administrative difficulties encountered trying to correct this. Parking near the emergency department is considered prime real estate and any change to the established system required a great deal of support from upper management. After much negotiation, team members now have a card to hang on their rear view mirrors stating “Emergency Cath Team,” which they can use to park in the emergency department parking lot.

Future Plans

This issue requires constant supervision to maintain easy access to the emergency department for CCL team members, particularly during times of hospital renovation and construction.

CCL TEAM ARRIVAL TO PATIENT TRANSFER TO THE CATH LAB (15 MINUTES)

We also struggled to get the cath lab set up and the patient transferred to the lab with only two team members and the interventional cardiologist. Therefore, in late 2007, a third staff member was added to the team (Figure 3C). This additional team member has improved our efficiency considerably. After receiving a CodeCor page, everyone gets into their car before calling the

operator back with their estimated time of arrival. Each team member knows their on-call partners and has their phone numbers, allowing for coordination of responsibilities before arrival. The first team member to arrive at the hospital goes straight to the cath lab to set up, while the second and third team members go to the emergency department to assist with preparation and transport of the patient to the cath lab. Meanwhile, the interventional cardiologist calls the emergency department on their way in to discuss initial treatment options (anticoagulation, antiplatelet agents, beta blockers, etc).

We also found that there were occasions when the patient was ready for transport to the cath lab, and the interventional cardiologist had not yet arrived. Because the emergency physician could not leave the department, we added the intensive care unit (ICU) resident/hospitalist to the CodeCor pager list. These physicians now assist in transporting the patient to the CCL and remain with the patient until the interventional cardiologist arrives. Because all STEMI patients are transferred to the ICU after catheterization, involvement of the ICU resident/hospitalist early in the patient's presentation improved hand-offs and continuity of care, in addition to providing an opportunity for further house-staff education.

Future Plans

To foster the relationship between the CCL team and the emergency department, as well as to improve D2B times, we are encouraging the CCL team to give immediate feedback to the emergency department on the patient preparation and procedural outcomes after the conclusion of the case.

PATIENT ARRIVAL IN THE CATH LAB TO BALLOON INFLATION (30 MINUTES)

In preparation for a possible STEMI at night and on weekends, all equipment is set out for a PCI at the end of each day, with all sealed supplies laid out and ready to be opened. The addition of the third CCL team member has also made considerable improvements to this time interval. For example, when the patient arrives in the CCL, one staff member has already started to set up the room. During the procedure, the three-member team divides their specific duties. One member monitors and records, one member circulates, and the third member takes direct care of the patient. Occasionally, there are cases in which the culprit lesion is clearly indicated by the ECG. In such cases, the physician may forego the use of a diagnostic catheter and go in immediately with a guide catheter to save time in catheter exchanges.

Future Plans

Crew resource training, which has been used successfully in other areas of the hospital, would improve teamwork, workflow, and communication for all members of the CCL team.

REAL-TIME REVIEW

Another key component of the process is our real-time review of all cases (Figure 3D) at three different time points: (1) immediately after the conclusion of the case with the CCL team, (2) the following days with a broader audience, and (3) at the monthly D2B meeting. At the end of each case, physicians and staff review what worked well and where delays may have occurred anywhere during the process. An electronic form was developed that automatically calculates the times of all five D2B steps, and the CCL staff input the data at the conclusion of the case. When the form calculates the time, the staff receives immediate feedback on where problems appeared. They can then deliver this information back to the emergency department. The interventional cardiologist also frequently informs the emergency physician of the findings and eventual outcome. This discussion, with both positive and constructive feedback, not only updates the emergency department of the patient's status, but also strengthens the ties between the two departments. The day after each case, the electronic D2B form is also distributed to members of the D2B committee. The quality improvement department nurse then confirms the data and analyzes each step, looking for trends and system issues that can be addressed on an ongoing basis. This process identifies potential problems immediately and allows us to address them at that time without waiting for the monthly meetings. For example, the delay in the team arrival indicated a need for closer parking. On another occasion, there was a delay in the pager going off. A meeting with the communication department the next day revealed a new inexperienced staff member and the need for improved orientation and education. Finally, the monthly D2B committee meetings look for outliers of each specific time interval, not just cases of aggregate D2B time greater than 90 minutes.

CONCLUSION

Many of the process developments presented herein were the result of the identification of gaps and roadblocks in our D2B process. Because our goal is to keep best practice in the forefront, it takes all of us, working together, to succeed. Hopefully, some of the changes we initiated will be useful for others attempting to optimize their D2B time programs, practices, and performance measures. ■

Aman Ali, MD, is from the NorthShore University HealthSystem in Evanston, Illinois. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein.

Ryan Cunnane, MD, is from the NorthShore University HealthSystem in Evanston, Illinois. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein.

Hannah Whitney, RN, is from the NorthShore University HealthSystem in Evanston, Illinois. She has disclosed that she holds no financial interest in any product or manufacturer mentioned herein.

Timothy A. Sanborn, MD, FSCAI, is Head, Division of Cardiology, NorthShore University HealthSystem, and Clinical Professor, University of Chicago Pritzker School of Medicine in Evanston, Illinois. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein. Dr. Sanborn may be reached at (847) 570-2250; tsanborn@northshore.org.

1. Scanlon PJ, Faxon DP, Audet AM, et al. ACC/AHA guidelines for coronary angiography: executive summary and recommendations: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Coronary Angiography). *Circulation*. 1999;99:2345-2357.
2. Cannon CP, Gibson CM, Lambrew CT, et al. Relationship of symptom-onset-to-balloon time and door-to-balloon time with mortality in patients undergoing angioplasty for acute myocardial infarction. *JAMA*. 2000;283:2941-2947.
3. Antman EM, Anbe DT, Armstrong PW, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction—executive summary: a report of the ACC/AHA Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines on the Management of Patients With Acute Myocardial Infarction). *Circulation*. 2004;110:588-636.
4. McNamara RL, Herrin J, Bradley EH, et al. (The NRM Investigators). Hospital improvement in time to reperfusion in patients with acute myocardial infarction, 1999 to 2002. *J Am Coll Cardiol*. 2006;47:45-51.
5. Mehta RH, Bufalino VJ, Pan W, et al. Achieving rapid reperfusion with primary percutaneous coronary intervention remains a challenge: insights from American Heart Association's Get With The Guidelines Program. *Am Heart J*. 2008;155:1059-1067.
6. Krumholz HM, Bradley EH, Nallamothu BK, et al. A campaign to improve the timeliness of primary percutaneous coronary interventions: door-to-balloon: an alliance for quality. *JACC Cardiovasc Interv*. 2008;1:97-104.
7. Nallamothu BK, Krumholz HM, Peterson ED, et al. Door-to-balloon times in hospitals within the Get-With-The-Guidelines Registry after initiation of the Door-to-Balloon (D2B) Alliance. *Am J Cardiol*. 2009;103:1051-1055.
8. Pedersen SH, Galatius S, Hansen PR, et al. Field triage reduces treatment delay and improves long-term clinical outcome in patients with acute ST-segment elevation myocardial infarction treated with primary percutaneous coronary intervention. *J Am Coll Cardiol*. 2009;54:2296-2302.
9. Kushner FG, Hand M, Smith SC Jr, et al. 2009 Focused updates: ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction (updating the 2004 guideline and 2007 focused update) and ACC/AHA/SCAI guidelines on percutaneous coronary intervention (updating the 2005 guideline and 2007 focused update): a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2009;120:2271-2306.