EDITORIAL COMMENT

Improving Timeliness of and Access to Primary Percutaneous Coronary Intervention During All Hours

Mission Accomplished?*

Henry H. Ting, MD, MBA,†
Brahmajee K. Nallamothu, MD, MPH‡

Rochester, Minnesota; and Ann Arbor, Michigan

For patients with ST-segment elevation myocardial infarction (STEMI), primary percutaneous coronary intervention (PCI) achieves the best outcomes if delivered in a timely manner with a first medical contact-to-balloon time <90 min and by experienced operators at high-volume hospitals (1). Organized systems of care have been implemented in many countries to improve both timeliness of and access to primary PCI. Health care system delays related to diagnosis of STEMI in the pre-hospital or emergency

department setting, activation of the cardiac catheterization laboratory, and patient transport and transfer have been identified and mitigated (2). Consequently, first medical contact-to-balloon and door-to-balloon times have dramatically decreased, and more patients with STEMI are receiving primary PCI (3,4). However, the results of these systems of care on the efficiency and effectiveness of primary PCI during off-hours have not been fully studied. In organized systems, do patients with STEMI who present at 1:00 AM on Sunday have comparable timeliness of and access to primary PCI compared with patients who present at 1:00 PM on Monday?

Before organized systems of care were implemented, patients who presented during off-hours had longer door-

to-balloon times and higher mortality. Magid et al. (5) analyzed 33,647 patients with STEMI treated with primary PCI from the National Registry of Myocardial Infarction (1999 to 2002) and showed that door-to-balloon times were 21 min longer and adjusted in-hospital mortality (odds ratio [OR]: 1.07; 95% confidence interval [CI]: 1.01 to 1.14; p = 0.02) was higher for patients presenting during off-hours compared with those presenting during regular hours. In a more recent analysis of the National Registry of Myocardial Infarction (2000 to 2006), Fazel et al. (6) showed that, among 39,911 patients with STEMI, those presenting during off-hours were less likely to receive primary PCI (OR: 0.27; 95% CI: 0.25 to 0.29; p < 0.0001). During the past 5 years, many organized systems of care have been implemented and reduced delays in reperfusion with primary PCI (7,8). In 1 such system—the Mayo Clinic Fast Track STEMI program consisting of 30 hospitals in Minnesota, Wisconsin, and Iowa—reported door-to-balloon times for nontransferred patients were 65 min during regular hours versus 74 min during off-hours (p = 0.085) and for transferred patients were 118 min during regular hours versus 114 min during off-hours (p = 0.15) (9).

In this issue of *JACC: Cardiovascular Interventions*, Casella et al. (10) reported timeliness of primary PCI and mortality for patients with STEMI treated during off-hours (weekdays 8:01 PM to 7:59 AM, weekends, and holidays) versus regular hours (weekdays 8 AM to 8 PM) in the Emilia-Romagna regional network in Italy from 2004 to 2006. This regional network included 9 PCI-capable STEMI-receiving hospitals and 19 STEMI-referral hospitals (distances ranged from 12 to 58 km). Among 3,072 patients with STEMI, symptom onset-to-balloon times were 195 min versus 186 min (p = 0.03), and door-to-balloon times were 88 min versus 77 min (p < 0.0001) during off-hours and regular hours, respectively. The authors also reported that in-hospital cardiac mortality (5.8% vs. 7.2%, p = 0.11) and 1-year cardiac mortality (8.4% vs. 10.3%, p = 0.08) were comparable during off-hours versus regular hours, respectively.

Another important finding was that access to primary PCI increased from 582 patients treated during the first 6 months of 2004 to 732 patients treated during the first 6 months of 2006. Furthermore, the percentage of patients with STEMI who were not transferred to STEMI-receiving hospitals decreased from 26.7% during the first 6 months of 2004 to 15.5% during the first 6 months of 2006. Patients who were not transferred were older and had in-hospital mortality ranging from 25% to 35%, considerably higher than the 5% to 8% in-hospital mortality for those who were transferred and received primary PCI. Among these vulnerable patients who were not transferred, the use of any reperfusion therapy and the percentage who presented during off-hours were not reported. A future target for improvement for this regional network would be to better understand the clinical contexts of these patients, including:

Why were they not transferred? How were they treated? How many were eligible and received any reperfusion? And how can access to primary PCI be further expanded?

Finally, what should we make of the conclusion of the authors that mortality was comparable between off-hours and regular-hours patients with STEMI? The Emilia-Romagna regional network achieved rapid reperfusion times with primary PCI for off-hours patients, nearly matching the rapid reperfusion times it demonstrated during regular hours. Although the comparable mortality makes intuitive sense, we must be cautious in our interpretation, given the potential for confounding and selection bias. This analysis only included patients who received primary PCI and excluded 827 (20%) patients for missing data; 170 (4%) patients treated with both fibrinolysis and PCI; and an unknown number of patients who were treated with fibrinolysis alone, did not receive any reperfusion, and might have died out-of-hospital. There are some suggestions from the descriptive data that patients who presented during off-hours were less likely to receive primary PCI and were more likely to be excluded from the analysis. From 2004 to 2006, there was a 29% increase in use of primary PCI for patients who presented during off-hours versus a 22% increase for patients who presented during regular hours. Furthermore, patients who did not undergo primary PCI decreased from 27% in 2004 to 16% in 2006 but exhibited very high risk of in-hospital mortality ranging from 25% to 35%. It is unclear whether these patients included a higher concentration of patients who presented during off-hours. There is little plausible explanation for the observed trend for a lower mortality among patients who presented during off-hours compared with regular hours (OR: 0.70, 95% CI: 0.49 to 1.01), because comparable symptom onset-to-balloon times were observed. The most likely explanation is the presence of selection bias and preferential exclusion of patients who presented during off-hours, were of high clinical risk, and were not transferred for primary PCI.

Organized systems of care for patients with STEMI are being implemented in many countries, and the Emilia-Romagna regional network is a wonderful example of what is possible by achieving rapid door-to-balloon times regardless of time of day or day of week. But, an equally important finding is that 16% patients with STEMI were not transferred, were treated at the STEMI-referral hospital, and had striking in-hospital mortality of 25% to 35%. It is unclear how these patients were treated and how many received any reperfusion therapy. The American Heart Association, Mission: Lifeline initiative aims to promote the implementation of organized systems of care to improve timeliness of reperfusion therapy and increase the number of patients with access to primary PCI (11). In an organized system where primary PCI can be performed rapidly during all hours, focused efforts should be undertaken to ensure that this efficient system is available and accessible to all patients, regardless of whether the patient presents to an STEMI-receiving or STEMI-referral hospital at 1:00 in the morning or afternoon. Counterbalancing measures of reperfusion quality should include, in addition to first medical contact-to-balloon times, the percentage of patients treated with primary PCI as well as any reperfusion therapy. Assessments of mortality would be most informative at the population level for all patients with STEMI, regardless of time of day and type of hospital—PCI-capable or not.

Reprint requests and correspondence: Dr. Henry H. Ting, Division of Cardiovascular Diseases, Mayo Clinic, 200 First Street Southwest, Rochester, Minnesota 55905. E-mail: ting.henry@mayo.edu.

REFERENCES

1. Kushner FG, Hand M, Smith SC Jr., et al., American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. 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. J Am Coll Cardiol 2009;54:2205–41.
2. Bradley EH, Nallamothu BK, Herrin J, et al. National efforts to improve door-to-balloon time: results from the Door-to-Balloon Alliance. J Am Coll Cardiol 2009;54:2423–9.
3. Roe MT, Messenger JC, Weintraub WS, et al. Treatments, trends, and outcomes of acute myocardial infarction and percutaneous coronary intervention. J Am Coll Cardiol 2010;56:254–63.
4. Widimsky P, Wijns W, Fajadet J, et al. Reperfusion therapy for ST elevation acute myocardial infarction in Europe: description of the current situation in 30 countries. Eur Heart J 2010;31:943–57.
5. Magid DJ, Wang Y, Herrin J, et al. Relationship between time of day, day of week, timeliness of reperfusion, and in-hospital mortality for patients with acute ST-segment elevation myocardial infarction. JAMA 2005;294:803–12.
6. Fazel R, Krumholz HM, Bates ER, et al. Choice of reperfusion strategy at hospitals with primary percutaneous coronary intervention: a national registry of myocardial infarction analysis. Circulation 2009;120:2455–61.
7. Ting HH, Rihal CS, Gersh BJ, et al. Regional systems of care to optimize timeliness of reperfusion therapy for ST-elevation myocardial infarction: the Mayo Clinic STEMI Protocol. Circulation 2007;116:729–36.
8. Jollis JG, Roettig ML, Aluko AO, et al. Implementation of a statewide system for coronary reperfusion for ST-segment elevation myocardial infarction. JAMA 2007;298:2371–80.
9. Holmes DR Jr., Bell MR, Gersh BJ, et al. Systems of care to improve timeliness of reperfusion therapy for ST-segment elevation myocardial infarction during off hours: the Mayo Clinic STEMI Protocol. J Am Coll Cardiol Intv 2008;1:88–96.
10. Casella G, Ottani F, Ortolani P, et al. Off-hour primary percutaneous coronary angioplasty does not affect outcome of patients with ST-segment elevation acute myocardial infarction treated within a regional network for reperfusion: the REAL (Registro Regionale Angiolastiche dell'Emilia-Romagna) Registry. J Am Coll Cardiol Intv 2011;4:270–8.
11. Jacobs AK, Antman EM, Faxon DP, Gregory T, Solis P. Development of systems of Care for ST-elevation myocardial infarction patients: executive summary. Circulation 2007;116:217–30.

Key Words: door-to-balloon ■ percutaneous coronary intervention (PCI) ■ ST-segment elevation myocardial infarction (STEMI) ■ systems of care.