Achieving Rapid Door-To-Balloon Times
How Top Hospitals Improve Complex Clinical Systems

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Background—Fewer than half of patients with ST-elevation acute myocardial infarction (STEMI) are treated within guideline-recommended door-to-balloon times; however, little information is available about the approaches used by hospitals that have been successful in improving door-to-balloon times to meet guidelines. We sought to characterize experiences of hospitals with outstanding improvement in door-to-balloon time during 1999–2002.

Methods and Results—We performed a qualitative study using in-depth interviews (n=122) with clinical and administrative staff at 11 hospitals that were participating with the National Registry of Myocardial Infarction and had median door-to-balloon times of ≤90 minutes during 2001–2002, representing substantial improvement since 1999. Data were organized with the use of NUD-IST 4 (Sage Publications Software) and were analyzed by the constant comparative method of qualitative data analysis. Eight themes characterized hospitals’ experiences: commitment to an explicit goal to improve door-to-balloon time motivated by internal and external pressures; senior management support; innovative protocols; flexibility in refining standardized protocols; uncompromising individual clinical leaders; collaborative teams; data feedback to monitor progress and identify problems and successes; and an organizational culture that fostered resilience to challenges or setbacks in improvement efforts.

Conclusions—Several themes characterized the experiences of hospitals that had achieved notable improvements in their door-to-balloon times. By distilling the complex and diverse experiences of organizational change into its essential components, this study provides a foundation for future efforts to elevate clinical performance in the hospital setting. (Circulation. 2006;113:1079-1085.)

Key Words: health services research ▪ myocardial infarction ▪ quality

Recent evidence from the National Registry of Myocardial Infarction (NRMI) indicates that fewer than half of patients with ST-segment–elevation myocardial infarction (STEMI) are treated within guideline-recommended door-to-balloon times (time from arrival at the hospital to percutaneous coronary intervention [PCI]). Moreover, despite widespread publication of protocols for expediting reperfusion therapy, the percentage of patients with median door-to-balloon times within the guideline recommendations is not increasing. Meanwhile, with public reporting of door-to-balloon times of patients with STEMI who undergo PCI, hospitals are facing growing pressure to reduce treatment delays.

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Hospitals that excel in reducing door-to-balloon times may provide insights to other institutions that wish to improve this core indicator of quality of care for patients with STEMI. Door-to-balloon time reflects a complex clinical process requiring coordination across departments and disciplines to effect timely triage, diagnosis, and treatment of a critically ill patient. The key determinants to successful organizational change in this complex clinical process may differ from those found in less complex processes and have relevance for other clinical processes that require interdepartmental or interdisciplinary coordination.
Accordingly, we characterized the experiences of hospitals with marked improvement over a 4-year period and outstanding current performance to identify key themes in improving this complex clinical process. Using data from NRMI, we identified hospitals with median door-to-balloon times of ≤90 minutes for their most recent 50 cases and, among those, selected hospitals with the greatest improvement in median door-to-balloon time during 1999–2002. We then conducted site visits with in-depth interviews of clinical and administrative staff at each hospital to understand what they perceived as central factors in their improvement efforts. As is common in qualitative research seeking to characterize a specific phenomenon, we selected “information-rich” cases, ie, hospitals with substantial improvement and outstanding performance, to elicit key themes in their experience. We did not interview hospitals with poor performance because they had not experienced the phenomenon we sought to study and would therefore be unable to characterize features of improvement on the basis of their experience. The study design is descriptive, seeking to illuminate themes among top performers. Future quantitative studies are needed to test the degree to which these themes are statistically associated with improvement. Nonetheless, understanding how successful hospitals improved performance, including key impetuses for change and successful approaches to overcoming setbacks in the improvement process, can provide needed evidence to improve performance in hospitals that are lagging behind.

**Methods**

**Study Design and Sample**

We conducted a qualitative study using in-depth interviews6–7 of clinical and administrative staff at hospitals with exceptional performance and substantial improvement over time in door-to-balloon time for patients with STEMI treated with PCI. We chose the qualitative method because it is well suited for investigating complex interactions among people and characterizing organizational change.7–10 Our previously published article from the present study4 focused on specific process designs at these hospitals, which respondents viewed as critical to reducing door-to-balloon times. The present report focuses on the organizational context in which such process designs were implemented to identify recurrent themes in effecting such process improvements.

We used data from NRMI to identify participating hospitals with at least 50 patients with STEMI who were treated with primary PCI between January 1, 2001, and December 31, 2002 (n=151). We focused on hospitals with sufficient PCI volume to report a range of experiences with door-to-balloon times. From these hospitals, we selected those with median door-to-balloon times of ≤90 minutes for their most recent 30 PCI cases (n=35 hospitals) and ranked them by their improvement in median door-to-balloon times for all cases reported during the prior 4 years (January 1, 1999, through December 31, 2002). Consistent with the principles of grounded qualitative research,7 we did not select hospitals with poor performance because they would not be information-rich cases that could enhance the thematic description of performance improvement on the basis of their experience. In each hospital, we requested to speak with any staff who had been substantially involved with efforts to improve door-to-balloon time. We suggested that this might include the medical, nursing, and administrative leadership in emergency medicine, catheterization laboratory, cardiology, quality improvement, and general administration. Typically, the director of quality improvement was our first contact, and he or she recommended the key staff in the other areas. We interviewed approximately 10 to 12 individuals per hospital. We conducted site visits and in-depth interviews at the top-ranked hospitals until additional interviews produced no new concepts, ie, until theoretical saturation7 was reached. This occurred after visiting the first 11 hospitals in which we interviewed a total of 122 staff, including physicians, nurses, other clinical staff, and administrators. All of the initially selected 11 hospitals agreed to participate. The research procedures were approved by the institutional review board at the Yale University School of Medicine.

**Data Collection and Measures**

Members of the research team with extensive experience in performance improvement, cardiology, and qualitative interviewing conducted in-depth, open-ended interviews.6–7 In most cases, interviews were conducted with individual participants, although in some cases, at the request of the hospital site visit organizers, we conducted interviews in groups with 3 to 5 participants. The types of comments and concepts discussed did not differ substantially between individual and group interviews. We included 2 researchers in each interview, allowing one to conduct the interview and the other to prompt to clarify ideas and aid in subsequent review and interpretation of transcripts. Interviews began with a “grand tour” question, asking participants to describe what, if anything, had been done in the hospital during the last 4 years to reduce door-to-balloon times for patients with STEMI. We also asked about difficulties faced during these efforts, strategies used to overcome such difficulties, and how progress in reducing door-to-balloon time was maintained. As recommended by experts in in-depth interviewing,5,11,12 we used open-ended probes to elicit detailed stories about participants’ experiences with changing practices to improve door-to-balloon time. The 1- to 1.5-hour interviews were audiotaped and transcribed by an independent, professional transcriptionist.

**Data Analysis**

We used the constant comparative method of qualitative data analysis6–13,14 to develop and implement consistent and comprehensive coding of the open-ended data. The constant comparative method is an approach to conducting qualitative data analysis in which verbatim quotations or observations are cataloged into their essential concepts with the use of codes developed iteratively to reflect the data. As additional open-ended data are reviewed, sections of the transcripts are constantly compared with previously coded sections to ascertain whether the same concept(s) is apparent and thus the same code(s) assigned. This “constant comparison”6,7,14 of data helps to flesh out and refine the properties and dimensions of existing codes, as the researcher expands or narrows particular code definitions, and helps to identify and name new codes to fit the concepts emerging from the data. The processes of code list development and code assignment are often conducted by a team of researchers with diverse backgrounds working together to promote more in-depth discussion and refined understanding of the conceptual content of the data.

In this study, line-by-line review and coding of interview transcripts were accomplished by 3 to 4 researchers (E.H.B., T.R.W., and the 2 researchers who conducted the site visit for the specific hospital) who had diverse backgrounds including cardiovascular and internal medicine, emergency medicine, nursing, quality improvement, organizational psychology, public health, and health services research. All transcripts were coded first independently by 3 to 4 researchers and then in group sessions to negotiate consensus when there were differences in independent coding. This process, recommended by experts in qualitative research,15,16 ultimately produced a single agreed-on set of coded transcripts. We developed codes in steps, based first on detailed review and discussion of data from the first 2 site visits and then expanded with review of transcripts from successive site visits. The full research team reviewed the code structure and definitions 3 times during the study to ensure comprehensiveness and clarity. The process of refining codes and describing the properties and dimensions of each continued until we found no new concepts in remaining transcripts, as recommended by experts in qualitative data analysis.17,18 We documented the development of the coding structure, code definitions, and principles we used in
applying the codes and memos concerning relationships among codes in an “audit trail.” Using the coded data, we summarized key themes, or recurrent and unifying ideas, that described the hospitals’ experiences. We entered all data in NUD-IST 4 (Sage Publications Software) to facilitate review, analysis, and reporting. The authors had full access to the data and take full responsibility for its integrity. All authors have read and agree to the manuscript as written.

Results
The characteristics of the hospitals (n=11) and interviewees (n=122) are shown in Tables 1 and 2, respectively. Table 1 shows the median door-to-balloon times for the last 50 PCI cases for the 11 hospitals. The Figure shows the annual improvement in median door-to-balloon times for available NRMI data since 1999 for the 11 hospitals. Interviewed staff included physicians (19%), nurses (30%), quality improvement and other clinical support staff (15%), and administrators (36%). All hospitals were committed to PCI as the preferred treatment approach for STEMI and engaged in substantial, ongoing performance improvement efforts. Through the qualitative analysis, 8 themes emerged that were recurrent and unifying ideas and characterized the experiences of improving door-to-balloon times in the study hospitals. These themes were apparent in all 11 hospitals.

Key Themes Characterizing Experiences in Hospitals

Explicit Goal of Reducing Door-to-Balloon Time
Hospital staff indicated that their organizations had an explicit goal of reducing door-to-balloon time and that the presence of this shared organizational goal was critical to motivating and sustaining improvement efforts.

This is a part of the culture of the organization in that time to reperfusion needs to be excellent. When we all have the same goal and we know how the data are being

![Graph showing trend in median door-to-balloon times (1999–2002) for 11 study hospitals. (One hospital was not enrolled in NRMI in 1999, and 2 hospitals were not enrolled in NRMI in 2002.)]
gathered, we trust the system. We say, “Here’s where we are. This is where we’re going. We can continue to improve because this is our goal.”

—Vice President, Cardiology Services

Explicit goals initially developed at the level of individual staff and teams in response to scientific literature and hospital performance data indicating that current door-to-balloon times were unacceptably long. However, over time the goals to reduce door-to-balloon time grew into shared organizational goals. Participants described that the adoption of reducing door-to-balloon time as an organizational goal was in part due to external pressures such as public performance reporting, Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requirements, and market competition based on quality. One physician described the following:

“All of a sudden, the hospital’s interested, and we are having meetings with a lot more people than I kind of pulled together in the hallway. People said, “JCAHO is going to monitor this and it might be published in U.S. News & World Report.” For me, it was like, “Hallelujah! I’m invited to a meeting on angioplasty and everyone’s going to be there.”

—Medical Director, Emergency Services

Visible Senior Management Support
Senior management at these hospitals took an active and ongoing interest in door-to-balloon time, considering it an indicator of overall hospital performance. The senior management support was viewed as critical at times when improvement efforts were slowed by staffing issues, space limitations, or resistance among individuals to implementing recommended changes in clinical processes. Tangible signs of senior management support included provision of resources (eg, on-call compensation for catheterization laboratory teams, additional ECG equipment), increasing the visibility of performance data (eg, regular presentation of door-to-balloon time data to senior management and the board), and addressing individuals’ resistance to recommended changes.

“It is important to have the expectation that the senior management is going to work on the individuals who aren’t putting out what they need to put out to reduce door-to-balloon time. Holding people accountable: I think that’s the role of administration, to provide human and other kinds of resources that are needed, but also, because of their authority, they can make things happen that individuals cannot.

—Medical Director, Emergency Services

Innovative, Standardized Protocols
Hospitals had specific, focused initiatives to redesign existing processes and protocols for treating patients with STEMI. Hospital staff used diverse quality improvement techniques such as root-causes analysis,19 flowcharting, and brainstorming to develop and refine protocols. Developing protocols often involved breaking the full process of door-to-balloon time into smaller segments such as door-to-ECG, ECG-to-decision, decision-to-laboratory, and laboratory-to-balloon:

All of us got together and came up with the steps to get a patient from the emergency room to the cath laboratory. We broke it into 8 or 9 steps. At each one of those spots on the time line, we decided on a certain number of minutes that we were going to allow, and then we saw if we lived up to that. As we found out where the delays were, we were able to minimize those delays.

—Cardiologist

The development of these protocols fostered several innovations. Examples of innovations included tackle boxes for the Emergency Department with needed medications, equipment, and step-by-step procedures for STEMI care; “Heart Alert” or an overhead paging system to prepare all parts of the hospital for the arrival of patients with STEMI; periodic rehearsals with play-acting patients pretending to have STEMI to test the system; protocols for catheterization teams to be ready to start within 20 minutes of a page; and color-coded floor plans in the Emergency Department and catheterization laboratory to ensure that equipment was always stored in the same location for easy access. Innovations also extended beyond the hospital including coordinating with Emergency Medical Services and referral hospitals to increase the number and usefulness of prehospital ECGs. Several hospitals helped to develop systems for paramedics to do 12-lead ECGs in the field, call in or transmit ECG findings to the Emergency Department, and have the catheterization team activated on the basis of prehospital ECG findings.

Flexibility in Implementing Standardized Protocols
Hospital staff also continuously refined standardized protocols, demonstrating flexibility in how such protocols were implemented over time. Although protocols called for a standard set of procedures, hospital staff frequently experimented with changes to the protocols based on rapid-cycle feedback, with staff trying new procedures and measuring their impact. Examples of such experimentation were having Emergency Medical Services paramedics call in prehospital ECG results rather than send a facsimile; using on-call lists that included only interventional cardiologists; and alternative rules for transporting patients from the Emergency Department to the catheterization laboratory. Successful strategies were integrated into standard protocols; unsuccessful strategies were dropped. As one medical director stated,

“This is a continual thing: you never finish this. Even though we refine the process and we think we’ve got it down pat, things continually change, so we continually look at how we’re doing things and refining the process.”

—Catheterization Laboratory Nurse

Uncompromising Individual Clinical Leaders
Central to improvement efforts were 1 or more clinical leaders who were extremely committed, tenacious, and uncompromising in their efforts to improve door-to-balloon time. These included physicians and nurses who were viewed as “pushers” and “drivers.”

Dr [name], an interventional cardiologist, thought you could always do it better, bigger, faster, stronger.
beat that to the death—door-to-balloon time. We all had the message. There were no ifs, ands, or buts. He was pretty much a standout, and his input changed the practice. It’s now the standard.
—Director of Pulmonary Services

In addition to their tenaciously, clinician leaders were typically highly respected clinicians who were persuasive with their peers. The clinician leaders were also willing to monitor performance and talk with individuals and teams about how to improve their performance.

Dr [name] is not hesitant about putting reports in front of cardiologists. I’m sure he does it very tactfully. He has a very nonpunitive way about approaching people. He brought people on board to achieve our goal.
—Quality Improvement Staff

Collaborative, Interdisciplinary Teams
In addition to the strong leadership from individual clinicians, hospital staff reported that interdepartmental and interdisciplinary collaborative teams, which included key physicians, were essential. As one physician said, “I can’t say it is one individual. I would have to say it is the whole team because it would not have worked otherwise.” Mutual respect among disciplines and departments developed over time as teams worked together with a common goal, as illustrated by the following quotations.

I just feel like when I talk to somebody, they respect my opinion, so if I call the cardiologist and say this person is having an anterior MI, I believe me. They don’t try to talk me out of it or spend 5 minutes haranguing me about where I trained.
—Emergency Services Physician

You don’t get the feeling that, okay, you’re the doctor, you’re the nurse, and you’re just a tech, and you do this and that’s it. [An ECG technician] can actually get with the nurses and talk to the doctors and feel like we’re all working together. We collaborate. It’s a horizontal team.
—ECG Technician

Data Feedback to Monitor Progress and Identify Problems or Successes
Data feedback was integral to improvement efforts. Data were used to highlight where delays were occurring, motivate changes, reinforce adherence to protocols, make visible the teams’ successes, and sustain new processes over the longer term. However, staff cautioned that data had to be valid, presented by a credible clinician, and formatted in a readily understandable way to influence changes in clinical processes.

Rapid, patient-specific data feedback, although resource intensive, was viewed as particularly critical to improvement. However, systematic rapid data feedback was typically not initiated until projects matured and individuals gained experience as a team. Staff in several hospitals indicated that they were more able to attain needed resources to gather such data only after there was widespread support for the project. Furthermore, some suggested that intensive feedback could backfire if used too early in the improvement process before adequate trust and common goals across departments and disciplines were established. In addition to the formal data feedback mechanisms, informal feedback was commonplace among team members and across departments and disciplines. Over time, individuals and teams learned that informal, positive feedback based on performance data were critical.

I think it helped the [Emergency Department] staff tremendously that the cardiologist would come back from the cath laboratory with a picture of the open artery, so the staff felt like—this is what we have done. And the cardiologist would say the patient is doing great; you guys did a great job. Having that feedback, everybody likes to have praise.
—Vice President, Emergency Services

Organizational Culture That Fostered Persistence Despite Challenges and Setbacks
Staff described aspects of organizational culture that allowed them to address challenges in initial improvement efforts and overcome setbacks as they persisted in maintaining progress. The key aspects of organizational culture described by staff as helping them persist in their efforts to improve despite challenges and setbacks were a nonblaming approach to identifying problems and a shared vision of improving the patient’s health.

The nonblaming approach to identifying problems developed over time and engendered willingness to raise problems with each other, examine failures, and learn from apparent mistakes. These positive interpersonal relationships and behaviors helped sustain teams when there were challenges or setbacks to improvement efforts. The nonblaming aspect of organizational culture was reflected in statements by both unit-based staff and senior management.

There are no secrets. Everybody’s data are open to anybody. But we’re also not finger-pointing. It’s “What’s my role in helping them get their score?” It’s not “You’re a dog. What are you doing wrong?” It’s “How can I help?”
—Emergency Department Director

If we go astray a little bit, it’s “Oops,” but it’s not beat somebody up because they went out of line a little bit; it’s saying “Okay, let’s correct it and get back to where we’re going.” So there is not a lot of blaming; there’s not a lot of fault-finding.
—Chief Executive Officer

The shared vision that the patient’s well-being is the top priority was also integral to the culture staff described. The explicit commitment to this shared vision was particularly helpful as a tool for refocusing staff when resistance to change was apparent and teams faced setbacks in their collaboration.

When those meetings get heated and there are turf battles and people have personal agendas, you have to be able to herd cats back together and say, “Wait a minute, we’re here for the patient.” You’d be surprised...
how that suddenly gets everybody to say, “Okay, all right, let’s go back; let’s rethink it.” —Nurse Manager

Discussion

Several recurrent themes, which span environmental, operational, and cultural features, characterized the experiences of hospitals that were successful in achieving marked improvement and outstanding performance in door-to-balloon time. The experiences of these hospitals strongly suggest that innovative protocol development does not occur in isolation but is most effective when integrated into an environment that includes explicit goals; engaged senior management and clinical leaders; collaborative, interdisciplinary teams; detailed data feedback; and a nonblaming, patient-focused organizational culture. This study, through its qualitative approach, has elicited prominent features in hospitals with successful improvement and can serve as a foundation for multifaceted efforts to improve door-to-balloon times.

Previous studies evaluating the impact of hospital improvement efforts on hospital quality in acute myocardial infarction have focused on less complex clinical processes and quality indicators, such as appropriate medication use. Although we found features consistent with this previous work (ie, the importance of organizational goals, administrative support, clinician leadership, supportive systems, and data feedback), the themes concerning teams and organizational culture in the present study were not addressed or found to be nonsignificant in this earlier research. The role of these themes may be particularly important in more complex clinical processes, such as door-to-balloon time, which require greater coordination across disciplines and departments than that needed for the less complex process of medication prescription.

In studies of conditions other than acute myocardial infarction, the roles of teamwork and organizational culture on performance have been investigated, although none has examined how these factors influence clinical performance measures. These studies have linked teamwork and organizational culture to more advanced quality improvement efforts, more innovative thinking for creative systems improvement, lower nurse turnover, higher patient satisfaction, and increased numbers of reported improvements made to chronic care processes. Our results demonstrate that collaborative, interdisciplinary teamwork and a nonblaming, patient-focused organizational culture are prominent features of hospitals that achieved marked improvement and outstanding performance in an important clinical quality indicator for patients with STEMI.

A central insight from our work is the importance of balancing contrasting approaches in successful organizational change. The insight emerged from in-depth analysis of hospitals’ reported experiences in performance improvement. The unifying themes that characterized the hospitals’ experiences reflected juxtaposition of apparently conflicting approaches. The simultaneous presence of all 8 themes in these top-performing hospitals illustrates their ability to enable such contrasting approaches to coexist. The balancing of potentially conflicting approaches, or “balancing paradox,” has been described in the management literature as enhancing an organization’s ability to function effectively. Balancing such paradoxes means that organizations do not “average” or “resolve” apparently conflicting approaches but find a way to enable contrasting approaches to coexist.

Consistent with this literature, hospitals with successful improvement and outstanding performance demonstrated the ability to pursue simultaneously contrasting approaches and balance the tension between them. One such juxtaposition was standardization and flexibility. Hospitals implemented standardized protocols and, at the same time, maintained flexibility to continually revisit and improve the protocols. A second juxtaposition was uncompromising individual clinicians and collaborative, interdisciplinary teams. The hospitals balanced both potentially conflicting leadership styles. In a third example of balancing contrasting approaches, hospitals used detailed, department-specific and clinician-specific data feedback to enable explicit accountability while keeping interdepartmental and interpersonal fault-finding and blame at a minimum. Based on propositions from organizational theory, successful balancing of apparent paradoxes and simultaneous implementation of contrasting approaches require strong support for both sides of the paradox, acceptance of the conflict that sometimes emerges between them, and adequate environments that contain, tolerate, and work through such conflicts. Such balancing can provide internal regulating mechanisms for organizations and thus may enhance their resiliency to challenges, resistance, and setbacks inherent in the process of organizational change.

This qualitative study suggests key components of successful efforts to improve door-to-balloon time, a performance measure that reflects a complex clinical process. By focusing on high-performing hospitals that had substantial improvement over time, the method allowed for detailed description and analysis of complex processes of organizational change, involving social interactions and organizational culture, which are difficult to capture quantitatively. To enhance the validity and reliability of our findings, we used several techniques as recommended by experts in qualitative methods, including sampling to the point of theoretical saturation, consistent use of a discussion guide, audiotaping and professional transcription of interviews, multiple investigators from varying backgrounds in the coding and analysis process, and maintenance of an audit trail to document analytical decisions. However, interviewed staff may have provided responses that exaggerated or misrepresented their improvement efforts, especially if these were viewed as more desirable. To limit this potential bias, we interviewed multiple staff in each hospital and asked for detailed descriptions of interventions, which would be difficult to misrepresent in such detail. Finally, the study is descriptive, proposing themes that characterize the experience of substantial hospital performance improvement in a complex clinical process. Future quantitative studies are needed to test the degree to which these themes are statistically associated with improvement with the use of a random sample of hospitals with diverse performance.

At a time when there is increasing pressure to improve hospital performance in time to reperfusion and other perfor-
formance measures, there remains a paucity of studies that investigate the strategies that enable hospitals to improve their performance. Understanding of the interplay between clinical processes and the organizational context in which they occur is particularly underdeveloped. By distilling complex and diverse experiences of organizational change into its essential components, our work provides a foundation for future efforts to elevate clinical performance in the hospital setting.

Acknowledgment
This research was supported by the National Heart, Lung, and Blood Institute (R01HL072575). Dr Bradley is supported by the Patrick and Catherine Weldon Donaghue Medical Research Foundation (02-102) and a grant from the Claude D. Pepper Older Americans Independence Center at Yale (F30AG21342). The authors acknowledge Maria Johnson for her editorial assistance with this article.

Disclosures
None.

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Achieving Rapid Door-To-Balloon Times: How Top Hospitals Improve Complex Clinical Systems
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Circulation. 2006;113:1079-1085; originally published online February 20, 2006; doi: 10.1161/CIRCULATIONAHA.105.590133
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2006 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

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http://circ.ahajournals.org/content/113/8/1079

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