Expansion of a Regional ST-Segment–Elevation Myocardial Infarction System to an Entire State

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Background—Despite national guidelines calling for timely coronary artery reperfusion, treatment is often delayed, particularly for patients requiring interhospital transfer.

Methods and Results—One hundred nineteen North Carolina hospitals developed coordinated plans to rapidly treat patients with ST-segment–elevation myocardial infarction according to presentation: walk-in, ambulance, or hospital transfer. A total of 6841 patients with ST-segment–elevation myocardial infarction (3907 directly presenting to 21 percutaneous coronary intervention hospitals, 2933 transferred from 98 non–percutaneous coronary intervention hospitals) were treated between July 2008 and December 2009 (age, 59 years; 30% women; 19% uninsured; chest pain duration, 91 minutes; shock, 9.2%). The rate of patients not receiving reperfusion fell from 5.4% to 4.0% (P=0.04). Treatment times for hospital transfer patients substantially improved. First-hospital-door-to-device time for hospitals that adopted a “transfer for percutaneous coronary intervention” reperfusion strategy fell from 117 to 103 minutes (P=0.0008), whereas times at hospitals with a mixed strategy of transfer or fibrinolysis fell from 195 to 138 minutes (P=0.002). Median door-to-device times for patients presenting directly to PCI hospitals fell from 64 to 59 minutes (P<0.001). Emergency medical services–transported patients were most likely to reach door-to-device goals, with 91% treated within 90 minutes and 52% being treated within 60 minutes. Patients treated within guideline goals had a mortality of 2.2% compared with 5.7% for those exceeding guideline recommendations (P<0.001).

Conclusion—Through extension of regional coordination to an entire state, rapid diagnosis and treatment of ST-segment–elevation myocardial infarction has become an established standard of care independently of healthcare setting or geographic location. (Circulation. 2012;126:189-195.)

Key Word: myocardial infarction

The ideal treatment of ST-segment–elevation myocardial infarction (STEMI) involves early diagnosis followed by rapid reperfusion therapy.1–5 Such treatment becomes more challenging when the activities of diagnosis and reperfusion span multiple, loosely connected hospitals and emergency medical services (EMS). To overcome these barriers and to provide ideal reperfusion as a uniform standard of care regardless of healthcare setting or geographic location, we established coordinated regional care across the entire state of North Carolina.6–8 Specifically, we aimed to determine whether expanding our STEMI system to all hospitals and EMS agencies in North Carolina on a voluntary and grass roots basis would improve the rate and speed of myocardial reperfusion. According to protocols established in the Regional Approach to Cardiovascular Emergencies (RACE) project, we implemented processes to expedite care in 119 hospitals across a state with a population of 9.4 million residents and area of 53 000 square miles.9 Hospitals adopted synchronized strategies to expedite reperfusion for patients presenting by EMS, hospital transfer, and walk-in.

Editorial see p 166
Clinical Perspective on p 195

Methods

Our work was approved by the Institutional Review Board at Duke University. Data use agreements for a Health Insurance Portability and Accountability Act–defined limited data set were established...
with all primary percutaneous coronary intervention (PCI) hospitals. We implemented our system by building on a model established in prior work and by using the principles outlined in the American Heart Association Mission: Lifeline and the American College of Cardiology D2B programs.9–12 First, we developed leadership composed of a state director, hospital system coordinators, and nursing, EMS, and physician leaders from multiple institutions across the state (see the online-only Data Supplement). This leadership team conferred in weekly conference calls and numerous regional and state meetings. Next, we instituted the Acute Coronary Treatment and Intervention Outcomes Network Registry–Get With The Guidelines (AR-G) as our main data collection instrument, requesting that all participating primary PCI hospitals participate in and contribute to state-system reports.13 These data, maintained by the leadership team, were used to monitor and report treatment rates and times to individual hospitals, benchmarked to state performance. The AR-G registry at PCI hospitals represented the majority of STEMI patients in the state eligible for reperfusion during the study period because 95% of patients treated at non-PCI hospitals were transferred to PCI hospitals before discharge.9

Once leadership and data systems were established, we organized all 21 PCI hospitals in the state with onsite surgery to serve as regional primary PCI centers (10 in the initial RACE intervention, 11 additional for the statewide intervention).9 These hospitals agreed to collect and share AR-G data; to fund or cofund a hospital STEMI system coordinator; to accept all STEMI patients regardless of bed availability on a 24-hour 7-days-per-week basis; to allow catheterization laboratory activation by a single call from emergency physicians or trained paramedics without the need for cardiology consultation; to have the catheterization laboratory available within 30 minutes, including the presence of an interventional cardiologists at the start of the procedure; to establish a single treatment regimen agreed on by all physicians; and to provide immediate and regular feedback to the emergency physicians and paramedics who initiated the procedure. The 98 non-PCI centers (55 in the initial RACE intervention, 43 additional for the statewide intervention) designated themselves according to their reperfusion strategy for patients presenting with STEMI: routine transfer for primary PCI, routine fibrinolytic therapy, or a mixed strategy that consisted of transfer for primary PCI when transportation was readily available (Figure 1).

Supported by the primary PCI facilities, system coordinators and their leadership approached every hospital and EMS within their referral region to establish a single plan to rapidly diagnose and reperfuse patients with an acute STEMI according to national time standards and guidelines. Emergency departments were encouraged to ascertain whether patients had potential symptoms before registration, to designate an area and personnel to perform ECG within 10 minutes of arrival, and to choose a reperfusion plan according to local consensus and resources that involved either primary PCI or fibrinolysis. Hospitals that selected fibrinolysis also developed plans for rapid primary PCI for patients with contraindications. For hospitals served by >1 primary PCI center, all PCI centers were represented in planning meetings. Under the guidance of the North Carolina Office of EMS, emergency medical systems were encouraged to obtain an ECG for every patient with potential STEMI symptoms, to interpret the ECG and communicate the findings of a possible STEMI to receiving hospitals, to divert to PCI centers if first medical contact to device could reliably be achieved within 90 minutes or patients were ineligible for fibrinolysis, and to provide a standard method for the EMS time data to be available to receiving hospital personnel.

The final step of our intervention involved multiple levels of communication between hospitals and EMS about system performance, immediately after PCI, within 24 hours of a myocardial infarction admission, and in regularly scheduled hospital, EMS, regional, and state meetings. During these meetings, we shared best practices, reviewed treatment intervals (derived from symptom onset, first medical contact, door time, ECG time, departure time, catheterization laboratory time, device time, needle time), outcomes (deaths, complications, hospital and angiography findings), and opportunities for system improvement. An additional description of our intervention can be found in the RACE Operations Manual (http://www.nccacc.org/RACE/RACEOperationsManualOct.09.pdf).

**Statistical Analysis**

Descriptive statistics for continuous and categorical variables were described as median (interquartile range) and number (percentage), respectively. Patient characteristics and process measures were compared by use of the Wilcoxon rank-sum test for 2-group comparisons (Kruskal-Wallis test for >2-group comparisons) and χ² tests as appropriate. The Cochran-Armitage test for trend was used to assess changes in rates over time. To consider whether changes in treatment time varied by hospital, mixed-effects model analyses were conducted with PCI hospitals as a random effect. Performance data were compared in 3-month intervals from July 2008 through December 2009 stratified according to treatment and presentation to PCI hospital (fibrinolysis or primary PCI; presentation to PCI hospital by transfer, self, or EMS).

For the PCI hospitals, the objectives of the RACE intervention were to reduce door-to-device times for directly presenting patients and times from first medical contact to device for EMS-transported patients. For non-PCI hospitals, the objectives of RACE were to reduce the door-in-to–door-out times and first-door-to-device times for patients who were transferred to undergo PCI elsewhere and door-to-needle times for those receiving fibrinolysis. For both hospital settings, we also aimed to increase the rate of reperfusion among eligible patients. In cases when the first ECG did not have diagnostic ST-segment elevation, door or first medical contact time was reset to the first diagnostic ECG. All tests were conducted at the 0.05 significance level. All patients with ischemic symptoms lasting >10 minutes within 24 hours before arrival and an ECG with diagnostic ST-segment elevation were included in the analyses. Statistical analyses were carried out with SAS version 9.2 (SAS Institute Inc, Cary, NC).

**Results**

Between July 2008 and December 2009, 6841 patients presented with acute STEMI, including 3907 patients who...
presented directly (57%) and 2933 patients who were transferred (43%) to PCI hospitals (the Table). The median age of the cohort was 59 years (interquartile range, 51–69 years); 30% of patients were women; and 15% were either black or of Latino ethnicity. Nineteen percent of patients had no insurance, and 7% were covered by Medicaid. Median duration of chest pain from onset to ECG was 91 minutes; 20% of patients had prior myocardial infarction or PCI; and shock was present on admission for 9% of patients. By medical record review, 86% of patients were thought to be reperfusion candidates, and STEMI was apparent on the initial ECG for 89% of patients.

Means of transport to the first facility was EMS for 55% of patients and walk-in for 43% of patients. Over the course of the study, there was an increase in the percentage of patients presenting by EMS to PCI hospitals, from 70% to 75% (P<0.04). The inverse pattern and trend were seen at non-PCI hospitals; EMS presentation fell from 35% to 30% (P=0.10). During the final quarter of data collection, prehospital ECGs were identified for 88% of patients presenting to

Table. Patient Characteristics, Procedures, and Outcomes According to Direct or Transfer Presentation to a Percutaneous Coronary Intervention Hospital

<table>
<thead>
<tr>
<th></th>
<th>All (n=6841)</th>
<th>Direct (n=3907)</th>
<th>Transfer (n=2933)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median (IQR), y</td>
<td>59 (51–69)</td>
<td>60 (51–70)</td>
<td>59 (51–69)</td>
<td>0.03</td>
</tr>
<tr>
<td>Female, %</td>
<td>29.6</td>
<td>30.0</td>
<td>29.1</td>
<td>0.36</td>
</tr>
<tr>
<td>Race, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>83.9</td>
<td>84.3</td>
<td>83.4</td>
<td>0.03</td>
</tr>
<tr>
<td>Black</td>
<td>13.6</td>
<td>13.6</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2.5</td>
<td>2.1</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>Latino ethnicity, %</td>
<td>1.6</td>
<td>1.5</td>
<td>1.7</td>
<td>0.56</td>
</tr>
<tr>
<td>Insurance, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private/HMO</td>
<td>47.7</td>
<td>49.7</td>
<td>44.9</td>
<td>0.002</td>
</tr>
<tr>
<td>Medicaid</td>
<td>7.2</td>
<td>7.0</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>19.1</td>
<td>18.2</td>
<td>20.2</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>26.1</td>
<td>25.2</td>
<td>27.4</td>
<td></td>
</tr>
<tr>
<td>Prior myocardal infarction, %</td>
<td>20.1</td>
<td>21.8</td>
<td>17.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Prior heart failure, %</td>
<td>4.7</td>
<td>5.3</td>
<td>4.0</td>
<td>0.03</td>
</tr>
<tr>
<td>Prior PCI, %</td>
<td>19.6</td>
<td>21.4</td>
<td>17.3</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Prior coronary bypass surgery, %</td>
<td>6.5</td>
<td>7.5</td>
<td>5.2</td>
<td>0.0002</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>22.4</td>
<td>21.8</td>
<td>23.2</td>
<td>0.16</td>
</tr>
<tr>
<td>Chest pain duration, median (IQR), min</td>
<td>91 (49–190)</td>
<td>83 (42–181)</td>
<td>100 (58–205)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Means of transport to first facility, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self/family</td>
<td>43.4</td>
<td>26.5</td>
<td>65.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Ambulance</td>
<td>55.2</td>
<td>71.3</td>
<td>33.7</td>
<td></td>
</tr>
<tr>
<td>Other (air/ICU)</td>
<td>1.4</td>
<td>2.2</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Shock on presentation, %</td>
<td>9.2</td>
<td>9.6</td>
<td>8.6</td>
<td>0.18</td>
</tr>
<tr>
<td>Heart failure on presentation, %</td>
<td>8.1</td>
<td>7.9</td>
<td>8.3</td>
<td>0.51</td>
</tr>
<tr>
<td>Reperfusion candidate</td>
<td>86.2</td>
<td>86.6</td>
<td>85.8</td>
<td>0.38</td>
</tr>
<tr>
<td>STEMI first diagnosed, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First ECG</td>
<td>88.6</td>
<td>89.3</td>
<td>87.5</td>
<td>0.03</td>
</tr>
<tr>
<td>Subsequent ECG</td>
<td>11.4</td>
<td>10.7</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Procedures during hospitalization, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCI</td>
<td>85.6</td>
<td>87.1</td>
<td>83.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Coronary bypass surgery</td>
<td>6.7</td>
<td>6.4</td>
<td>7.0</td>
<td>0.38</td>
</tr>
<tr>
<td>Complications, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-hospital death</td>
<td>5.7</td>
<td>5.8</td>
<td>5.5</td>
<td>0.60</td>
</tr>
<tr>
<td>Stroke</td>
<td>1.1</td>
<td>0.8</td>
<td>1.5</td>
<td>0.007</td>
</tr>
<tr>
<td>Hemorrhagic stroke</td>
<td>0.2</td>
<td>0.1</td>
<td>0.3</td>
<td>0.54</td>
</tr>
<tr>
<td>Cardiogenic shock</td>
<td>6.1</td>
<td>6.2</td>
<td>5.9</td>
<td>0.72</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>6.1</td>
<td>5.4</td>
<td>6.9</td>
<td>0.02</td>
</tr>
<tr>
<td>Major bleeding</td>
<td>5.7</td>
<td>5.4</td>
<td>6.2</td>
<td>0.16</td>
</tr>
<tr>
<td>Reinfarction</td>
<td>0.8</td>
<td>0.7</td>
<td>0.9</td>
<td>0.34</td>
</tr>
</tbody>
</table>

IQR indicates interquartile range (25th–75th percentile); HMO, health maintenance organization; PCI, percutaneous coronary intervention; ICU, intensive care unit; and STEMI, ST-segment–elevation myocardial infarction.
PCI centers via EMS and for 32% of patients presenting to non-PCI centers (P<0.0001) (Figure 2).

**Treatment Rates and Times**

Among the 5888 eligible patients, the rate of patients not receiving reperfusion fell from 5.4% to 4.0% (P=0.04), largely attributable to a 4% absolute decline in eligible untreated patients at non-PCI hospitals (P<0.01; Figure 3). During the same period, primary PCI as a reperfusion mode increased from 52% to 66% in non-PCI hospitals with a corresponding decrease in fibrinolysis from 41% to 31% of eligible patients. For patients presenting directly to PCI hospitals, primary PCI remained stable at 95%, with only 17 patients being treated with fibrinolysis during the study period. These patients received fibrinolysis either before reaching the hospital or when a significant delay in catheterization laboratory availability was anticipated because of simultaneously presenting patients.

Corresponding with guideline goals, treatment times of interest included times from door to device for patients undergoing primary PCI, from first medical contact to device for patients presenting to PCI hospitals by EMS, from first hospital door to device for patients transferred between hospitals, and from door to needle for patients treated with fibrinolysis. Over the study period, median door-to-device times for patients presenting directly to PCI hospitals fell modestly from 64 to 59 minutes (P<0.001), with improvements in both self-presenting patients from 79 to 73 minutes (P=0.01) and EMS-transported patients from 58 to 55 minutes (P=0.06; Figure 4). The proportion of directly presenting patients who underwent PCI within 90 minutes increased from 83% to 89%.

For patients transported directly to PCI hospitals by EMS, prehospital ECG rates increased from 67% to 88% during the intervention. This improvement was accompanied by a decline in median time from first medical contact to device from 103 to 91 minutes (P<0.0001), with 50% of patients being treated within 90 minutes by the last quarter. The transport component of this time interval remained stable at a median of 35 minutes (interquartile range, 25–49 minutes) from first medical contact to hospital door. The percentage of patients receiving device activation within 90 minutes of first medical contact increased from 36% to 50% (P=0.0002). Patients transported by EMS were most likely to reach door-to-device goals, with 91% undergoing device activation within 90 minutes of hospital arrival and 52% being treated with 60 minutes by the end of the study.

Treatment times for patients transferred between hospitals for primary PCI significantly improved (Figure 5). The
median time from first hospital door to device activation for 1175 patients transferred from hospitals that adopted a transfer for PCI strategy (52 hospitals) fell from 117 to 103 minutes ($P=0.0008$), with 39% patients being treated within the 90-minute goal by the end of the intervention. A time interval of focus for these transferred patients involved first hospital door-in–door-out time, improving from 44 to 39 minutes. The 474 patients transferred from hospitals with a mixed strategy of transfer and fibrinolysis (15 hospitals) had substantially longer treatment time, with first-door-to-device time falling from 195 to 138 minutes by the end of the study ($P=0.002$). Treatment time varied substantially by transfer distance expressed as drive times according to standard mapping software (http://www.mapquest.com; accessed October 21, 2010). Median first-door-to-device time for hospitals within 30 minutes was 94 minutes, 134 minutes for hospitals between 31 and 45 minutes of drive time, and 192 minutes for hospitals exceeding 45 minutes of drive time. Mixed-strategy hospitals had a 21-minute-longer median drive time compared with hospitals with a transfer for PCI strategy. Among the 903 patients treated with fibrinolysis before transfer, door-to-needle times did not significantly improve, with median times of 35 and 27 minutes in the first and last quarters of the study ($P=0.27$) and 48% being treated within 30 minutes during the entire study period. When treatment-time analyses were stratified according to patients treated at the initial RACE intervention hospitals or hospitals added for the full state intervention, the findings were similar for both subgroups of patients. When treatment times were further considered in mixed-effects models with PCI hospital as a random effect, the models were significant, indicating that some hospitals had significantly greater improvement than others ($P<0.01$).

**Outcomes**

Patients treated within times suggested by guidelines had a mortality of 2.2% compared with 5.7% for patients whose treatment time exceeded guideline recommendations ($P=0.001$). Overall in-hospital mortality was 5.7% (95% confidence interval, 5.2%–6.3%) during the study period, including 5.9% during the first half of the intervention and 5.5% during the second half ($P=NS$). Other clinical outcomes, bleeding, stroke, hemorrhagic stroke, congestive heart failure, and shock did not vary significantly over the study period.

**Discussion**

The RACE system is the largest statewide STEMI system ever implemented in the United States. Our intervention demonstrates that systematic barriers to timely reperfusion can be overcome with a broadly organized voluntary effort to fill leadership gaps in health care. These gaps exist primarily between competing institutions and between healthcare entities that function in separate and distinct systems. By building consensus among all primary PCI hospitals in the state, we were able to convince the majority of emergency departments and EMS systems to adopt uniform and coordinated processes for rapid diagnosis and treatment. This universal approach allowed us to establish and embed a standard of care that was independent of healthcare setting or geographic location of the patient. By the end of our intervention, our protocols were adopted by state regulation for all EMS agencies, and all PCI hospitals voluntarily agreed to continue sharing data and support regional care (http://www.ncems.org/pdf/OverviewEMSTriageandDestinationPlan.pdf).

The findings identify some remarkable changes in patterns of care and improvements in performance measures. Notable achievements of the RACE system include a historically low rate of eligible but untreated patients of 4.0% and exceptionally fast coronary intervention for patients presenting directly to PCI facilities, with 89% treated within 90 minutes and 52% treated within 60 minutes. These results achieved across all 21 PCI hospitals in the state are comparable to those achieved by 10 select systems that reported on EMS-transported patients alone by Rokos and colleagues of 86% within 90 minutes and 50% within 60 minutes.

At the same time, this work highlights areas that need further consideration in formulating STEMI treatment guidelines and building systems of care. Two particular areas of interest include EMS-transported patients and patients transferred between hospitals for primary PCI. In 2007, the American College of Cardiology/American Heart Association STEMI guidelines first directed device activation to occur within 90 minutes of first medical contact rather than hospital door for patients initially treated by emergency personnel, defined as the time that the EMS crew arrives at the scene of the patient. By adding scene time and transport time to the 90-minute goal, this guideline effectively raised the bar on primary PCI and made hospitals and EMS jointly accountable for patient treatment. This work describes the first broad application of this new standard, with 50% of patients treated within 90 minutes of first medical contact (or EMS arrival on scene) by the end of our study. Time from scene arrival to hospital door consumed a median of 36 minutes of the 90-minute goal, including 15-minute scene time and 21-minute transport time. Our findings indicate that incremental improve-

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**Figure 5.** Reperfusion times for patients presenting to hospitals without percutaneous coronary intervention (PCI) facilities by quarter (Q), median times. Door-to-needle times for patients treated with fibrinolysis. First-hospital-door-to-device time for patients transferred for PCI. For transferred patients, treatment times are presented according to hospital reperfusion strategy. For lytic, $P=0.27$; transfer strategy, $P=0.0008$; mixed strategy, $P=0.002$. 
ments in all processes of care will allow a majority of EMS-transported patients to meet this goal. These improvements should include universal adoption of catheterization laboratory activation by paramedics as a standard of care (median time savings, 17 minutes). The 28-minute median hospital-door-to-laboratory-arrival time for EMS-transported patients also indicates potential for a further improvement in hospital processes such as preregistration of patients, proceeding directly to the catheterization laboratory when available, and cross-training laboratory, emergency department, and intensive care unit personnel to cover emergency STEMI patients.

To the best of our knowledge, the 39% of patients undergoing primary PCI within 90 minutes of first hospital door in transfer strategy hospitals represents the highest rate reported in a multicenter study. For comparison, 15% of patients requiring hospital transfer in Massachusetts were treated within 90 minutes in 2008, the latest year for which data are available, and the AR-G registry reported that 24% of patients transferred for PCI in the fourth quarter of 2009 had device times within 90 minutes of first door.14 The AR-G registry involved a select group of ≈220 hospitals that were submitting data, and this national benchmark likely reflects above-average performance. The treatment times in RACE for transferred patients also compare favorably with selected single-center or single-region reports from Abbot Northwestern of 32%, Mayo Clinic of 12%, and Springfield (IL) Stat Heart of 12%.1,2,3 With national guidelines for interhospital transfer continuing to call for device activation within 90 minutes of first medical contact as a systems goal, our inability to reach this goal in a majority of patients despite focused efforts raises questions about the feasibility of achieving this benchmark on a broad scale.15 First-door-to-device time varied as a function of interhospital drive time: 93 minutes for hospitals within 30 minutes, 117 minutes for 31- to 45-minute drive times, and 121 minutes for hospitals beyond a 45-minute drive time. Patients transported by air were not treated faster, with median first-door-to-device times of 125 minutes for hospitals in the 31- to 45-minute drive time range and 138 minutes for hospitals beyond 45-minute drive times. Thus, treatment by the 90-minute goal for hospitals located beyond the 30-minute drive time appears less likely to occur for the majority of patients with the use of current processes. Our work supports the extension of the standard to 120 minutes to have relevance for the majority of patients undergoing hospital transfer for primary PCI.16

Mortality

Although there are trends toward lower STEMI mortality in North Carolina since the initiation of our regional system, our study lacked adequate sample size to identify mortality differences reliably. Pathological, imaging, and clinical data support a strong relationship between earlier treatment, less myocardial necrosis, and lower mortality, and we believe that the significant time improvements in coronary reperfusion resulting from our intervention represent an important improvement in myocardial infarction care in North Carolina.17–19 Observations from our RACE data also support timely treatment on the basis of a 2.2% mortality for those receiving reperfusion according to overall guideline time goals compared with a 5.7% mortality for those treated beyond recommended time intervals (P<0.001).

Limitations

This study relied on the voluntary submission of data to the AR-G registry, a system that lacks any mechanism for auditing. Thus, it is possible that some of the observed improvements in performance and outcome may have been due to self-reporting. The extent to which our data elements overlapped with door-to-device and door-to-needle measures in CMS Hospital Compare, a subset of our data were subject to random audit, providing some impetus for accurate reporting.20 Our study design did not allow us to determine whether changes in care were directly attributable to the RACE interventions or whether they occurred independently of the project. During the corresponding time period from the third quarter of 2008 to the fourth quarter of 2009, the 220 hospitals submitting data to AR-G had improved median door-to-device times for directly presenting patients from 66 to 62 minutes compared with 64 to 59 minutes in our study and from 120 to 113 minutes for transferred patients compared with 152 to 118 minutes in RACE. Thus, the improvements in our system were of a magnitude similar to that seen for all AR-G hospitals for directly presenting patients and appear to be substantially larger for transferred patients. Because hospitals participating in AR-G represent a select group focused on improving treatment times among the 1200 to 1400 hospitals in the United States that perform primary PCI, we believe that the improvements in North Carolina, particularly among transferred patients, likely reflect the effect of our system.

Conclusions

A uniform and comprehensive approach to organizing STEMI care across an entire state on a voluntary basis resulted in marked improvements in timely coronary artery reperfusion. Patients presenting directly to PCI hospitals received the fastest treatment, and those requiring interhospital transfer showed the greatest improvements in treatment time. As a result of the extension of our organization to an entire state, rapid diagnosis and treatment of STEMI has become an embedded standard of care that is independent of healthcare setting or geographic location.

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Disclosures

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Many of the decisions and processes that affect the speed of coronary artery reperfusion occur long before patients reach the cardiologist. Particularly in the case of patients who are diagnosed with ST-segment–elevation myocardial infarction (STEMI) on scene by paramedics, early catheterization laboratory activation can lead to reperfusion times <1 hour. Similarly, patients presenting to hospitals without primary percutaneous coronary intervention capability require coordinated protocols for diagnosis and transfer to be treated in ≤2 hours. In both scenarios, accelerated coronary reperfusion has been associated with improved survival. This article describes the largest voluntary statewide system for ST-segment–elevation myocardial infarction diagnosis and treatment. The North Carolina Regional Approach to Cardiovascular Emergencies (RACE) system included every percutaneous coronary intervention hospital (n=21), most hospitals lacking percutaneous coronary intervention capability (n=98), and >500 emergency medical service agencies in a state of 9 million people. Over a 2-year period, the implementation of common protocols resulted in significantly improved treatment times for patients presenting directly to percutaneous coronary intervention hospitals and patients requiring hospital transfer. Similar to prior work, treatment within guideline goals was associated with significantly lower mortality compared with those exceeding guideline goals (2.2% versus 5.7%; P<0.001).

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CLINICAL PERSPECTIVE

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Expansion of a Regional ST-Segment–Elevation Myocardial Infarction System to an Entire State

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