The Treatment of Elderly Diabetic Patients With Acute Myocardial Infarction

Insight From Michigan’s Cooperative Cardiovascular Project

Rajendra H. Mehta, MD; Thomas J. Ruane, MD; Patricia A. McCargar, RN, MGA; Kim A. Eagle, MD; Erik J. Stalhandske, MPP, MHSA

Background: Diabetic patients with acute myocardial infarction (AMI) have higher morbidity and mortality rates than nondiabetic patients with AMI. Thus, reliable adherence to quality care is necessary in these patients to improve outcomes. We analyzed data from the Health Care Financing Administration’s Cooperative Cardiovascular Project (CCP) in Michigan, addressing quality of care in diabetic patients with AMI.

Methods: All acute-care hospitals in Michigan had 8 consecutive months of baseline CCP data abstracted from medical records of all Medicare patients who were discharged with a principal diagnosis of AMI. Owing to the staggered 8-month periods, abstraction occurred for patients who were discharged between April 1, 1994, and July 31, 1995.

Results: Diabetic patients accounted for 33% of 8455 patients with AMI. Diabetic patients were primarily younger, female, and nonwhite. They had a greater frequency of non–Q-wave AMI and presented less often within 6 hours of their infarction. Comorbid conditions, such as hypertension, prior AMI, prior stroke, and/or prior revascularization, were more frequent in diabetic than in nondiabetic patients. Congestive heart failure occurred more frequently in diabetic patients. Length of stay (7.9 vs 7.0 days; P < .001), in-hospital mortality rates (16% vs 13%; P < .001), and rates for mortality within 30 days (21% vs 17%; P < .001) were higher in diabetic patients.

Conclusions: Despite greater frequencies of comorbid conditions, poorer outcomes, and greater resource use, there is poor overall adherence to most quality indicators in diabetic patients with AMI. Better methods for systematizing proven prevention and treatment strategies in the care of patients with AMI are needed in this unique high-risk cohort.

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Diabetes mellitus is an important risk factor for the development of coronary artery disease, with overall prevalence as high as 55% among adults with this disease compared with only about 4% among those without diabetes.1 After acute myocardial infarction (AMI), there is at least a 2-fold increase in the in-hospital mortality rate for men with diabetes and at least a 4-fold increase in the in-hospital mortality rate for women with diabetes over those without it.2 Similarly, sudden death accounts for 50% more deaths in men and 300% more deaths in women with diabetes than their age-matched nondiabetic counterparts.3 Long-term survival is also significantly decreased in diabetic patients compared with nondiabetic patients. Over a 12-year period, the relative risk of dying was 1.56 times higher among diabetic men than among nondiabetic men (95% confidence interval [CI], 1.43-1.68). Diabetic women were 1.57 times more likely to die than nondiabetic women (95% CI, 1.45-1.73).4 Nearly 30% of patients with diabetes die after AMI before receiving thrombolytic therapy; even among those patients receiving thrombolytic therapy, diabetic patients have a 2-fold increase in relative risk compared with nondiabetic patients.5,6 Diabetic patients with AMI are more likely to have severe diffuse 3-vessel or left main disease than those without it.7,8 Similarly, the incidence rates of congestive heart failure, cardiogenic shock, recurrent infarction, atrioventricular and intraventricular conduction abnormalities, and large transmural anterior infarction are greater in diabetic compared with nondiabetic patients.9-13

As a result of increased morbidity and mortality in diabetic patients with AMI, reliable adherence to the quality of care is necessary in this high-risk cohort to im-
PATIENTS AND METHODS

DATA COLLECTION

The baseline data for the CCP consisted of all Medicare patients who were discharged from any acute-care hospital in Michigan with a principal discharge diagnosis of AMI (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM], codes 410.0-410.9) over a period of 8 consecutive months. Patients who were readmitted for AMI as indicated by the ICD-9-CM code 410.2 were excluded from the study cohort. In order to sample all acute-care hospitals, the data collection was staggered. As a result, the reporting period was not identical for each hospital, but each hospital reported data for 8 consecutive months between April 1, 1994, and July 31, 1995. Medicare administrative data were used to identify cases for chart review and also provided the basic demographic data. Identified patient records were then requested and sent to commercial data abstraction centers. Registered nurses and trained technicians conducted a retrospective review of the charts; guided by standard data definitions and range checks to prevent recording invalid values, they obtained data regarding prespecified key clinical elements. Approximately 5% of charts were randomly reviewed a second time for quality control. The result of this quality assurance check was consistent across all acute-care hospitals, the data collection was staggered. Chart abstraction data were merged with Medicare administrative file data. Quality-of-care indicators were predefined prior to data abstraction in accordance with the American College of Cardiology/American Heart Association national guidelines on AMI management. For each indicator, specific criteria were developed to determine which patients qualified to receive particular treatments. More stringent exclusion criteria also defined a population of patients for whom the treatment was clearly indicated (ideal patients).

STATISTICAL ANALYSIS

Statistical analysis was performed using the STATA statistical software package (release 2; STATA Corp, College Station, Tex). We used χ² analysis to compare the demographic variables and quality indicators within subsets of the state population. For the continuous variables, analysis of variance was performed to measure statistically significant differences in the means. P<.05 indicated significant differences between cohorts of patients with and without diabetes. Multivariable logistic regression analysis was undertaken for the quality indicators and in-hospital and 30-day mortality to control for potentially confounding variables, such as age, sex, and ethnicity.

prove outcomes. The current study analyzes data from the Cooperative Cardiovascular Project (CCP) in Michigan and evaluates adherence to key quality indicators and outcomes in a large group of diabetic patients with AMI.

Table 1. Baseline Variables and Outcomes in Diabetic and Nondiabetic Patients

<table>
<thead>
<tr>
<th></th>
<th>All Patients (n = 8455)</th>
<th>Diabetic Patients (n = 2804)</th>
<th>Nondiabetic Patients (n = 5651)</th>
<th>P†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y, median</td>
<td>74.0</td>
<td>74.0</td>
<td>75.0</td>
<td></td>
</tr>
<tr>
<td>Age &gt;75 y</td>
<td>45.2</td>
<td>40.9</td>
<td>47.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Male</td>
<td>51.3</td>
<td>46.6</td>
<td>53.7</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>White</td>
<td>88.7</td>
<td>87.0</td>
<td>89.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Cigarette smokers</td>
<td>17.8</td>
<td>13.8</td>
<td>19.7</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Pain &lt;6 h</td>
<td>42.7</td>
<td>40.8</td>
<td>43.7</td>
<td>.01</td>
</tr>
<tr>
<td>Anterior AMI</td>
<td>47.9</td>
<td>49.4</td>
<td>47.1</td>
<td>.06</td>
</tr>
<tr>
<td>Q-wave AMI</td>
<td>58.6</td>
<td>56.1</td>
<td>59.8</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Comorbid Conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>65.2</td>
<td>74.5</td>
<td>60.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Prior AMI</td>
<td>35.4</td>
<td>41.8</td>
<td>32.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Prior PTCA</td>
<td>8.1</td>
<td>10.2</td>
<td>7.01</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Prior CABG</td>
<td>13.3</td>
<td>15.1</td>
<td>12.5</td>
<td>.001</td>
</tr>
<tr>
<td>Prior CVA/TIA</td>
<td>15.1</td>
<td>18.9</td>
<td>13.1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PVOD</td>
<td>11.6</td>
<td>16.9</td>
<td>9.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>43.7</td>
<td>52.5</td>
<td>39.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Shock</td>
<td>6.7</td>
<td>7.3</td>
<td>6.4</td>
<td>.11</td>
</tr>
<tr>
<td>APACHE II score, mean</td>
<td>9.6</td>
<td>10.0</td>
<td>9.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>MMPS score, mean</td>
<td>0.18</td>
<td>0.19</td>
<td>0.18</td>
<td>.003</td>
</tr>
<tr>
<td><strong>Reperfusion/Invasive Treatment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombolytic therapy</td>
<td>16.0</td>
<td>12.6</td>
<td>17.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Cardiac catheterization</td>
<td>39.1</td>
<td>37.9</td>
<td>38.7</td>
<td>.11</td>
</tr>
<tr>
<td>PTCA</td>
<td>15.8</td>
<td>14.2</td>
<td>16.6</td>
<td>.005</td>
</tr>
<tr>
<td>CABG</td>
<td>8.6</td>
<td>9.2</td>
<td>8.3</td>
<td>.16</td>
</tr>
</tbody>
</table>

*Values are percentages unless otherwise indicated. AMI indicates acute myocardial infarction; PTCA, percutaneous transluminal coronary angioplasty; CABG, coronary artery bypass graft; CVA, cerebrovascular accident; TIA, transient ischemic attack; PVOD, pulmonary vascular obstructive disease; APACHE, Acute Physiology and Chronic Health Evaluation; and MMPS, Medicare Mortality Prediction System.

†Comparing diabetic and nondiabetic patients.

RESULTS

CHARACTERISTICS, COMORBID CONDITIONS, AND OUTCOMES IN DIABETIC VS NONDIABETIC PATIENTS

We identified 8455 patients with AMI among 1414295 Medicare beneficiaries in the state of Michigan. Diabetic patients represented 33.2% of the patients with AMI (n = 2804). On average, diabetic patients were younger, more often female, and more likely to be white (Table 1). In addition, they were less likely to be current smokers. Diabetic patients as a group were less likely to present within 6 hours of the onset of their symptoms. They more often had non-Q-wave AMI and were more likely to have congestive heart failure and shock. Comorbid conditions, such as hypertension, peripheral vascular disease, and prior AMI, stroke, percutaneous transluminal coronary angioplasty (PTCA), or coronary artery bypass graft (CABG), were present more often in diabetic than nondiabetic patients. The mean Acute Physiology and Chronic Health Evaluation II (APACHE II) and Medicare Mortality Prediction System (MMPS) scores were higher in diabetic patients, attesting to their high-risk profile. Diabetic patients had a significantly longer hospital
stay. Both in-hospital and 30-day mortality rates were higher in diabetic than nondiabetic patients (Table 2). These differences in both the in-hospital and 30-day mortality rates persisted even after accounting for confounding variables, such as age, sex, and ethnicity (Table 3).

QUALITY-OF-CARE INDICATORS AND INVASIVE TREATMENTS IN DIABETIC AND NONDIABETIC PATIENTS

The quality-of-care indicators that were met less frequently in diabetic patients who were considered to be ideal candidates for such therapy included the initiation of thrombolytic therapy within the first hour, reperfusion within 12 hours, and receiving aspirin on day 1 and at the time of discharge. Counseling for smoking cessation was documented less frequently in diabetic patients.

B-Blockers were used in similar proportions of diabetic and nondiabetic patients at discharge. Angiotensin-converting enzyme (ACE) inhibitors were prescribed more frequently for diabetic than nondiabetic patients at discharge. There was no difference in the use of cardiac catheterization and CABG in diabetic and nondiabetic patients, and diabetic patients were less likely to undergo PTCA.

Even after controlling for confounding variables (age, sex, and ethnicity), multivariable logistic regression analysis revealed that diabetic patients (ideal candidates for therapy for AMI) were less likely to receive thrombolytic therapy within the first hour, reperfusion within 12 hours, and aspirin on day 1.

The major findings of our analysis were as follows:

- Diabetic patients have more comorbid conditions and thus, not surprisingly, have more complications and higher mortality rates following AMI.

- Despite higher risk and greater resource use, key quality indicator scores were lower for diabetic than nondiabetic patients. We demonstrated that diabetic patients were less likely to receive thrombolytic therapy (especially during the first hour), any form of reperfusion therapy within 12 hours (thrombolytic therapy or PTCA), aspirin on day 1 or at the time of discharge, and counseling for smoking cessation prior to their discharge.

- B-Blocker use was similar for both diabetic and nondiabetic patients, and opportunities to improve the use of B-blocker therapy exist for both groups.

- Calcium channel blockers were appropriately avoided in the majority of patients with AMI and left ventricular dysfunction in both groups.

- Angiotensin-converting enzyme inhibitors were used more frequently in diabetic patients compared with nondiabetic patients.

Thus, our finding that diabetic patients with AMI have higher morbidity and mortality rates is consistent with the findings of prior studies.1-13 Furthermore, treatment of this high-risk cohort is far from optimal. Strategies that were previously documented to improve outcomes were withheld from a large number of patients, more so in diabetic than nondiabetic patients. The goal of initiating thrombolytic therapy in a timely fashion was not met in the majority of patients, with only 12.6% of diabetic patients with AMI (55.5% of ideal eligible patients) receiving this therapy. This finding is similar to the observations of underutilization of thrombolytic therapy reported by prior investigators.17-19 Our study does not show that alternate forms of reperfusion, such as primary PTCA, were used more often for elderly diabetic patients to circumvent the increased bleeding and stroke risks of thrombolytic therapy as documented in a recent review of random-
ized trials comparing thrombolytic therapy with primary angioplasty.\textsuperscript{20} Thus, PTCA was performed less frequently in diabetic patients (14.2% vs 16.6%; \(P = .005\)), and in the diabetic group receiving PTCA only 35% received it within the first 12 hours. Overall, reperfusion therapy was instituted in only 59% of ideal diabetic candidates vs 73% of ideal nondiabetic candidates. Atypical symptoms of coronary insufficiency, late presentation, nondiagnostic electrocardiograms, more comorbid conditions, and physician concerns regarding increased risks for major bleeding, stroke, and intracranial hemorrhage have been the major deterrents to the use of reperfusion therapy (especially thrombolytic therapy) in the elderly.\textsuperscript{21-23} Recent reports have shown that asymptomatic myocardial infarction or myocardial ischemia is more common in diabetic patients.\textsuperscript{24-26} Thus, as in our study, diabetic patients present late in their illness, which leads to a significant delay in the diagnosis of AMI. For some patients, this delay negates consideration of reperfusion therapy. Whereas cardiac catheterization and CABG were performed in similar proportions of diabetic and nondiabetic patients, PTCA was used less frequently in diabetic patients compared with nondiabetic patients. The higher incidence of left main or 3-vessel disease, left ventricular dysfunction, and diffuse disease of native vessels with a greater degree of calcification and the higher restenosis rates in this group of patients may make them less suitable candidates for PTCA.\textsuperscript{8,13,27} Currently, this trend toward a lower PTCA treatment rate in diabetic patients may be more pronounced, given the increased morbidity and mortality rates in diabetic patients undergoing multivessel angioplasty compared with CABG.\textsuperscript{28}

Equally disappointing, and in keeping with prior reports, there was less frequent use of aspirin therapy for diabetic patients, an intervention proven to be efficacious, safe, and inexpensive in improving outcomes.\textsuperscript{18,19,20} Increased platelet reactivity that promotes the progression of atherosclerosis and the development of occlusive thrombus at the site of plaque rupture has been demonstrated in diabetic patients.\textsuperscript{30-32} Thus, even in the absence of targeted randomized trials of aspirin therapy for secondary prevention in diabetic patients with coronary artery disease, it is believed that aspirin therapy is even more beneficial in this group of patients with AMI. Part of the reluctance to prescribe aspirin may stem from the concern that aspirin therapy would precipitate retinal hemorrhage in diabetic patients. However, long-term treatment with aspirin (325 mg 3 times a day) in 267 diabetic patients with early retinopathy resulted in a decrease in the formation of retinal microaneurysms and not a single case of retinal bleeding.\textsuperscript{33} Similarly, in a recent report from the Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries (GUSTO) trial,\textsuperscript{34} a combination of aspirin plus thrombolytic therapy was not associated with an increased incidence of retinal hemorrhage. Both these studies suggest that aspirin therapy is safe in patients with diabetes.

Diabetic patients in our study were less likely to smoke (14% vs 20%; \(P < .001\)). Among the smoking cohort, counseling for smoking cessation was documented less frequently in diabetic patients compared with nondiabetic patients (30% vs 38%; \(P = .02\)). Cigarette smoking is an independent predictor of mortality, especially in women with insulin-dependent diabetes, since it increases their cardiac mortality more than 2-fold.\textsuperscript{35} Thus, the decreased incidence of smoking-cessation counseling identifies another important area of missed opportunity in patients with diabetes.

The disparity between adherence to goals of treatment for elderly diabetic and nondiabetic patients was not demonstrated uniformly for all key quality indicators in our study. There was a similar trend toward avoidance of using calcium channel blockers to treat diabetic and nondiabetic patients. The growing recognition that calcium channel blockers may be detrimental in patients with AMI, particularly those with left ventricular dysfunction, accounts for the appropriate avoidance of these drugs in most of our patients and is consistent with the trends observed by others.\textsuperscript{35,36} Although the overall use of \(\beta\)-blockers in the entire study population was far from desired goals, \(\beta\)-blockers were prescribed to similar proportions of diabetic and nondiabetic patients, unlike previous studies.\textsuperscript{18,37,38} Increasing evidence supports the benefits of \(\beta\)-blockers in the treatment of diabetic patients,\textsuperscript{39,40} including those with left ventricular dysfunction. Availability and greater use of \(\beta\)-selective agents with fewer adverse effects (such as masking symptoms of hypoglycemia, exacerbation of peripheral vascular disease, worsening of dyslipidemia, and increasing fatigue and depression and decreasing libido) may have helped overcome some of the negative attitudes toward the use of \(\beta\)-blockers to treat this high-risk cohort.\textsuperscript{41,42}

Finally, ACE inhibitors were prescribed more frequently to diabetic patients, corroborating the findings of previous studies.\textsuperscript{10,32,43} We suspect this is owing to the increased frequency of comorbid conditions, such as more severe left ventricular dysfunction, the higher incidence of hypertension, and the association with diabetic nephropathy, all of which have been shown to be effectively treated with the concomitant use of ACE inhibitors.\textsuperscript{45,46}

**LIMITATIONS AND STRENGTHS OF OUR STUDY**

We acknowledge some specific limitations of this study. First, we analyzed data from only one state, limiting generalizability to other states. Second, data were abstracted by retrospective review of charts, with initial cases identified from claims data. Such data lack complete information and rely heavily on appropriate documentation in patient charts. Third, clinical indicators identified only those patients who were considered candidates by conservative criteria. The remaining patients were lumped into one category, with no distinction between relative and absolute contraindications. Therefore, some patients who were appropriately given specific treatment were not considered ideal candidates by the algorithm. Fourth, our data did not allow the distinction between diabetic patients who required insulin vs those patients taking oral hypoglycemic agents.
Nevertheless, our study has several strengths. In addition to the usual administrative data, the CCP database from Michigan contains a wealth of clinical information. The application of algorithms that reflect the input of a broad array of practicing physicians and specialty organizations tempered the project with the synthesis of clinical evidence and opinion, allowing a richer interpretation of our chart-review data. Unlike prior studies that addressed only the risk of poor outcomes among diabetic patients with AMIs, our study identified surprisingly poor scores for some of the quality indicators. The results lead to a clear conclusion that cardiac care for this high-risk group of patients, ie, elderly diabetic patients, is suboptimal and should be targeted for improvement.

CONCLUSIONS

Despite greater resource use and higher morbidity and mortality rates, we found that there was actually poor adherence to many key quality indicators for diabetic patients with AMI. Better methods for systematizing the initiation of proven treatment strategies for secondary prevention after AMI are needed in this unique high-risk cohort.

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