Patterns of Secondary Prevention in Older Patients Undergoing Coronary Artery Bypass Grafting During Hospitalization for Acute Myocardial Infarction

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Background—Aggressive risk factor modification decreases cardiovascular events and mortality in patients after coronary artery bypass grafting (CABG). Little is known regarding the use of secondary prevention in older patients undergoing CABG during hospitalization for acute myocardial infarction (AMI).

Methods and Results—Medical records were reviewed for a sample of 37,513 patients hospitalized with AMI in the United States between April 1998 and March 1999. Patients ≥65 years of age who underwent CABG after AMI (n=2,267 [8%]) were evaluated for the prescription of 4 therapies at discharge: aspirin, β-blockers, angiotensin-converting enzyme (ACE) inhibitors, and lipid lowering, in eligible patients without contraindications to therapy and compared with patients who did not undergo CABG (n=26,484 [92%]). Patients undergoing CABG had higher rates of aspirin than patients who did not undergo CABG (88.0% versus 83.2%, P=0.0002). However, CABG patients were less likely to receive β-blockers (61.5% versus 72.1%, P<0.0001), ACE inhibitors (55.5% versus 72.1%, P<0.0001), or lipid lowering (34.7% versus 55.7%, P<0.0001) prescriptions than patients who did not undergo CABG. After adjustment for disease severity, patients undergoing CABG were no longer more likely to receive discharge aspirin, and the magnitude of other differences in care increased.

Conclusions—Evidence-based discharge therapies are underutilized in older patients who underwent CABG during hospitalization for AMI. Although national efforts focusing on improving short-term surgical mortality have been successful, strategies should be developed to increase the utilization of therapies known to improve long-term mortality in patients undergoing CABG. (Circulation. 2003;108[suppl II]:II-24-II-28.)

Key Words: ■ heart surgery ■ risk factors ■ elderly ■ quality assessment

More than 400,000 CABG surgeries are performed annually in the United States.1 The majority of these are performed in patients ≥65 years of age, and the number of older patients undergoing CABG is steadily increasing.2,3 Over the past decade, patients undergoing CABG have an increasing burden of cardiac risk factors and, as such, are at increased risk for subsequent cardiac events.4 Cumulative data from observational and clinical trials demonstrate that aggressive lipid-lowering,5–8 antiplatelet therapy,9–17 ACE inhibitors,18–21 and β-blockers22 reduce overall mortality, and decrease subsequent cardiovascular events in patients undergoing coronary revascularization. Based on this evidence, national guidelines from the American Heart Association and American College of Cardiology23 support aggressive risk factor modification to prevent recurrent cardiac events after CABG. Despite these recommendations, CABG patients enrolled in clinical trials are less likely to receive lipid-lowering therapy24 or β-blockers22 at hospital discharge than patients not undergoing CABG. Whether similar patterns are observed in a representative national cohort of older patients undergoing CABG during AMI hospitalization is not known. Accordingly, we utilized data from the Centers for Medicare and Medicaid Services (CMS) National Heart Care Project to evaluate quality of care for older patients undergoing coronary artery bypass grafting (CABG) after AMI.

Methods

Data Source and Sampling
We analyzed data abstracted from hospital medical records collected as part of the CMS National Heart Care Program. Patients hospitalized with a principal discharge diagnosis of AMI (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] code 410, excluding 410.x2) between April 1998 and...
March 1999 were identified (n=37,513).25 Identified discharges were sorted within each state by age, sex, race, and admitting hospital, and up to 750 AMI discharges were sampled from each state (including the District of Columbia and Puerto Rico). If the number of records for a state was less than the number targeted for the sample, all of the AMI discharges in the relevant period were included. The 35,713 records obtained and abstracted represent 96% of the 37,376 records that were targeted for the sample.

**Data Collection and Quality Monitoring**

Trained abstractors at two CMS-contracted Clinical Data Abstraction Centers performed medical record abstraction. Inter-rater reliability of medical record abstraction was monitored using random reabstraction of samples of records. Discrepancies between abstractors were identified and examined, and retraining of staff was performed as needed on the basis of the results. Extensive written abstraction guidelines provide instruction for standardized data collection.

When assessing the reliability associated with measuring process-of-care performance for hospitalized AMI patients, we first examined the reliability of the individual variables used to generate the quality indicators. Variable agreement (agreement rate between 2 abstracters assessing the same variable) averaged >90%. Second, we examined the indicator components, namely the numerators and denominators that also comprise the individual variables. Quality indicator reliability (agreement rate between 2 abstracters assessing patient eligibility for and receipt of quality indicator) of 93% to 99% (κ 0.41–0.76).

Analyses were restricted to the sample of patients ≥65 years of age, because younger Medicare beneficiaries typically have comorbid conditions or disabilities that make them nonrepresentative of patients <65 years of age. In addition, we excluded patients without clinically confirmed AMI (defined as a creatine kinase-MB fraction >5%, troponin level >95% CI, or 2 of 3 criteria: chest pain, a 2-fold elevation of creatine kinase level, or new AMI on ECG), who were transferred to another acute care hospital, had a terminal illness, left the hospital “against medical advice,” or who died during hospitalization. Our final study cohort consisted of 28,720 patients. Patients undergoing CABG were defined as those patients receiving CABG any time during hospitalization at the discharging hospital.

**Quality Indicators**

The CMS quality indicators, discharge prescription of aspirin, β-blockers, and ACE inhibitors for patients with left ventricular systolic dysfunction, have been described previously.25 Patients were counted as eligible for discharge therapies if they had confirmed AMI, were not transferred to another acute care hospital, and did not die during the hospitalization. Additional criteria were used for specific indicators. After identifying confirmed AMI patients eligible for the therapy, a subset of patients who were “ideal” candidates for the therapy was defined by excluding patients with absolute or relative contraindications from the denominator26 (see Appendix).

In addition, detailed chart abstraction was performed to discern discharge prescription of lipid-lowering medication including 3-hydroxy-3-methylglutaryl-coenzyme A reductase inhibitors, resins, fibrates, bile acid sequestrants, and nicotinic acid. Patients were deemed eligible if low-density lipoprotein cholesterol (LDL-c) was ≥130 mg/dL, according to thresholds established by national guidelines for the initiation of pharmacologic therapy for elevated LDL-c. After identifying patients eligible for lipid lowering therapy, a subset of patients who were ideal candidates for the therapy was defined by excluding patients with absolute or relative contraindications from the denominator (see Appendix).

**Statistical Methods**

Sample weights were assigned to each record on the basis of the inverse of the selection probability. We compared differences in patient medical history, comorbidities, admission characteristics, and eligibility for each of the quality indicators between patients with or without CABG using χ² and Wilcoxon rank-sum tests. Differences in discharge prescription of aspirin, β-blockers, ACE inhibitors, and lipid lowering were assessed using χ² tests. In order to account for potential differences in clinical characteristics between patients undergoing CABG and those not, we evaluated quality indicator rates by multivariate logistic regression analysis adjusting for patient clinical characteristics. Independent variables incorporated in the model included cardiac arrest or congestive heart failure on admission, myocardial infarction (MI) location, systolic blood pressure, white blood cell count, and serum creatinine levels—predictors of 30-day mortality in the Cooperative Cardiovascular Project identified by Krumholz et al.26 The software used for these analyses was SAS version 8.1 (SAS Institute, Inc., Cary, NC).

**Results**

**Patient Characteristics**

Of the 28,780 patients in our sample, 2,296 (8%) underwent CABG. Patients undergoing CABG during AMI were significantly younger than patients not undergoing CABG (mean age 73.7 years versus 77.7 years, P<0.001; Table 1), with few patients over the age of 85 years receiving CABG (3.6% versus 20.8%, P<0.0001). In general, patients undergoing CABG had fewer comorbid conditions than patients not undergoing CABG. Other characteristics of patients by receipt of CABG are shown in Table 1.

**Discharge Therapies**

Patients undergoing CABG were more likely to be ideal for each of the discharge therapies studied. (Table 2) Patients undergoing CABG ideal for aspirin therapy were more likely to be treated than post-MI patients not undergoing CABG (88.0% versus 83.2%, P=0.0002). However, among ideal candidates for treatment, CABG patients were less likely to receive β-blocker (61.5% versus 72.1%, P<0.0001) or ACE inhibitor (55.5% versus 72.1%, P<0.0001). In our cohort only 27.2% of patients had LDL-c documented in the chart, and of these, mean LDL-c was 113 mg/dL and only 28% had an LDL-c ≥130 mg/dL. In these patients, those undergoing CABG were significantly less likely to receive lipid lowering on discharge (34.7% versus 55.7%, P<0.0001) prescription at time of discharge (Table 2). After adjustment for clinical variables, patients undergoing CABG were no more likely than patients not undergoing CABG to receive aspirin prescription on discharge and remained significantly less likely to receive β-blockers, ACE inhibitors, and lipid lowering on discharge.

**Discussion**

These data from the Medicare Health Care Quality Improvement Program’s National AMI Project demonstrate that many Medicare patients undergoing CABG after AMI are not receiving high-quality evidence-based care. In general, older patients undergoing CABG are significantly less likely to receive β-blockers, ACE inhibitors, or lipid-lowering therapy on discharge compared with other MI patients. Despite clinical data and national guidelines supporting aggressive secondary prevention in patients undergoing revascularization, patients undergoing CABG are 50% less likely to receive these evidence-based therapies. However, irrespective of revascularization strategy, quality of care for older patients with coronary artery disease remains low.

These results highlight the need for expanded national efforts to monitor secondary prevention for patients undergo-
ing CABG and emphasize the importance of recent efforts by the Society of Thoracic Surgery (STS) to monitor discharge therapies in patients enrolled in the STS national database. Whereas recent national quality improvement initiatives within the surgical community (CQI CABG) have demonstrated substantial success in improving rates of use of preoperative β-blockers as well as the use of internal mammary arteries on a national scale through the STS, our data highlight the need for efforts to ensure that evidence-based discharge therapies are provided to all appropriate patients.

Programs such as the Cardiac Hospitalization Atherosclerosis Management Program,27 the American College of Cardiology Guidelines Applied in Practice,28 and the American Heart Association’s Get With the Guidelines29 have demonstrated significant improvements in the rates of secondary prevention in cardiac patients including those undergoing CABG, and have underscored the importance of programmatic change as a key element in improving and sustaining quality of care. Our results highlight gaps in secondary prevention and the need to develop comprehensive quality improvement pro-

### Table 1. Patient Characteristics by Coronary Artery Bypass Grafting Status

<table>
<thead>
<tr>
<th>Characteristic (%)</th>
<th>CABG (n=2,267)</th>
<th>No CABG (n=26,513)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>2,267 73.7</td>
<td>26,513 77.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Female</td>
<td>846 38.7</td>
<td>13,174 51.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>White</td>
<td>2,133 93.3</td>
<td>24,321 91.5</td>
<td>0.0178</td>
</tr>
<tr>
<td>Cardiac risk factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>1,559 70.6</td>
<td>17,743 68.0</td>
<td>0.0448</td>
</tr>
<tr>
<td>Diabetes</td>
<td>726 32.6</td>
<td>8,438 32.6</td>
<td>0.9698</td>
</tr>
<tr>
<td>Current smoker</td>
<td>485 21.7</td>
<td>4,491 17.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Cardiac history</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous Myocardial Infarction</td>
<td>773 33.7</td>
<td>9,429 35.9</td>
<td>0.0987</td>
</tr>
<tr>
<td>Previous Percutaneous Coronary Intervention</td>
<td>276 11.0</td>
<td>3,221 11.9</td>
<td>0.3403</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>219 9.5</td>
<td>4,488 17.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>History of heart failure</td>
<td>315 15.1</td>
<td>7,196 28.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>History of stroke</td>
<td>285 12.8</td>
<td>4,561 17.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Medical history/comorbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung disease</td>
<td>427 20.0</td>
<td>5,976 23.1</td>
<td>0.0069</td>
</tr>
<tr>
<td>Dementia</td>
<td>24 1.2</td>
<td>2,165 9.1</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Transferred in from long term care</td>
<td>10 0.6</td>
<td>1,809 7.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Anterior MI</td>
<td>928 42.2</td>
<td>9859 39.8</td>
<td>0.0971</td>
</tr>
<tr>
<td>Troponin T (median)</td>
<td>21 0.8</td>
<td>287 0.7</td>
<td>0.7497</td>
</tr>
<tr>
<td>Troponin I (median)</td>
<td>1,259 8.1</td>
<td>16,948 8.0</td>
<td>0.5645</td>
</tr>
<tr>
<td>Peak CK (median)</td>
<td>1,951 472.0</td>
<td>24,465 402.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Peak CK-MB&gt;5%</td>
<td>1,411 78.7</td>
<td>18,000 81.2</td>
<td>0.0618</td>
</tr>
<tr>
<td>LVEF&lt;40%</td>
<td>610 29.7</td>
<td>6696 36.9</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

### Table 2. Quality Indicator Rates by Coronary Artery Bypass Grafting Status

<table>
<thead>
<tr>
<th>Quality Indicator</th>
<th>Yes</th>
<th>No</th>
<th>P*</th>
<th>Odds ratio*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge aspirin</td>
<td>Eligible (n%)</td>
<td>Received (%)</td>
<td>Eligible (n%)</td>
<td>Received (%)</td>
</tr>
<tr>
<td>Discharge β-blocker</td>
<td>947 (41)</td>
<td>88.0</td>
<td>8932 (33)</td>
<td>83.2</td>
</tr>
<tr>
<td>Discharge ACE inhibitor</td>
<td>399 (18)</td>
<td>61.5</td>
<td>3013 (11)</td>
<td>72.1</td>
</tr>
<tr>
<td>Discharge lipid lowering</td>
<td>393 (17)</td>
<td>55.5</td>
<td>3177 (11)</td>
<td>72.1</td>
</tr>
<tr>
<td>Discharge lipid lowering</td>
<td>193 (8)</td>
<td>34.7</td>
<td>1346 (5)</td>
<td>55.7</td>
</tr>
</tbody>
</table>

ACE=Angiotensin converting enzyme.

*Adjusted for cardiac arrest or congestive heart failure on admission, MI location, systolic blood pressure, white blood cell count, and serum creatinine levels.
grams on a national scale to improve secondary prevention in older patients undergoing CABG.

Although our study represents the largest study to date to assess quality of care in older patients undergoing CABG after MI, there are several issues to consider. Whereas our study assesses the use of evidence-based therapy in patients deemed ideal on the basis of national guidelines, we are unable to account for patient frailty or preferences in care decisions. Furthermore, our cohort is of older patients hospitalized with AMI undergoing CABG before discharge, and our results may not be generalizable to older patients undergoing CABG in other settings or to younger patients undergoing CABG. Nevertheless, our data represent “real-life” patterns of care in a nationally representative sample of older patients undergoing CABG during AMI hospitalization.

These data demonstrate significant gaps in secondary prevention and highlight opportunities to improve care nationally for a large number of older patients undergoing revascularization annually. These results should prompt health care providers, health care systems, and national professional organizations to strengthen efforts to improve the quality of care in older patients undergoing revascularization and to support ongoing professional society efforts to monitor and improve the quality of care for patients undergoing CABG.

Appendix: Quality Indicators for Post-AMI Care of Medicare Beneficiaries

Aspirin at Discharge

Eligible
All patients with confirmed AMI discharged alive and not transferred to another acute care hospital

Exclusions
Bleeding on admission or during hospitalization; history of bleeding or chronic liver disease; coagulopathy; platelet count <100×10⁹/L; serum creatinine >3 mg/dL; history of peptic ulcer disease or discharge diagnosis of an upper gastrointestinal disorder; Hb <10.0 g/L or Hct <0.30; allergy to aspirin; treatment with warfarin; metastatic cancer or other terminal illness.

Criterion
Evidence of a discharge prescription for aspirin

β-Blockers at Discharge

Eligible
All patients with confirmed AMI discharged alive and not transferred to another acute care hospital

Exclusions
Hypotension or shock during hospitalization or systolic BP <100 mm Hg at discharge; history of asthma or chronic obstructive pulmonary disease; bradycardia or pulse at discharge <50/min (unless discharged while receiving a β-blocker); conduction disorder including 2nd or 3rd degree heart block, bifasicular block, or trifasicular block; left ventricular ejection fraction <35%, pulmonary edema or congestive heart failure; metastatic cancer or other terminal illness.

Criterion
Evidence of a discharge prescription for a β-blocker

ACE Inhibitors at Discharge

Eligible
All patients with confirmed AMI and left ventricular ejection fraction <40%, discharged alive and not transferred to another acute care hospital

Exclusions
Aortic stenosis; allergy or intolerance to ACE inhibitors, serum creatinine >2.0 mg/dL; systolic BP <100 mm Hg at discharge; metastatic cancer or other terminal illness.

Criterion
Evidence of a discharge prescription for an ACE inhibitor

Lipid Lowering Agent at Discharge

Eligible
All patients with confirmed AMI and documented LDL-c >130 mg/dL discharged alive and not transferred to another acute care hospital

Exclusions
Allergy or intolerance to lipid lowering therapy; liver disease documented in the chart; metastatic cancer or other terminal illness.

Criterion
Evidence of a discharge prescription for a lipid lowering agent (3-hydroxy-3-methylglutarlyl-coenzyme A reductase inhibitors, resins, fibrates, bile acid sequestrants, and/or nicotinic acid)

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References


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