Alabama Coronary Artery Bypass Grafting Project
Results of a Statewide Quality Improvement Initiative

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During the past decade, there has been increased interest in measuring and improving the quality of health care. In the field of cardiac surgery, these efforts have focused primarily on reducing the risk-adjusted mortality associated with commonly performed surgical procedures, including coronary artery bypass grafting (CABG) surgery. The risk-adjusted mortality for CABG has significantly improved as a result of these efforts1-3; however, the best methodological approach to improvement is under debate.

Objective To test an intervention to improve performance of CABG surgery.

Design and Setting Quality improvement project based on baseline (July 1, 1995–June 30, 1996) and follow-up (July 1–December 31, 1998) performance measurements from medical record review for all 20 Alabama hospitals that provided CABG surgery.

Patients Medicare patients discharged after CABG surgery in Alabama (n=5784), a comparison state (n=3214), and a national sample (n=3758).

Intervention Confidential hospital-specific performance feedback and assistance with multimodal improvement interventions, including the option to share relevant experience with peers.

Main Outcome Measures Duration of intubation, reintubation rate, aspirin therapy at discharge, use of the internal mammary artery (IMA), hospital readmission rate, and risk-adjusted in-hospital mortality.

Results Proportion of extubation within 6 hours increased from 9% to 41% in Alabama, decreased from 40% to 39% in the comparison state, and increased from 12% to 25% in the national sample. Use of IMA increased from 73% to 84%, 48% to 55%, and 74% to 81%, respectively, in the 3 samples, but aspirin use increased only in Alabama (from 88% to 92%). The amount of improvement in all 3 of these process measures was greater in Alabama than in the other samples (IMA use for Alabama vs comparison state was \( P = .001 \) and for Alabama vs national sample, \( P = .02 \); and \( P = .001 \) for all other comparisons). Risk-adjusted mortality decreased in Alabama (4.9% to 2.9%), but this decrease was not statistically significantly different from mortality changes in the other groups (odds ratio, 0.76; 95% confidence interval, 0.54-1.07 vs national sample).

Conclusion Confidential peer-based regional performance feedback and process-oriented analysis of shared experience are associated with some improvement in quality of care for patients who underwent CABG surgery.

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The Alabama CABG project is a statewide initiative that is based on collaboration between the state peer review organization (PRO) (the Alabama Quality Assurance Foundation [AQAF]) and CABG providers (eg, surgeons, nurses, anesthesiologists, perfusionists, respiratory therapists, physician assistants, and hospital administrators). Funding for the project was provided through AQAF’s contract with the Health Care Financing Administration (HCFA). All of the 20 hospitals in Alabama that offer CABG surgery participated voluntarily in the project. A description of the methods and baseline results for the project have been published previously.\(^4\) Baseline and additional follow-up data, 2 years apart, were used to test the hypothesis that process-oriented interventions, based on confidential peer-based performance feedback and experience sharing, accelerate statewide change in processes of care, without an adverse effect on outcomes. Comparison data were from another state that did not provide performance feedback to providers and a sample of national CABG data provided by HCFA.

**METHODS**

**Overview**

The Alabama CABG project and its baseline findings are described in detail elsewhere.\(^4\) Briefly, a project study group consisting of 6 cardiothoracic surgeons, 2 invasive cardiologists, and AQAF staff identified indicators to measure the quality of care delivered to patients who underwent CABG surgery. Baseline performance on these quality indicators was measured for each hospital in Alabama providing CABG surgery, followed by an intervention providing feedback on performance and suggesting tools for improvement. Performance was measured again after this intervention, then changes in performance across Alabama were compared with changes in a comparison state where no intervention had been performed and with changes observed in a national sample.

**Quality Indicators**

The indicators chosen by the study group represent process and outcome as well as intermediate (ie, mixed process and outcome) measures. These quality indicators were (1) aspirin therapy (acetylsalicylic acid [ASA]) at discharge; (2) use of the internal mammary artery (IMA) for myocardial revascularization; (3) duration of intubation after CABG surgery; (4) intraoperative use of an intra-aortic balloon pump (IABP); (5) reoperation for excessive bleeding; (6) readmission rate to the intensive care unit (ICU) after ICU discharge; (7) hospital readmission rate within 30 days of discharge, and (8) risk-adjusted in-hospital mortality. The processes included in the analysis were considered as indicated in all patients who underwent CABG surgery unless a specific contraindication was documented in the patient’s chart (see exclusions below). The goal of the project was to improve the processes during and after CABG surgery (ASA therapy at discharge, use of IMA, and duration of intubation) while monitoring the other quality indicators listed above.

The quality indicator numerators and denominators and the exclusions are as follows:

1. **Internal mammary artery use for revascularization**:
   - **Numerator**: number of patients indicated to receive an IMA graft who received an IMA graft and denominator, number of patients indicated to receive the IMA graft. Exclusions included an emergency case; history of mastectomy; prior use of IMA; or acute, evolving myocardial infarction.

2. **Aspirin therapy at hospital discharge**:
   - **Numerator**: number of patients indicated to receive ASA at discharge who received ASA at discharge and denominator, number of patients indicated to receive ASA at discharge. Exclusions included patients who had a history of bleeding or coagulation disorder; internal bleeding within the last 6 months; an increased risk of bleeding (admission platelet count of <100,000/mm\(^3\) and history of hemorrhagic stroke); active peptic ulcer disease presently under treatment; or an allergy to ASA or taking warfarin at discharge.

3. **Duration of intubation**: median time was defined as the intubation time for those patients who were intubated during surgery. Time calculation started at the end of surgery time and ended when patients were no longer receiving support by a mechanical ventilator. Exclusions included patients who were intubated before induction of anesthesia for CABG surgery.

4. **Intraoperative use of an IABP**: numerator, number of patients who had an IABP inserted during surgery and denominator, number of patients who had a CABG surgery and did not have an IABP inserted prior to surgery. Exclusions included patients who had undergone IABP prior to surgery.

5. **Readmission to the ICU**: numerator, number of patients who were admitted to the ICU after initially being discharged and denominator, number of patients who had undergone CABG surgery.

6. **Reoperation for bleeding**: numerator, number of patients who returned to surgery due to bleeding or tamponade and denominator, number of patients who had undergone CABG surgery.

7. **Readmission to hospital within 30 days after discharge**: numerator, number of patients who were readmitted to the hospital for any reason within 30 days of discharge following the CABG surgery and denominator, number of patients who had undergone CABG surgery. Exclusions included patients who died while in the hospital and those not listed in the Alabama Medicare beneficiary file.

**Project Samples and Data Collection**

Data for this analysis included Medicare patients who had isolated CABG surgical procedures (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9 CM])\(^3\) codes 36.10-36.20, excluding diagnosis related groups 104, 105, and 468). Samples
the CABG project's objectives and methods to the participants. Results from the initial round of data analysis, that is, baseline data covering CABG surgical procedures performed between July 1, 1995, and June 30, 1996, were presented at a second meeting in January 1998. A cardiothoracic surgeon from the Northern New England Cardiovascular Disease Study Group discussed this group's efforts to date, to provide an example of a successful regional quality improvement initiative. At the third meeting in July 1998, the goal of decreasing the duration of post-CABG mechanical ventilation was presented. An anesthesiologist provided information on how this goal was achieved in his working environment. Attendance at each of these meetings ranged from 120 to 175 people and included anesthesiologists, surgeons, nurses, physician assistants, perfusionists, and respiratory therapists, all who were members of local quality improvement teams.

Each hospital's quality improvement team was given their own facility's performance compared with statewide mean performance and achievable benchmarks of care based on peer performance, as well as the other facilities' anonymized performances, together with comparison state and national mean performance data. Suggestions were made for implementing a quality improvement program at their local hospital, and specific suggestions were given for shortening the duration of post-CABG intubation. A conference was held in February 1999 to discuss the progress of teams at each hospital. The results of the statewide project were presented together with national and comparison state data at a meeting held in September 1999. Project updates were available via the AQAF website, and from an AQAF newsletter that was periodically mailed to all members of the local quality improvement teams.

A member of the AQAF staff made on-site visits at participating hospitals to consult on local improvement efforts and to monitor interim progress with the main targeted process variable (ie, duration of post-CABG intubation). Hospitals were encouraged, but not required, to participate in comparative process analysis (CPA) visits, which were modeled after the round-robin site visits previously used by the Northern New England Cardiovascular Disease Study Group. Typically, the visiting surgeons would watch cardiac surgical procedures during the morning, while other team members observed and spoke with their counterpart at the host hospital. At the end of the visit, the host and visiting teams met to answer any questions that had arisen regarding the procedures and processes of care for CABG used by the host hospital. Within 1 month of the visit, the visiting team completed a written summary that described similarities and differences in the hospitals' approaches to CABG surgery. Thirteen different Alabama hospitals participated in at least 1 CPA visit.

At the group meetings, data were presented from Alabama, from a national sample supplied by HCFA, and from another state that has a demographic profile similar to Alabama but that did not give performance feedback to their CABG providers.

Data Analysis
Mean change from baseline to follow-up in process and outcome variables within each of the 3 samples were compared using \( \chi^2 \) tests for discrete variables and nonparametric analysis of variance (Kruskal-Wallis test) for continuous variables. Between sample comparisons (Alabama vs comparison state or national samples) of change over time in process measures were performed by constructing regression models with universes containing both Alabama and comparison group patients in which there was a binary indicator for collection period and an indicator for exposure to the Alabama quality improvement program. Odds ratios were calculated to demonstrate the effect of
the Alabama quality improvement program, also accounting for the effect of patient clustering within hospitals (SAS Institute, Inc; Cary, NC).

### Table 1. Alabama Quality Assurance Foundation’s CABG In-Hospital Mortality Model**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Mortality OR (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior CABG</td>
<td>3.0 (2.3-3.9)</td>
</tr>
<tr>
<td>BUN (per 10-mg/dL increase)</td>
<td>1.3 (1.2-1.5)</td>
</tr>
<tr>
<td>Age (per 10-year increase)</td>
<td>1.6 (1.3-1.8)</td>
</tr>
<tr>
<td>Preoperative shock</td>
<td>3.1 (2.1-4.6)</td>
</tr>
<tr>
<td>MI day of CABG surgery</td>
<td>3.5 (2.2-5.6)</td>
</tr>
<tr>
<td>Female</td>
<td>1.6 (1.3-1.9)</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>1.6 (1.3-2.0)</td>
</tr>
<tr>
<td>CHF</td>
<td>1.6 (1.3-2.1)</td>
</tr>
<tr>
<td>Preoperative IABP</td>
<td>1.7 (1.2-2.3)</td>
</tr>
<tr>
<td>COPD</td>
<td>1.4 (1.1-1.7)</td>
</tr>
<tr>
<td>Cerebral vascular disease</td>
<td>1.4 (1.0-1.9)</td>
</tr>
</tbody>
</table>

*CABG indicates coronary artery bypass grafting; OR, odds ratio; CI, confidence interval; BUN, blood urea nitrogen; MI, myocardial infarction; CHF, congestive heart failure; IABP, intra-aortic balloon pump; and COPD, chronic obstructive pulmonary disease. †C-index = 0.754, Hosmer-Lemeshow statistic P = .45.

### Table 2. Patient Demographic Profiles and Comorbidities for Alabama, the Comparison State, and National Samples of Patients Who Underwent Coronary Artery Bypass Grafting Surgery*

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Alabama</th>
<th>Comparison State</th>
<th>National</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Baseline</td>
<td>Follow-up</td>
</tr>
<tr>
<td>Hospitals, No.</td>
<td>20</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>Patients, No.</td>
<td>4090</td>
<td>1694</td>
<td>2288</td>
</tr>
<tr>
<td>Mean age, y</td>
<td>69.9</td>
<td>70.7</td>
<td>70.6</td>
</tr>
<tr>
<td>Male, %</td>
<td>65</td>
<td>55</td>
<td>66</td>
</tr>
<tr>
<td>White, %</td>
<td>91</td>
<td>91</td>
<td>94</td>
</tr>
<tr>
<td>BMI†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight, %</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Normal, %</td>
<td>58</td>
<td>55</td>
<td>61</td>
</tr>
<tr>
<td>Overweight, %</td>
<td>23</td>
<td>26</td>
<td>21</td>
</tr>
<tr>
<td>Obese, %</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>CAD†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left main, %</td>
<td>16</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td>MI within 3 days, %</td>
<td>9</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>MI within 6 months, %</td>
<td>22</td>
<td>26</td>
<td>21</td>
</tr>
<tr>
<td>CHF‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor LVF, %§</td>
<td>26</td>
<td>29</td>
<td>20</td>
</tr>
<tr>
<td>Cardiogenic shock, %§</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>COPD, %¶</td>
<td>25</td>
<td>30</td>
<td>23</td>
</tr>
<tr>
<td>Diabetes mellitus, %¶</td>
<td>29</td>
<td>32</td>
<td>27</td>
</tr>
<tr>
<td>Dialysis, %</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*XNA indicates not available; BMI, body mass index (kg/m²); CAD, coronary artery disease; MI, myocardial infarction; CHF, congestive heart failure; LVF, left ventricular function; and COPD, chronic obstructive pulmonary disease. †Underweight is defined as BMI ≤ 20 kg/m²; normal weight for men as BMI of 20 to 27.7 kg/m² and for women as 20.3 to 27.2 kg/m²; overweight for men as BMI of 27.8 to 31.0 kg/m² and for women as 27.3 to 32.2 kg/m²; and obese for men as BMI of ≥ 31 kg/m² and for women as ≥ 32.2 kg/m². §CAD status is the presence of left main stenosis less than 50% and the presence of an MI within 3 days or 6 months prior to coronary artery bypass grafting (CABG) surgery were included as comorbid conditions. †Cardiac function is the LVF assessment, including the presence of symptoms of CHF within 2 weeks before CABG, left ventricular ejection fraction less than 45% (poor LVF), and the presence of cardiogenic shock immediately prior to surgery. ¶Noncardiac comorbidities included a diagnosis of COPD, diabetes mellitus, and renal failure requiring dialysis.

Adjusted in-hospital mortality rates were computed using a previously published multiple logistic regression model. The risk factors evaluated for inclusion in the risk-adjustment model were chosen based on a number of previously published CABG risk models. The final model contained 11 risk factors, which are listed in Table 1. The same risk factors were then used to construct models for between sample comparisons in mortality, as described in the previous paragraph for process measures.

### RESULTS

The patients from the 3 groups have comparable demographic and comorbidity profiles (Table 2); however, there are interesting differences for the baseline measurements of the process variables (Table 3). Specifically, the prevalence of IMA use was lower in the comparison state sample than in the Alabama or the national samples. The median duration of intubation was shorter and the percentage of patients who were intubated for longer than 6 hours was lower in the comparison state than in Alabama. The prevalence of ASA use at discharge and the reintubation rates were similar for all 3 samples.

Remeasurement of the process variables shows that the duration of intubation was markedly shortened in the Alabama sample, where it was specifically targeted for improvement. During the study period in Alabama, the median duration of post-CABG intubation decreased from 12 to 7 hours, and the percentage of patients who were intubated for less than 6 hours increased from 9% to 41% (Table 3). These measures for the comparison state remained constant. In the national sample, the duration of intubation decreased and the prevalence of intubation for less than 6 hours increased; however, the change was less than the change that occurred in Alabama. The use of IMA increased in all 3 samples, and ASA use increased only in the Alabama sample. The improvements in these 3 process indicators (proportion of patients who were intubated < 6 hours, IMA use, and ASA use) were significantly higher in Alabama than in the comparison state and in the national sample (IMA use for Alabama vs comparison state was P = .001 and for Alabama vs national sample, P = .02; and P < .001 for all other comparisons). Of note, these improvements occurred statewide rather than at just a few hospitals, as demonstrated in Figure 1 and Figure 2. For example, 92% of Alabama hospitals showed improved performance for intubation for less than 6 hours compared with only 30% of the comparison state hospitals (Figure 1, first pair of bars).

The changes in duration of post-CABG intubation were achieved without a clinically important increase in the prevalence of reintubation (Table 3). Subsequent data sampling in Alabama indicates that the change in duration of post-CABG intubation has persisted up...
to 1 year after the initial push to shorten the duration of intubation (Figure 2).

Note that this change was evident in data acquired by local quality improvement teams and by a CDAC. The CDAC data indicate that the percentage of intubation duration less than 6 hours was 52.6% for the first 6 months of 1999.

At the individual hospitals within Alabama, there was variation in the process variables that warrants further examination. Variation was greater than predicted in several of the baseline measures. For instance, there is general agreement that IMA use for the left anterior descending artery is beneficial to graft patency and patient survival. However, within Alabama the prevalence of IMA use at individual hospitals ranged from 34% to 93%, with a mean of 73%, in the baseline sample (Figure 2B). Although this variable was not specifically targeted for improvement, the prevalence of IMA use increased to 84% in the follow-up measurement, while variability across Alabama hospitals narrowed to range from 65% to 98%. This change was due to more than 40% of hospitals in Alabama significantly increasing IMA use, while none of the Alabama hospitals decreased IMA use (Figures 1 and 2B). This effort led to an increase in IMA use that was greater than in the comparison state where confidential feedback to practitioners was not provided and where only 30% of hospitals improved their performance on the IMA use indicator. Similar changes were seen in the prescription of ASA at the time of discharge (Figures 1 and 2C).

There were no clinically important changes in the prevalence of intraoperative IABP use, return to the operating room for excessive bleeding, or re-admission to the ICU (Table 4). The mean post-CABG hospital length of stay decreased for all 3 study samples, reflecting a national trend to shorten overall length of hospital stay for patients with ischemic heart disease.

Risk-adjusted mortality for CABG surgery decreased significantly in Alabama concurrent with the changes in the processes of care for patients who underwent CABG surgery. Similar significant reductions in risk-adjusted mortality did not occur in the comparison state or in the national sample (Table 4). Analysis of the change in post-CABG mortality, adjusted for risk factors present at the time of each data sample, shows a statistically significant decrease in mortality in Alabama but not in the comparison state or the national sample. When directly comparing decreases in mortality across samples, the odds ratios (95% confidence intervals [CIs]) of mortality at follow-up (after adjustments for risk factors and baseline mortality) were 0.72 (95% CI, 0.46-1.13; P = .15) for Alabama vs the comparison state, and 0.76 (95% CI, 0.54-1.07; P = .12) for Alabama vs the national sample.

**COMMENT**

With this cooperative statewide quality improvement project, we observed significant reductions in the duration of post-CABG intubation as well as increases in IMA use and ASA prescription. These process changes occurred simultaneously with a significant reduction in risk-adjusted in-hospital mortality in Alabama Medicare patients. Similar changes in mortality were noted during the same period in a comparison state and in a national sample of CABG cases, but a comparable profile of favorable changes in processes of care for CABG was not observed. The changes implemented in these processes of care in Alabama were not associated with increased complications (30-day hospital readmission rates or reintubation rates). However, in the rate of readmission to the ICU during the same time, there was an insignificant increase in Alabama with an insignificant decrease in the national sample, and the comparison state had a statistically insignificant increase.

The first and previously published finding from this analysis was the magnitude of variation in-process measures among individual Alabama hospitals. In our study, we show that providing hospitals with a description of their own performance relative to their peers on a confidential basis and using aggregate and benchmark per-

**Table 3. Quality Measurement Variables for the Alabama, Comparison State, and National Samples of Patients Who Underwent Coronary Artery Bypass Grafting Surgery**

<table>
<thead>
<tr>
<th>Process Measures</th>
<th>Alabama Baseline</th>
<th>Alabama Follow-up</th>
<th>Comparison State Baseline</th>
<th>Comparison State Follow-up</th>
<th>National Baseline</th>
<th>National Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal mammary artery use, %</td>
<td>73</td>
<td>84</td>
<td>48</td>
<td>55</td>
<td>74</td>
<td>81</td>
</tr>
<tr>
<td>Aspirin therapy, %</td>
<td>88</td>
<td>92</td>
<td>48</td>
<td>55</td>
<td>74</td>
<td>81</td>
</tr>
<tr>
<td>Intubation, median, h</td>
<td>12</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>Intubation &lt;6 h, %</td>
<td>9</td>
<td>41</td>
<td>40</td>
<td>39</td>
<td>12</td>
<td>25</td>
</tr>
</tbody>
</table>

*P < .001 for baseline vs follow-up measurement (within group analysis).

1 For between group analysis for rate of change, for internal mammary artery use, P = .001 in Alabama vs comparison state, and P = .02 in Alabama vs national sample; for all other comparisons, P > .001.

**Figure 1. Process Improvement in Coronary Artery Bypass Grafting for Alabama and Comparison State Hospitals**

Percentage of hospitals showing statistically significant improvement of intubation time of less than 6 hours, internal mammary artery (IMA) use, and aspirin (acetylsalicylic acid [ASA]) use at discharge in Alabama vs comparison state (IMA use for Alabama vs comparison state was P = .001 and for Alabama vs national sample, P = .02; and P < .001 for all other comparisons). Remainder of hospitals showed no significant improvement in performance (ie, no hospital’s performance deteriorated). This information cannot be calculated for the national sample.
Figure 2. Frequency Distribution for Duration of Intubation, Internal Mammary Artery Use, and Aspirin Use at Hospital Discharge for Coronary Artery Bypass Grafting Surgery for Alabama Hospitals

![Box plot](image)

The center horizontal line in each box plot indicates the median; the top and bottom of the box, the interquartile range; the top error bar, the 90th percentile; and the bottom error bar, the 10th percentile. ASA indicates acetylsalicylic acid.

### Table 4. Outcome Variables for Alabama, Comparison State, and National Samples of Patients Who Underwent Coronary Artery Bypass Graft Surgery

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Alabama Baseline</th>
<th>Alabama Follow-up</th>
<th>Comparison State Baseline</th>
<th>Comparison State Follow-up</th>
<th>National Baseline</th>
<th>National Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk-adjusted in-hospital mortality, %</td>
<td>4.9</td>
<td>2.9†</td>
<td>3.9</td>
<td>3.7</td>
<td>4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>IABP, %</td>
<td>4.0</td>
<td>3.2</td>
<td>2.4</td>
<td>3.5</td>
<td>3.8</td>
<td>3.0</td>
</tr>
<tr>
<td>Readmission to ICU, %‡</td>
<td>3.7</td>
<td>4.5</td>
<td>3.4</td>
<td>4.4</td>
<td>4.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Bleeding, %§</td>
<td>3.7</td>
<td>3.4</td>
<td>3.5</td>
<td>2.3</td>
<td>2.9</td>
<td>4.5</td>
</tr>
<tr>
<td>Hospital LOS, median, d</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Readmission to hospital, %¶</td>
<td>14.9</td>
<td>17.3</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

* IABP indicates intra-aortic balloon pump; ICU, intensive care unit; LOS, length of stay; and NA, not available.
†P=.001 for baseline vs follow-up (within group analysis). When directly comparing decreases in mortality across samples, the odds ratios (95% confidence intervals) of mortality at follow-up (after adjustments for risk factors and baseline mortality) were 0.72 (95% CI, 0.46–1.13; P=.13) for Alabama vs the comparison state and 0.76 (95% CI, 0.54–1.07; P=.12) for Alabama vs the national sample.
‡Return to the operating room for excessive bleeding.
¶Hospital readmission rate within 30 days of discharge.

The performance of peers spurred improvements in the processes of care for CABG surgery. Of note, hospitals with substandard performance for variables that were not specifically targeted for change by the statewide initiative nevertheless recognized and rectified their deficiencies.

It is possible that the changes that occurred in the Alabama hospitals represent regression to the mean rather than an improvement directly related to the study intervention. However, similar improvements in the processes of care for CABG were found less consistently in the comparison state where provider feedback was not given. In addition, improvements within the Alabama hospital process of care for CABG were achieved for the sake of delivering high-quality health care alone, since this confidential peer-review information did not carry the threat of adverse publicity or other punitive actions. The degree of change that would have occurred with threat of adverse publicity or other punitive action was not determined by this study because the study design did not include a state where punitive actions are taken against hospitals with substandard performance. Nevertheless, in our opinion, these data suggest a fundamental desire of health care providers to attain high-quality performance by striving toward benchmarks for best practices. This level of performance is provided that funding is available for obtaining measures of performance and a framework for implementing change is supplied to hospital-based quality improvement teams.

As part of our statewide quality improvement program, representatives of 13 of the 20 hospitals chose to visit or host another hospital in the state to compare the management of patients undergoing CABG surgery. These CPA visits were organized with the assistance of AQA and were structured to be nonadversarial learning experiences in which all members of the CABG team had an opportunity to interact and learn from their counterparts. The details of quality improvement procedures varied from one hospital to another. However, in general, they were based on meetings of quality improvement teams that identified local problems and opportunities for improvement and then acted on them with help from the AQA on an as-needed basis.

The Alabama CABG project primarily focuses on improvement in the processes rather than the outcome of care. Defining and measuring the processes of care helps hospitals identify areas for improvement. The change that occurred in the targeted process variable (ie, duration of post-CABG intubation, Figure 2A) suggests that a coordinated statewide quality improvement effort can bring about change broadly and rapidly. These statewide process improvements were associated with a lower in-hospital risk-adjusted mortality for CABG surgery, although a causal relationship was not established. Separating the changes that occurred due to the project intervention from secular changes in the practice of cardiac surgery is always difficult. These changes were documented in our study by national and comparison state data samples, as well. However, our multivariable analyses suggest that in 3 of the indicators (intubation for <6 hours, IMA use, and ASA use) the improvement in the Alabama hospitals was significantly larger than in the other 2 groups (Table 2). Because some improvements in the processes of care did occur in the other 2 groups without a specific intervention, the costs of data
acquisition and analysis for this project need to be further investigated. This investigation is beyond the scope of our study, although it will need to be addressed before advocating similar large-scale studies for other regions.

In addition to directing change in practice patterns, regional and statewide studies offer unique opportunities to develop and validate optimal practice guidelines. The Northern New England Cardiovascular Disease Study Group already has successfully undertaken investigations into optimal practices for CABG surgery. In Alabama, data from the CABG project were recently used to test the hypothesis that prophylactic preincision placement of an IABP is beneficial for patients who are considered high risk for CABG surgery but who do not have preoperative hemodynamic instability or unstable angina. Studies like these are expected to help define best-practice guidelines and further lead to regional implementation of these guidelines more quickly than has been previously possible.

Results from the Alabama CABG project suggest that health care providers are willing to respond to clinical data and to improve health care under a confidential peer-review system. Other studies that examined the effects of publicly released outcome data on physician and patient practices have shown that the effect of publicly released information on referral patterns for CABG surgery is relatively small, and that publicly released outcome data have little influence on patient choice of hospital for CABG surgery. More recently, the purchasing behavior of managed care and private fee-for-service insurers in New York State was investigated. This analysis indicated that managed care insurers typically choose higher-mortality CABG providers than private fee-for-service insurers. Thus, at present there are no data to support assumptions made previously regarding publication of surgeon- or hospital-specific report cards, although ethical considerations argue for continued public access to outcome information.

Several regional quality assurance and improvement projects in cardiac surgery have been published. They generally have been associated with decreases in risk-adjusted mortality, although the methods for data collection and presentation to providers differ somewhat from one study to another. Of note, these previous studies have not included comparison groups such as ours and therefore are less convincing in attributing improvement to specific interventions rather than secular trends. Only 1 of the previously published projects, conducted in northern New England, used a cooperative process in which hospitals actively learned from another’s experience. At the outset of the Alabama project, we did not know if we would be able to transfer the comparative process analysis approach to our region where several competing cardiac surgical programs coexist in close proximity. This study demonstrates that the CPA approach is feasible even in a state where hospitals in the same city are actively competing for patients.

Even though debates persist regarding the meaning and importance of changes in risk-adjusted mortality, it is likely that patients are well served in most circumstances by regional quality improvement efforts. Thus, the continued evolution of regional quality improvement projects and evidence-based guidelines for optimal practices in cardiac surgery and other fields of medicine should be encouraged. Our experience with the Alabama CABG project indicates that a nonpunitive, collaborative atmosphere created by a confidential peer-review effort can achieve improvements in processes of care and that establishing a uniform and high-quality mechanism for statewide data abstraction, analysis, and reporting is feasible. Credibility based on accurate data collection is crucial for capturing the attention, and the commitment of health care providers, including all members of the hospital staff who participate in the care of patients who underwent CABG surgery. It also is crucial to achieving sustained quality improvement.

Our study suggests that a quality improvement effort, such as the Alabama CABG project, leads to better health care. Initiation and implementation of the project was facilitated by AQAF, an organization with experience in clinical outcome analysis and quality improvement. Collaboration between a state PRO and health care providers can be used as a model for others. Funding for regional and statewide quality improvement projects is essential. To date, grants from public or private agencies or contributions from practicing surgeons fund regional and statewide quality improvement efforts. Who will pay for future quality improvement studies for continued progress in this area is yet to be decided.

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