Providing financial incentives for higher quality of care (pay for performance [P4P]) has become common, many worry that P4P will lead providers to avoid offering surgical procedures to the sickest patients out of concern that poor outcomes will lead to financial penalties.

Methods and Results—We used Medicare data to compare change in rates of coronary artery bypass graft surgery between 2002 to 2003 and 2008 to 2009 among patients with acute myocardial infarction (AMI) admitted to 126 hospitals participating in Medicare’s Premier Hospital Quality Incentive Demonstration P4P program with patients in 848 control hospitals participating in public reporting through the Health Quality Alliance. We examined rates for all patients with AMI and those in the top decile of predicted mortality based on demographics, medical comorbidities, and AMI characteristics. We identified 91,393 patients admitted for AMI in Premier hospitals and 502,536 Medicare patients admitted for AMI in control hospitals. Coronary artery bypass graft surgery rates for patients with AMI in Premier decreased from 13.6% in 2002 to 2003 to 10.4% in 2008 to 2009; there was a comparable decrease in non-Premier hospitals (13.6%–10.6%; \( P \) value for comparison of changes between Premier and non-Premier, 0.67). Coronary artery bypass graft surgery rates for high-risk patients in Premier decreased from 8.4% in FY 2002 to 203 to 8.2% in 2008 to 2009. Patterns were similar in non-Premier hospitals (8.4%–8.3%; \( P \) value for comparison of changes between Premier and non-Premier, 0.82).

Conclusions—Our results show no evidence of a deleterious effect of P4P on access to coronary artery bypass graft surgery for high-risk patients with AMI. These results should be reassuring to those concerned about the potential negative effect of P4P on high-risk patients. (Circ Cardiovasc Qual Outcomes. 2014;7:727-734.)

Key Words: coronary artery bypass grafting • pay for performance
WHAT IS KNOWN

• Pay for performance (P4P) has become ubiquitous in both the private and the public healthcare sectors.
• P4P has raised concern about access to care for high-risk patients because providers of care may avoid providing care for such patients because of concerns about their measured performance on quality indicators, such as risk-adjusted mortality.

WHAT THE STUDY ADDS

• To our knowledge, this is the first article to examine the effect of P4P on the access to high-risk procedures for severely ill patients.
• We compared changes in the use of coronary artery bypass graft surgery for patients with acute myocardial infarction in hospitals participating in the Premier Quality Incentive Demonstration (which had financial incentives for risk-adjusted mortality from coronary artery bypass graft surgery) with changes in a comparison group of hospitals not under P4P and found virtually identical patterns.
• The study provides evidence that P4P did not limit the access of severely ill patients to coronary artery bypass graft surgery in the Premier Demonstration and should be reassuring to those concerned about a negative effect from P4P on access to care.

To address this data gap, we studied rates of CABG surgery for patients with AMI in the Premier HQID and a comparison group treated in non-Premier hospitals. We focused on patients with AMI to reduce heterogeneity among candidates for CABG in different settings and because the literature supports using CABG surgery in an important subset of such patients. We sought to determine whether rates of CABG decreased over time under P4P compared with those in non-Premier hospitals. We examined differences in these patterns overall and for patients at high and low risk of mortality, hypothesizing that Premier hospitals would be more likely to show a relative decrease in CABG rates among high-risk patients.

Methods

Premier HQID Participants and Comparison Hospitals

In 2003, CMS invited 421 hospitals participating in the Premier Healthcare Informatics Program to join the HQID P4P program, and 255 (61%) agreed to do so. Participating hospitals were required to provide information on 33 quality measures for CABG, total hip replacement, total knee replacement, AMI, CHF, and pneumonia. The quality indicators specific to CABG surgery included process measures (eg, aspirin at discharge, prophylactic antibiotic received within 1 hour before surgery and antibiotic discontinued within 48 hours) and risk-adjusted mortality. Hospitals performing in the top decile for each condition received a bonus payment of 2% of Medicare payments for that condition. Hospitals scoring in the second decile received a 1% bonus. The lowest performing hospitals were liable for a 1% to 2% financial penalty, which was implemented in year 4 of the demonstration. During the course of the program, the Premier HQID modified its incentive structures to reward improvement and performance.

As a comparison group, we identified the national sample of hospitals not participating in Premier but participating in public reporting of processes and outcomes of care for AMI, CHF, and pneumonia through the Hospital Quality Alliance. We chose hospitals reporting data in the Hospital Quality Alliance because we felt that they had sufficient patients for reporting and had demonstrated potential interest in quality improvement activities, thus reducing the selection bias associated with choosing to participate in Premier. During the time period of our study, the Hospital Quality Alliance collected data on several process and outcome measures, but none of these were directly related to CABG. The only control or Premier hospitals with publicly reported data on CABG were those located in 3 states with state-based CABG mortality reporting systems (New York, Pennsylvania, and Massachusetts). Below we describe sensitivity analyses eliminating these 3 states from our analyses.

Access to CABG

To examine access to CABG, we used Part A Medicare data from January 1, 2002, to September 30, 2009, on all patients >65 years of age discharged with a principal diagnosis of AMI (International Classification of Diseases-Ninth Revision [ICD-9] codes 410.x1). Transferred patients were assigned to the receiving hospital, consistent with CMS practice in calculating mortality rates for CABG within the Premier program. We only included patients with AMI who were admitted or transferred to a CABG-capable hospital in each of the study years (126 Premier and 848 non-Premier hospitals); in sensitivity analyses, we excluded transfer patients and our results were qualitatively similar. Our primary end point was receipt of an isolated CABG (procedure codes 3610–3619).

Risk of 30-Day Mortality

We estimated each patient’s risk of 30-day mortality using a logistic regression model that included age, sex, and the presence of 28 comorbidities used in the Elixhauser risk-adjustment scheme (we dropped a 29th comorbidity, AIDS, because its prevalence was too low in our population), a validated, widely used tool, developed for use with administrative data. Consistent with previous work, we also adjusted for characteristics of the AMI: we identified patients with non-ST-segment–elevation myocardial infarction as patients with a primary diagnosis of subendocardial AMI (ICD-9 code 410.71), patients with ST-segment–elevation myocardial infarction as those with a diagnosis of ST-segment–elevation myocardial infarction (ICD-9 codes 410.x1 excluding 410.71), and patients with cardiogenic shock or cardiac arrest as those with additional codes for those conditions (ICD-9 codes 785.51 and 427.5, respectively).

Data Analysis

We first compared characteristics of Premier and non-Premier hospitals, the characteristics of patients who received care for AMI at those hospitals, and how patient characteristics changed between 2002 to 2003 and 2008 to 2009. We calculated patients’ predicted risk of mortality with the logistic regression model described above and examined the association between each decile of predicted mortality and observed 30-day mortality rates and CABG rates.

Our primary outcome was receipt of CABG surgery. We expected that rates at Premier hospitals would decrease more over time under P4P and hypothesized that Premier hospitals would seek to avoid performing CABG on high-risk patients (ie, those in the top decile of predicted mortality) to avoid high mortality rates and consequent financial penalties. We first plotted out annual, unadjusted rates of...
CABG surgery among patients at Premier and non-Premier hospitals for high-risk patients (those in the highest decile of predicted risk of 30-day mortality) and low-risk patients (the remainder of the population) separately. To examine changes over time formally, we compared the rate from January 1, 2002, to September 30, 2003 (the 21-month time period just before P4P was initiated) to the rate from January 1, 2008, to September 30, 2009 (the last 21 months of the program). Changes were examined using a patient-level hierarchical logistic regression model clustered by hospital, adjusting for age, sex, 28 Elixhauser medical comorbidities, and characteristics of the AMI. We also included variables for hospital characteristics (size, region, profit status, teaching status, proportion of Medicare patients, margin, and location in a competitive market), time (2008–2009 versus 2002–2003), Premier status, and a 2-way interaction between time and Premier status. The $P$ value from this interaction term was used to assess whether changes in rates of CABG over time were statistically different in Premier versus non-Premier hospitals.

We repeated this analysis for the high-risk group and the low-risk group separately. We then extended this analysis focusing on additional variables shown to be more highly associated with improvement in process of care in response to P4P—proportion of patients with Medicare coverage, margin, and location in a competitive market. Three-way interactions between each of these variables, Premier status and time were used to determine whether any of them modified the relationship between Premier status and change in access to CABG. As a sensitivity analysis, we defined high risk as those patients in the top 2 deciles of predicted mortality. To address concerns that Premier hospitals may code comorbid conditions more aggressively to make their patients seem sicker than similar patients in non-P4P hospitals, we repeated the analyses without adjusting for comorbidity. Finally, as a sensitivity analysis, we eliminated hospitals in the 3 states with public reporting for risk-adjusted CABG mortality and repeated our analyses. All analyses were performed using SAS software, version 9.3 (SAS Institute, Inc, Cary, NC). The study was granted exemption by the Harvard School of Public Health Institutional Review Board.

**Results**

**Hospital and Patient Characteristics**

Hospitals participating in the Premier HQID were more often private, nonprofit institutions than non-Premier hospitals (Table 1). Patients with AMI admitted to Premier hospitals were younger, more often black, less often low income, more likely to have a non–ST-segment–elevation myocardial infarction or chronic obstructive pulmonary disease and less likely to have cardiogenic shock (Table 2).

| Table 1. Characteristics of Premier vs Non-Premier Hospitals* |
|-------------------------------|-------------------|-----------------|------|
| Hospital Characteristics      | Premier           | Non-Premier     | $P$ Value |
| No. of Hospitals              | 126               | 848             | N/A   |
| Size, %                       |                   |                 |       |
| Small                         | 0.0               | 1.7             | 0.13  |
| Medium                        | 55.6              | 61.0            |       |
| Large                         | 44.4              | 37.4            |       |
| Region, %                     |                   |                 |       |
| Northeast                     | 13.5              | 13.4*           | 0.09  |
| Midwest                       | 23.0              | 28.3            |       |
| South                         | 48.4              | 37.3            |       |
| West                          | 15.1              | 21.0            |       |
| Ownership, %                  |                   |                 |       |
| For-profit                    | 0.8               | 18.6            | <0.001|
| Private nonprofit             | 90.5              | 70.1            |       |
| Public                        | 8.7               | 11.3            |       |
| Teaching, %                   |                   |                 |       |
| Major                         | 23.8              | 22.3            | 0.90  |
| Minor                         | 36.5              | 36.1            |       |
| Not teaching                  | 39.7              | 41.6            |       |
| RUCA, %                       |                   |                 |       |
| Urban                         | 75.3              | 73.9            | 0.90  |
| Suburban                      | 7.2               | 9.6             |       |
| Large rural town              | 8.3               | 7.7             |       |
| Small town/isolated rural     | 9.3               | 8.8             |       |
| Median (IQR) percent Medicare | 42.6% (37.8%–48.9%) | 42.8% (37.5%–48.2%) | 0.59  |
| Median (IQR) percent Medicaid | 16.9% (11.8%–20.8%) | 16.8% (11.3%–21.3%) | 0.56  |
| Median (IQR) proportion black | 4.5% (1.6%–11.8%)  | 3.8% (1.3%–9.9%) | 0.86  |
| Median (IQR) county income†   | $46 299 ($41 586–$53 934) | $47 792 ($41 852–$54 375) | 0.30  |
| Median (IQR) county povertyrate† | 15.3% (12.6%–17.1%) | 15.3% (12.4%–17.6%) | 0.71  |

COPD indicates chronic obstructive pulmonary disease; IQR, interquartile range; and RUCA, rural urban commuting area.

*χ² tests were performed for categorical variables, whereas for continuous variables, the table shows medians and IQRs, along with $P$ values from a Mann–Whitney $U$ test.

†Income and poverty rate refer to the county where hospitals are located.
Patient populations of both Premier and non-Premier hospitals changed modestly over time (Table 3). For example, in both sets of hospitals the patient population became older. The average number of comorbid medical conditions increased comparably in Premier and non-Premier hospitals.

### Risk of Mortality

The mean observed mortality among patients with AMI spanned from 1.8% among those assigned to the lowest decile of predicted risk of mortality to ≈50% among patients assigned to the highest decile of predicted risk (Figure 1). We found

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Premier</th>
<th>Non-Premier</th>
<th>PValue</th>
<th>Premier</th>
<th>Non-Premier</th>
<th>PValue</th>
<th>PValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>91393</td>
<td>502537</td>
<td>N/A</td>
<td>281876</td>
<td>220661</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Age, y (mean)</td>
<td>77 (71–83)</td>
<td>77 (71–83)</td>
<td>&lt;0.001</td>
<td>77.9</td>
<td>77.8</td>
<td>&lt;0.001</td>
<td>0.60</td>
</tr>
<tr>
<td>Sex (women)</td>
<td>47.7</td>
<td>47.8</td>
<td>0.94</td>
<td>57.3</td>
<td>57.5</td>
<td>0.73</td>
<td>0.16</td>
</tr>
<tr>
<td>Black, %</td>
<td>7.7</td>
<td>7.2</td>
<td>&lt;0.001</td>
<td>6.9</td>
<td>7.6</td>
<td>&lt;0.001</td>
<td>0.04</td>
</tr>
<tr>
<td>Hispanic, %</td>
<td>1.4</td>
<td>1.4</td>
<td>0.28</td>
<td>1.3</td>
<td>1.5</td>
<td>0.14</td>
<td>0.22</td>
</tr>
<tr>
<td>Acute MI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSTEMI</td>
<td>62.0</td>
<td>61.3</td>
<td>&lt;0.001</td>
<td>56.3</td>
<td>67.7</td>
<td>&lt;0.001</td>
<td>0.08</td>
</tr>
<tr>
<td>STEMI</td>
<td>31.0</td>
<td>31.3</td>
<td>0.07</td>
<td>36.3</td>
<td>24.9</td>
<td>&lt;0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Cardiogenic shock/cardiac arrest</td>
<td>7.1</td>
<td>7.4</td>
<td>&lt;0.001</td>
<td>7.5</td>
<td>7.4</td>
<td>0.54</td>
<td>0.01</td>
</tr>
<tr>
<td>Comorbid conditions, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average no. of comorbidities</td>
<td>1.8</td>
<td>1.85</td>
<td>0.14</td>
<td>1.8</td>
<td>1.9</td>
<td>&lt;0.001</td>
<td>0.14</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>0.9</td>
<td>1.0</td>
<td>0.22</td>
<td>1.2</td>
<td>0.6</td>
<td>&lt;0.001</td>
<td>0.09</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>26.6</td>
<td>26.4</td>
<td>0.36</td>
<td>26.9</td>
<td>25.8</td>
<td>&lt;0.001</td>
<td>0.01</td>
</tr>
<tr>
<td>Hypertension</td>
<td>55.7</td>
<td>55.6</td>
<td>0.73</td>
<td>54.0</td>
<td>57.7</td>
<td>&lt;0.001</td>
<td>0.16</td>
</tr>
<tr>
<td>COPD</td>
<td>20.1</td>
<td>19.6</td>
<td>&lt;0.001</td>
<td>21.4</td>
<td>17.3</td>
<td>&lt;0.001</td>
<td>0.15</td>
</tr>
<tr>
<td>Low income, %*</td>
<td>14.6</td>
<td>14.4</td>
<td>&lt;0.001</td>
<td>13.6</td>
<td>13.7</td>
<td>0.008</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

COPD indicates chronic obstructive pulmonary disease; NSTEMI, non–ST-segment–elevation myocardial infarction; and STEMI, ST-segment–elevation MI.

*Low income is defined as the proportion of people below the poverty line in the patients’ county of residence.

**χ²** tests were performed for categorical variables, whereas for continuous variables, the table shows medians and IQRs, along with P values from a Mann–Whitney U test.
that procedure rates were inversely related to risk (except for
the highest decile) with 17.5% of patients in the lowest risk
decile receiving CABG surgery when compared with 8.3% in
the highest-risk group (Figure 2).

Change in the Use of CABG Surgery After
Initiation of P4P

Crude rates of CABG surgery for both high-risk and low-
risk patients with AMI decreased between FY2002-3 and
FY2008-9 in both Premier and non-Premier hospitals (Fig-
ure 3), and the changes were comparable in both types of hos-
pital. After adjusting for patient and hospital characteristics,
CABG rates at Premier hospitals decreased by 3.2% between
FY2002-3 and FY2008-09 (P<0.001) and by 3.0% at non-Prem-
ier hospitals (P<0.001; difference, 0.2%; 95% confidence
interval, −0.6% to 0.9%; P=0.67; Table 4). Rates of CABG
surgery for high-risk patients decreased minimally over time
for both Premier (8.4%–8.2%) and non-Premier (8.4%–8.3%)
hospitals, and the difference in change between Premier and
non-Premier hospitals was small (0.2%; 95% confidence
interval, −1.2% to 1.5%; P=0.82). Rates for low-risk patients
decreased substantially in Premier (14.0%–10.5%) and non-
Premier hospitals (14.0%–10.6%; both P<0.001), but the
changes were comparable in the 2 groups of hospitals (dif-
ference, 0.2%; 95% confidence interval, −0.6% to 0.9%;
P=0.66).

We performed additional analyses examining whether there
was significant effect modification in hospitals characterized
by a higher proportion of Medicare patients, higher margins,
or location in a competitive market; but there was none. We
repeated our analyses with no adjustment for comorbidity
and found qualitatively similar results. Sensitivity analyses
in which we defined the high-risk group as those patients
in the top 2 deciles of predicted mortality gave qualita-
tively similar results as well. Finally, when we repeated our
analyses dropping hospitals in the 3 states with public report-
ing for CABG outcomes (Massachusetts, New York, and
Pennsylvania), the results were nearly identical and the con-
clusions unchanged.

Discussion

We examined the effect of P4P on receipt of CABG surgery
among patients with AMI and found no evidence that being
under financial incentives led hospitals to restrict access for
patients overall or those at particularly high risk of mortal-
ity. Even among hospitals that have been previously found to
be more responsive to P4P (those with a large proportion of
Medicare patients, higher margin, or location in a more com-
petitive market), we found no evidence that patients were less
likely to receive CABG surgery under P4P.

There are several potential explanations for our findings.
One possibility is that the overall decline in the use of CABG
for high-risk patients over the study period overwhelmed any
effect of P4P on patient selection. Our study period corre-
sponds with a time in which the use of multivessel and left
main percutaneous coronary interventions grew significantly,
and this secular trend may have reduced our ability to see a dif-
fERENCE BETWEEN THE 2 GROUPS. It is also possible that, in con-
trast to previous studies examining risk aversion in selection
for CABG under public reporting,15 the fact that both AMI and
CABG mortality were explicitly incented provided protection
against underuse of this procedure. In patients with AMI for
whom CABG was clearly the treatment of choice, financial
incentives for AMI mortality may have acted to reduce risk
aversive behavior.

Our findings likely have implications for VBP, the recently
introduced federal P4P program modeled on Premier. As in
Premier, there are incentives in VBP for both improvement
and attainment, and the amount of money at risk is relatively
small16—set in statute as 1% in the initial year and rising to

Figure 1. Observed 30-day mortality by predicted mortality risk deciles.
only 2% in 2017. Also as in Premier, there is overlap in the
targeted conditions and surgical procedures (CHF, AMI, and
pneumonia and next year CABG) and in the condition-based
quality indicators used to measure performance (both pro-
cess indicators and risk-adjusted mortality). Thus, our results
should be reassuring to those concerned about the federal pro-
gram’s potential effect on access.

We are unaware of previous US work that has directly
examined whether hospitals that are under financial incen-
tives restrict access to care for medically high risk or severely
ill populations. In the only other study of P4P and access,
Ryan17 examined the effect of the Premier HQID on access
for minority patients, focusing on AMI, CHF, pneumonia,
and CABG after admission for AMI. He found little evidence
of effect; only other race beneficiaries had a reduction in use
rates relative to white patients and only for AMI. However,
there is more evidence on the effect of public reporting on
access to care. Several studies have documented that physi-
cians perceive public reporting to create access problems for
patients who might benefit from care.18,19 Furthermore, evi-
dence from New York State suggests that disparities in rates
of CABG surgery increased for black and Hispanic patients rela-
tive to white patients after implementation of public report-
ing,20 and evidence from Massachusetts shows that access to
percutaneous coronary intervention decreased, especially for
severely ill patients, after the introduction of public report-
ing.14 Additional studies have shown mixed results.21–23

Our study has limitations. First, the data come from a single
voluntary P4P program although the Premier HQID is in many
ways a model for the federal program. Previous studies suggest

Figure 2. Observed coronary artery bypass grafting (CABG) rates by predicted mortality risk deciles.

Figure 3. Unadjusted CABG procedure rates. FY 2002 includes 9 months from January 1, 2002, to September 30, 2002.
that the Premier HQID had a modest effect on process quality, at least in the short run.\(^3,24\) It is possible that programs constructed differently might have both a greater effect on quality improvement and a deleterious effect on access to care. The small size of the incentives in Premier may have been insufficient to make hospitals risk adverse. Premier hospitals participated in the program voluntarily and may differ from other hospitals in their willingness to maintain access for high-risk patients; it is possible that in a universal program the results would differ. We caution readers not to generalize our findings to all P4P programs although the program we studied shares many similar features with the existing federal program, which makes our findings particularly relevant to policy concerns.

Our assessment of comorbidities and patients’ risk is based on administrative data and the Elixhauser risk algorithm, whereas physicians judging risk have information about a broader array of physiological and clinical variables that may have enabled more accurate assessments. The type of AMI as defined by the ICD codes used in this study produced strata with heterogeneous cohorts of patients, so unrecognized confounders may still have affected our results. We cannot determine whether our data showing modest changes in comorbidity reflect actual changes in comorbidity or changes in patterns of coding. Because we had no information on appropriateness of care, we could only evaluate access on the basis of use rates. Finally, our findings were limited to Medicare patients >65 years of age and may not generalize to a younger population.

In summary, our study suggests that P4P did not lead to lower access to CABG for patients with AMI in the Premier HQID, the largest demonstration of hospital P4P to date. These results should be reassuring to those concerned about the potential negative effect of VBP, the P4P program recently introduced by CMS, on access to care for high-risk populations.

Sources of Funding

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Disclosures

Arnold Epstein currently serves full-time in the Office of the Assistant Secretary for Planning and Evaluation in the Department of Health and Human Services (HHS).

Table 4. Change in Coronary Artery Bypass Grafting Rates by Risk of Mortality and Overall in Premier versus Non-Premier Hospitals

<table>
<thead>
<tr>
<th></th>
<th>Premier Hospitals</th>
<th>Non-Premier Hospitals</th>
<th>Difference in Change (Premier vs Non-Premier)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk</td>
<td>8.4%</td>
<td>8.2%</td>
<td>−0.2%</td>
</tr>
<tr>
<td>Low Risk</td>
<td>14.0%</td>
<td>10.5%</td>
<td>−3.5%</td>
</tr>
<tr>
<td>All</td>
<td>13.6%</td>
<td>10.4%</td>
<td>−3.2%</td>
</tr>
</tbody>
</table>

Results adjusted for age, sex, 28 Elixhauser comorbidities, type of myocardial infarction, and hospital characteristics (size, region, profit status, teaching status, proportion of Medicare patients, margin, and location in a competitive market). CI indicates confidence interval.

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Arnold M. Epstein, Karen E. Joynt, Ashish K. Jha and E. John Orav

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