INFORMATION, PRICING, AND PRODUCTIVITY OF MEDICAL TECHNOLOGY

The Role of Information in Medical Markets: An Analysis of Publicly Reported Outcomes in Cardiac Surgery

By David M. Cutler, Robert S. Huckman, and Mary Beth Landrum

During the past two decades, several public and private organizations have initiated programs to report publicly on the quality of medical care provided by specific hospitals and physicians. These programs have sparked broad debate among economists and policymakers. At issue is the question of whether, and to what extent, these "report card" programs have improved or harmed medical productivity.

Economists typically see more information as obviously beneficial. How can patients be harmed by knowing more about the quality of their medical-care providers? The key problem is the potential inaccuracy of quality data. Consider an attempt to rate the quality of surgeons performing cardiac bypass surgery, which we examine in this paper. The outcome of any bypass operation depends on physician and hospital characteristics and on the underlying health of the patient. Patients who are sicker are more likely to have poor outcomes than those who are healthier.

If the quality reporting system does not take these patient differences into account, several problems might result. First, patients and referring physicians, many of whom have prior informal data about the quality of various providers, may make decisions based on the new data without realizing the potential inaccuracies. Second, even if the patients do not rely on the new information, its existence may confuse them to the point that they ignore both sources of information. Either way, it is possible that referral patterns might change for the worse.

The situation could be even more problematic. If hospitals know that their reputations may be penalized if they treat high-risk patients, they might reduce their willingness to operate on such patients, denying them potentially needed care or forcing them to travel to other areas. As a result, health outcomes may suffer.

These possibilities are not simply theoretical. David Dranove et al. (2003) argued that quality report cards for coronary artery bypass graft (CABG) surgery in New York State and Pennsylvania hurt quality, by limiting access to surgery for high-risk patients. Similarly, Nowamagbe Omoigui et al. (1996) found that a larger percentage of high-risk bypass surgery patients were transferred out of New York State following the introduction of report cards, and Eric Schneider and Arnold Epstein (1996) found that many cardiac surgeons reported a decreased willingness to operate on severe patients after introduction of CABG report cards in Pennsylvania. But the evidence on this issue is not uniform. Edward Hannan et al. (1994) and Eric Peterson et al. (1998) found that the average in-hospital mortality rate for CABG surgery in New York declined significantly after introduction of hospital report cards.1

1 This issue is also debated. William Ghali et al. (1997) find that the decline in mortality in New York from 1990 to
With few exceptions, the above studies all examine the impact of report cards by considering trends at the state level. Identification of the impact of report cards thus comes from average effects within states with report cards relative to average effects in those without such programs. An alternate approach, and that which we employ, is to examine the impact of report cards on the outcomes for and allocation of patients across individual providers within a given state that adopted a report-card system. This allows more observations on quality as well as very complete data for risk adjustment.

We take advantage of a cross-sectional time series of different hospitals to address two fundamental questions about quality reporting. First, we examine whether report cards affect the distribution of where patients go for bypass surgery. Second, we determine whether report cards lead to improved medical quality among hospitals identified as particularly bad or good performers. Our data are from one of the longest-standing efforts to measure and report health care quality—the Cardiac Surgery Reporting System (CSRS) in New York State.

I. New York’s Cardiac Surgery Reporting System

Since the late 1980’s, CSRS has collected detailed information on every patient receiving bypass surgery at a hospital in New York State. In addition to identifying the surgeon and hospital involved with the procedure, CSRS collects data on clinical outcomes (specifically, whether or not the patient died in the hospital following the procedure) and incoming severity of the patient. The severity data contain information on whether a given patient has a history of one or more of roughly 40 clinical conditions including diabetes, kidney failure, liver failure, or prior heart attack (for a detailed description of this clinical information, see Hannan et al. [1994]). Once every 12–18 months, the state releases these data, along with information on which hospitals were statistically significantly better or worse than the statewide average. These data are reported with a lag of several years. For example, the data on hospitals for 1999 were released in September 2002.

To adjust for underlying health risks of the patients, New York uses a logistic regression to predict the expected probability of in-hospital mortality. The covariates for the regression are drawn from the clinical variables contained in CSRS. We follow this procedure in our analysis. Figure 1 illustrates the 25th percentile, median, and 75th percentile values of risk-adjusted mortality across all hospitals performing bypass surgery in New York in a given year.

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1992 was not significantly different from that in Massachusetts (which had not adopted a report card system as of 1992) over the same period.

Dana Mukamel and Alvin Mushlin (1998) find that hospitals and surgeons with better reported outcomes experienced higher rates of growth in the market shares following the reports, though they do not consider how the outcomes for or severity of future patients seen by these providers is affected. Stanley Dzibban et al. (1994) consider the impact of the New York report cards on one hospital that was cited as having significantly poorer than average outcomes. This case study provides some insight into steps that one hospital took in response to the reports.

3 One difference in our analysis is that we keep the set of covariates constant over time, while New York State varies them each year based on a stepwise regression procedure. In our risk-adjustment model, we include any covariate that (i) was used in the New York models for all data from 1991 through 1999 and (ii) was reliably collected for all nine years in our sample. A detailed list of the covariates included in this regression is available from the authors upon request.
Risk-adjusted mortality fell significantly across the state during the first decade of the report-card program. Further, the range between the hospitals at the 25th and 75th percentiles narrows during the early years of the reporting program, suggesting improved performance among initial poor performers. Although these results do not compare New York to other states without report-card programs, they are consistent with prior findings that suggest an improvement in outcomes in New York during the initial years of the reporting.

To examine the impact of report cards on the allocation of patients across hospitals, we use the total number of CABG cases for each hospital-month as the dependent variable in regressions that include hospital and year fixed effects. Our basic equation is of the following form:

\[
\text{Cases}_{it} = \beta_1 (\text{High}_{ita}) + \beta_2 (\text{Low}_{ita}) + \delta_i + \lambda_t + \varepsilon_{it}
\]

where \(i\) denotes hospital, \(m\) denotes month of hospital admission (for years 1991 through 1996) or discharge (for years 1997 through 1999), and \(t\) denotes year of admission or discharge. The vectors \(\delta\) and \(\lambda\) include fixed effects for hospital and year, respectively. The key independent variables are indicators for whether the hospital previously has received a high-mortality flag (High\(_{ita}\)) or low-mortality flag (Low\(_{ita}\)). Given lags in the release of the report cards, the flags assigned to hospitals in period \(t\) are typically based on performance data for year \(t - 2\) or \(t - 3\). Each of these indicators is interacted with indicators for the number of months since a hospital received its first flag (e.g., 1-12 months, 13-24 months, 25-36 months, and more than 36 months) to estimate the persistence of any effects on volume.\(^4\)

The first column of Table 1 shows the results of this regression. Being identified as a high-mortality hospital is associated with a decline of approximately 4.9 bypass-surgery patients per month during the 12 months following that designation. This decline is significant at the 5-percent level. The decline is reasonably large. The average hospital performs about 50 bypass-surgery operations per month, so the change in volume is about 10 percent. While this negative impact on volume remains in the estimates be-

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4 While there is a small set of hospitals that received multiple high- or low-mortality flags during the nine-year period, we use only the first occurrence of either type of flag in determining when the high- or low-mortality indicator shifts from 0 to 1.

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**Table 1—Regressions of CABG Cases and Risk-Adjusted Mortality on Publicly Reported Performance**

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>CABG cases</th>
<th>Risk-adjusted mortality rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All patients</td>
<td>Low severity</td>
</tr>
<tr>
<td>Months since initial high-mortality flag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-12</td>
<td>-4.9*</td>
<td>-5.4**</td>
</tr>
<tr>
<td></td>
<td>(2.4)</td>
<td>(2.0)</td>
</tr>
<tr>
<td>13-24</td>
<td>-3.1</td>
<td>-3.7*</td>
</tr>
<tr>
<td></td>
<td>(2.6)</td>
<td>(2.1)</td>
</tr>
<tr>
<td>25-36</td>
<td>-3.7</td>
<td>-4.0</td>
</tr>
<tr>
<td></td>
<td>(3.7)</td>
<td>(2.8)</td>
</tr>
<tr>
<td>More than 36</td>
<td>-7.1</td>
<td>-5.9</td>
</tr>
<tr>
<td></td>
<td>(4.9)</td>
<td>(3.8)</td>
</tr>
<tr>
<td>Months since initial low-mortality flag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-12</td>
<td>3.0</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>(6.6)</td>
<td>(4.5)</td>
</tr>
<tr>
<td>13-24</td>
<td>-0.8</td>
<td>-0.3</td>
</tr>
<tr>
<td></td>
<td>(6.8)</td>
<td>(4.2)</td>
</tr>
<tr>
<td>25-36</td>
<td>-1.8</td>
<td>-1.9</td>
</tr>
<tr>
<td></td>
<td>(5.9)</td>
<td>(4.1)</td>
</tr>
<tr>
<td>More than 36</td>
<td>-7.1</td>
<td>-3.2</td>
</tr>
<tr>
<td></td>
<td>(8.8)</td>
<td>(6.3)</td>
</tr>
<tr>
<td>Hospital fixed effects?</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Year fixed effects?</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Average value of dependent variable</td>
<td>47.49</td>
<td>35.63</td>
</tr>
<tr>
<td>Number of observations:</td>
<td>3,406</td>
<td>3,404</td>
</tr>
<tr>
<td>Adjusted $R^2$:</td>
<td>0.862</td>
<td>0.838</td>
</tr>
</tbody>
</table>

**Notes:** The level of observation is the hospital-month. Standard errors (in parentheses) are heteroscedasticity-robust and clustered by hospital. In regression with risk-adjusted mortality as the dependent variable, observations are weighted by the total number of cases for the relevant hospital-month.

* Statistically significant at the 10-percent level.
* Statistically significant at the 5-percent level.
** Statistically significant at the 1-percent level.
yond one year after the initial report, these
effects are not significant at conventional levels.
In contrast to their impact on low-quality hospitals, the reports do not seem to increase
future volume for those facilities receiving low-
mortality flags. The estimated coefficient is pos-
itive in the first year following a report and
becomes negative in subsequent years. It is al-
ways imprecisely estimated. With only data
from New York State, we cannot tell whether
the patients moving out of low-quality hospitals
are not receiving surgery at all or are simply
being spread over all non-low-quality hospitals.
We can understand more about what is hap-
pening by considering the type of patients who are
not receiving bypass surgery at high-mortality hospitals. A reduction in relatively healthy pa-

tients is more indicative that patients (or their
referring doctors) are choosing not to go to
low-quality providers. A reduction in sicker
patients, who often receive more immediate
surgery, would suggest that low-quality hos-
pitals (or the surgeons who work at those
facilities) are choosing to operate less

The next two columns of Table 1 repeat
our regressions separately for low- and high-
severity subsamples of the patient population. The decline in volume for hospitals receiving
high-mortality flags is driven by reductions in
the number of low-severity cases. The number
of such cases declines by roughly 15 percent
and 10 percent relative to the sample average in
the first and second years, respectively. There is
no change in the number of high-severity pa-
tients. Thus, it appears that patients and refer-
ing cardiologists are choosing to reduce opera-
tions at low-quality institutions.
These volume effects notwithstanding, we re-
call that the stated goal of cardiac-surgery re-
porting is to improve the quality of medical
care. To examine the impact of reporting on
outcomes, we repeat these regressions using the
risk-adjusted mortality rate as the dependent
variable. We form values of risk-adjusted mor-
thality for each hospital-month by dividing aver-
age observed mortality by average predicted
mortality for a given hospital-month and multi-
plying that ratio by the statewide average mor-
tality rate for the entire nine-year period. To
account for heterogeneity based on sample size
and to mitigate the effect of small numbers of
observations, we weight the observations by the
total number of bypass-surgery cases for a given
hospital-year.

The last column of Table 1 shows the results
for mortality. Identification as a high-mortality hospital is associated with improved future per-
formance. Hospitals that are publicly identified
as being of low quality experience a decline of 1.2 percentage points (significant at the
1-percent level) during the first 12 months after
an initial report. This decrease remains for the
three years following the report, though the sig
cificance is only at the 10-percent level for
months 13 through 24. The average risk-
adjusted mortality rate is 2.55 percent for the
entire sample. For those hospitals receiving a
high-mortality flag, the average risk-adjusted
mortality rate prior to receiving that flag is 3.82
percent. Relative to either of these baselines, the
change we identify represents a significant im-
provement in performance.

Those hospitals receiving a low-mortality flag show little evidence of mortality changes.
The coefficients are slightly positive, but only
statistically significant in the third year after the
report.

II. Discussion

The evidence from the first decade of New
York’s bypass-surgery reporting program sug-

3 We divide bypass-surgery patients into low and high
severity based on whether the predicted mortality deter-
mined by our patient-level logistic regression is below or
above the mean predicted mortality for the state of New
York in a given year.
Another possibility is that supply-side factors within the affected hospitals are generating this result. For example, surgeons at poorly performing hospitals may simply be choosing to do fewer procedures or may be encouraged to do fewer procedures by hospital administrators. In the extreme, some surgeons may be exiting the market entirely. To the extent that those surgeons leaving the market were previously doing relatively routine cases, this reduction might be concentrated among relatively healthy patients. Regardless of the importance of demand- and supply-side factors in affecting procedural volumes, our results do suggest that the largest reductions for poor-performing hospitals are among low- rather than high-severity patients. Whatever efforts physicians may be making to reduce surgery to high-risk patients are not reducing their volumes of those patients in equilibrium.

Our findings with respect to quality improvement might also be explained by multiple factors. First, to the extent that hospitals flagged as poor performers lose surgical volume, they may work harder to replace that volume, particularly given the high marginal profitability associated with cardiac procedures. Alternatively, hospitals and surgeons may make efforts to improve their future quality for reasons that are motivated not by financial concerns, but by concern for patient health and their reputations as providers of high-quality medical care. Stanley Dziuban et al. (1994) argue that this is why one hospital improved its performance after quality reporting.

While New York’s experience with bypass-surgery report cards has provided clear evidence of market changes associated with the public release of quality information, the exact mechanisms underlying these changes represents an area for future research. Identifying such mechanisms will provide a better understanding of the impact of public quality reports on medical productivity.

REFERENCES


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