Impact of Independent Data Adjudication on Hospital-Specific Estimates of Risk-Adjusted Mortality Following Percutaneous Coronary Interventions in Massachusetts

Kurt G. Barringhaus, MD; Katya Zelevinsky, BA; Ann Lovett, RN, MA; Sharon-Lise T. Normand, PhD; Kalon K.L. Ho, MD, MSc

Background—As part of state-mandated public reporting of outcomes after percutaneous coronary interventions (PCIs) in Massachusetts, procedural and clinical data were prospectively collected. Variables associated with higher mortality were audited to ensure accuracy of coding. We examined the impact of adjudication on identifying hospitals with possible deficiencies in the quality of PCI care.

Methods and Results—From October 2005 to September 2006, 15,721 admissions for PCI occurred in 21 hospitals. Of the 864 high-risk variables from 822 patients audited by committee, 201 were changed, with reassignment to lower acuities in 97 (30%) of the 321 shock cases, 24 (43%) of the 56 salvage cases, and 73 (15%) of the 478 emergent cases. Logistic regression models were used to predict patient-specific in-hospital mortality. Of 241 (1.5%) patients who died after PCI, 30 (12.4%) had a lower predicted mortality with adjudicated than with unadjudicated data. Model accuracy was excellent with either adjudicated or unadjudicated data. Hospital-specific risk-standardized mortality rates were estimated using both adjudicated and unadjudicated data through hierarchical logistic regression. Although adjudication reduced between-hospital variation by one third, risk-standardized mortality rates were similar using unadjudicated and adjudicated data. None of the hospitals were identified as statistical outliers. However, cross-validated posterior-predicted P values calculated with adjudicated data increased the number of borderline hospital outliers compared with unadjudicated data.

Conclusions—Independent adjudication of site-reported high-risk features may increase the ability to identify hospitals with higher risk-adjusted mortality after PCI despite having little impact on the accuracy of risk prediction for the entire population. (Circ Cardiovasc Qual Outcomes. 2011;4:000–000.)

Key Words: coronary disease ■ statistics ■ stents ■ survival ■ catheterization

Quality improvement in patient care is receiving increasingly more attention from patients, caregivers, public health regulators, and third-party payers. For example, in 2009, the US Department of Health and Human Services contracted with the National Quality Forum to formulate priorities for the development of healthcare performance measurements over the next few years as part of section 183 of the Medicare Improvements for Patients and Providers Act of 2008. The tying of outcomes to reimbursement and the public disclosure of healthcare quality metrics are 2 of the more visible regulatory actions that may influence healthcare providers to review and continually improve their performance. The tracking and analysis of patient outcomes after invasive procedures are important steps in identifying key elements of patient care that may benefit from quality improvement processes.

The success of public reporting of healthcare provider performance relies, in part, on the quality of the data used to measure performance. In the clinical trials setting, detailed case report forms and systematic monitoring help to ensure data quality. Central adjudication committees also are widely used to ensure the accuracy of diagnoses and the validity of key end points, such as the occurrence of major adverse cardiovascular and cerebrovascular end points. Recent literature, however, has questioned the value of adjudication in the clinical trial setting. Ninomiya et al reported that adju-
dication of end points in the Process of the Results of Perindopril Protection Against Recurrent Stroke Study resulted in no discernable impact on the trial conclusions. Granger et al. reviewed the literature to determine the reasons for and the effect of central adjudication on trial outcomes. They also concluded that adjudication did not improve the ability to determine treatment effects in clinical trials.

Measures of healthcare performance, however, typically rely on observational information about both patient risk factors and clinical end points. Unlike the clinical trial setting, the data abstractors are not researchers but, rather, busy hospital personnel having variable expertise with data collection and heterogeneous familiarity with the definitions. Moreover, whereas the source of data for abstraction significantly influences provider performance estimates, relatively little published literature exists on the value of risk-factor adjudication for performance measurement in the observational setting. Researchers in New York reported observing no statistical differences statewide in expected inpatient mortality after coronary artery bypass graft surgery using audited data compared with that using the originally submitted data; however, unaudited data significantly overestimated expected risk of individual hospitals on 2 separate occasions. We sought to assess the value of data adjudication on predicting in-hospital mortality and on identification of hospitals with higher- or lower-than-expected mortality using a contemporary cohort of patients undergoing percutaneous coronary intervention (PCI) in Massachusetts.

WHAT THE STUDY ADDS

- The value of end point data adjudication in identifying treatment effects in clinical trials has been questioned.
- The accuracy of voluntary risk factor reporting between hospitals in the observational settings has been inconsistent within and between published works.

WHAT IS KNOWN

- In a statewide observational registry of PCI procedures, variables highly predictive of mortality were adjudicated to have been erroneously overcoded one third of the time.
- Data adjudication reduced between-hospital variation in mortality compared to nonadjudicated data.
- Accuracy of hospital performance assessments is influenced by data adjudication.

Methods

A mandate from the Department of Public Health for the Commonwealth of Massachusetts for public reporting of hospital-specific procedural outcomes requires all nonfederal hospitals within the commonwealth to report quality outcomes, including hospital mortality, after PCI for all patients aged ≥18 years at the time of their procedure. Procedural and clinical data collection began in April 2003 and used the National Cardiovascular Data Registry (NCDR) CathPCI Registry data collection instrument. Hospitals submitted data both to the NCDR and to the Massachusetts Data Analysis Center (Mass-DAC). Mass-DAC is the data coordinating center contracted by the Massachusetts Department of Public Health responsible for collection, cleaning, adjudication, storage, and analysis of the hospital and operator PCI outcomes data. To increase the quality of the submitted data, clinical characteristics associated with higher mortality or with inconsistent coding across institutions were audited by a review committee to ensure accuracy relative to NCDR definitions.

Patient Population and Data Sources

The study population includes data for 15,721 patient admissions from 21 nonfederal Massachusetts hospitals obtained between October 1, 2005, and September 30, 2006 (fiscal year 2006), a time frame that permitted institutions the opportunity to become accustomed with accurate data reporting but before covariate definition changes occurred in 2006. Trained hospital data managers collected data using the CathPCI Registry version 3 instrument. Additional data elements specific to Massachusetts, including patient-identifying information for linkages with other data sources, were collected and sent only to Mass-DAC. Mass-DAC linked the clinical data with 3 additional data sources to improve data quality: (1) diagnostic and procedural claims information from in-hospital billing discharge data collected by the Massachusetts Division of Health Care Finance and Policy, (2) mortality information from the Massachusetts Registry of Vital Records and Statistics, and (3) mortality information available on the Social Security Death Index Interactive Search Web site (http://ssdi.rootsweb.com/cgi-bin/ssdi.cgi). Finally, photocopies of medical records for patients selected for audit were delivered to Mass-DAC.

The selection of variables requiring audit were made by senior medical advisors to Mass-DAC and based on prior experience and information in the published literature. Patients selected for audit included those who either died before discharge or were coded with cardiogenic shock, salvage status, elective status despite an acutely evolving ST-segment elevation myocardial infarction (STEMI), or emergent status in the absence of both shock and STEMI. Clinical elements were defined using the CathPCI version 3 specifications (www.ncdr.com/WebNCDR/NCDRDocuments/dataedefonlyv330.pdf). Cardiogenic shock was defined as a clinical state of hypoperfusion requiring either intravenous inotropes or aortic counterpulsation to maintain a systolic blood pressure >80 mm Hg or a cardiac index >1.8 L/min per m². Transient hypotension alone was insufficient to warrant a diagnosis of cardiogenic shock. Salvage PCI status was defined as the requirement for ongoing cardiopulmonary resuscitation en route to the catheterization suite or immediately before coronary intervention. Emergency status required evidence for any of the following features: (1) ongoing ischemia, including resting angina despite maximal medical therapy; (2) clinical necessity for aortic counterpulsation; (3) an acute-evolving myocardial infarction within 24 hours of the procedure; (4) pulmonary edema requiring intubation; or (5) mechanical dysfunction with cardiogenic shock. Elective status was defined as stability of cardiac function for days or weeks before the diagnostic procedure such that a percutaneous intervention could be deferred without increased risk of compromised cardiac outcome. Urgent status was coded when clinical status dictated revascularization before hospital discharge but did not meet emergent criteria.

Adjudication Process

The charts were audited by a committee of 19 physicians and 4 hospital data managers. Physician-members were nominated by their respective institutions, and data managers were volunteers. All committee members underwent Harvard Medical School human subjects training. Members met in person at Harvard Medical School, where the adjudication protocol, including NCDR definitions, was reviewed. For logistical reasons, committee members could not be blinded to the hospital where the patients underwent PCI. Committee members were assigned charts for patients undergoing PCI at institutions other than their own. Each chart was reviewed by committee members using strict guidelines for interpre-
tation of clinical variables, with indeterminate cases resolved by consensus of the full panel. The study was approved by the Harvard Medical School Committee on Human Studies (M10774-116).

Primary Outcomes
We examined 2 outcomes: patient-specific all-cause inpatient mortality and hospital-specific risk-standardized inpatient mortality rates.

Statistical Methods
Our unit of analysis was patient discharge. Because patients could undergo more than 1 PCI during an admission, clinical and procedural characteristics associated with the first PCI procedure per admission were used. We computed frequencies of changes in the audited risk factors. Characteristics of our study population based on the NCDR risk-adjusted mortality model were calculated using the unadjudicated data and then again using the adjudicated data.

Discharge-Level Summaries
Probabilities for in-hospital death for each discharge were estimated using the published NCDR risk-adjusted mortality model (R. Shaw, personal communication, May 2008). We selected the NCDR risk-adjusted model coefficients based on its prior validation across a vast population and its widespread use. We note that the specific risk factors included in the published Mass-DAC model differ from those in the NCDR model; because of distributional differences in sociodemographic variables and of a smaller number of events. The Massachusetts public reports use 2 separate models: 1 for patients arriving in shock or having STEMI and 1 for patients not presenting with those factors.

We calculated 2 risk scores for each PCI admission accomplished by applying the NCDR risk-model coefficients to the unadjudicated data for each risk factor and then summing these products within each admission. A similar covariate was created using the adjudicated data for the risk factors. Using a logistic regression model, we then estimated the association between the NCDR risk score and in-hospital mortality. Model performance was assessed by the Hosmer-Lemeshow statistic, model accuracy by the receiver operating characteristic area under the curve (AUC), and model calibration by comparing the observed range of mortality risks across the predicted deciles.

To determine whether the adjudication process resulted in clinical risk reclassification, we divided the patients into 5 distinct clinical risk subgroups based on the probabilities of risk estimated from the logistic regression model: very low (0.0% to 0.5%), low (0.5% to 2.0%), intermediate (2% to 10%), high (10% to 25%), and very high (≥25%). We then computed the reclassification improvement measure that subtracts the net change in upward movement in risk categories and in downward movement among survivors from the net change among nonsurvivors. Because we expected more survivors to appropriately move down risk prediction categories than up, we anticipated the net reclassification improvement to be negative. We calculated this measure for all patients, those arriving in shock or having STEMI, those not presenting with these factors, and those arriving in shock or without STEMI.

Hospital-Level Summaries
Hospital-specific risk-standardized mortality rates were estimated in 2 stages. First, a hierarchical logistic regression model in which the log-odds of all-cause in-hospital mortality was assumed to be linearly related to the NCDR risk score, and a random hospital-specific intercept was estimated. Noninformative but proper prior distributions were used for the regression coefficients and for the between-hospital variance component. This model provided estimated parameters required to compute the hospital-specific risk-standardized mortality rates. We compared between-hospital variation estimates based on the adjudicated and unadjudicated data. The estimate of between-hospital variation represents unexplained differences in mortality beyond that accounted for by the NCDR risk score. If between-hospital variation is 0, then there is no empirical evidence to support hospital differences in mortality.

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. Variables Coded</th>
<th>Items Changed (% Audited)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiogenic shock</td>
<td>321</td>
<td>97 (30)</td>
</tr>
<tr>
<td>Changed to no cardiogenic shock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salvage PCI status</td>
<td>56</td>
<td>24 (43)</td>
</tr>
<tr>
<td>Changed to emergent PCI status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergent status without STEMI or shock</td>
<td>478</td>
<td>70 (15)</td>
</tr>
<tr>
<td>Changed to urgent PCI status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changed to elective PCI status</td>
<td>3 (0.6)</td>
<td></td>
</tr>
<tr>
<td>Elective with STEMI or cardiogenic shock</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Changed to urgent</td>
<td>1 (11)</td>
<td></td>
</tr>
<tr>
<td>Changed to emergent</td>
<td>6 (67)</td>
<td></td>
</tr>
<tr>
<td>Total items changed</td>
<td>201 (23)</td>
<td></td>
</tr>
</tbody>
</table>

Second, using the estimated regression coefficients from the hierarchical model, we computed for each hospital a ratio of the sum of the observed number of deaths divided by the sum of the expected number of deaths. Rather than using the actual, tabulated number of deaths, we used an adjusted number of deaths that corrected for within-hospital clustering and for varying hospital procedural volumes. We then multiplied this ratio by the statewide observed mortality rate to yield a risk-standardized mortality rate for that hospital.

Because it is possible for a single hospital’s performance to influence the calculation of the expected mortality rate for all hospitals, we used cross-validation procedures to compare the actual number of deaths at a hospital with the number of deaths predicted by peer hospitals—all hospitals except the particular hospital. This cross-validation was accomplished by eliminating each hospital, reestimating the hierarchical model, and predicting the number of deaths at the eliminated hospital using the model derived excluding that hospital applied to the patient characteristics from the eliminated hospital. Using simulation, we calculated the number of times out of 500 simulations the actual number of deaths at the eliminated hospital was larger than the number of deaths predicted by its peers. The number of times this event occurred divided by the number of simulations (500 in our study) is referred to as the posterior-predicted P value. Extreme posterior P values (≤0.01) suggest a discrepancy between the actual data and what was predicted.

A hospital was classified as a statistical outlier if the 95% posterior interval of its risk-standardized mortality rate excluded the Massachusetts mortality rate or if the cross-validated posterior-predicted P value was ≤0.01. Hospitals were considered borderline outliers if the cross-validated posterior P value was between 0.01 and 0.05. Hospital-specific risk-standardized mortality rates, 95% posterior intervals, and cross-validated posterior-predicted P values were calculated using both adjudicated and unadjudicated data sets. All analyses were undertaken using a fully Bayesian approach through WinBUGS.

Results
Of the 15 721 patients who underwent PCI, 241 (1.5%) died before hospital discharge. The number of items selected for audit was 864 from 822 patients. Of the 864 items reviewed, 201 (23%) were recoded by the adjudication committee (Table 1). Downcoding occurred most frequently in patients coded as cardiogenic shock or salvage status. Status was changed to urgent or emergent in only 7 patients who were initially coded as elective status despite evidence of an ongoing STEMI.
Table 2 lists the prevalence of patient characteristics from this Massachusetts population used in the NCDR risk-adjustment model. The majority of patients underwent PCI in either an urgent or emergent setting, with 26% presenting within 24 hours of myocardial infarction. Patients with documented pre-PCI left ventricular ejection fraction <30% represented only 3.7% of patients undergoing PCI, and <1% of patients required aortic counterpulsation immediately before the procedure.

**Impact of Adjudication on Patient Clinical Risk**

The NCDR risk score ranged from -8.08, representing an inpatient mortality risk of 0.03%, to 1.72, a risk of 84.8%, using either adjudicated or unadjudicated data. A 1-SD increase in the risk score increased the odds of death 4.6 times (95% CI, 4.2 to 5.2). The NCDR risk score had excellent discrimination between in-hospital survivors and patients who died when either the unadjudicated (AUC = 0.92) or adjudicated (AUC = 0.91) data sets were used. No model-fit problems were identified based on the Hosmer-Lemeshow goodness-of-fit tests ($\chi^2 = 12.8 \ [P = 0.12]$ for unadjudicated data; $\chi^2 = 9.6 \ [P = 0.30]$ for adjudicated data).

Of the 241 patients who died after PCI, 30 had a predicted mortality rate that was lower when using the adjudicated as opposed to the unadjudicated data. By comparison, downcoding occurred in only 159 of the 15,480 patients who survived to hospital discharge (12.4% versus 1.0%; 92% lower; $P < 0.001$) (Figure 1).

Of the 382 patients categorized as high or very-high risk before adjudication, 84 (22%) were reclassified to a lower risk subgroup after adjudication, reflecting the high-risk nature of the variables selected for adjudication (Table 3). In contrast, adjudication of these same variables affected clinical risk characterization to a far lesser extent among patients of intermediate or lower risk, as only 80 (0.5%) patients were reclassified. The net reclassification improvement for the entire cohort was $-9.5\% \ (P = 0.39)$, which indicates that 9.5% more patients who survived appropriately moved down a category of risk compared to those who died. The largest net

![Figure 1](http://circ.outcomes.ahajournals.org/)

**Figure 1.** Risk scoring according to the NCDR model showing 189 patients with adjudicated risk scores lower than unadjudicated data, 30 of whom died before hospital discharge. Seven patients had risk scores that were higher with the adjudicated data set.
reclassification improvement was observed for patients having shock or STEMI before their PCI (−10.8%; P = 0.40) and the smallest for the subset of 822 patients who had at least 1 risk factor adjudicated (−1.3%; P = 0.49).

Impact of Adjudication on Hospital Quality Inferences
The adjudication process did not significantly alter the risk-standardized mortality rate point estimates for individual hospitals. No hospital was identified as a statistical outlier based on initial comparison with statewide data (Figure 2). However, adjudication reduced the extent of between-hospital variation by one third (estimate ± posterior SD, 0.112 ± 0.0976 versus 0.075 ± 0.0799; 32% reduction). Using the adjudicated data, the estimate may be interpreted as stating that the odds of in-hospital mortality for a patient treated at a hospital 1 SD above average mortality was 1.7 times that for a patient treated at a hospital 1 SD below average mortality; with unadjudicated data, the odds increased to almost 2 for that same comparison.

Four hospitals rather than 2 were identified as being borderline outliers when adjudicated data were used for calculating cross-validated posterior-predicted P values. Hospital 14 was identified as having borderline higher-than-expected mortality, whereas hospital 10 was identified as having borderline lower-than-expected mortality with the adjudicated data set. Hospitals 6 and 18 were borderline lower-than-expected when either the adjudicated or unadjudicated data sets were used.

Discussion
Our results demonstrate that although independent adjudication of high-risk clinical variables frequently resulted in reclassifying high-risk patients to a lower-risk status, hospital-specific risk-adjusted mortality point estimates remained unaffected. However, adjudication reduced between-hospital variability and may increase the ability to identify hospitals at risk of becoming outliers (both positive and negative) when cross-validation methods are used.

One out of every 3 variables associated with the highest risk, namely cardiogenic shock and salvage PCI status, was recoded to a lower risk category in our study after adjudication. Additionally, patients dying before discharge were far more frequently downcoded than those who survived. These findings confirm a propensity toward overestimation of procedural risk in these patient subsets when data acquisition relies on self-reporting and support the use of a targeted auditing process. It is important to note that this study occurred in a context in which the hospitals were aware that their data would be rigorously audited. The data collection activities in Massachusetts began in 2003 and have used audits since that time. Moreover, data cleaning is continuous throughout the year through quarterly face-to-face meetings of all data managers and continuous data quality reporting to hospitals. Given the high prevalence of overcoding (unintentional or deliberate) seen even when a vigorous auditing and adjudication mechanism is in place, one might expect the frequency of overestimation of predicted risk to be higher in other settings where minimal or no auditing occurs. Although underreporting of variables was not examined systematically, we would expect this to occur less frequently than overcoding, particularly when outcomes are reported publicly. To some extent, this expectation was validated by the finding that few STEMI cases were coded as elective. Our findings that even high-risk variable adjudication did not affect patient-level risk and had a modest effect on between-hospital variability suggest to us that adjudication of lower-risk variables would be of significantly lesser value. With the exception of chronic lung disease and lesion classification, lower-risk variables are not subject to interpretation.

### Table 3. Admissions Stratified by Predicted Risk Groups for 15,721 Adults Undergoing PCI in Massachusetts (October 2005 to September 2006)

<table>
<thead>
<tr>
<th>Predictions Using Adjudicated Data</th>
<th>Very Low (≤0.05%)</th>
<th>Low (0.05%–2.0%)</th>
<th>Intermediate (2.0%–10%)</th>
<th>High (10%–25%)</th>
<th>Very High (&gt;25.0%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n 8305 (99.9)</td>
<td>1 (0.01)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mortality 9 (0.11)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Low (0.05%–2.0%)</td>
<td>n 22 (0.4)</td>
<td>4977 (99.5)</td>
<td>2 (0.03)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mortality 0</td>
<td>37 (0.74)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Intermediate (2.0%–10%)</td>
<td>n 6 (0.3)</td>
<td>48 (2.4)</td>
<td>1977 (97.3)</td>
<td>0</td>
<td>1 (0.04)</td>
</tr>
<tr>
<td>Mortality 0</td>
<td>81 (4.1)</td>
<td>0</td>
<td>0</td>
<td>1 (100)</td>
<td>0</td>
</tr>
<tr>
<td>High (10%–25%)</td>
<td>n 0</td>
<td>20 (9.4)</td>
<td>24 (11.3)</td>
<td>169 (79.3)</td>
<td>0</td>
</tr>
<tr>
<td>Mortality 0</td>
<td>4 (20.0)</td>
<td>10 (41.7)</td>
<td>27 (16.0)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Very high (&gt;25.0%)</td>
<td>n 0</td>
<td>1 (0.6)</td>
<td>22 (13.0)</td>
<td>17 (10.1)</td>
<td>129 (76.3)</td>
</tr>
<tr>
<td>Mortality 0</td>
<td>1 (100)</td>
<td>5 (22.7)</td>
<td>7 (41.2)</td>
<td>59 (45.7)</td>
<td>0</td>
</tr>
</tbody>
</table>

Data are presented as no. (%) wherein n indicates number of admissions (row percentage) and mortality, the observed number (percentage of n) of in-hospital deaths.
NCDR definition for chronic lung disease is broad, and adjudication is not likely to improve accuracy in reporting. Regarding reporting of lesion classification, adjudication would require participation of a core laboratory and is therefore impractical.

Adjudication did not significantly alter individual hospital risk-standardized mortality rates in contrast with the New York surgical experience, where recoding decreased expected mortality rates by as much as 52%.8 Dissimilarities in the risk models, patient populations, procedural factors, and analytic approaches likely account for this disparity, although differences in the method and extent of the auditing processes may have played a role as well. Whether adjudication would affect the identification of specific interventional cardiologists as outliers based on physician-specific risk-adjusted mortality rates is unknown.

Patient characteristics from the Massachusetts PCI Registry were similar to those in the NCDR CathPCI Registry national sample, with the exception of PCI status. Massachusetts patients undergoing elective PCI represented only 33% of the population, whereas elective PCI accounted for 49% of the overall NCDR population.18,19 Although patients in Massachusetts requiring PCI may present more urgently than patients nationwide, the relative subjectivity of the definition may permit considerable variation in coding interpretation and accuracy. The NCDR prediction model was well calibrated and discriminated patients in our sample appropriately according to clinical risk, with a C statistic comparable to those seen in similar studies evaluating its accuracy.20,21

The enhanced ability to identify statistical outliers after adjudication may afford the opportunity to initiate procedural reviews at a greater number of hospitals earlier to implement systematic improvements in patient care operations.22 A report from the NCDR database revealed that some PCI programs persist as having the highest risk-adjusted mortality across a 4-year period, whereas others operated outside the margin for shorter durations.19 Decreasing the variability of reported measures of hospital quality by data adjudication may permit earlier identification of programs at risk of reaching outlier status. Caution should be exercised, however, in interpreting risk-adjusted mortality as a global metric of the quality of patient care or as a tool for comparing hospitals directly. Use of risk-adjusted mortality as a means for directly comparing hospitals to one another often is severely limited by covariate imbalance, a concept frequently overlooked but often critical in recognizing that 2 hospitals may share only a minority of patients with similar risk profiles.23

Public reporting of procedural outcomes has relied primarily on hospital- and operator-specific case volume and less commonly on risk-adjusted mortality. Whether risk-adjusted mortality accurately identifies poor performers remains a highly debatable question, particularly when low event rates

Figure 2. Risk-standardized mortality rates for 21 Massachusetts hospitals with corresponding 95% CIs and cross-validated posterior P values. No hospital risk-standardized mortality rate CI excluded the statewide mortality rate (P=0.01), whereas 4 hospitals were identified as borderline outliers by cross-validation. *0.01 < P < 0.05.
and inconsistent data collection mechanisms exist.24 Risk-adjusted in-hospital mortality correlated poorly with preventable mortality in a retrospective review of 347 deaths following bypass surgery in Ontario.25 Resnic and Welt26 found that less than one quarter of deaths following PCI at their institution were plausibly related to the procedure itself. Massachusetts has attempted to overcome some of the limitations of risk modeling through the collection of additional covariates, including a compassionate use indication, a supplemental variable that provided excellent discrimination and is based on the presence of extreme anatomic risk, coma, or ongoing cardiopulmonary resuscitation immediately before commencement of PCI. Every discharge reported to fall in this category is carefully adjudicated.26–28 Incorporating risk-adjusted mortality as a component rather than as the sole metric of patient care performance has been advised, and targeted data adjudication may impart objectivity to high-impact covariates.

In conclusion, we believe that the use of an independent adjudication committee is valuable when assessing hospital performance using risk-adjusted patient outcomes derived from self-reported data. Complexity in the definition of key risk factors, varying levels of expertise of the data collectors, and the high profile of public reports of hospital-specific performance on the basis of procedural mortality justify this recommendation.

Acknowledgments

We thank the data collectors at the participating PCI centers in Massachusetts and the dedicated members of the Mass-DAC PCI Data Adjudication Committee (http://massdac.org/CommPCIAJudsonication).

Disclosures

Efforts by Ms Zelevinsky and Lovett, and Dr Normand were supported through a contract with the Massachusetts Department of Public Health (620022A4PRE).

References


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