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Limits Of Readmission Rates In Measuring Hospital Quality Suggest The Need For Added Metrics

ABSTRACT Recent national policies use risk-standardized readmission rates to measure hospital performance on the theory that readmissions reflect dimensions of the quality of patient care that are influenced by hospitals. In this article our objective was to assess readmission rates as a hospital quality measure. First we compared quartile rankings of hospitals based on readmission rates in 2009 and 2011 to see whether hospitals maintained their relative performance or whether shifts occurred that suggested either changes in quality or random variation. Next we examined the relationship between readmission rates and several commonly used hospital quality indicators, including risk-standardized mortality rates, volume, teaching status, and process-measure performance. We found that quartile rankings fluctuated and that readmission rates for lower-performing hospitals in 2009 tended to improve by 2011, while readmission rates for higher-performing hospitals tended to worsen. Regression to the mean (a form of statistical noise) accounted for a portion of the changes in hospital performance. We also found that readmission rates were higher in teaching hospitals and were weakly correlated with the other indicators of hospital quality. Policy makers should consider augmenting the use of readmission rates with other measures of hospital performance during care transitions and should build on current efforts that take a communitywide approach to the readmissions issue.

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Reducing hospital readmissions has become a top priority in US health care. The federal government recently implemented three policies aimed at encouraging hospitals to lead this effort. First, Hospital Compare, the Centers for Medicare and Medicaid Services (CMS) data reporting website for consumers, began in 2009 to publish annually readmission rates for most short-term, acute care hospitals in the United States.[1] Second, through a provision in the Affordable Care Act, CMS launched the Community-based Care Transitions Program, a $500 million initiative that provides funds to hospitals and community-based organizations to implement programs collaboratively to reduce readmissions.[2] Third, also through the Affordable Care Act, CMS began in October 2012 to reduce payments to hospitals with higher-than-expected readmission rates.

Each of these policies holds hospitals primarily accountable for readmissions and assesses their performance using risk-standardized readmission rates (hereafter referred to as readmission rates), a measure that controls for certain patient characteristics. The measure is

intended to reflect the quality of health care provided in the inpatient and outpatient settings and during the transition between them. However, performance on this measure is attributed to the individual hospitals from which patients are discharged.[3,4]

Focusing readmission policies on hospitals is logical because of their central role in inpatient care and the discharge process.[5] But the use of readmission rates as a measure of hospital quality remains controversial in light of conflicting evidence on the relationship between readmission and quality of care, the poor predictive ability of most readmission risk models, and the potential for negative unintended consequences.[6–15]

In this study our objective was to assess readmission rates as a hospital quality measure through the following research questions. First, how much do quartile rankings of hospitals based on readmission rates change over a two-year period? Second, do changes occur in a pattern that suggests changes in quality or random variation? Finally, are readmission rates correlated with commonly used indicators of hospital quality, including mortality, volume, teaching status, and performance on process measures?

Study Data And Methods

DATA We used data published through CMS's Hospital Compare website in 2009 and 2011 on hospitals' performance on process and outcome measures for acute myocardial infarction (heart attack), congestive heart failure, and pneumonia. The process measures, which assess how often hospitals followed certain evidence-based practices, were calculated by CMS from data voluntarily provided by hospitals. The outcome measures (hospital readmission and mortality rates) were derived by CMS from administrative claims and enrollment data for Medicare fee-for-service beneficiaries age sixty-five or older. Outcomes data published in 2009 and 2011 were based on hospital admissions and discharges occurring from July 2005 to July 2008 and from July 2007 to July 2010, respectively.

A total of 2,247 hospitals for heart attack, 3,758 hospitals for heart failure, and 3,940 hospitals for pneumonia had readmission rates published in both 2009 and 2011 in Hospital Compare. Our study data included these hospitals. We also used data from the American Hospital Association 2008 annual survey to determine hospital teaching status.

The study was approved by the Institutional Review Board of the University of Pennsylvania.

READMISSION AND MORTALITY RATES We used risk-standardized hospital readmission and mortality rates published through Hospital Compare for heart attack, heart failure, and pneumonia hospitalizations. Readmission rates were based on all-cause readmissions within thirty days of hospital discharge date for patients discharged alive to non–acute care settings. Mortality rates were based on death within thirty days of admission date. To estimate each hospital's readmission and mortality rates, CMS uses a hierarchical regression model that takes into account patient characteristics available in claims data, including age, sex, past medical history, and comorbidities.[16] This model yields "risk-standardized" outcome rate estimates for readmission and mortality that allow comparisons between hospitals, theoretically minimizing statistical noise and controlling for patient case-mix.

The model also calculates, and CMS publishes, interval estimates (that is, confidence intervals) for each hospital's outcome rate point estimate. Based on a comparison of these interval estimates to the national unadjusted outcome rate, hospitals receive one of three designations on the Hospital Compare website for each outcome (readmission and mortality) and each diagnosis (heart attack, heart failure, pneumonia). These designations are "better than the US national rate," "no different than the US national rate," and "worse than the US national rate." For the purposes of our analyses, we focus on these designations and on the point estimates of the outcome rates.

OTHER INDICATORS OF HOSPITAL QUALITY We used hospital volume published through Hospital Compare, teaching status from the American Hospital Association survey, and a composite of process-measure performance calculated from data published through Hospital Compare. We defined *volume* as the number of eligible patients treated for each of the three conditions, and we divided hospitals into quartiles for each condition based on their volume. Hospitals were identified as teaching hospitals if they were members of the Council of Teaching Hospitals.

We calculated composite process-measure performance by averaging hospitals' "scores" for process measures presented in Hospital Compare as the percentage of occurrences in which recommended care was provided, while weighting each score by the number of eligible patients. We used seven process measures for heart attack, four for heart failure, and six for pneumonia (see online Appendix E for a list of the measures).[17] Hospitals had to have data for at least one process measure in order to generate the composite, which eliminated less than 2 percent of hospitals from this analysis. We divided hospitals into

quartiles based on their composite process-measure performance, which ranged from 57 percent (worst) to 100 percent (best) for heart attack and from 0 percent to 100 percent for heart failure and pneumonia.

ANALYSIS First, we compared quartile rankings of hospitals based on readmission rates in 2009 and in 2011. Our a priori assumption was that rankings would change minimally over the two-year period, allowing high- and low-performing hospitals to be identified with a high degree of consistency. We ranked all hospitals from lowest readmission rate (quartile 1) to highest readmission rate (quartile 4) separately for each year. We report the number of hospitals that changed quartiles between 2009 and 2011 and the degree to which readmission rates changed, using percentage change in readmission rates (calculated as the difference between the 2009 and 2011 readmission rates divided by the 2009 readmission rate). We used linear regression to quantify the relationship between the readmission rate in 2009 and the percentage change in readmission rates between 2009 and 2011. We also repeated the regression adjusting for the expected amount of regression to the mean, defined as one minus the correlation coefficient.[18,19] Regression to the mean is a statistical phenomenon in which values initially above the mean tend to decline on repeat measurement, and values initially below the mean tend to increase.

Next we examined the relationship between readmission rates and several commonly used indicators of hospital quality: risk-standardized mortality rates, volume, teaching status, and process-measure performance. Although it has been criticized, mortality is often used as a hospital quality measure, including by CMS in Hospital Compare.[20] The other indicators we examined are also frequently used in analyses of hospital quality.[21–27] We assumed that readmission rates would correlate to some extent with these other indicators, signifying that readmission rates reflect hospital-specific aspects of quality.

We compared readmission rates in 2011 across quartiles of mortality rates, volume, and process-measure performance and in teaching versus nonteaching hospitals using analysis of variance (ANOVA). We also evaluated the cross-sectional association between the Hospital Compare quality designations (better, worse, or no different than the US national average) for readmission and mortality in 2011. All analyses were performed using the statistical software SAS, version 9.2.

LIMITATIONS Our study had three main limitations. First, we compared the readmission rate point estimates from two years. Longer data panels, or accounting for the readmission rate confidence intervals, could allow for more consistent identification of hospital performance.

Second, the quartile ranges of the composite process-measure scores were close together, which may have limited our ability to detect a relationship between readmission rates and process-measure performance.

Third, other than the discharge-related activities in the process-measure composite, we did not compare readmission rates to direct indicators of the quality of care transitions. However, we sought to determine whether readmission rates were reflective of a more general and traditional concept of hospital quality. Although there is no gold standard for hospital quality, and none of the indicators we used should be taken alone as a perfect proxy for hospital quality, we believe that together they reflect a construct of core hospital quality against which readmission rates can be compared. It seems reasonable to expect that a hospital deemed high quality would perform well across a variety of domains of care and that its underlying processes of care would drive some correlation between readmission rates and the other quality indicators.

Study Results

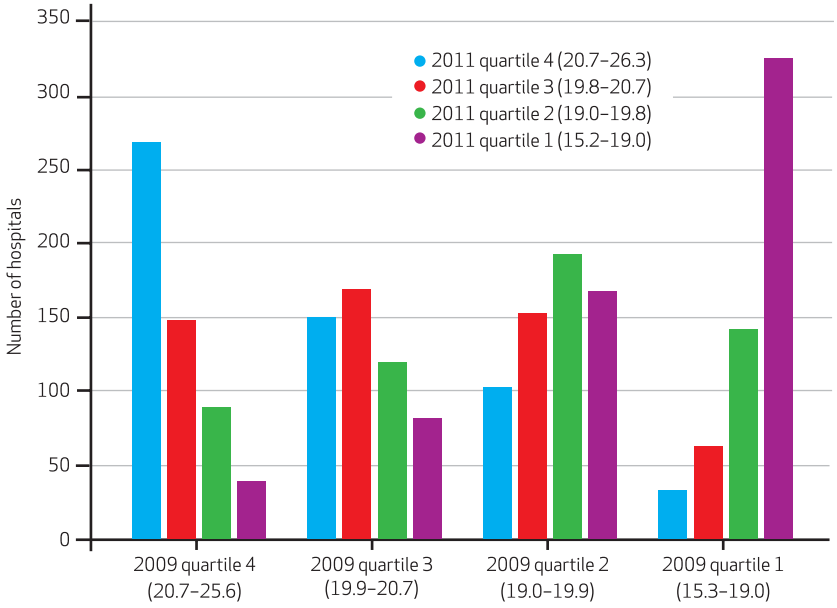
CHANGE IN HOSPITAL RANKINGS For heart attack in 2009, readmission rates ranged from 20.7 percent to 25.6 percent for hospitals within quartile 4 ("worst" performers), while rates for quartile 1 ("best" performers) ranged from 15.3 percent to 19.0 percent (Exhibit 1), representing an absolute difference of 1.7 percentage points between the margins of the best and worst quartiles. Of the 545 hospitals classified in quartile 4 in 2009 for heart attack, 269 (49 percent) remained in quartile 4 in 2011, and 276 (51 percent) moved into quartiles 1–3. Of the 564 hospitals classified in quartile 1 in 2009 for heart attack, 326 (58 percent) remained in quartile 1 in 2011, and 238 (42 percent) moved into quartiles 2–4.

Results for heart failure and pneumonia were similar: respectively, 42 percent and 43 percent of hospitals in quartile 4 in 2009 were classified in other quartiles in 2011, while 43 percent and 45 percent of hospitals in quartile 1 were classified in other quartiles in 2011 (see Appendix A).[17] On average for all three conditions, approximately 59 percent of the hospitals in quartiles 1 and 4 in 2009 that changed classifications moved into the adjacent quartile, while the remainder moved into nonadjacent quartiles (see Appendix B).[17]

The direction and magnitude of the change in

EXHIBIT 1

Distribution Of Hospital Quartiles In 2009 Across Quartiles In 2011 (Heart Attack)



SOURCE Authors' analysis of data downloaded from Hospital Compare. **NOTES** For each quartile in 2009, the exhibit shows how those hospitals in that quartile were distributed across quartiles for 2011. Average percentage change in risk-standardized readmission rate from 2009 to 2011 for quartile 4 was −4.1, for quartile 3 was −0.9, for quartile 2 was 0.9, and for quartile 1 was 2.8. The numbers in parentheses are the lowest and highest readmission rates within a quartile.

readmission rates between 2009 and 2011 was inversely related to readmission rates in 2009. That is, hospitals with higher readmission rates in 2009 tended to improve by 2011, while hospitals with lower readmission rates in 2009 tended to worsen by 2011. On average, readmission rates for hospitals in quartile 4 in 2009 decreased over time by 2.3 percent to 4.1 percent (percentage change) for all three conditions, while readmission rates for hospitals in quartile 1 in 2009 increased by 2.8 percent to 6.8 percent (Appendix B).[17]

Exhibit 2 depicts the fitted relationship from linear regression between readmission rates in 2009 and the change in readmission rates from 2009 to 2011 (see Appendix C for scatterplots).[17] Eighteen percent (heart attack), 21 percent (heart failure), and 27 percent (pneumonia) of the variation in changes in readmission rates is explained by the baseline rate. When we performed the linear regression adjusting for the expected amount of regression to the mean, all (for heart attack) or nearly all (for heart failure and pneumonia) of the association between the baseline rate in 2009 and the change from 2009 to 2011 was removed (Appendix D).[17] Therefore, the observed association is due almost exclusively to regression to the mean.

CORRELATION WITH MORTALITY AND OTHER QUALITY INDICATORS Readmission rates in 2011 had a weak or inverse correlation with the other commonly used indicators of hospital quality (Appendix E).[17] There were no significant differences in mean readmission rates across all quartiles of mortality rates for heart attack and pneumonia (19.8–19.9 percent and 18.4–18.5 percent, respectively). For heart failure, mean readmission rates were significantly higher for the hospitals in the lowest mortality quartile (25.2 percent versus 24.9 percent, 24.8 percent, and 24.5 percent for the higher mortality quartiles). Results comparing the change in readmission and mortality rates longitudinally, which controls for time-invariant hospital confounders, showed a weak correlation between the two outcomes for all three conditions (Appendix F).[17]

For heart attack, heart failure, and pneumonia, hospitals in the highest volume quartile had average readmission rates of 19.7 percent, 24.9 percent, and 18.7 percent, respectively, compared with 19.9 percent, 24.7 percent, and 18.2 percent for hospitals in the lowest volume quartile (Appendix E).[17] Readmission rates for teaching hospitals were significantly higher than for nonteaching hospitals for heart attack, heart failure, and pneumonia (20.3 percent, 25.6 percent, and 19.3 percent versus 19.8 percent, 24.8 percent, and 18.4 percent, respectively). Hospitals in the quartile with the highest composite process-measure performance had average readmission rates of 19.8 percent, 25.0 percent, and 18.4 percent for the three conditions respectively, compared with 20.0 percent, 24.9 percent, and 18.5 percent for hospitals in the quartile with the lowest performance. For the volume and process-measure analyses, some of the differences in readmission rates were statistically significant. However, the directionality of the trend differed across the conditions, and the differences in readmission rates were clinically insignificant, which indicates that the correlations were weak.

The cross-sectional association between the Hospital Compare quality designations for readmission and mortality in 2011 was sometimes conflicting (Exhibit 3). Of the hospitals designated "worse than the US national rate" for readmission for heart attack, heart failure, and pneumonia, 6 (18 percent), 41 (22 percent), and 12 (10 percent), respectively, were designated "better than the US national rate" for mortality. Of the hospitals designated "better than the US national rate" for readmission for heart attack, heart failure, and pneumonia, 0, 13 (11 percent), and 1 (2 percent), respectively, were designated as "worse than the US national rate" for mortality.

Discussion

We found that quartile rankings of hospitals based on risk-standardized readmission rates fluctuated between 2009 and 2011. Hospitals with higher readmission rates in 2009 tended to improve, while hospitals with lower readmission rates tended to worsen. Our analysis indicates that these changes were due in part to regression to the mean. In addition, we found weak or inverse correlations between readmission rates and commonly used hospital quality indicators, including risk-standardized thirty-day mortality rates, volume, teaching status, and process-measure performance.

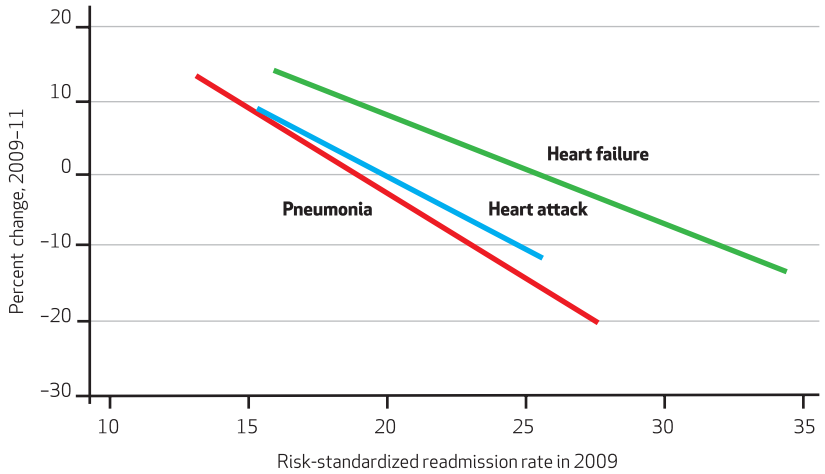
POSSIBLE EXPLANATIONS The changes in hospital readmission rates we observed over time could be explained by changes in the quality of care, changes in patient case-mix, or random variation. The estimator used by CMS to generate readmission rates adjusts for case-mix, is based on three years of data to reduce measurement variability, and accounts for random variation due to low volume—all of which should facilitate measurement of the quality of care and minimize statistical noise. We found, however, that whether a hospital's readmission rate went up or down, and to what degree if it did change, is explained in part (18–27 percent of the explanation, depending on the condition) by how high or low it was to start. This relationship was due primarily to regression to the mean.

Whether this is an "acceptable" amount of regression to the mean for a quality measure is debatable, since there is no commonly accepted benchmark for comparison and some degree of random variation is to be expected with any measure. The finding, however, does indicate that some element of hospital performance, as measured by the change in readmission rates, is due to statistical noise rather than true changes in quality of care. That is, hospitals identified as poor performers at one point in time may not be poor performers at a future point, and the change may be due in part to factors other than changes in care. Policies that assess hospital quality based on readmission rates should account for the regression-to-the-mean effect; the same is true for any evaluation of the policies' impact.

A potential explanation for the poor correlation between readmission and mortality is that a direct relationship between the two measures, driven by quality, would be tempered by a competing risk phenomenon: Hospitals with low mortality rates have more patients who can be readmitted, and hospitals with high mortality rates have fewer patients who can be readmitted. These direct and inverse effects could offset one another, resulting in no detectable correlation between readmission and mortality (or, in the case of heart failure, competing risk could outweigh quality). However, our finding that readmission rates also had no clear quality-driven relationship with the other indicators of hospital quality (volume, teaching status, and process-measure performance), for which there is no

EXHIBIT 2

Relationship Between Risk-Standardized Readmission Rate In 2009 And Percentage Change In Risk-Standardized Readmission Rate For Three Acute Conditions, 2009–11



SOURCE Authors' analysis of data downloaded from Hospital Compare. **NOTES** This exhibit depicts hospitals' risk-standardized readmission rates (RSRRs) in 2009 with the percentage change in RSRRs between 2009 and 2011. Higher RSRRs in 2009 are associated with subsequent decreases, and lower RSRRs are associated with subsequent increases, suggesting regression to the mean. Curves fit as simple linear regression. Sample sizes were 2,247 (heart attack), 3,758 (heart failure), and 3,940 (pneumonia) hospitals. For heart attack, $R^2 = 0.18351$. For heart failure, $R^2 = 0.21442$. For pneumonia, $R^2 = 0.27224$. See online Appendix C for scatterplots for each condition (see Note 17 in text).

EXHIBIT 3

Number Of US Hospitals, By Hospital Compare Designation For Readmission And Mortality, 2011

	Mortality designation		
Readmission designation	**Better than US national rate**	**No different than US national rate**	**Worse than US national rate**
HEART ATTACK			
Better than US national rate	3	27	0
No different than US national rate	88	2,165	35
Worse than US national rate	6	27	0
HEART FAILURE			
Better than US national rate	8	95	13
No different than US national rate	135	3,273	101
Worse than US national rate	41	139	4
PNEUMONIA			
Better than US national rate	4	40	1
No different than US national rate	177	3,485	190
Worse than US national rate	12	98	11

SOURCE Authors' analysis of data downloaded from Hospital Compare.

competing risk, challenges this argument.

Another potential explanation for the poor correlation we observed is that readmission rates are affected by care across settings (for example, discharge planning, care coordination, and outpatient follow-up), while the other quality indicators are primarily driven by inpatient care alone.[28] This notion stems from evidence that improved processes of care during care transitions can reduce readmission rates.[29–31] However, publicly reported measures of hospital care processes that are specific to care transitions have previously been shown to have modest associations with readmission rates.[11] Furthermore, if readmission rates do in fact reflect a unique dimension of quality (thus explaining the lack of correlation), the question then becomes whether hospitals alone should be held accountable for readmission rates, particularly if they perform well in other measures of quality. A quality measure that is completely distinct from others makes it difficult, especially for consumers, to gauge the overall level of care that patients are receiving.

The lack of correlation between volume and readmission rates is unique in that it suggests either that readmission rates do not reflect quality factors related to volume (as is commonly seen with other outcome measures) or that the discontinuity between inpatient and outpatient care that may be more present at high-volume hospitals offsets any quality-driven relationship that does exist. Although we could not definitively address this in the current study, the lack of correlation found between readmission rates and the other indicators of quality supports the former explanation. However, the estimator used by CMS to calculate each hospital's risk-standardized readmission rate, which "shrinks" the point estimates of small-volume hospitals toward the mean for patients across all hospitals, may also mitigate the relationship between volume and readmission rates.

POLICY IMPLICATIONS Based on our findings, policies that use readmission rates from a single observation period to identify hospitals as low quality could have several problematic implications. First, financial incentives may penalize hospitals whose performance is driven to some extent by factors other than quality of care or that perform well in other measures of quality, such as mortality.[15,32,33] Second, assessing the success of these policies may prove difficult because it would not be clear how much of the changes in readmission rates resulted from changes in quality of care. Third, consumers may be confused if their hospital is one that has a conflicting designation for readmission and mortality performance.

Current policies regarding hospital readmissions could be improved by building on ongoing efforts that go beyond measurement and payment based on hospital readmission rates alone. Hospital performance could be judged not just by all-cause readmission rates but by developing and using measures of preventable readmissions.[34] Another approach would be to augment readmission rates with other measures of hospital quality during care transitions, such as Eric Coleman and colleagues' patient-centered Care Transitions Measure.[6,35]

In addition, because the responsibility for care transitions cuts across a variety of hospital and nonhospital providers within a given community, readmission policies could address a wider clinical landscape that includes outpatient physicians, home health agencies, and nursing homes.[5,36] CMS's Community-based Care Transitions Program has begun to work toward this goal by funding community-based organizations that partner with hospitals to reduce readmission rates. Other initiatives, such as the Institute for Healthcare Improvement's State Action on Avoidable Rehospitalizations, have sought to align the interests of different clinical entities.[37,38] Such programs could track readmission rates geographically as they try to improve collaboration between different health care providers involved in care transitions. Accountable care organizations could have a positive impact on this issue because they have an integrated structure that allows for measurement of readmission rates, shared accountability, and distribution of financial incentives across care settings.[39]

Conclusion

Readmission to the hospital is often an undesirable outcome from the perspectives of cost, quality, and patient-centered care. Recent national policies aimed at reducing readmissions—including payment reform—have prompted many hospitals to focus on improving processes of care related to discharge and postdischarge care coordination. As a result, the traditional paradigm of hospital quality has begun to extend beyond inpatient care. Given the extensive evidence on lapses in quality of care during care transitions, this is a net positive for patients. Readmissions to US hospitals almost certainly occur too frequently and may be one indicator of quality of care, especially during care transitions. Our findings, however, identify some limitations with the use of all-cause hospital readmission rates alone in the assessment of hospital performance during care transitions.

These findings do not imply that readmission

rates should not be measured, that incentives should not be provided to reduce them, or that policies seeking to improve quality during care transitions should dramatically change course. Rather, the findings suggest that comparisons of readmission rates within and between hospitals over time should account for regression to the mean and that other measures of hospital performance during care transitions could augment the use of readmission rates. We also recommend that policy makers build on current efforts that take a communitywide approach to measuring readmission rates and distributing incentives to reduce them. ■

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17 To access the Appendix, click on the Appendix link in the box to the right of the article online.

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