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DOI: 10.1377/hlthaff.2018.05178
HEALTH AFFAIRS 38,
NO. 1 (2019): 36–43

Decreases In Readmissions Credited To Medicare's Program To Reduce Hospital Readmissions Have Been Overstated

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ABSTRACT Medicare's Hospital Readmissions Reduction Program (HRRP) has been credited with lowering risk-adjusted readmission rates for targeted conditions at general acute care hospitals. However, these reductions appear to be illusory or overstated. This is because a concurrent change in electronic transaction standards allowed hospitals to document a larger number of diagnoses per claim, which had the effect of reducing risk-adjusted patient readmission rates. Prior studies of the HRRP relied upon control groups' having lower baseline readmission rates, which could falsely create the appearance that readmission rates are changing more in the treatment than in the control group. Accounting for the revised standards reduced the decline in risk-adjusted readmission rates for targeted conditions by 48 percent. After further adjusting for differences in pre-HRRP readmission rates across samples, we found that declines for targeted conditions at general acute care hospitals were statistically indistinguishable from declines in two control samples. Either the HRRP had no effect on readmissions, or it led to a systemwide reduction in readmissions that was roughly half as large as prior estimates have suggested.

In March 2010 the Affordable Care Act (ACA) established the Hospital Readmissions Reduction Program (HRRP) to incentivize hospitals to reduce readmissions among Medicare beneficiaries. The program penalized general acute care hospitals having higher-than-anticipated thirty-day risk-adjusted readmission rates for targeted conditions. In October 2012 the program began penalizing hospitals for three targeted conditions: acute myocardial infarction, heart failure, and pneumonia. The program targeted additional conditions in more recent years, and the penalty increased from a maximum of 1 percent of Medicare reimbursements in 2012 to a maximum of 3 percent starting in 2015.

A number of studies have documented that thirty-day risk-adjusted readmission rates declined after the HRRP was established. Declines were larger for targeted conditions than for nontargeted conditions, for Medicare patients than for other patients, and for hospitals that were subject to the HRRP than for hospitals that were not.[1–4] Readmission rates also declined for nontargeted conditions, which could have been a result of spillover effects of the program or of unrelated changes.[5,6] Most of the declines occurred during the period between the enactment of the ACA (March 2010) and the month when hospitals first faced penalties (October 2012).

This study presents new evidence on why risk-adjusted readmission rates have decreased since the HRRP was established and why reductions were larger for patients with targeted conditions treated at general acute care hospitals than for other patients. Andrew Ibrahim and coauthors have identified one concern with evidence for behavioral changes by hospitals: The majority of the decrease was generated by increased patient risk scores, rather than by actual lower readmission rates.[4] However, the study did not determine why patient risk scores increased, and the authors noted that the changes could have resulted from either increased patient risk or increased coding of diagnoses. The HRRP bases patient risk scores on age, sex, and comorbidities calculated using patient diagnoses from inpatient and outpatient claims for the twelve months before hospitalization for the targeted condition. Crucially, the HRRP risk scores exclude many diagnoses coded only during the targeted admission. As a result, it is unclear how much hospitals could have manipulated patient risk scores. To "game" the program's risk adjustment, hospitals would need to code patient diagnoses more aggressively for care received before the program's targeted admission.

We argue that the increased coding of patient risk scores has a more mundane explanation: Between the March 2010 establishment of the HRRP and the October 2012 introduction of penalties, the Centers for Medicare and Medicaid Services (CMS) changed the electronic transaction standards that hospitals use to submit Medicare claims, allowing for an increased number of diagnosis codes. This change coincided with the time window in which risk-adjusted readmission rates declined the fastest. In particular, before 2011 providers submitted claims using version 4010A of the electronic transaction standards. This version allowed a maximum of nine or ten diagnosis codes (the tenth code was reserved for coding an external cause of injury and was usually, but not always, blank). Starting in January 2011 CMS encouraged providers to submit claims using version 5010, and most hospitals immediately complied. That version allowed a maximum of twenty-five diagnosis codes.[7–9] Some providers submitted bills using the new system in 2010, while others waited for the mandatory transition in January 2012.

We document that around January 2011 the share of inpatient claims with nine or ten diagnoses plummeted and the share with eleven or more rose sharply. Accounting for this change reduces the decline in risk-adjusted readmission rates for patients in HRRP-targeted conditions at targeted hospitals by 48 percent.

We then reexamined a second piece of the ostensible evidence that the HRRP reduced risk-adjusted readmission rates: Decreases have been larger for patients with targeted conditions treated at hospitals targeted by the program than for other patients. Before the implementation of the program, patients with targeted conditions treated at targeted hospitals had higher readmission rates than those who had nontargeted conditions or were treated at nontargeted hospitals. Many factors (such as coding) that might affect readmission rates will have a more pronounced effect for conditions with higher initial readmission rates. When we accounted for differences in baseline readmissions across these samples, we no longer found evidence to suggest that declines have been larger for patients with targeted conditions and those admitted to targeted hospitals than for patients with nontargeted conditions or at nontargeted hospitals. These findings call into question the relatively broad-based consensus that the HRRP has meaningfully decreased risk-adjusted readmission rates.

Study Data And Methods

DATA SOURCES AND STUDY VARIABLES We constructed the sample and calculated risk-adjusted readmission rates to match those used in prior HRRP studies.[1,3,4] Specifically, we began with data from Medicare's 100 percent Research Identifiable Files, and we defined index admissions as hospitalizations that occurred in the period January 2007–November 2014 among beneficiaries who were enrolled in fee-for-service Medicare for at least twelve months before the index admission, who were age sixty-five or older, and who had at least thirty days of Medicare coverage following their discharge.

We constructed three samples of index admissions, one of which was targeted by the HRRP and two of which were not. Past studies compared changes in risk-adjusted readmission rates for the targeted sample against changes for these two ostensible control groups.[1,4] Specifically, the first sample consisted of index admissions to targeted general acute care hospitals for the three conditions that were always targeted (acute myocardial infarction, heart failure, and pneumonia). The targeted conditions and targeted hospitals sample included 7,049,806 index admissions to 3,350 hospitals. The second sample, nontargeted conditions, was composed of admissions to targeted general acute care hospitals for conditions that were never included in the HRRP but were included in CMS's thirty-day all-cause hospital readmission measure.[10] This sample included 40,148,231 index admissions to 3,467 hospitals. The third sample, nontargeted hospitals, was composed of admissions for the three always-targeted conditions to critical access hospitals, a group of hospitals that was not subject to the HRRP. That sample included 429,072 index admissions to 1,115 hospitals.

We constructed risk-adjusted readmission rates for each of the three samples using a common methodology. Specifically, we estimated two patient risk scores using these index hospital admissions. Logistic regression models related thirty-day condition-specific readmissions to indicator variables for patient age, sex, and (depending on the condition) 25–39 binary variables for whether a patient had specific diagnoses. The first patient risk score predicted the risk of readmission based upon all available diagnosis codes from prior-year inpatient and outpatient claims. The second excluded diagnosis codes beyond the ninth code on prior-year claims and repredicted the risk of readmission.

We constructed monthly risk-adjusted readmission rates for each sample by multiplying the sample's average readmission rate over the entire time period by the ratio of the sample's monthly average readmission rate to the sample's monthly average patient risk score.

Details about the data and methods are in the online appendix.[11] Appendix exhibit A3 confirms that our risk-adjusted readmission rates for targeted conditions and targeted hospitals closely track other estimates in the literature.[11] Crucially, both our estimates and those of others show a drop in readmission rates that was concurrent with the electronic transaction standards update. Appendix exhibit A4 illustrates that calculated risk-adjusted readmission rates were highly correlated with those CMS used to calculate initial penalties (correlation: 0.92).[11]

METHODS We performed three analyses. First, to illustrate the effect of the standards update on the coding of diagnoses, we calculated changes in the number of diagnoses per admission over time for targeted conditions and targeted hospitals, for admissions in the twelve months prior to an index admission.

Second, to quantify the impact of the update on risk-adjusted readmission rates, we estimated trends in these rates for targeted conditions and targeted hospitals using two sets of patient risk scores: scores using all available diagnosis codes and those using a maximum of nine diagnosis codes per claim. We estimated interrupted time-series models of changes in risk-adjusted readmission rates over three separate time periods: the pre-HRRP period, from January 2007 until the HRRP was enacted in March 2010; the HRRP anticipation period, from April 2010 through September 2012; and the HRRP post-period, following the October 2012 implementation of HRRP penalties. We selected these time periods to match those used in prior studies.[1,3] We restricted the interrupted time-series models to be continuous and allowed for monthly seasonality. The interrupted time-series models showed how much the trends in readmission rates changed across these three time periods.

In the third analysis we compared estimates of trends in risk-adjusted readmission rates for targeted conditions and targeted hospitals to estimates of trends in these rates for the two control groups used in prior studies: targeted conditions at nontargeted hospitals and nontargeted conditions at targeted hospitals. We performed comparisons using a difference-in-differences methodology, in two steps. For each sample we first calculated the change in trend between the pre-HRRP period and the anticipation period. We then calculated the difference between the change in trend for the targeted conditions and targeted hospitals sample and the change in trend for one of the control samples. This difference is an estimate of the program's effect.

To infer the HRRP's effect from the difference-in-differences methodology, two conditions must hold. First, the control groups must be unaffected by the HRRP. Second, it must be the case that absent the program, trends in risk-adjusted readmission rates would have been parallel for the treatment and control groups. The latter condition is unlikely to hold because readmission rates were initially higher in targeted hospitals and for targeted conditions. Therefore, proportionate changes in readmission trends would lead to a greater percentage-point change in readmission rates in the targeted samples. To gauge the importance of this assumption, we estimated models using both the level of risk-adjusted readmission rates and the natural logarithm of these rates as dependent variables. Models using the level of risk-adjusted readmission rates compared percentage-point decreases in these rates between targeted and nontargeted samples. Models using the logarithm of these rates compared the percentage change in each sample.

LIMITATIONS This study had two key limitations. First, nontargeted hospitals and nontargeted conditions are not ideal control groups because they were observably different from targeted hospitals and targeted conditions before the HRRP was established and may have experienced decreases in risk-adjusted readmission rates because of spillovers from the program. As a result, many of the conclusions in the prior literature and in this study rely on time-series data (that is, within-sample changes over time).

Second, it is impossible to know with certainty what patient risk scores would have been after January 2011, absent the electronic transaction standards update. However, data patterns discussed in the appendix suggest that limiting the scores to the first nine diagnoses provides an accurate approximation. In particular, appendix exhibit A5 illustrates that—both before and after the update—hospitals placed the diagnoses that most increased patient risk scores in earlier positions.[11] Therefore, the second measure approximated what patient risk scores would have been in the absence of the update.

Study Results

UPDATED ELECTRONIC TRANSACTION STANDARDS AND DIAGNOSIS CODING In November 2010, 81 percent of admissions reported nine or ten diagnoses, which was the maximum that hospitals could submit under the electronic transaction standards at that time (exhibit 1). CMS encouraged hospitals to submit claims using the updated electronic transaction standards by January 2011. It appears that most hospitals complied, and as a result, 70 percent of admissions in that month reported eleven or more diagnoses, while only 15 percent reported nine or ten diagnoses. The share of admissions with eight or fewer diagnoses did not change substantively around January 2011.[12]

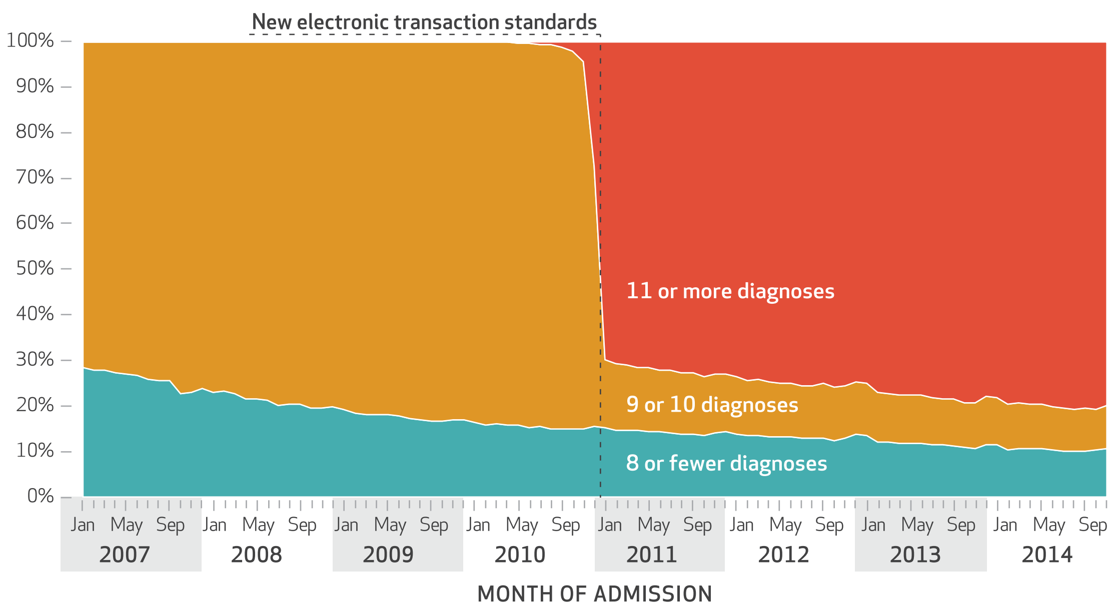
UPDATED STANDARDS AND RISK-ADJUSTED READMISSION RATES We next examined how risk-adjusted readmission rates changed over time. Furthermore, we quantified how much of an effect the previously noted increase in diagnosis coding had on risk-adjusted readmission rates, and we produced estimates of the decrease in these rates that was unaffected by the electronic transaction standards update. The two measures of risk-adjusted readmission rates (using all available diagnosis codes and using only the first nine) were effectively identical until December 2010 (exhibit 2). Over the next several months, the decline in readmission rates using all available diagnosis codes was meaningfully larger than that using only the first nine codes. The divergence between these series in the months around December 2010 led to the differences in the interrupted time-series estimates of the slopes in the anticipation period.

The risk-adjusted annualized changes in exhibit 3 that used all diagnosis codes and only the first nine codes correspond to the solid lines in exhibit 2. Exhibit 3 also presents additional calculations derived from the interrupted time-series estimates in exhibit 2. Specifically, the difference in annualized changes between the two risk-adjusted methods in exhibit 3 represents the extent to which the electronic transaction standards update inflated decreases in risk-adjusted readmission rates. The difference in slope between the pre-HRRP and anticipation periods in exhibit 3 is the estimate of how trends in risk-adjusted readmission rates changed after the announcement of the HRRP. Appendix exhibit A9 tested whether the coefficients in exhibit 3 were significantly different from zero.[11]

Before we turn to a comparison of slopes, it is

EXHIBIT 1

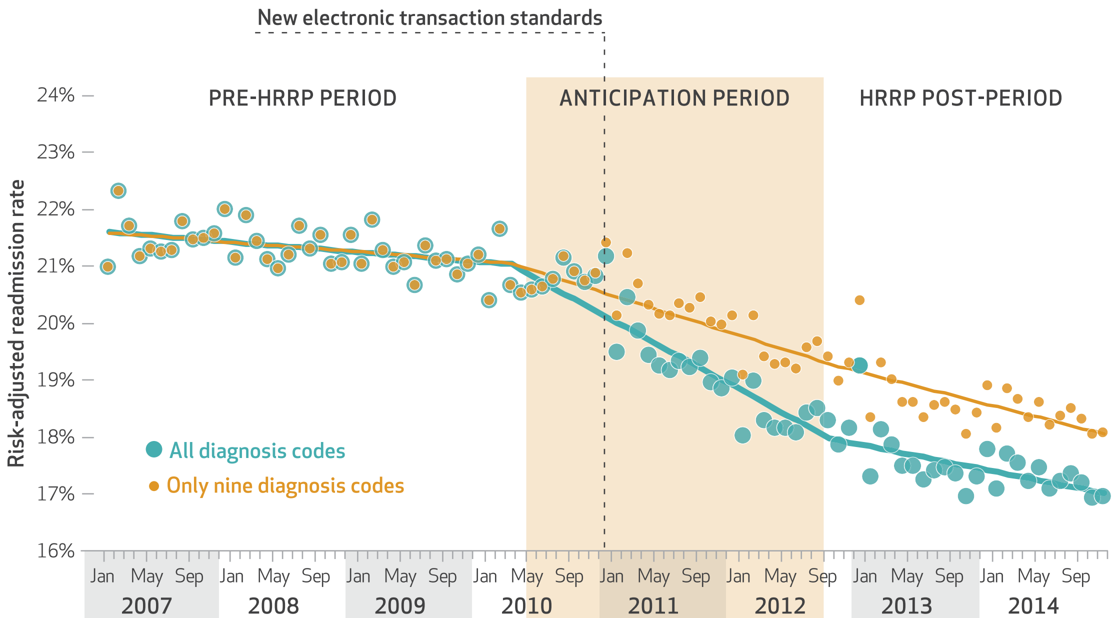
Share of hospital inpatient admissions in the period January 2007–November 2014, by number of diagnoses reported



SOURCE Authors' analysis of Medicare claims data for 2007–14. **NOTES** The sample is restricted to acute care hospital inpatient admissions occurring in the twelve months before an index admission. The Centers for Medicare and Medicaid Services changed the electronic transaction standards used by hospitals to submit Medicare claims, allowing hospitals to provide an increased number of diagnosis codes, and encouraged hospitals to use the new standards starting in January 2011.

EXHIBIT 2

Risk-adjusted readmission rates for targeted conditions and hospitals, January 2007–November 2014



SOURCE Authors' analysis of Medicare claims data for 2007–14. **NOTES** Targeted conditions are acute myocardial infarction, heart failure, and pneumonia. Targeted hospitals are general acute care hospitals. Risk-adjustment procedures adjust for age and for comorbidities calculated from diagnoses present on Medicare fee-for-service claims in the previous twelve months. "All diagnosis codes" means including all available diagnoses in the previous twelve months. "Only nine diagnosis codes" includes only the first nine codes listed on each claim. The dots represent monthly averages. The solid lines represent the interrupted time-series model's estimates. The pre-Hospital Readmissions Reduction Program (HRRP) period, anticipation period, and HRRP post-period are explained in the text. The new electronic transaction standard is explained in the notes to exhibit 1.

worth recalling that both measures of risk-adjusted readmission rates were effectively identical until December 2010. Over the next several months the decline in risk-adjusted readmission rates using all available diagnoses was meaningfully larger than the decline in those rates using nine or fewer diagnosis codes. The timing of this divergence, combined with the evidence above that documented a concurrent change in coding, suggests that a change in coding, rather than in true patient risk, explained the divergence.

In the pre-HRRP time period (January 2007–March 2010), risk-adjusted readmission rates declined at an annualized rate of roughly 0.18 percentage points (exhibit 3). Readmission rates declined faster during the anticipation period (April 2010–September 2012) than during the pre-HRRP period under both risk-adjustment

EXHIBIT 3

Percentage-point changes over time in readmission rates for targeted conditions and hospitals, by risk-adjustment method

	Risk-adjusted using all diagnosis codes		Risk-adjusted using only 9 diagnosis codes		Difference	
	Annualized change	**95% CI**	**Annualized change**	**95% CI**	**Annualized change**	**95% CI**
Slope by time period						
Pre-HRRP	−0.18****	[−0.25, −0.11]	−0.17****	[−0.23, −0.11]	−0.01	[−0.05, 0.02]
Anticipation	−1.22****	[−1.30, −1.14]	−0.71****	[−0.78, −0.64]	−0.52****	[−0.55, −0.47]
HRRP post	−0.44****	[−0.56, −0.34]	−0.56****	[−0.67, −0.47]	0.12****	[0.06, 0.19]
Difference in slope between pre-HRRP and anticipation periods	−1.04****	[−1.16, −0.91]	−0.54****	[−0.66, −0.42]	−0.50****	[−0.58, −0.43]

SOURCE Authors' analysis of Medicare claims data for 2007–14. **NOTES** Targeted conditions and hospitals, risk-adjustment procedures, and "all diagnosis codes" and "only 9 diagnosis codes" are explained in the notes to exhibit 2. The time periods are explained in the text. CI is confidence interval. HRRP is Hospital Readmissions Reduction Program. ****$p < 0.001$

methods. However, the decline during the anticipation period relative to the pre-HRRP period using nine or fewer diagnosis codes (–0.54 percentage points per year) was 48 percent smaller than the decline using all available diagnosis codes (–1.04 percentage points). Even after the electronic transaction standards update is accounted for, however, the annual decline in risk-adjusted readmission rates beyond the pre-HRRP trend was 0.54 percentage points. This implies that over the thirty-month anticipation period there was a policy-relevant decrease in risk-adjusted readmission rates of 1.35 percentage points.

During the HRRP post-period (October 2012–November 2014), the annualized change in risk-adjusted readmission rates was –0.44 percentage points when using all available diagnosis codes, versus –0.56 percentage points when using nine or fewer diagnosis codes. The gap between the two, 0.12 percentage points, was significant but small (roughly one-fifth the size of the difference during the anticipation period). Thus, only during the anticipation period were changes in risk-adjusted readmission rates very sensitive to risk-adjustment method.

UPDATED ELECTRONIC TRANSACTION STANDARDS AND RISK-ADJUSTED READMISSION RATES FOR DIFFERENT SAMPLES Some previous studies have compared decreases in risk-adjusted readmission rates for targeted conditions and targeted hospitals to decreases in rates in two control samples: nontargeted hospitals and nontargeted conditions.[1,3,4] The electronic transaction standards update affected risk-adjusted readmission rates for these two groups as well. Because we were not interested in the effect of the update on the control samples per se, we report and discuss in the text only estimates that risk-adjusted using a consistent number of diagnoses over time. Appendix exhibits A8–A10 present evidence on how the update affected readmission rates for nontargeted hospitals and nontargeted conditions.[11]

The difference-in-differences estimate that compared the change in slope of risk-adjusted readmission rates from the pre-HRRP period to the anticipation period for the targeted conditions and targeted hospitals with the same change for nontargeted hospitals was not significant. Over the thirty-month anticipation period the estimated annualized decrease in risk-adjusted readmission rates of –0.07 percentage points (exhibit 4) yielded an estimated nonsignificant decrease in these rates of only 0.18 percentage points. The difference-in-differences estimate that compared the change in slopes of risk-adjusted readmission rates between the pre-HRRP period and the anticipation period for the targeted conditions and targeted hospitals with the same change for nontargeted conditions suggests that these rates decreased by 0.54 percentage points during the anticipation period.

The difference-in-differences estimate that compared the percentage change in risk-adjusted readmission rates between the pre-HRRP period and the anticipation period for the targeted conditions and targeted hospitals with the same change for nontargeted hospitals was not significant. Over the anticipation period, the estimated annualized decrease in risk-adjusted readmission rates of 0.001 percent yielded a nonsignificant impact of 0.003 percent. The difference-in-differences estimate that compared the percentage change in risk-adjusted readmission rates between the pre-HRRP period and the anticipation period for the targeted conditions and targeted hospitals with the same change for nontargeted conditions suggests that these rates decreased by 1.20 percent during the anticipation period. Given that readmission rates were roughly 20.5 percentage points for targeted conditions and targeted hospitals when the ACA was enacted (authors' calculation), this corresponds to a nonsignificant decrease in rates of about 0.25 percentage points.

EXHIBIT 4

Difference-in-differences estimate of change in risk-adjusted readmission rates between pre–Hospital Readmissions Reduction Program and anticipation periods, by control sample

	Control sample			
	Nontargeted hospitals		Nontargeted conditions	
Dependent variable	**Annualized change**	**95% CI**	**Annualized change**	**95% CI**
Risk-adjusted readmission rates (percentage points)	–0.07	[–0.41, 0.26]	–0.22***	[–0.36, –0.07]
Natural logarithm of risk-adjusted readmission rates (%)	0.001	[–0.018, 0.022]	–0.005	[–0.013, 0.004]

SOURCE Authors' analysis of Medicare claims data for 2007–14. **NOTES** The time periods are explained in the text. Risk-adjustment procedures are explained in the notes to exhibit 2. Nontargeted hospitals are critical access hospitals, with admissions restricted to those for the three targeted conditions (acute myocardial infarction, heart failure, and pneumonia). Nontargeted conditions are defined in the appendix (see note 11 in text), with admissions for them restricted to targeted hospitals (general acute care hospitals). CI is confidence interval. ***$p < 0.01$

Exhibit 4 also suggests novel conclusions about whether decreases in risk-adjusted readmission rates were larger for targeted conditions and targeted hospitals, compared to nontargeted conditions and nontargeted hospitals. These new conclusions stem from the fact that readmission rates were higher for targeted conditions and targeted hospitals than for nontargeted conditions and nontargeted hospitals. As a result, the percentage-point decreases in readmission rates were larger for targeted conditions and targeted hospitals than they were for nontargeted conditions and nontargeted hospitals, even though the decreases in rates were no larger as a percentage of pre-HRRP readmission rates. Appendix exhibit A13 presents evidence that conditions with higher baseline readmission rates experienced larger decreases, and that once this was accounted for, decreases in rates for targeted conditions and targeted hospitals were no larger than decreases in rates for nontargeted conditions or nontargeted hospitals.[11] Those results also suggest that the electronic transaction standards update had a smaller effect on risk scores for the nontargeted conditions and nontargeted hospitals samples than on risk scores for the targeted conditions and targeted hospitals sample because patients in the nontargeted conditions and nontargeted hospitals samples had fewer diagnoses and lower baseline readmission rates.

Discussion

The Hospital Readmissions Reduction Program has been cited as one of the successes of value-based payment, which fosters the view that targeted financial incentives can lead to large changes in behavior.[13] However, altering two seemingly small details related to data and methodology meaningfully weakens the evidence that the HRRP lowered risk-adjusted readmission rates for targeted conditions and targeted hospitals. By coincidence, the HRRP was implemented just before a change in electronic transaction standards that increased diagnostic coding and therefore created the illusion that risk-adjusted readmission rates had decreased. Furthermore, given the higher rate of readmissions for targeted conditions at targeted hospitals than at nontargeted hospitals and nontargeted conditions, the decreases in readmission rates for targeted conditions and targeted hospitals were not atypically large.

This study confirms the findings of Ibrahim and coauthors that increased patient risk scores explain a meaningful share of the decrease in readmission rates following the passage of the HRRP.[4] We built on that study by documenting new facts about the decrease and providing an explanation of why patient risk scores increased. The increase in diagnoses per claim stems from fewer claims having nine or ten diagnosis codes and more claims having eleven or more diagnosis codes. Furthermore, the change in the number of codes occurred between November 2010 and January 2011. The most natural explanation of these changes is neither increased patient risk nor gaming of diagnosis coding. Instead, an unrelated electronic transaction standards update allowed hospitals to enter additional diagnoses codes, which mechanically increased the observed number of comorbidities per patient. This coding effect was magnified for the conditions and hospitals targeted by the HRRP. Because patients with HRRP-targeted conditions admitted to targeted hospitals had more diagnoses, the updated electronic standards increased risk scores for this group by more than it increased risk scores for the nontargeted conditions or nontargeted hospitals samples.

The electronic transaction standards update does not explain the entire decline in risk-adjusted readmission rates following implementation of the HRRP. Readmission rates for targeted conditions and targeted hospitals decreased by 1.35 percentage points more during the period directly after implementation than would have been anticipated based upon the rate of decreases before implementation. However, a similar decrease occurred for nontargeted conditions at targeted hospitals and targeted conditions at nontargeted hospitals. Thus, we cannot conclude that the HRRP led to a differential decline relative to the observed decline in the comparison groups.

This set of findings can be interpreted in two ways. One is that the HRRP had no effect on readmissions. The second is that the HRRP may have led to a systemwide reduction in readmissions (that is, a reduction not limited to targeted conditions and targeted hospitals) that was roughly half as large as prior estimates have suggested.[14] Distinguishing between these conclusions remains an important topic for research.

We note in closing that if the HRRP has not lowered readmission rates, then the rationale for the program's existence becomes substantially weaker. To see why, note that pay-for-performance programs have at least two potential downsides. First, participants may engage in undesirable efforts to game the system. In the case of the HRRP, many observers have raised concerns that hospitals may have been less willing to readmit patients after implementation of the program, which could have increased the use of care that was not counted as a readmission (such as emergency department visits or observation stays) or prevented patients from receiving needed care, possibly harming care quality.[15–17] Second, pay-for-performance schemes expose participants to the risk of unstable funding, in ways that may seem unfair or contrary to other social goals. In the case of the HRRP, the program was found to have initially penalized hospitals that cared predominantly for patients of low socioeconomic status—hospitals that are more likely to be safety-net providers already operating on tight budgets.[18]

In a successful pay-for-performance program, these two potential downsides must be more than made up for by robust improvements in performance. Our study suggests that any salutary effects of the HRRP are smaller than earlier estimates have suggested. ■

All authors acknowledge receiving funding from the Agency for Healthcare Research and Quality (Grant No. U19 HS24072). The authors thank Michael McWilliams for helpful comments. Leemore Dafny reports being a member of the Panel of Health Advisers for the Congressional Budget Office, being an academic affiliate of and providing expert witness support in antitrust matters for Bates White Economic Consulting, being on the board of the Health Care Cost Institute, receiving personal fees and nonfinancial support from the Massachusetts Medical Society, and advising a health care system on strategic alliances. David Grabowski served as a paid consultant to Precision Health Economics, Vivacitas, and CareLinx. He also serves on the Scientific Advisory Committee for NaviHealth. David Cutler serves as a paid consultant (receiving in excess of $5,000.00 per year in the past twelve months) to the Scientific Advisory Board, F-Prime Capital Partners (formerly the Scientific Advisory Board, Fidelity Investments); and Mercer Health and Benefits, LLC.

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11 To access the appendix, click on the Details tab of the article online.

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