Association Between Hospitals’ Engagement in Value-Based Reforms and Readmission Reduction in the Hospital Readmission Reduction Program

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**IMPORTANCE** Medicare is experimenting with numerous concurrent reforms aimed at improving quality and value for hospitals. It is unclear if these myriad reforms are mutually reinforcing or in conflict with each other.

**OBJECTIVE** To evaluate whether hospital participation in voluntary value-based reforms was associated with greater improvement under Medicare’s Hospital Readmission Reduction Program (HRRP).

**DESIGN, SETTING, AND PARTICIPANTS** Retrospective, longitudinal study using publicly available national data from Hospital Compare on hospital readmissions for 2837 hospitals from 2008 to 2015. We assessed hospital participation in 3 voluntary value-based reforms: Meaningful Use of Electronic Health Records; the Bundled Payment for Care Initiative episode-based payment program (BPCI); and Medicare’s Pioneer and Shared Savings accountable care organization (ACO) programs. We used an interrupted time series design to test whether hospitals’ time-varying participation in these value-based reforms was associated with greater improvement in Medicare’s HRRP.

**MAIN OUTCOMES AND MEASURES** Thirty-day risk standardized readmission rates for acute myocardial infarction (AMI), heart failure, and pneumonia.

**RESULTS** Among the 2837 hospitals in this study, participation in value-based reforms varied considerably over the study period. In 2010, no hospitals were participating in the meaningful use, ACO, or BPCI programs. By 2015, only 56 hospitals were not participating in at least 1 of these programs. Among hospitals that did not participate in any voluntary reforms, the association between the HRRP and 30-day readmission was −0.76 percentage points for AMI (95% CI, −0.93 to −0.60), −1.30 percentage points for heart failure (95% CI, −1.47 to −1.13), and −0.82 percentage points for pneumonia (95% CI, −0.97 to −0.67). Participation in the meaningful use program alone was associated with an additional change in 30-day readmissions of −0.78 percentage points for AMI (95% CI, −0.89 to −0.67), −0.97 percentage points for heart failure (95% CI, −1.08 to −0.86), and −0.56 percentage points for pneumonia (95% CI, −0.65 to −0.47). Participation in ACO programs alone was associated with an additional change in 30-day readmissions of −0.94 percentage points for AMI (95% CI, −1.29 to −0.59), −0.83 percentage points for heart failure (95% CI, −1.26 to −0.41), and −0.59 percentage points for pneumonia (95% CI, −1.00 to −0.18). Participation in multiple reforms led to greater improvement: participation in all 3 programs was associated with an additional change in 30-day readmissions of −1.27 percentage points for AMI (95% CI, −1.58 to −0.97), −1.64 percentage points for heart failure (95% CI, −2.02 to −1.26), and −1.05 percentage points for pneumonia (95% CI, −1.32 to −0.78).

**CONCLUSIONS AND RELEVANCE** Hospital participation in voluntary value-based reforms was associated with greater reductions in readmissions. Our findings lend support for Medicare’s multipronged strategy to improve hospital quality and value.
The US health care system is experiencing rapid change. Persistently high spending and variable population health outcomes have driven US policymakers to experiment with different approaches to care delivery and payment. Starting with the passage of the American Recovery and Reinvestment Act of 2009 and continuing through the Patient Protection and Affordable Care Act (ACA), the pace and breadth of experimentation has intensified, particularly for hospitals. Under the presumption that there is no silver bullet, the Centers for Medicare and Medicaid Services (CMS) has initiated numerous programs aimed at hospitals to improve quality and reduce spending growth. These include the Hospital Readmission Reduction Program (HRRP), meaningful use programs to encourage the adoption of electronic health records, the Pioneer and Medicare Shared Savings accountable care organization (ACO) programs, and the Bundled Payment for Care Initiative (BPCI).

The combined effects of these myriad, simultaneous reforms is unknown. On the one hand, the reforms may be synergistic and mutually reinforcing. For instance, meaningful use criteria encourage the adoption of computerized order entry of medications and clinical decision support. These functionalities are associated with greater adherence to evidence-based care, which may reduce the likelihood of readmissions. Similarly, because readmissions contribute to Medicare spending, hospitals participating in ACO and bundled payment reforms have stronger incentives to reduce readmissions. On the other hand, the complexity of the policy environment may be challenging for hospitals, leading to diffuse, ineffective responses to multiple reform efforts.

Herein, we evaluate whether hospital participation in voluntary value-based reforms was associated with greater improvement under Medicare’s HRRP.

Methods

Design of Hospital Incentive Programs

Acute care hospitals in the United States are currently subject to several mandatory value-based reforms and are eligible to participate voluntarily in others. The HRRP is mandatory for acute care hospitals. Under the program, CMS has the authority to reduce payments to hospitals with excess 30-day readmissions. In the 2013 fiscal year, CMS began imposing a payment reduction of up to 1% on hospitals that exceeded expected readmission rates for acute myocardial infarction (AMI), heart failure, and pneumonia. By the 2015 fiscal year, the payment reduction increased to up to 3%. The HRRP has penalized 30-day readmissions for additional conditions over time: patients receiving elective knee and hip replacement (FY 2015), patients hospitalized with chronic obstructive pulmonary disease (FY 2015), and patients receiving coronary artery bypass graft (FY 2017). In this analysis, we focus on hospitals’ performance in the HRRP because it is the most mature mandatory CMS program, has the largest financial impact on hospitals of all the CMS hospital incentive programs, and has been shown to engage hospitals in quality improvement efforts.

Beginning in 2011, hospitals became eligible to receive incentive payments from Medicare and Medicaid by meeting criteria that defined the meaningful use of electronic health records. The criteria for the meaningful use program evolved from stage 1 to stage 2. When hospitals became subject to the more stringent stage 2 criteria depended on when they first met stage 1 criteria. In 2015, hospitals began to receive financial penalties for not meeting meaningful use criteria. We considered hospitals as participating in meaningful use programs if they met either stage 1 or stage 2 criteria. While meaningful use programs did not include criteria specifically related to readmissions, many of the criteria involve the use of health information technology in ways that could help reduce readmissions.

Medicare ACO programs aim to improve the value of Medicare spending by creating new forms of clinician accountability. By holding groups of clinicians jointly responsible for cost and quality outcomes, the ACO programs attempt to increase coordination of care, reduce unnecessary spending, and improve quality. Beginning in 2012, groups of hospitals, physicians, and other health care professionals could choose to be part of an ACO. The ACO assumes responsibility for the spending and quality performance of attributed beneficiaries. Depending on the model (eg, Pioneer or Medicare Shared Savings Program) and the time since the start of participation, ACOs are subject to upside or both upside and downside financial risk. If ACOs’ spending is below the benchmark set by Medicare, they share the savings with Medicare. The amount of shared savings depends on ACOs’ quality performance. Reducing readmissions is an important means to reduce spending to achieve shared savings in these programs. Thirty-day all-cause readmission rate for beneficiaries attributed to the ACO is a quality measure in both the Pioneer and Shared Savings programs.

Finally, the BPCI is a voluntary, hospital-based, bundled payment program. Under the program, hospitals propose clinical areas that would be subject to episode payment (eg, orthopedic or cardiac surgery). Hospitals then choose 1 of 3 episode payment models, which vary with respect to the length of the episode (eg, only the inpatient admission to 90 days after discharge) and the care that is covered in the episode (eg, only hospital and physician care or all care billed to Medicare). The CMS implemented the BPCI in 2 phases. In phase 1,
CMS provided confidential information to participating hospitals on spending for selected conditions. In phase 2, beginning in 2013, the CMS adjusted hospital payments based on whether episode spending was above or below target levels. In this study, we consider only hospitals’ participation in phase 2 of the BPCI.

Data, Study Population, and Study Outcomes
The study was approved by the University of Michigan’s institutional review board. Our study population includes all acute care hospitals in the United States. We excluded critical access hospitals, children’s hospitals, and hospitals that did not have complete readmission data over the study period (2008-2015). Hospital readmission data were available for 8 separate data extracts. Each extract contained hospital-level readmission data covering 3 years of hospital discharges. For simplicity, we refer to these extracts by the last year of data reported in the extract; the 2008 extract included readmission rates from discharges occurring between July 1, 2006, and June 30, 2008. Our analytic sample included 1932 hospitals representing 15 456 hospital-years for AMI, 2785 hospitals representing 22 280 hospital-years for pneumonia, and 2837 hospitals representing 22 696 hospital-years for pneumonia.

Our study outcomes are hospital-level, 30-day risk-standardized readmission for AMI, heart failure, and pneumonia (Figures 1-3 in the Supplement). Readmission rates for these diagnoses have been targeted since the start of the HRRP. Data on 30-day risk-standardized readmission rates were downloaded from CMS’s Hospital Compare website. Hospital outcome data were linked to publicly available data on meaningful use programs and BPCI participation from CMS, and to data on hospital participation in ACO programs from Leavitt Partners (Table 1). We also used data on hospital teaching status, number of beds, and hospitals’ Disproportionate Share Index (a measure of the socioeconomic status of hospitals’ patients) from CMS’s 2010 Final Rule Impact File.

Design and Statistical Analysis
We performed an interrupted time series analysis to test the association between the HRRP and readmissions. This analysis tests whether there were greater changes in risk-standardized 30-day readmission rates after the HRRP was initiated relative to the preintervention trends for AMI, heart failure, and pneumonia. Given evidence of spillover effects to nonpenalized conditions, we did not evaluate the impact of the HRRP using nonpenalized conditions as controls.

Table 1. Characteristics of Hospital Cohorts

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>AMI</th>
<th>Heart Failure</th>
<th>Pneumonia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitals, No.</td>
<td>1932</td>
<td>2785</td>
<td>2837</td>
</tr>
<tr>
<td>Hospital-year observations, No.</td>
<td>15 456</td>
<td>22 280</td>
<td>22 696</td>
</tr>
<tr>
<td>30-d risk standardized readmission rate (2008-2015), mean (SD)</td>
<td>18.7 (1.8)</td>
<td>23.6 (2.3)</td>
<td>17.9 (1.7)</td>
</tr>
<tr>
<td>Beds, mean (SD)</td>
<td>263 (187)</td>
<td>208 (179)</td>
<td>205 (179)</td>
</tr>
<tr>
<td>Disproportionate Share Index, mean (SD)</td>
<td>0.28 (0.15)</td>
<td>0.28 (0.16)</td>
<td>0.28 (0.17)</td>
</tr>
<tr>
<td>Teaching hospital, %</td>
<td>42.8</td>
<td>32.9</td>
<td>32.3</td>
</tr>
<tr>
<td>Hospital located in urban area, %</td>
<td>83.3</td>
<td>71.4</td>
<td>70.8</td>
</tr>
<tr>
<td>Hospital participation during any time in the study period, %</td>
<td>98.1</td>
<td>97.6</td>
<td>97.5</td>
</tr>
<tr>
<td>Meaningful use of health information technology</td>
<td>21.8</td>
<td>18.6</td>
<td>18.3</td>
</tr>
<tr>
<td>Accountable Care Organization Programs</td>
<td>15.9</td>
<td>12.1</td>
<td>11.9</td>
</tr>
</tbody>
</table>

Abbreviation: AMI, acute myocardial infarction.
We considered the start date of the HRRP to be April 2010, the month following the passage of the ACA, which authorized the HRRP. While the penalties began to apply to hospitals in FY 2013, these penalties were based on hospital performance between July 2008 and June 2010. April 2010 is the earliest period in which hospitals could have begun to improve their performance in response to the HRRP.

We used data on hospital-level, 30-day risk standardized readmission rates from Hospital Compare extracts. These data allowed us to evaluate hospital performance using the precise risk-adjustment and standardization methods that CMS used to determine penalties in the HRRP. Because data were available for rolling 36-month periods, we were not able to measure readmission rates during intervals that immediately preceded and followed the passage of the ACA. To address this, our measure of hospital exposure to the HRRP was specified as the proportion of months in a given data extract that followed the ACA. For instance, the 2010 data extract included discharges from July 1, 2008, through June 30, 2010. Because 3 of the months covered in this extract followed the ACA (April, May, and June of 2010), the exposure variable was set to 3 of 36 = 0.083. For the 2011 data extract, the exposure was set to 15 of 36 = 0.417 (see eMethods and eFigure 4 in the Supplement). The exposure value took on a maximum value of 1 and was constant for all hospitals within a given year.

We estimated separate linear fixed-effects models for AMI, heart failure, and pneumonia at the hospital-year level. Our specification included hospital fixed-effects, linear time trends, and exposure to the HRRP. To test whether the effect of the HRRP was modified by hospitals’ participation in voluntary reforms, we added interaction terms between the exposure variable and hospitals’ time-varying participation in the meaningful use, ACO, and BPCI programs. These specifications also included interaction terms between the exposure variable and hospital characteristics (teaching, size, and the Disproportionate Share Index) (see eMethods in the Supplement). To test whether hospital participation in multiple voluntary reforms modified the impact of the HRRP, we included 2-way and 3-way interactions between the voluntary reforms and the exposure to the HRRP. We did not report the results for hospitals that participated in the BPCI alone or BPCI in combination with ACO programs, both of which had cell sizes that were too small to yield stable estimates (see eTable 1 in the Supplement).

Sensitivity analysis explored whether participation in voluntary reforms may be a proxy for hospitals’ interest and capability to reduce readmission rates. We first examined whether hospitals that participated in voluntary reforms had different readmission rates when they began to participate in specific reforms (compared with hospitals that had not yet participated). We then estimated models that randomly assigned the hospital participation dates for the voluntary reforms. If the estimates from these models were similar in magnitude to our main effects of the voluntary programs, it would suggest that our main effects were biased by selection.14

Standard errors were specified to be robust to heteroscedasticity at the hospital level. Confidence intervals were constructed for 2-sided hypothesis tests. All analysis was performed using Stata statistical software (version 14; StataCorp LP).

Results

Among the 2837 hospitals in this study, participation in value-based reforms varied considerably over the study period (Figure 1). In 2010, no hospitals were participating in the meaningful use, ACO, or BPCI programs. By 2015, only 56 hospitals were not participating in at least 1 of these programs. The greatest share of hospitals participated in meaningful use programs (97.5% in 2015), followed by ACO programs (83.3% in 2015), and BPCI (11.9% in 2015).

For each of the incentivized diagnoses, risk-standardized readmission rates fell after the ACA was initiated (Figure 2). Among all hospitals from 2008 to 2015, 30-day risk standardized readmission rates decreased from 19.9 to 16.9 for AMI, from 24.6 to 22.0 for heart failure, and from 18.3 to 17.2 for pneumonia (eTable 2 in the Supplement).

Estimates from our interrupted time-series analysis (Table 2) show that the association between the HRRP and 30-day readmission was −1.46 percentage points for AMI (95% CI, −1.59 to −1.32), −2.13 percentage points for heart failure (95% CI, −2.28 to −1.99), and −1.32 percentage points for pneumonia (95% CI, −1.44 to −1.29). Among hospitals that did not participate in any voluntary reforms, the association between the HRRP and 30-day readmission was −0.76 percentage points for AMI (95% CI, −0.93 to −0.60), −1.30 percentage points for heart failure (95% CI, −1.47 to −1.13), and −0.82 percentage points for pneumonia (95% CI, −0.97 to −0.67).

Compared with hospitals that did not participate in any reforms, hospital participation in voluntary reforms was associated with greater reductions in readmissions in the HRRP (Table 2). Participation in meaningful use programs alone was associated with an additional change in 30-day readmissions of −0.78 percentage points for AMI (95% CI, −0.89 to −0.67), −0.97 percentage points for heart failure (95% CI, −1.08 to −0.86), and −0.56...
percentage points for pneumonia (95% CI, −0.65 to −0.47). Participation in ACO programs alone was associated with an additional change in 30-day readmissions of −0.94 percentage points for AMI (95% CI, −1.29 to −0.59), −0.83 percentage points for heart failure (95% CI, −1.26 to −0.41), and −0.59 percentage points for pneumonia (95% CI, −1.00 to −0.18).

Participation in multiple reforms led to additional improvement (Table 2, Figure 3). For instance, compared with hospitals that participated in no reforms, participation in all 3 programs (meaningful use, ACOs, and BPCI) was associated with an additional change in 30-day readmissions of −1.27 percentage points for AMI (95% CI, −1.58 to −0.97), −1.64 percentage points for heart failure (95% CI, −2.02 to −1.26), and −1.05 percentage points for pneumonia (95% CI, −1.32 to −0.78).

In the supplemental analysis, we found that the count of voluntary programs in which a hospital participated (eg, 0, 1, 2, 3) was similarly associated with reductions in 30-day readmissions (eTable 3 in the Supplement). We also found that longer periods of exposure to the voluntary programs were associated with greater reductions in readmissions (eTable 4 in the Supplement). Sensitivity analysis that explored the potential impact of selection bias found that hospitals that participated in voluntary reforms did not have different performance at baseline than those that eventually participated (eTable 5 in the Supplement). We also found that estimates of the impact of voluntary reforms from models that randomly assigned the timing of hospital participation in voluntary reforms were very small and were almost always non-significant (eTable 6 in the Supplement). This analysis suggests that the association between participation in voluntary reforms and readmission reductions was not largely due to selection.

Discussion

We found that hospital participation in 1 or more voluntary value-based reforms—including the Meaningful Use of Electronic Health Records program, the ACO programs, and the Bundled Payment for Care Initiative—was associated with reductions in 30-day risk-standardized readmissions that were greater than reductions from participation in the HRRP alone. While other studies have documented the effects of the HRRP on safety net hospitals, to our knowledge, ours is the first to consider whether these effects were enhanced by hospital participation in voluntary value-based reforms.

The impact of hospital participation in these voluntary reforms is substantial (eTables 7-10 in the Supplement). Combining our estimates with published figures on the number of readmissions and Medicare spending per readmission, we estimate that, across the 3 targeted diagnoses, in 2015 hospital participation in meaningful use, ACOs, and BPCI programs led to 2377 fewer readmissions (95% CI, −2516 to −2238) saving Medicare $32746283 (95% CI, $34656437 to $30834271).

Our findings are subject to different interpretations. It is possible that hospitals that engaged in voluntary reforms were more likely to have reduced readmissions, regardless of whether they had participated in the reforms. Voluntary participation in these reforms may be a proxy for hospitals’ capacity and willingness to develop clinical processes to improve quality. To account for such self-selection, our analysis controlled for hospital characteristics that did not change over the study period, which may include the structural capacity to reduce readmissions. In addition, our main analysis found that the specific timing of participation in voluntary reforms was associated with improvement in readmissions. Sensitivity analysis confirmed this result. Taken together, these results suggest that engagement in reform was not a mere proxy for other factors that may drive improvements in readmissions.

Instead, participation in other voluntary reform programs offered by the CMS may have enhanced hospitals infrastructure and strengthened their incentives to reduce readmissions. Meaningful use programs may have increased adherence to evidence-based care (eg, the use of postdischarge instructions) while also improving coordination through electronic information exchange, registries, and patient engagement tools, all of which could have reduced
readmissions.18,19 The ACO and BPCI programs increased hospital incentives to reduce readmissions.18,19 This may have led hospitals to enhance care coordination and increase the adoption of specific protocols to reduce readmissions, such as estimating the risk of readmission, discharging patients with follow-up appointments, and using electronic medication reconciliation.6,20

Limitations

Our study has several limitations. First, programs and policies other than the HRRP have accelerated reductions in readmissions. Prior to the enactment of the ACA, concerns about high readmission rates in Medicare were expressed on the national level. In addition to establishing the HRRP, the CMS took steps to reduce readmissions through publicly reporting data on Hospital Compare and funding hospital-level improvements as part of the Partnership for Patients’ Hospital Engagement Networks.21,22 These initiatives, rather than the HRRP alone, could have contributed to reductions in readmissions. However, these initiatives are unrelated to the additional benefits from engaging in other voluntary programs.

Our analysis was conducted at the hospital-level, which allowed us analyze the precise hospital readmission rates that were used to determine penalties in the HRRP. Nonetheless, a patient-level analysis would have allowed for a more fine-grained accounting of the relationship between patient risk factors and readmission rates.

Our interrupted time-series design may also be compromised by “shocks” independent of the HRRP that could have affected readmissions. However, readmissions were relatively flat before the start of the program, suggesting that rates would likely have remained relatively constant in the absence of the program. Alternative research designs to evaluate the HRRP have other weaknesses. Published research suggests that the HRRP decreased readmission rates for non-Medicare patients (eg, commercially insured patients) and for nontargeted diagnoses (eg, gastrointestinal diseases).7,13,23 These spillovers can bias estimates of the HRRP when evaluations are based on comparing readmission rates between patients who were targeted and not targeted by the program. The consistency of our estimates using the interrupted time series across the targeted diagnoses, along with similar evidence from other research, suggests that the initiation of the HRRP is likely to be responsible for the observed reduction in readmissions.24,25

Finally, the HRRP is unique in the strength of its financial incentives and its apparent ability to motivate hospitals to improve.26 It is unknown, and perhaps unlikely, whether participation in voluntary reforms would drive improvement in other mandatory reforms, such as Hospital Value-Based Purchasing.

Conclusions

Despite these limitations, our results help to address the question of how multiple programs focused on increasing hospital value interact.27 Our study suggests that hospital engagement with voluntary value-based reforms was associated with greater reductions in readmissions. These findings lend support for CMS’s multipronged strategy to improve hospital value.
Value-Based Reforms and the Hospital Readmission Reduction Program

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Study concept and design: Ryan, Krinsky, Adler-Milstein, Damberg, Hollingsworth.
Acquisition, analysis, or interpretation of data: Ryan, Krinsky, Adler-Milstein, Maurer.

Drafting of the manuscript: Ryan, Krinsky, Damberg, Maurer.

Critical revision of the manuscript for important intellectual content: Ryan, Krinsky, Adler-Milstein, Hollingsworth.

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REFERENCES


