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Impact of the Hospital Readmission Reduction Program on Surgical Readmissions Among Medicare Beneficiaries

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Abstract

Objective—To understand the impact of the Hospital Readmission Reduction Program on both future targeted and non-targeted surgical procedures.

Summary Background Data—The Hospital Readmission Reduction Program, established under the Affordable Care Act in March of 2010, placed financial penalties on hospitals with higher-than-expected rates of readmission beginning in 2012 for targeted medical conditions. Multiple studies have suggested a “spill-over” effect into other conditions, but the extent of that effect for specific surgical procedures is unknown.

Methods—A retrospective review 5,122,240 Medicare beneficiaries who underwent future targeted procedures (total hip replacement, total knee replacements) or non-targeted procedures (colectomy, lung resection, abdominal aortic aneurysm repair, coronary artery bypass graft, aortic valve replacement, mitral valve repair) using an interrupted time-series model to assess the rates of readmission before the Hospital Readmission Reduction Program was announced (2008 to 2010), while the program was being implemented (2010 to 2012) and after penalties were initiated (2012 to 2014). We also explored if the change in readmission rates were correlated with changes in index length of stay, use of observation status or discharge to a skilled nursing facility.

Results—From 2008 to 2014 rates of readmission declined for both target conditions (6.8% to 4.8%; slope change -0.07 to -0.10 , $p<0.001$) and non-target conditions (17.1% to 13.4%; slope change -0.04 to -0.11 , $p<0.001$). The rate of reduction was most prominent after announcement of the program between 2010 and 2012 for both targeted and non-targeted conditions. During the same time period, mean hospital length of stay decreased; non-targeted conditions (10.4 days to 8.4 days) and targeted conditions (3.6 days to 2.8 days). There was no correlation between hospital reduction in readmissions and use of observation-only admissions (Pearson Correlation Coefficient=0.01) or discharge to a skilled nursing facility (Pearson Correlation Coefficient=0.05).

Conclusions—Trends in readmissions after inpatient surgery are consistent with hospitals responding to financial incentives announced in the Hospital Readmission Reduction Program. There appears to be both an anticipatory effect (future targeted procedures reducing readmission

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before payments implemented) as well as a spillover effect (non-targeted procedures also reducing readmissions).

Introduction

Readmissions after inpatient hospitalizations are common, costly and in many cases may be preventable. In 2009, a review of Medicare beneficiaries observed that 19.6% patients were readmitted within 30 days of discharge¹. Moreover, the study found that Medicare paid more than \$17 billion annually on unplanned rehospitalizations suggesting that readmissions could be an important target for quality improvement. Building on these findings, the *Affordable Care Act* announced the *Hospital Readmission Reduction Program* in 2010. Under this policy, hospitals with higher than expected readmissions rates beginning in 2012 for three common medical conditions—myocardial infarction, heart failure, pneumonia—would be subject to payment penalties. A growing number of studies now support that the program has led to significant reductions in readmissions rates for these targeted medical procedures^{2,3}.

Whether or not the *Hospital Readmissions Reduction Program* had any impact on readmission rates for surgical procedures remains understudied. On the one hand, hospital efforts to prevent readmissions may have been purposefully focused on the targeted medical conditions where penalties were being enforced. In contrast, hospitals may have taken a more comprehensive approach to prevent readmissions by investing in system and network-wide resources that improve coordination of care⁴. Hospitals would have reason to pursue this broader systems based-approach as the *Hospital Readmission Reduction Program* had the stated goal of expanding penalties at a future date to additional conditions, including specific surgical procedures. In fact, the most recent evaluation of program identified that several conditions beyond the initial three target medical conditions experienced reduction in readmission rates, suggesting a “spill-over” effect of the policy. Whether or not this spill-over effect exists for specific surgical cohorts, however, remains unknown.

In that context, we designed a study to understand the impact of the *Hospital Readmission Reduction Program* on both future targeted and non-targeted surgical procedures. In addition to understanding the overall trend in readmission rates before and after the policy, we also explored if the changes in readmission rates could be explained by concurrent changes in length of stay during initial admission, use of observation status or discharge to skilled nursing facility.

Methods

Data Source and Population

We used data from the Medicare Provider Analysis and Review (MEDPAR) file including procedures from 2008 to 2014. This represented 7 years of the most recent data available from the Centers for Medicare and Medicaid Services. Moreover, it importantly spanned a time period before and after the *Hospital Readmission Reduction Program* was announced and implemented so that trends could be adequately assessed.

International Classification of Disease – Clinical Modification, 9th Edition codes were used to identify a total of 8 different surgical procedures. Specifically, we included patients undergoing procedures that are being targeted in the future by the *Hospital Readmission Reduction Program* (total hip replacement, total knee replacements) as well as non-targeted procedures (colectomy, lung resection, abdominal aortic aneurysm repair, coronary artery bypass graft, aortic valve replacement, mitral valve repair). Of note, in 2015 coronary artery bypass graft was added to the list of future-targeted procedures. Because, however, our present data included procedures through only 2014, we categorized coronary artery bypass graft as a non-targeted procedure.

Hospitals included in this study were identified by their provider number in the MEDPAR file. By linking the MEDPAR file with data from the American Hospital Association Annual Survey⁵, additional information about each hospital was obtained to better understand any associations with their rates of readmissions.

Consistent with definitions used by the Centers for Medicare and Medicaid Services, we excluded patients who experienced mortality during the index admission⁶. In addition, 416 hospitals and 78,575 patients were excluded because they did not include adequate pre- and post- data surrounding the *Hospital Readmission Reduction Program*. This study was approved by the Institutional Review Board at the University of Michigan and deemed exempt due to use of secondary data.

Outcomes

Rate of Readmissions—The primary outcome in this study was the rate of readmission after the index admission. We applied definitions for readmissions as outlined by the *Hospital Readmission Reduction Program*⁷. Briefly, this included any readmission within 30 days of discharge from an index hospitalization where the procedure was performed.

Rates of readmissions were risk-adjusted in a manner consistent with the measure specifications outlined by the *Hospital Readmission Reduction Program*. This was performed using a multivariable logistic regression model that included patient demographic characteristics and patient comorbidities as defined by Elixhauser and Southern^{8,9}. For comparison across hospitals, we added the type of procedure into our risk-adjustment model.

Length of Stay, Observation Status, Skilled Nursing Facility—Length of stay was assessed because previous reports have suggested that a shorter length of stay may put patients at higher risk of a readmission¹⁰. Therefore, we wanted to evaluate if, overtime, hospitals may have kept patients in the hospital longer in an effort to avoid a readmission. Length of stay was calculated within MEDPAR data by subtracting the day of discharge from the date of the procedure.

Because of concern that hospitals may be gaming the readmission metric by placing patients who return to the hospital in “observation status”¹¹, we also assessed changes in the rate of observations. We identified observations in the outpatient claims of the MEDPAR file using methods described Office of the Inspector General within the Department of Health and Human Services¹².

Use of skilled nursing facilities was determined based on the patient's discharge destination.

Analysis

The first portion of our analysis was to characterize the hospitals who made the least and most improvement in their rate of readmissions. Change in readmission rate was defined as the difference in the risk-adjusted readmission rate for each hospital before the *Hospital Readmission Reduction Program* was announced (2008 to 2010) and after it was implemented (2012 to 2014). Hospitals were then placed into rank order based on the absolute change in readmission rate and divided into quartiles. Hospitals in the quartile that made the smallest change were labeled "Least Improved Hospitals" while those in the quartile that made the largest change were labeled, "Most Improved Hospitals." Patient and hospital characteristics were compared with between the two groups using t-test, chi-squared and Wilcoxon rank sum as appropriate.

The second step in our analysis was to trend the rate of readmissions for both future-targeted and non-targeted surgical procedures before and after the *Hospital Readmission Reduction Program* was initiated. To do so, we performed an interrupted time-series analysis at three month intervals using risk-adjusted rates of readmissions for each of the 8 procedures. By doing so, this approach allowed us to adjust for underlying secular trends (e.g. adoption of laparoscopy over the study period for studied procedures) that may influence the rate of readmissions. The slope of change for readmissions was assessed during three specific time periods related to the Hospital Readmission Reduction Program: before the program was announced (January 2008 to March 2010), while the program was being implemented (April 2010 to September 2012) and after penalties were initiated (October 2012 to December 2014). In addition, absolute differences in risk-adjusted readmissions rates were determined for each procedure comparing the mean rate before the program was announced and after it was implemented.

The next portion of our analysis was to assess if the change in rates of readmissions were associated with changes in length or stay. Length of stay was trended in a similar fashion as readmissions using an interrupted time series to ultimately compare the mean length of the stay before announcement and after implementation of the *Hospital Readmission Reduction Program*.

Finally, we wanted to assess if the change in readmission rates had any relationship, at the hospital level, with the use of observation status admissions. We plotted the hospital level absolute differences in readmission rates against the absolute change in observation status. A Pearson correlation coefficient was used to assess both the strength and directionality.

All analyses were performed using STATA 14 (Stata Corp, College Station, TX). All tests were two-tailed using 0.05 as the threshold for significance.

Results

A total of 5,122,240 patients (average age 74.5; 43.3% men; 90.3% white) were included in our study (Table 1). Compared to hospitals with the least improved readmissions rates,

hospitals who improved their readmission the most were more likely to be non-profit (71.6% vs 78.4%; $p<0.001$) and larger (% with >500 beds, 29.7% vs 16.2%). On average, hospitals who improved their readmissions rates the least had a higher proportion of Medicaid days (17.7% vs 16.9%; $p<0.001$) and perform fewer operations annually (11,559 vs 16,325; $p<0.001$). Overall, each hospital had a mean 2.4% decreased in the rate of readmissions, with the least improved quartile reducing readmissions by 0.5% (9.8% to 9.3%) and the most improved quartile by 4.3% (12.7% to 8.4%). Additional hospital characteristics are summarized in Table 2.

All eight procedures studies improved their readmission rates during the study period (Table 3). Overall, non-targeted procedures experienced a 3.7% reduction in readmissions rate (17.1% to 13.4%; $P<0.001$) while future targeted procedures experienced a reduction in readmissions rates by 2.0% (6.8% to 4.8%). The largest absolute difference was seen in aortic valve replacement (21.7% to 16.2%; difference 5.5%).

From 2008 to 2014 rates of readmission declined for both future target conditions (6.8% to 4.8%; slope change -0.07 to -0.10 , $p<0.001$) and non-target conditions (17.1% to 13.4%; slope change -0.04 to -0.11 , $p<0.001$). The rate of reduction was most prominent after announcement of the program between 2010 and 2012 for both targeted and non-targeted conditions (Figure 1). During the same time period, mean hospital length of stay decreased; non-targeted conditions (10.4 days to 8.4 days) and targeted conditions (3.6 days to 2.8 days) (Figure 2).

During the study period most hospitals ($n=2,190$; 70.9%) increased their use of the observation status admission. However, there was no correlation between hospital reduction in readmissions and use of observation-status admissions (Pearson Correlation Coefficient= 0.01 ; $p=0.47$) (Figure 3a). Similarly, we found no correlation between hospital reduction in readmissions and discharge to skilled nursing facility (Figure 3b).

Discussion

The present study has two principle findings that improve our understanding of the *Hospital Readmissions Reduction Program* and surgical readmissions. First, we found that that announcement and implementation of the *Hospital Readmissions Reduction Program* for target medical conditions had significant spill-over effect on surgical procedures, including both future targeted and non-targeted procedures. Second, we found that changes in hospital length of stay or use of observation status did not account for the overall decrease in readmissions. Taken together, the trends in readmissions reported in this study are consistent with hospitals responding to financial incentives in the *Hospital Readmission Reduction Program* and making broad systems improvements beyond only the targeted conditions.

Previous studies on the *Hospital Readmissions Reduction Program* have primarily focused on medical conditions. For example, a study by Zuckerman and colleagues³ analyzed Medicare beneficiaries admitted for three targeted medical conditions—heart failure, pneumonia, myocardial infarction—and found a significant decrease in readmissions for these conditions and other non-targeted conditions. Moreover, they found no correlation

between the decrease in readmissions and use of observation status. Our findings in this study mirror those results, and others similarly focused on medical conditions¹³, but with added specificity for both future targeted and non-targeted *surgical* conditions.

While our study was not designed to identify the exact mechanisms by which hospitals reduced their rate of readmissions for surgical procedures, the data do inform several possible explanations. Although most hospitals during this time period did increase their use of “observation status” billing, we found no correlation between use of observation status and a reduction in readmissions. In fact, a sizable proportion of hospitals who reduced their readmission rate *also* reduced their use of observation admissions. We also did not find evidence of overt patient selection to reduce readmissions. Hospitals making the most and least improvements in the readmission rates appeared to care for similar patient populations with respect to age, gender and comorbidities profiles. Finally, because decreases were seen across a diverse selection of 8 procedures in different specialties, it appears most likely that hospitals made broad system wide efforts to reduce readmissions rather than focusing on isolated procedures or conditions.

Whether or not readmissions are an appropriate quality metric for surgical patients has been a matter of debate^{14–16}. Particularly in surgical patients, there may in fact be many appropriate or even desired readmissions. For example, a review of surgical readmissions by Merkow and colleagues¹⁷ found the most common reasons for a readmission included a surgical site infection, obstruction or bleeding. Similarly, Morris and colleagues¹⁸ also noted that a large proportion of surgical readmissions were to manage complications that in some cases may not be avoidable. In such situations, a readmission should be seen as valuable rather than a sign of poor quality care. These reports of appropriate rehospitalizations among surgical patients are an important reminder to temper our enthusiasm for reducing readmissions. In our study, across hospitals who made the least and most improvements in their readmissions rates, they both appear to level out around a readmission rate of 8-9% suggesting there may be a “floor” for how far readmissions could be reduced for surgical patients. Nonetheless, the large effect size seen here across all eight procedures examined indicates that at least some surgical readmissions can and should be prevented.

Our study should be interpreted within the context of several important limitations. First, by using administrative claims data we may not fully capture the circumstances around a readmission to appropriately risk-adjust rates for hospitals. Several important readmissions studies have identified disparities^{15,19}, systems²⁰ and socioeconomic factors^{18,21} not currently included in our risk-adjustment models. Although the Centers for Medicare and Medicaid Services is considering modification to their risk-adjustment methodology^{22,23}, we chose to use the same risk-adjustment framework *currently* in place to make our findings consistent with other studies assessing also examining *Hospital Readmissions Reduction Program* in Medicare claims data^{3,13–15,19,24}. Second, our study included only Medicare patients and may not be generalizable to other patient populations (e.g. those on private insurance, or in the Veterans Affairs system) who may also undergo these same surgical procedures. Nonetheless, our findings do appear consistent with other reports in non-Medicare databases that identified a reduction in readmissions after announcement and implementation of the program. Finally, our study cannot definitively state a cause and effect

relationship between the *Hospital Readmission Reduction Program* and reduction in surgical readmissions. Indeed, multiple concurrent efforts to reduce readmissions were happening in parallel given the broad interest from providers to improve coordination of care. However, the effect size and temporal relationship seen in our time-series analysis are compelling that the *Hospital Readmission Reduction Program* at least partially contributed to the overall reductions seen in readmissions for surgical procedures.

Our findings have important policy and practice implications related to readmissions and surgical procedures. First, for payers, this study supports the focus on readmissions as a meaningful quality metric that can be incentivized. As the *Hospital Readmissions Reduction Program* expands to additional conditions, more attention will be needed around identifying truly preventable readmissions in surgical cohorts^{17,25} and accounting for possible socioeconomic confounders. Second, for providers and hospitals administrators, these findings should be encouraging. The efforts to reduce readmissions for targeted conditions appears to have a sizeable impact on those procedures, as well as additional procedures that were not targeted. Finally, for patients these findings should mark another example of payers and providers attempting to align incentives that ultimately delivers higher quality care.

Conclusion

The trends in readmissions after inpatient surgery reported in this study are consistent with hospitals responding to financial incentives in the *Hospital Readmission Reduction Program* and making broad systems improvements. There appears to be both an anticipatory effect (future targeted procedures reducing readmission before payments implemented) as well as a spillover effect (non-targeted procedures also reducing readmissions.) As the program expands to target more surgical conditions, more attention will be needed on better risk-adjustment models that account for appropriate readmissions and socioeconomic confounders.

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Figure 1.
Trends in Surgical Readmissions and the Hospital Readmission Reduction Program

Figure 2.
Trends in Length of Stay and The Hospital Readmission Reduction Program

a. **b.** **Figure 3.**

- a. Hospital Use of Observation Status Admission versus Change in Readmission Rate
- b. Discharge to Skilled Nursing Facility versus Change in Readmission Rate

Table 1

Patient Characteristics at Hospitals with the Least and Most Improved Readmission Rates

	All Patients	Least Improved Readmission Rates	Most Improved Readmission Rates	p-value
Number of Patients	5,122,240	1,305,285	1,183,247	
Age (mean (SD), years)	74.48 (6.49)	74.45 (6.49)	74.47 (6.51)	0.176
Male (%)	43.3	43.4	42.6	<0.0001
White (%)	90.3	90.6	89.7	<0.0001
Black (%)	6.1	5.7	6.7	<0.0001
Comorbidities (%)				
Hypertension	69.6	69.2	70.3	<0.0001
Diabetes	20.2	20.4	20.6	0.0002
Chronic Pulmonary Disease	17.6	17.2	18.1	<0.0001
Fluid and electrolyte disorders	15.5	14.3	16.4	<0.0001
Hypothyroidism	15.2	15.2	15.2	0.605
Deficiency Anemias	14.1	13.7	15.1	<0.0001
Obesity	13.0	12.5	13.2	<0.0001
Depression	8.2	7.9	8.4	<0.0001
Renal failure	7.7	7.4	7.7	<0.0001
Peripheral Vascular Disease	7.2	6.8	7.2	<0.0001
Coagulopathy	5.1	4.5	5.5	<0.0001
Congestive heart failure	4.1	4.0	4.4	<0.0001
Valvular disease	4.0	3.7	4.1	<0.0001
Weight loss	3.2	3.1	3.4	<0.0001
Metastatic cancer	2.9	2.9	3.0	0.424
Chronic blood loss anemia	1.8	1.7	1.9	<0.0001
Solid Tumor	1.6	1.5	1.6	<0.0001
Psychoses	1.5	1.4	1.5	<0.0001
Liver Disease	0.8	0.7	0.8	<0.0001
Paralysis	0.6	0.6	0.7	<0.0001
Lymphoma	0.5	0.5	0.5	<0.0001
Alcohol abuse	0.3	0.3	0.3	0.195
Drug abuse	0.0	0.1	0.0	0.0002
Elixhauser No. of Comorbidities (%)				
0	9.5	10.1	8.9	<0.0001
1	24.7	25.6	24.1	<0.0001
2	65.8	64.4	67.1	<0.0001
Minimally Invasive Surgery (%) *	39.5	37.9	38.4	0.0002
Discharge Destination (%)				
Skilled Nursing Facility	67.4	65.4	68.9	<0.0001

	All Patients	Least Improved Readmission Rates	Most Improved Readmission Rates	p-value
Home	29.8	32.0	28.0	<0.0001
Died	1.7	1.7	1.8	<0.0001
Hospice	0.3	0.3	0.4	0.0002
Transferred	0.5	0.4	0.5	<0.0001
Other	0.2	0.2	0.4	<0.0001

* Minimally invasive Vs. open surgery among patients who received colectomy, lung resection or abdominal aortic aneurysm repair

Table 2

Characteristics of Hospitals with the Least and Most Improved Readmission Rates

	All	Least Improved Readmission Rates	Most Improved Readmission Rates	
No. of hospitals	3,497	770	771	
Change in Readmission Rate (before and after HRRP)	2.4% (11.1% to 8.7%)	0.5% (9.8% to 9.3%)	4.3% (12.7% to 8.4%)	
Ownership (%)				
For-profit	14.4	17.5	12.3	<0.0001
Non-profit	77.1	71.6	78.4	
Other	8.5	10.9	9.3	
Bed Size (%)				
<250 beds	37.2	41.6	39.7	<0.0001
250 to <500 beds	37.4	42.3	30.6	
500 beds	25.5	16.2	29.7	
Geographic Region (%)				
Northeast	18.4	13.6	22.9	<0.0001
Midwest	25.7	20.8	32.6	
South	37.3	38.5	32.6	
West	18.7	27.1	11.9	
Additional Characteristics				
Teaching Hospital (%)	60.0	52.7	62.1	<0.0001
No. of operating rooms	21.2	16.7	22.6	<0.0001
Nurse Ratio	8.1	7.9	8.0	<0.0001
Technology hospital	83.6	81.5	81.6	0.004
Percentage of Medicaid days	17.0	17.7	16.9	<0.0001
Total annual inpatient surgical operations	6,075	4,742	6,477	<0.0001
Licensed beds	462	386	484	<0.0001
Total admissions	19,401	16,002	20,442	<0.0001
Full-time equivalent employees	2,597	1,946	2,921	<0.0001

Table 3

Change in Readmission Rates by Surgical Procedure

Procedure	Readmission Rate Before HRRP (%)	Readmission Rate After HRRP (%)	Absolute Difference (%)	P-value
Future Targeted Procedures	6.8	4.8	-2.0	<0.001
Total Hip Replacement	7.6	5.2	-2.4	<0.001
Total Knee Replacement	6.3	4.6	-1.7	<0.001
Non-Targeted Procedures	17.1	13.4	-3.7	<0.001
Aortic Valve Replacement	21.7	16.2	-5.5	<0.001
Coronary Artery Bypass Graft	18.0	13.0	-5.0	<0.001
Mitral Valve Repair	26.6	22.1	-4.5	<0.001
Abdominal Aortic Aneurysm	13.8	10.5	-3.3	<0.001
Lung Resection	13.6	10.4	-3.2	<0.001
Colectomy	17.2	14.4	-2.8	<0.001