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How Patient Complexity and Surgical Approach Influence Episode-Based Payment Models for Colectomy

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Abstract

BACKGROUND: Bundled payment programs broaden hospitals' responsibility for spending to entire episodes of care. After demonstration programs in cardiac surgery and joint replacement, these payment reforms could soon extend to major operations like colectomy under Medicare's Bundled Payments for Care Improvement-Advanced Program.

OBJECTIVE: To evaluate how specific policies and surgical practice patterns would influence hospital reimbursement in a bundled payment program for colectomy.

DESIGN: This was a population-based study.

SETTINGS: We used national data from the 100% Medicare Provider Analysis and Review files for the years 2010 to 2014.

PATIENTS: We identified patients undergoing colon resections using Diagnosis Related Group codes and International Classification of Disease, Ninth Revision, Clinical Modification codes.

MAIN OUTCOME MEASURES: We simulated per case reconciliation payments as the difference between actual price-standardized 90-day episode payments and estimated regional spending benchmarks among fee-for-service Medicare beneficiaries undergoing colectomy (2010-2014). We projected per-patient and overall hospital-level reconciliation payments and the proportion of hospitals that would achieve shared savings under bundled payment conditions. We also assessed how variation in the use of laparoscopy could influence shared savings, using instrumental variable methods to account for selection bias between laparoscopic and open procedures.

RESULTS: Under simulated bundled payment conditions, 51.8% of hospitals would achieve shared savings, but the average case would incur a reconciliation penalty of -\$234 (95% CI -\$245 to -\$223). Risk-adjustment would increase the proportion of hospitals with shared savings to 54.3% (per case payment +\$237, 95% CI \$96 to \$379). Hospitals performing a greater proportion of cases laparoscopically would achieve higher per case reconciliation payments. For example, per

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case reconciliation penalties would be −\$472 (95% CI −\$506 to −\$438) for hospitals that performed 10% of their procedures laparoscopically, whereas those that performed 70% laparoscopically would receive payments of +\$294 (95% CI \$262 to \$326).

LIMITATIONS: Alternative payment models for colectomy have not yet been introduced.

CONCLUSIONS: Surgical leaders must be prepared with strategies for optimizing episode efficiency. Inclusion of risk-adjustment in bundled payment calculations and expanding utilization of laparoscopic surgery may represent approaches to achieve shared-savings and improve surgeon engagement in alternative payment models for surgical care. See **Video Abstract** at <http://links.lww.com/DCR/A928>.

Keywords

Bundled payments; Colectomy; Payment reform

INTRODUCTION

The Center for Medicare and Medicaid Service's (CMS) bundled payment demonstrations in cardiac surgery and joint replacement suggest continued interest in testing alternative payment models for the delivery of surgical care.¹ Despite recent regulatory changes that curtailed mandatory participation in the Comprehensive Joint Replacement (CJR) program, CMS has committed to expanding its use of alternative payment models in 2018 through the Bundled Payments for Care Improvement (BPCI) Advanced model.² Surgeons and hospital administrators are increasingly attuned to how these programs will impact the delivery of expensive and resource-intensive services like inpatient surgery. To date, however, few providers have identified strategies for engaging front-line surgeons in strategies for success in alternative payment models.

Critical to considerations of bundled payment strategy are the ways in which these programs not only achieve savings for payers, but also provide reasonable benchmarks that incentivize surgeons to contain costs. Specific policies, like risk-adjustment, have been shown to increase the likelihood that hospitals caring for more complex patients achieve shared savings following cardiac procedures or hip replacement.^{3,4} While numerous surgical practices, like minimally invasive surgery, have been shown to reduce the costs of care, none have been evaluated as potential strategy for to mitigate financial risk in bundled payments models.^{5–11} In this context, identifying practices that shift control to surgeons may represent a means to garner collective support for new payment models.

We sought to simulate a bundled payment environment for colectomy, a common and expensive procedure performed across a heterogeneous patient population. We then evaluated how risk adjustment and surgical practice changes may influence the likelihood of financial success in a bundled payment model. We capitalize on our previous work, using an instrumental variable method to account for selection bias in the comparison of open and laparoscopic colectomy to enable comparisons between surgical approaches.^{10,12,13}

MATERIALS AND METHODS

Data Source and Study Population

We used national data from the 100% Medicare Provider Analysis and Review (MEDPAR) files for the years 2010 to 2014. We extracted patient data including age, demographic information, and comorbidities. We also linked patient records to other Medicare files containing claims relevant to the surgical episode of care. These data included durable medical equipment, home health, long-stay hospitalizations, outpatient, and skilled nursing facility claims. We identified patients undergoing colon resections using Diagnosis Related Group (DRG) codes (329, 330, 331) and International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) codes (45.73, 17.33, 17.32, 45.75, 45.76, 17.35, 17.36, 45.74, 17.34, 45.82, 45.83, 45.81, 48.50, 48.51, 48.52, and 48.53). We excluded patients under 65 or greater than 99 years of age. We further excluded patients not continuously enrolled in Medicare Part A and B throughout the 90-day perioperative episode. Finally, we linked the Medicare data to the American Hospital Association (AHA) Annual Survey data to obtain additional information on hospital characteristics such as bed size and non-profit status.

Medicare Payments

Our primary outcome was a hospital's estimated reconciliation payment for the surgical episode of care. We calculated reconciliation payments in the following manner, in accordance with methods that have been previously described and validated¹⁴:

$$\text{Reconciliation Payment} = \text{Benchmark Payment} - \text{Medicare Spending}$$

Benchmark payments were calculated according to CMS's specifications used for the cardiac and joint replacement programs, and those proposed for BPCI Advanced.³ Benchmark payments represent average episode spending for a specific DRG, in a given year, in 1 of the 9 census divisions across the country. We used the prior year's payments to create simulated benchmark payments for a particular year (i.e. 2010 payments to benchmark 2011 spending).

To compute Medicare spending, we first calculated 90-day total episode payments using price-standardization to account for payments related to indirect medical education, Disproportionate Share Hospitals (DSH), and regional variation in prices.¹⁴ We chose the 90-day interval because it has been used to define episodes for many of the CMS bundled payment demonstrations. We winsorized high-cost episodes with spending in excess of two standard deviations above the regional DRG mean to that value. For subsequent analyses, we further divided payment information in to service types, including the index hospitalization, physician payments, readmissions, and post-acute care spending. Post-acute care spending included payments made by Medicare to home health agencies, skilled nursing or sub-acute rehabilitation facilities.

Statistical Analysis

We calculated hospitals' mean per-episode reconciliation payments or penalties and the total estimated reconciliation payment or penalty for each year of the study period (excluding 2010 because there is no prior year benchmark). We compare hospitals that, on average, earned reconciliation payments against those that incurred penalties under the simulated bundled payment model.

We then evaluated how specific policy changes in the design of the bundled payment model would impact hospitals' reconciliation payments. We first calculated reconciliation payments after the application of a 1% or 3% "discount" to the benchmark payment. This approach has been used by CMS in other bundle payment demonstrations as a way to incentivize greater reductions in spending (BPCI Advanced will apply a 3% discount). We then fit linear regression models to assess the impact of risk-adjustment on reconciliation payments. For this analysis, we adjusted reconciliation payments for differences in patient illness using Hierarchical Condition Categories (HCC) as fixed effects.^{15–17} These categories are assembled from data on patient's age and medical comorbidities. They were designed and validated by CMS for risk-adjustment of Medicare payments and are considered more accurate comorbidity counts when the outcome of interest is financial data.¹⁶

Next, we evaluated how changes in surgical practice, specifically proportional use of laparoscopic colectomy, would influence hospitals' reconciliation payments. Laparoscopy is increasingly used for colon surgery, and is associated with lower costs than traditional open operations,^{6,18} even after accounting for selection bias and differences between patients undergoing each approach.¹⁰ The use of laparoscopy is not currently a factor in determining Medicare payments.

We hypothesize that greater use of laparoscopy may represent a "lever" for providers to improve the likelihood of receiving a reconciliation payment. However, selection bias may lead to biased results. Patients undergoing laparoscopic operations may have lower episode payments because they have less complex procedures, have more favorable anatomy or are healthier in general. This would falsely inflate the financial benefits of laparoscopy over open surgery. To account for this, we exploit regional variation in the use of laparoscopy and performed an instrumental variable (IV) approach as we have described and validated in prior studies with this patient population.¹³ We employed a two-stage least squares (2SLS) model to generate estimates for reconciliation payments that accounted for both measured and unmeasured differences in characteristics between patients undergoing laparoscopic or open surgery.¹⁹ We then estimated mean per case reconciliation for open and laparoscopic surgery, and across hospitals that performed different proportions of their operations laparoscopically. The differences in treatment effect from the instrumental variable approach are most relevant to patients that would be considered candidates for either operations (i.e. the marginal patient).

Finally, we used the mean reconciliation payment for laparoscopic surgery to construct projections for how hospitals mean per case reconciliation payments may change should they increase their utilization of laparoscopy by increments of 10%. Projections were made

by replacing reconciliation payments for open surgery with the overall mean reconciliation payment for laparoscopic cases. Because some surgeons may be more proficient with laparoscopic colectomy than others, projections were also stratified by surgeons' annual volume with laparoscopic colectomy. We defined high and low volume surgeons (laparoscopists) as those within the top (>10 cases/year) and bottom (≤4 cases/year) quartile, respectively.

All confidence intervals were derived from bootstrapping with 1000 replications, where draws were made at the hospital level to deal with clustering at the hospital level. All statistical analyses were performed using STATA statistical software version 14 (College Station, Texas). We employed a 2-sided approach at the 5% significance level for all hypothesis testing. This study was deemed exempt by the Institutional Review Board at the University of Michigan.

RESULTS

Hospital, Surgeon, and Patient Characteristics

Data on the hospitals, surgeons, and patients included in the study are displayed in Table 1. Hospitals included in the study represented a broad range of geographic regions, resources, academic missions, and business models. Hospitals performed an average of 44.2 (Range 4 to 236; SD=33.4) colectomy operations each year, whereas individual surgeons performed an average of 9.3 (Range 1 to 73; SD=8.2). Patients included in the study had an average of 2.9 (SD 1.9) comorbid conditions and the most common DRG was 330, which represented 46.0% of the population. Hospitals with shared savings were generally similar to those with penalties with respect to resources, region, size, and overall case mix.

Episode of Care and Hospital Reconciliation Payments

Benchmark, reconciliation, and episode payments for hospitals with annual savings versus those with annual penalties are displayed in Table 2. Total episode payments were lower for hospitals with annual shared savings (\$21,923; 95% CI \$21,854 to \$21,991) versus those with annual penalties (\$26,512; 95% CI \$26,419 to \$26,605). While payments across all components of the surgical episode were higher for hospitals with annual penalties (versus shared savings), the largest relative differences resulted from readmission (73.2% higher; 95% CI 71.4% to 74.9%) and post-acute care expenditures (74.1% higher; 95% CI 70.5% to 77.7%). Analyses were repeated using diagnoses, instead of DRG's as a reference, yielding similar results.

Impact of Policy Changes on Reconciliation Payments

Under the baseline specifications, mean per case reconciliation payments were −\$234 (95% CI −\$245 to −\$223) with 51.8% of hospitals reporting annual shared savings (Table 3). A preemptive 3% discount decreased the proportion of hospitals achieving shared savings to 42.6%. An approach that included adjustment for differences in case mix and patient illness severity was projected to increase average per case reconciliation payments to \$237 (95% CI \$96 to \$379) and increase the proportion of hospitals achieving shared savings to 54.3%.

Impact of Practice Changes on Reconciliation Payments

Mean per case reconciliation payments differed significantly between patients undergoing laparoscopic (\$1,113; 95% CI \$1,068 to \$1,156) versus open (−\$941; 95% CI −\$991 to −\$890) colectomy. For hospitals, higher annual proportions of laparoscopic colectomies were associated with higher mean per case reconciliation payments. For example, mean reconciliation payments were −\$472 (95% CI −\$506 to −\$438) for hospitals that performed 10% of their procedures laparoscopically versus \$294 (95% CI \$262 to \$326) for those that performed 70% laparoscopically (Figure 1).

Increases in the use of laparoscopy were projected to result in a greater proportion of hospitals achieving shared savings. With an increase in laparoscopy of 10% distributed across average volume surgeons, the proportion of hospitals achieving shared savings was estimated to increase from 51.8% to 51.2%, with that number rising to 62.6% at a 50% increase. However, for low volume surgeons the effect was diminished, suggesting that effects of increasing laparoscopy are related to surgeon experience. For low volume surgeons, even a 100% increase would result in only 59.8% of hospitals achieving shared savings (Figure 2).

DISCUSSION

Under simulated bundled payment conditions for colectomy, hospitals achieving shared savings had lower Medicare payments for all components of the surgical episode of care than those that incurred penalties. Hospital characteristics and case mix was similar between the hospitals with and without savings. The largest relative differences were for expenditures associated with readmissions and post-acute care. Adjusting reconciliation payments for differences in patient illness severity increased the proportion of hospitals that would achieve shared savings. In an instrumental variable analysis, accounting for both measured and unmeasured differences in patient complexity, laparoscopic colectomy was associated with overall positive per-patient reconciliation payments, whereas open surgery was associated with penalties. Thus, hospitals that performed a greater proportion of laparoscopic colectomy had higher average reconciliation payments. However, projections indicated that very large increases in the proportion of laparoscopic cases performed in a hospital would be required to increase the likelihood of that hospital achieving shared savings, and that only high-volume laparoscopists could accrue substantial savings through incremental increases in use of laparoscopy. These findings suggest that surgical leaders could encourage increased use of laparoscopic colectomy as a strategy for success in bundled payments only if they could introduce high-volume laparoscopists into a practice with low baseline laparoscopy rates.

Attention to bundled payment strategies is likely to intensify in the near future because of emerging payment reforms. Earlier this year, CMS announced the Bundled Payments for Care Improvement Advanced (BPCI-Advanced) program, which builds on the experience of earlier BPCI models and suggests ongoing interest in alternative payment models. BPCI-Advanced may have immediate relevance to surgeons and hospitals that offer colectomy, as major bowel procedures are included under its list of covered episodes.² Numerous prior studies evaluated how different policy changes impact hospitals' financial success under

bundled payment programs for other major operations. For example, recent work examined how the CJR program may have unfairly penalized hospitals that care for more medically complex patients by failing to include meaningful risk adjustment.⁴ In that study, adjusting reconciliation payments for patient illness severity increased hospital's financial benefits by up to \$114,000 per year for joint replacement alone. To date, little consideration has been given to how surgical practice, rather than policy, might influence hospitals' financial outcomes under bundled payment conditions. We find that increased utilization of laparoscopic, rather than open colectomy, could improve hospitals' shared savings when they are responsible for the financial risks of an entire episode of care.

This study has several important limitations. Because CMS has yet to outline a bundled payment program for colectomy, it is possible that any such program would not resemble the models simulated in this analysis or that certain DRG's would be excluded. However, most programs to date have closely resembled the approach used here and we explored several alternative designs to reflect a more inclusive group of models proposed by CMS continues to refine these programs. It is also possible that our risk-adjustment is not exhaustive. However, we have addressed this in two ways. First, by using HCC's, we are modeling what CMS currently uses in their own calculations. Second, because differences in patient complexity between laparoscopic and open colectomy can be influential, and challenging to address with administrative risk adjustment, we employed our previously published instrumental variable approach to further account for potentially unmeasured differences in patient characteristics not explicitly captured in the Medicare data.^{10,12,13} Even in that context, some may argue that simply switching patients from an open to laparoscopic operation is not practical or even technically feasible. However, there is a reasonable amount of clinical discretion responsible for the choice of approach, as we have found very wide variation in the use of laparoscopy between hospitals and surgeons.²⁰ Further, beyond the changes in surgeon discretion that shift patients toward one approach, a variety of other practice changes might accomplish the same end result. For example, a hospital may select patients more carefully under bundled payment conditions, selectively accepting more patients amenable to laparoscopic surgery. Finally, this analysis is unable to fully simulate the market effects of a bundled payment environment. Nonetheless, this study is designed to illustrate how payment reforms may affect hospital reimbursement across a range of policy and practice scenarios. It also illustrates more generally how a bundled payment program for colectomy, a high-risk operation performed on a heterogeneous patient population, may place greater financial strain on providers.

This study has important implications for surgical reimbursement policy design. Consistent with similar studies for other procedures, risk-adjustment will be an essential component of episode-based reimbursement in surgery, to ensure that hospitals are not penalized by caring for more complex patients. This may be particularly important for operations like colectomy, as the patient population is markedly heterogeneous and the potential for adverse events is significant. As a result, any bundled payment program for colectomy should incorporate risk-adjustment when calculating reconciliation payments.

For years, leaders in healthcare policy have recognized the importance of provider engagement in payment reform. Surgeons have rarely been included in system-level

strategies for success in alternative payment models, as their influence on total costs of care has not been well understood.²¹ In this study, however, we identify an example of practice change that could meaningfully influence bundled payment outcome, and shift control from policymakers and administrators to frontline surgeons. Hospitals that performed a higher proportion of laparoscopic operations were more likely to succeed in episode-based reimbursement, but we find that the success of a laparoscopy-based strategy for savings will depend on the expertise of the surgeons involved. Nonetheless, these data suggest that for selected patient populations, greater utilization of laparoscopy, especially in the hands of experienced specialist surgeons, could be a strategy for achieving higher reconciliation payments for colectomy. It will also be important to study robotic surgery in this context as population-based data becomes available.¹¹ These findings also have important implications for the development and introduction of bundled payment programs for operations like colectomy. If enrollment remains voluntary, participation could concentrate only among hospitals that perform more laparoscopic surgery or care for less complex and costly patients.

CONCLUSIONS

In this population-based study, we identify practice-based strategies for surgeon influence on bundled payment outcomes and reinforce the importance of clinical risk adjustment in surgical episode-based payment algorithms. Compared to those projected to incur penalties, hospitals achieving shared savings after colectomy accrue lower Medicare payments for all components of the surgical episode, but the largest relative differences are observed in readmission and post-acute care payments. Hospitals that performed a greater proportion of laparoscopic colectomy had higher reconciliation payments and may perform better when financial risk is expanded to the entire episode of care.

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Figure 1.

Figure shows annual mean per case reconciliation payments for hospitals stratified by the hospitals' proportion of procedures performed laparoscopically in that same year. Bars display bootstrapped 95% confidence intervals.

Figure 2.

Figure displays projections for how increases in the annual proportion of laparoscopic colectomy impact the proportion of hospitals achieving annual shared savings. Results are stratified different types of surgeons and reflect the local average treatment effect of laparoscopy for average surgeons, versus high and low volume laparoscopists.

Table 1.

Characteristics of Hospitals Performing Colectomy Procedures on Medicare Beneficiaries, 2010-2014.

Hospital Characteristics	All Hospitals	Hospitals with Annual Savings	Hospitals with Annual Penalties
Total hospitals, n	4,040	2,092	1,948
Bed size, n (%)			
Less than 200, n (%)	2,547 (64.0)	1380 (66.1)	1,231 (63.2)
200-349	758 (18.8)	366 (17.5)	368 (18.9)
350-499	434 (10.7)	257 (12.3)	216 (11.1)
500 or greater	309 (7.6)	89 (4.3)	133 (6.8)
Resources, mean (SD)			
Total surgical procedures	14,027 (13,126)	14,076 (14,299)	13,745 (12,012)
Inpatient surgical procedures	5,557 (5,339)	5,336 (5,402)	5,546 (5,215)
Nurse-to-bed ratio	1.9 (0.7)	1.9 (0.7)	1.8 (0.6)
Intensive care beds	26 (24)	25.4 (23.4)	28.1 (25.7)
Demographics, n (%)			
Teaching hospital	1,767 (43.7)	928 (44.4)	816 (41.9)
National Cancer Institute (NCI) hospital	1,545 (38.2)	761 (36.4)	777 (39.9)
Critical access hospital	667 (16.5)	324 (15.5)	345 (17.7)
Geographic region, n (%)			
Northeast	560 (14.1)	347 (16.3)	255 (13.1)
Midwest	1,127 (28.3)	649 (31.0)	536 (27.5)
West	762 (19.1)	362 (17.3)	405 (20.8)
South	1,532 (38.5)	834 (39.9)	752 (38.6)
Ownership, n (%)			
For profit	766 (19.0)	404 (19.3)	368 (18.9)
Not for profit	2,602 (64.4)	1,366 (65.3)	1,223 (62.8)
Other	672 (16.6)	322 (15.4)	357 (18.3)
Practice Characteristics, n (%)			
Annual volume, mean (SD)	44.2 (33.4)	43.6 (34.7)	43.7 (32.1)
Annual laparoscopic volume, mean (SD)	16.2 (16.5)	17.0 (15.2)	15.7 (15.6)
Surgeon Characteristics			
Total surgeons, n	32,502	20,030	19,707
Annual volume, mean (SD)	9.3 (8.2)	9.4 (8.2)	9.2 (8.1)
Annual laparoscopic volume, mean (SD)	3.9 (1.2)	4.1 (1.2)	3.8 (1.4)
Patient Characteristics			
Total patients, n	330,280	130,768 (50.7)	127,184 (49.3)
Age, mean (SD)	76.6 (7.5)	76.3 (7.4)	76.8 (7.5)
White, n (%)	292,268 (88.8)	116,996 (90.0)	105,898 (87.7)

Hospital Characteristics	All Hospitals	Hospitals with Annual Savings	Hospitals with Annual Penalties
Black, n (%)	25,021 (7.6)	8,705 (6.7)	10,281 (8.5)
Elixhauser comorbidities, mean (SD)	2.9 (1.9)	2.9 (1.9)	3.1 (2.0)
Colon cancer diagnosis, n (%)	142,345 (43.1)	56,612 (43.3)	54,208 (44.7)
DRG 329, n (%)	100, 142 (30.3)	37,055 (28.4)	35,962 (29.7)
DRG 330, n (%)	151,883 (46.0)	61,080 (46.7)	56,440 (46.5)
DRG 331, n (%)	78,255 (23.7)	32,551 (24.9)	28,889 (23.8)
Surgical Case Mix			
Right hemicolectomy, n (%)	149,579 (45.3)	59,529 (45.6)	55,487 (45.8)
Left hemicolectomy, n (%)	130,037 (39.4)	51,046 (39.1)	46,938 (38.7)
Total colectomy, n (%)	4,013 (1.2)	2,036 (1.6)	1,308 (1.1)
Unadjusted Outcome Rates			
Mortality, 30d	6.4	6.2	5.9
Complications, 30d	26.3	24.2	27.1
Readmissions, 30d	14.9	12.3	17.4

Table 2. Average Medicare payments for hospitals with annual savings versus those with penalties under bundled payment conditions.

	US, \$		US, \$ (95% CI)	Proportion, (95% CI)	P
	Hospitals with Annual Savings	Hospitals with Annual Penalties			
Bundled Payment Metrics					
Benchmark	23927	24617	–689 (–687 to –691)	0.03 (0.02 to 0.04)	<0.01
Per Case Reconciliation Payment	1712	–2234	3946 (3952 to 3940)	2.30 (2.22 to 2.38)	<0.01
Annual Reconciliation Payments	57962	–72082	130043 (129907 to 130180)	2.25 (2.21 to 2.28)	<0.01
Episode Payments					
Total Episode	21923	26512	–4589 (–4614 to –4564)	0.21 (0.20 to 0.22)	<0.01
Index Hospitalization	15189	17187	–1998 (–2016 to –1978)	0.13 (0.12 to 0.14)	<0.01
Physician	3405	4295	–889 (–894 to –884)	0.26 (0.25 to 0.27)	<0.01
Readmission	998	1737	–739 (–753 to –727)	0.73 (0.71 to 0.75)	<0.01
Post-Acute Care	2553	4421	–1868 (–1884 to –1851)	0.74 (0.71 to 0.78)	<0.01

Hospitals' average estimated reconciliation payments based on changes to the bundled payment model or surgical practice.

Table 3.

	%	US, \$ (95% CI)
Changes in Bundled Payment Model	Proportion of Hospitals with Annual Savings	Average Hospital-Level Reconciliation Payment
Baseline Model	51.8	-234 (-245 to -223)
Preemptive 1% Discount to Benchmark	48.8	-474 (-484 to -463)
Preemptive 3% Discount to Benchmark	42.6	-953 (-964 to -942)
Adjustment for Patient Illness Severity	54.3	237 (96 to 379)