Title of Project

Physician Organization and the Efficiency of Surgical Specialty Care

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Organization

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I. Structured Abstract

Purpose: To examine variation in episode payments for common inpatient surgeries and to understand the relationship between delivery system organization and the quality and cost of such episodes.

Scope: Surgical specialty care represents a major component of specialty healthcare services. Wide variation in the cost and quality of these surgical episodes suggests opportunities for improvement on both sides of the efficiency equation.

Methods: Using complete Medicare claims data for a sample of patients undergoing selected inpatient procedures from January 2005 through November 2007, we examined price-standardized and case-mix-adjusted Medicare payments for hospital, physician, and post-discharge care around episodes of common inpatient surgeries. We also evaluated differences in the quality and cost of inpatient surgical care among patients treated in hospitals affiliated with integrated delivery systems (IDS) versus those undergoing surgery in a matched group of non-IDS-affiliated centers.

Results: The average total episode payment for Medicare beneficiaries undergoing elective hip replacement, coronary artery bypass grafting, back surgery, or colectomy was $20,807, $42,194, $26,540, and $26,491, respectively. After accounting for both price and case mix, total payments at high-cost hospitals remained between $2,549 (colectomy) and $7,759 (back surgery) higher than at low-cost hospitals. Post-discharge care accounted for a large proportion of variation in payments for all four procedures. Adjusted rates for measures of quality, as well as price-standardized total and component episode payments, were generally similar for patients treated in IDS versus non-IDS hospitals.

Key Words: Surgery, Quality, Cost, Physician organization, Delivery systems, Episode payments

II. Purpose

To examine variation in episode payments for common inpatient surgeries and to understand the relationship between delivery system organization and the quality and cost of such episodes.

III. Scope

Surgical care is a major contributor to Medicare spending growth

Surgical specialty care—that is, care provided by general and/or subspecialty surgeons—represents a major component of specialty healthcare services. In 2005, for example, nearly 45 million operative procedures were performed among hospitalized patients in the United States, including 16 million inpatient procedures among Medicare-eligible patients age 65 years and older. From 2000 through 2005, moreover, the annual percentage change in the number of surgical procedures per Medicare beneficiary (5.7%) far outpaced the 2.4% annual increase in evaluation and management services during the same time interval. As a consequence of these trends, surgical care is a major contributor to the unrelenting spending growth that now threatens Medicare's fiscal sustainability.

Payment reform and inpatient surgical care

Moreover, wide variation in payments per inpatient surgery episode suggests opportunities for reducing these costs considerably. Toward this end, the Centers for Medicare and Medicaid Services (CMS) is evaluating bundled payments for inpatient surgery, lumping reimbursements to hospitals, physicians, and other providers involved in care around a surgical episode into a single payment. Already, CMS established the Medicare Acute Care Episode (ACE) demonstration project that involves a single payment for both part A and part B services for beneficiaries undergoing a variety of cardiac and orthopedic inpatient procedures. Private payers have expressed interest in following suit.

From the perspective of CMS and other payers, bundled payments are intended to improve care coordination and reduce duplicative and/or unnecessary services by creating financial incentives for hospitals and affiliated providers to keep the costs of surgical (and other acute care) episodes below the lump sum payment. Ultimately, the potential savings will depend on the procedures and services included in bundled payments and decisions about where to set reimbursement rates. Savings will also hinge on the extent of true variation in current payments. Obviously, wide variation in current episode payments would imply substantially greater potential savings for payers than would a scenario with more narrow payment distributions.

Delivery system integration and the cost and quality of surgical care

In addition to bundled payment pilots, the Patient Protection and Affordable Care Act of 2010 (ACA) includes a directive to create Accountable Care Organizations (ACOs) in the Medicare program. As defined in the legislation, ACOs represent provider groups that are accountable for the quality of care and total spending for a population of Medicare beneficiaries. At present, more than 300 voluntary ACOs have been established through either the Shared Savings or Pioneer programs. Proponents argue that ACOs will improve efficiency (both quality and costs) by encouraging previously unaligned hospitals and physicians to better coordinate care and function more like existing integrated delivery systems (IDS). Indeed, current evidence suggests that IDS —i.e., multispecialty physician groups affiliated with hospitals, health plans, or other delivery system components—are in fact more efficient for ambulatory and preventive care services.

What is less clear, however, is whether IDS also provide more efficient hospital-based care, which accounts for nearly half of total Medicare spending. In addition to wide variation in clinical outcomes, recent evidence suggests that price- and case-mix-adjusted inpatient episode payments differ by up to 30% across hospitals. This variation suggests opportunities for improvement on both sides of the efficiency equation. Although this issue has not been studied empirically, there are multiple reasons why IDS might achieve better quality and cost outcomes for inpatients with common medical and surgical diagnoses. Because providers from different specialties share infrastructure and information systems, IDS may be uniquely positioned to improve outcomes (e.g., fewer complications) through better care coordination and greater adherence to evidence-based inpatient treatment protocols By virtue of greater care coordination, IDS may also decrease costs of hospital-based care by reducing readmission rates and/or utilizing fewer post-discharge ancillary services.

These conceptual considerations notwithstanding, prior empirical work examining the relationship between IDS and efficiency of inpatient care is extremely limited in scope and insufficient to address at least two critical gaps in scientific knowledge. First, the impact of IDS on the quality of inpatient care remains undefined. In fact, although debates surrounding ACO implementation focus mainly on the extent to which this policy will reduce healthcare costs, an underemphasized concern is whether ACOs will also maintain or improve quality. In order to answer this question fully, it is essential to better understand the relationship between IDS and deaths, complications, and readmissions among hospitalized Medicare beneficiaries. Second, little is known about the influence of IDS on “bottom-line” costs of hospital-based care. Though previous work has evaluated selected conditions and geographic regions,!there are no studies based on national data that examine the effect of IDS on total and component Medicare payments around an index hospitalization (including payments for surgical care, which account for roughly 40% of overall spending for inpatient care). It is also unknown whether the presumed efficiency benefits of IDS are greatest for specific services (e.g., readmissions) and/or patient populations (e.g., patients with multiple comorbidities). A better understanding of these issues would prove invaluable to CMS and other policymakers as they deliberate potential efficiency gains with Medicare ACOs.

In this policy context, we sought to gain additional insight around cost variation for inpatient surgery and to understand whether existing IDS provide more efficient hospital-based care. To do this, we first examined Medicare payments for hospital, physician, and post-discharge care around episodes of common inpatient surgeries. We defined surgical episodes as spanning from the date of hospital admission for the index procedure to 30 days after the hospital discharge date. We then assessed the degree to which intentional differences in Medicare payments (e.g., price differences based on regional wages, cost of living, or illness severity) explain variations in episode expenditures, and we examined specific types of services that account for the remaining or unexplained variation in payments around surgical episodes.

In order to anticipate the likely effects of ACOs on the efficiency of hospital-based care, we also used national Medicare data to evaluate differences in the quality and cost of inpatient surgical care among patients treated in IDS-affiliated hospitals versus those undergoing surgery in a matched group of non-IDS-affiliated centers.

IV. Methods

Subjects and Databases

This study was based on complete Medicare claims data for a sample of patients undergoing selected inpatient procedures from January 2005 through November 2007. We excluded from analysis patients enrolled in Medicare managed care plans, patients younger than 65 years of age or older than age 99, and those not enrolled in both Medicare parts A and B at the time of their procedures (approximately 4 percent). We also excluded the small percentage (<1 percent) of patients who were nursing home residents before surgery.

We identified (from the MEDPAR file) patients undergoing coronary artery bypass grafting (CABG), hip replacement, back surgery, and colectomy based on the presence of the appropriate procedure codes from the International Classification of Diseases, version 9 (specific codes available from the authors upon request). We linked the records for each of these patients to other CMS files containing claims potentially relevant to the surgical episode, including the carrier (i.e., physician), outpatient, home health, skilled nursing facility, long-stay hospital, and durable medical equipment files. The study cohorts included patients undergoing surgery between January 1, 2005, and November 30, 2007. To ensure complete postoperative mortality, complications, readmission, and payment data, we did not include patients having surgery in December 2007. We also excluded patients treated in hospitals performing fewer than 30 of the procedures of interest during the study period.

Calculation of Medicare payments

For each patient, we assessed actual Medicare payments, not submitted charges. In keeping with the approach employed by the Medicare Payment Advisory Commission (MedPAC), we extracted payment information for all service types from the date of hospital admission for the index procedure to 30 days from the hospital discharge date. We sorted the total payment data into four discrete components: index hospitalization, readmissions, physician services, and care provided after discharge from the short-term acute care hospital. The latter category includes payments for rehabilitation hospitals, home health care, skilled nursing facilities, and nursing homes. We refer to payments for care provided after discharge from the short-term acute care hospital as payments for post-discharge care. To account for intended differences in Medicare payments (i.e., differences in compensation based on regional wages, teaching medical trainees, and caring for underinsured patients, among other factors), payments were then price standardized using methods described by researchers with the Dartmouth Atlas of Healthcare, which are quite similar to those employed by MedPAC.

Identification of hospitals affiliated with integrated delivery systems (IDS)

After identifying all hospitals performing the procedure(s) of interest among Medicare beneficiaries, we used the Integrated Healthcare Networks Profiling Solution database from IMS Health to ascertain the presence or absence of IDS affiliations for each hospital. These commercially available data provide information on delivery system relationships, including affiliations between hospitals and physician practices. There is also self-report data from participating IDS describing degrees of integration and centralization in areas such as information systems and physician affiliations. On a yearly basis, the vendor utilizes these data to also generate an IHN Rating System that compares nonspecialty integrated delivery systems on their performance level and degree of integration. The overall rating system analyzes each IDS' performance for 33 attributes in the following eight domains: overall integration, integrated technology, hospital utilization, financial stability, services, access, contract capabilities, and physicians. Domain-specific scores are added together to yield an overall score for the IDS; higher scores reflect greater degrees of self-reported integration.

For this analysis, we limited our sample of IDS-affiliated hospitals to those meeting the following criteria that had been established a priori: 1) the “parent” IDS reported a formal affiliation with one or more physician practices; 2) the “parent” IDS had performance scores in 2007 for both the overall integration and integrated technology domains of the SDI rating system that exceeded the median value nationally; and/or 3) the hospital was affiliated with a prominent IDS described previously in the literature in this area. Finally, we excluded from this sample any hospitals that were part of the Tricare (military) or Veterans Affairs healthcare systems.

This process yielded an overall sample of 374 hospitals affiliated with 92 IDS from 36 states (range for number of hospitals associated with a “parent” IDS 1-23). The IDS-affiliated hospital sample sizes for CABG, hip replacement, back surgery, and colectomy were 167 (86 IDS), 307 (89 IDS), 209 (87 IDS), and 240 (87 IDS), respectively. Among the “parent” IDS represented in our final sample, 99%, 92%, 84%, 80%, 77%, and 52% reported formal affiliations with pharmacy, laboratory, home health, imaging, rehabilitation, and nursing home services, respectively.

Identification of comparison hospitals

Next, we identified a comparison sample of hospitals that possessed structural characteristics similar to our sample of IDS-affiliated hospitals but that did not have an IDS affiliation in 2007. To do this, we used data from the American Hospital Association to implement a propensity score matching approach that identified an equally sized sample of non-IDS-affiliated hospitals (for each procedure) that matched as closely as possible with hospitals in our IDS sample with respect to case volume, bed size, Medicare discharges, and teaching hospital status. The non-IDS-affiliated hospital sample sizes for CABG, hip replacement, back surgery, and colectomy were 167, 307, 209, and 240, respectively.

Primary Outcomes

We defined two categories of outcomes for this analysis: 1) episode payments, and 2) technical quality. We measured total and component Medicare payments for the surgical episodes as described above. Our measures of technical quality included operative mortality, postoperative complications, and readmissions. We defined operative mortality as death occurring within 30 days or before discharge from the index surgical hospitalization. Consistent with our prior work, complications were ascertained using a subset of serious complications from the Complication Screening Project of Iezzoni et al, believed to have acceptable sensitivity and specificity based on medical chart review. These included pulmonary failure, pneumonia, myocardial infarction, deep venous thrombosis/pulmonary embolism, acute renal failure, postoperative hemorrhage, surgical site infection, and gastrointestinal bleeding. Finally, we classified patients as having a readmission (or not) based on the presence of a value greater than zero for readmission payments.

Statistical analyses

Our first goal was to describe hospital-level variation in Medicare payments for inpatient surgery. For each procedure, we ranked hospitals according to total episode payments and then grouped them into quintiles. We then reassigned hospital payment quintiles after price standardization, and again after adjusting for both price and for differences in demographics, comorbidity, and illness severity (i.e., case mix) among patients treated in different hospitals. To minimize chance variation, we also adjusted all hospital payment estimates for reliability using empirical Bayes methods, described previously. Because it tends to "shrink" hospital payments toward the mean, we employed this technique to produce conservative estimates of variation in payments across hospitals.

For the episode payments, we performed case mix adjustment using multiple linear regression, accounting for clustering of patients within hospitals. We adjusted for patient age, gender, race, admission acuity, and preoperative length of stay. To account for potential differences in procedure mix (e.g., 2-vessel vs. 4-vessel coronary artery bypass grafting), our models also included the primary procedure code. Using codes developed by Elixhauser et al., individual comorbidities were also considered for inclusion in the risk adjustment models. To minimize confounding by unmeasured differences in patient illness severity and their baseline "costliness," we also adjusted for expenditures occurring in the 6 months before surgery.

Next, we compared episode payment and technical quality among patients treated in IDS-affiliated versus non-IDS-affiliated hospitals. As a first step, we used chi-squared and t tests to compare characteristics of the hospitals and patients in our two samples. With patients as the unit of analysis, we then fit overall and procedure-specific multivariable regression models to estimate associations between our technical quality (i.e., operative mortality, complications, readmission) and cost outcomes (i.e., episode payments) and treatment in an IDS-affiliated hospital. For modeling purposes, we specified operative mortality, complications, and readmissions as binary (i.e., yes/no) variables, and we log-transformed total episode payments.

We implemented generalized estimating equations or random effects models to account for clustering of patients within hospitals, and we adjusted the models for patient characteristics, including age, gender, race, admission acuity, and preoperative length of stay. Again using codes developed by Elixhauser et al., individual comorbidities were also considered for inclusion in the risk-adjustment models. In an effort to minimize confounding by unmeasured differences in patient illness severity and their baseline "costliness," we also adjusted for expenditures occurring in the 6 months before surgery. Finally, we included in our models several measurable hospital characteristics, including bed size, Medicare discharges, teaching status, and procedure-specific case volumes. From the cost models, we calculated for each procedure the case-mix-adjusted, price-standardized, predicted total and component episode payments for patients treated in IDS-affiliated versus non-IDS-affiliated hospitals.

We performed all analyses using computerized statistical software (SAS, v10) at the 5% significance level. The University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board determined that this study was exempt from its oversight.

V. Results

The average total episode payment for Medicare beneficiaries undergoing elective hip replacement, coronary artery bypass grafting, back surgery, or colectomy was $20,807, $42,194, $26,540, and $26,491, respectively. As illustrated in Table 1 (below), we observed wide variation in total payments around surgical episodes for each of the four procedures. With back surgery, for example, hospitals in the highest cost quintile had total payments that were $22,801 (130 percent) higher than at hospitals in the lowest cost quintile. Similarly, total payments at high cost hospitals were 73 percent, 70 percent, and 48 percent higher than at low-cost hospitals with hip replacement, coronary artery bypass grafting, and colectomy, respectively. Differences in price per service explained a substantial proportion of variation in total payments across hospitals. Nonetheless, after price adjustment, there remained significant differences in total payments at high-cost and low-cost hospitals, ranging from $3,869 (16 percent) for colectomy to $15,828 (82 percent) for back surgery.

Patients treated at hospitals in the high-cost quintile differed from those at low-cost hospitals in several regards (data not shown). For all four procedures, higher-cost hospitals treated a higher proportion of black patients and patients with more comorbidities. They were also more likely to admit patients emergently, particularly before coronary artery bypass grafting and colectomy, and as a result had longer preoperative lengths of stay. Finally, patients treated at hospitals in the high payment quintile had consistently higher expenditures in the 6 months before the surgical episode.

Although price adjustment had larger effects, accounting for differences in case mix had the net effect of narrowing further variation in total episode payments across hospital quintiles (Table 1). After accounting for both price and case mix, total payments at high-cost hospitals remained between $2,549 (colectomy) and $7,759 (back surgery) higher than at low-cost hospitals.

Among different components of the price- and case-mix-adjusted total payments, post-discharge care accounted for a large proportion of variation in payments for all four procedures (Table 2). With hip replacement, for example, post-discharge care accounted for 85 percent of the difference in total payments to hospitals in the first and fifth quintiles. With coronary artery bypass grafting, payments for the index hospitalization explained a large share of excess payments at high-cost hospitals, whereas readmissions were a more important factor with colectomy. Physician services accounted for a smaller share of variation in payments for each procedure (Table 2).

In terms of our quality and cost comparisons based on IDS affiliation, IDS-affiliated hospitals were slightly lower capacity in terms of annual Medicare discharges (Table 3). The average case volumes were evenly matched across hospitals, both overall (Table 3) and for the procedure-specific cohorts (data not shown). Although the differences were generally small in magnitude and dependent on procedure, patients treated in IDS hospitals varied from those treated in non-IDS centers according to several characteristics including race, admission acuity, and comorbidity (data not shown).

In terms of quality measures, unadjusted rates for the individual procedures ranged from 0.6% (hip replacement) to 7.3% (colectomy) for operative mortality, 4.2% (hip replacement) to 22.7% (CABG) for complications, and 8.3% (hip replacement) to 19.9% (CABG) for readmissions. Adjusted rates for measures of quality were generally similar for patients treated in IDS versus non-IDS hospitals (Figure 1), with the exception that patients treated in IDS had a lower likelihood of readmission following colectomy (12.6% vs 13.5%, p=0.03).

After accounting also for differences in patient demographics and illness severity (i.e., case!mix), the price-standardized total and component episode payments for patients treated in IDS were largely indistinguishable from those for non-IDS facilities (Table 4). One exception is that total episode payments for hip replacement were $932 (4%) lower in IDS-affiliated hospitals (p<0.05), with this difference explained almost entirely by lower expenditures for post-discharge care (Table 4). Total episode payments varied by 1% or less for the other three procedures, and these differences were not statistically significant.

Table 1. Average total Medicare payments around episodes of four common inpatient procedures, with and without adjusting for price and case mix

	Total payments, by hospital quintile					
	1 (Lowest cost)	**2**	**3**	**4**	**5 (Highest cost)**	**Difference in payments between 1st and 5th quintiles (%)**
Hip replacement						
Actual	$15,997	$18,314	$20,126	$22,441	$27,676	$11,679 (73.0%)
After price adjustment	$17,524	$19,477	$20,837	$22,252	$24,963	$7,439 (42.5%)
After price and case mix adjustment	$17,784	$19,575	$20,835	$22,168	$24,693	$6,909 (38.9%)
Coronary Artery Bypass Grafting						
Actual	$34,143	$38,295	$41,690	$46,722	$57,976	$23,833 (69.8%)
After price adjustment	$38,083	$40,464	$42,278	$44,260	$47,863	$9,780 (25.7%)

After price and case mix adjustment	$39,155	$41,123	$42,413	$43,668	$46,590	$7,435 (19.0%)
Back surgery						
Actual	$17,571	$22,103	$25,436	$29,606	$40,372	$22,801 (130%)
After price adjustment	$19,353	$23,382	$26,007	$28,953	$35,181	$15,828 (81.8%)
After price and case mix adjustment	$23,249	$24,943	$26,123	$27,568	$31,009	$7,759 (33.4%)
Colectomy						
Actual	$22,385	$24,340	$26,081	$28,297	$33,217	$10,832 (48.4%)
After price adjustment	$24,740	$25,640	$26,317	$27,115	$28,609	$3,869 (15.6%)
After price and case mix adjustment	$25,372	$25,956	$26,341	$26,835	$27,922	$2,549 (10.1%)

Table 2. Average Medicare payments for different components of care around surgical episodes

	Quintiles of total hospital payments (price- and case-mix-adjusted)			
	1 (Lowest cost)	**5 (Highest cost)**	**Difference in payments between 1st and 5th quintiles**	**Proportion of total difference attributed to cost category**
Hip replacement				
Index hospitalization	$11,306	$11,265	-$41	-0.6%
Readmissions	$582	$1,052	$470	6.8%
Physician services	$2,056	$2,651	$595	8.6%
Post-discharge care	$3,840	$9,725	$5,885	85.2%
Total episode	$17,784	$24,693	$6,909	100%

Coronary Artery Bypass grafting				
Index hospitalization	$29,749	$33,139	$3,390	45.6%
Readmissions	$1,810	$2,715	$905	12.2%
Physician services	$4,762	$5,571	$808	10.9%
Post-discharge care	$2,833	$5,165	$2,332	31.4%
Total episode	$39,154	$46,590	$7,435	100%
Back surgery				
Index hospitalization	$15,535	$18,464	$2,929	37.8%
Readmissions	$891	$1,569	$679	8.7%
Physician services	$4,085	$5,081	$996	12.8%
Post-discharge care	$2,738	$5,894	$3,156	40.7%
Total episode	$23,249	$31,009	$7,759	100%
Colectomy				
Index hospitalization	$18,847	$19,130	$283	11.1%
Readmissions	$988	$1,893	$905	35.5%
Physician services	$3,430	$3,669	$239	9.4%
Post-discharge care	$2,107	$3,230	$1,122	44.0%
Total episode	$25,372	$27,922	$2,549	100%

Table 3. Characteristics of IDS-affiliated versus non-IDS-affiliated hospitals*

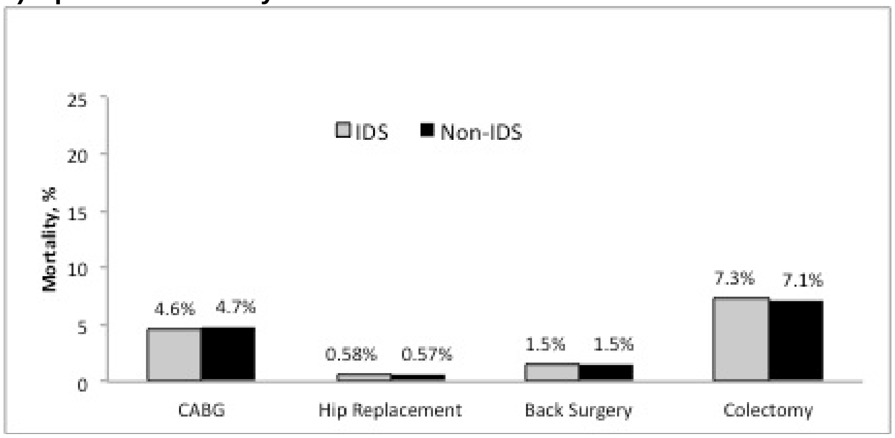
	IDS hospitals (n=374)	**Non-IDS hospitals (n=374)**	**p-value**
Hospital characteristics			
Average total beds	281	308	0.08
Median total beds	209	276	<0.001
Mean number of annual Medicare discharges	5,725	6,576	0.004

Median number of annual Medicare discharges	4,407	6,003	<0.001
Percent teaching hospitals	17.17	17.38	0.94
Median Medicare case volume			
CABG	272	269	0.743
Back surgery	173	169	0.769
Hip Replacement	125	168	<0.001
Colectomy	66	75	0.045
Mean Medicare case volume			
CABG	374	327	0.134
Back surgery	239	210	0.136
Hip Replacement	182	192	0.392
Colectomy	82	83	0.818

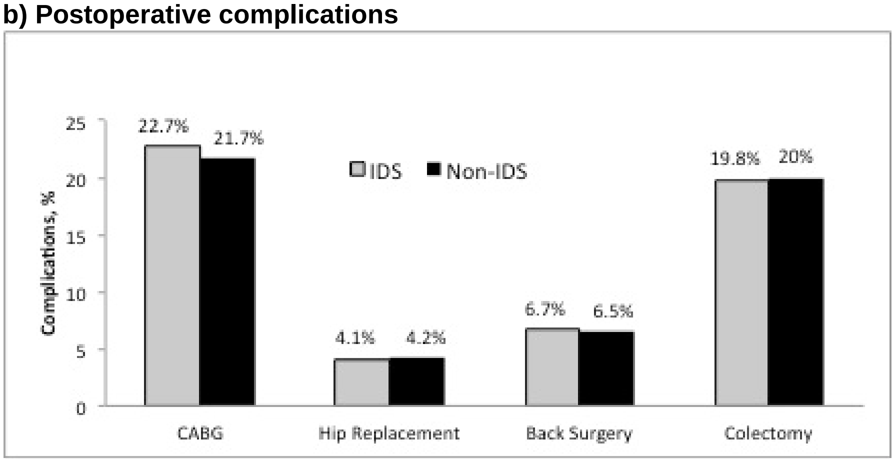
*The case volumes presented are limited to hospitals that performed at least 30 of the procedures of interest during the study interval.

Figure 1. Adjusted rates of operative mortality, postoperative complications, and hospital readmission following common inpatient surgeries according to hospital affiliation with an integrated delivery system.

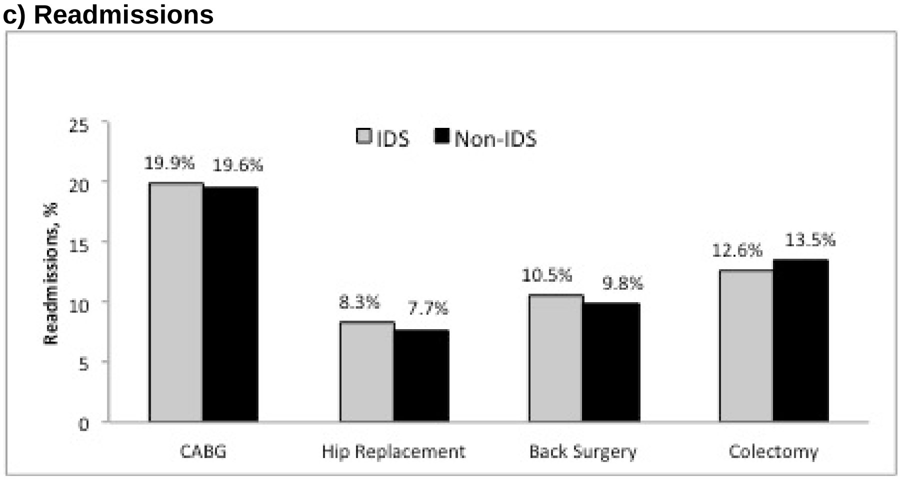
a) Operative Mortality



b) Postoperative complications



c) Readmissions



For each panel, the y-axis presents the adjusted percentage of patients with the outcome of interest. None of the differences between IDS-affiliated and non-affiliated hospitals are statistically significant, with the exception that patients treated in IDS-affiliated hospitals had a lower likelihood of readmission following colectomy (p=0.03).

Table 4. Total and component Medicare payments around surgical episodes according to hospital affiliation with an integrated delivery system

Procedure	IDS hospitals	Non-IDS hospitals	Difference
Total episode payments			
CABG	$44,709	$44,956	-$247
Hip Replacement†	$21,999	$22,931	-$932
Back Surgery	$35,877	$36,289	-$411
Colectomy	$24,428	$24,678	-$250
Index hospitalization			
CABG	$33,216	$33,100	$116
Hip Replacement	$12,413	$12,478	-$65
Back Surgery	$22,222	$22,050	$172
Colectomy	$17,757	$17,616	$140
Readmissions			
CABG	$2,352	$2,288	$63
Hip Replacement	$833	$788	$45
Back Surgery	$1,572	$1,542	$31
Colectomy	$1,216	$1,301	-$85
Physician Services			
CABG	$5,450	$5,416	$34
Hip Replacement	$2,423	$2,521	-$98
Back Surgery	$6,192	$6,215	-$23
Colectomy	$3,181	$3,337	-$156
Post-discharge care			
CABG	$3,874	$4,151	-$278
Hip Replacement	$6,330	$7,145	-$815

Back Surgery	$5,891	$6,482	-$592
Colectomy	$2,273	$2,423	-$150

*Payments are price-standardized and case-mix-adjusted. Index hospitalization is the first hospitalization in which the primary diagnosis would be treated by one of the specified procedures; † For total episode payments, the only significant difference between IDS and non-IDS hospitals was among patients undergoing hip replacement (p<0.05).

Conclusions and Implications

We observed that Medicare payments around episodes of inpatient surgery vary widely across hospitals in the United States. The current study builds on this body of research by examining explicitly how much of this variation in episode payments is due to intentional differences in Medicare payment rates based on, among other factors, regional wage disparities and costs associated with medical education and caring for underinsured patients. We also describe the extent to which case-mix differences between providers explain this variation. Finally, we examined and identified specific types of services that account for the remaining or unexplained variation in payments around surgical episodes while also assessing the extent to which there is correlation between episode payments across procedures and specialties.

Differences in Medicare prices—used to compensate hospitals for differences in regional wages, teaching medical trainees, and caring for underinsured patients—accounted for a large share of variation in surgical episode payments. A much smaller proportion could be explained by case mix—i.e., high cost hospitals caring for sicker, more expensive patients. After accounting for both price differences and case mix, however, hospitals in the highest cost quintile still had total payments that were 10-40 percent (approximately $2,549 to $7,759) more expensive than low-cost hospitals, depending on the procedure. This remaining (i.e., unexplained) variation is arguably not a consequence of existing Medicare payment policy and may therefore be unwarranted.

The causes for this unexplained variation are undoubtedly complex. Broadly speaking, this variation appears to be driven mainly by the use of potentially discretionary physician services and post-discharge care. With physician payments, for example, some services are obligatory (e.g., those of the operating surgeon and anesthesiologist), whereas others, including inpatient consultations by hospitalists, critical care physicians, and medical specialists, no doubt vary widely across hospitals. Likewise, the use of post-discharge home health care and rehabilitation facilities in patients undergoing uncomplicated procedures is similarly discretionary and, for some procedures (e.g., hip replacement, back surgery), explains a considerable amount of overall variation in payments.

In addition to overall variation in surgical episode payments, we also examined whether integrated delivery systems provide higher-quality and/or lower-cost hospital-based care. We examined this question by comparing quality and cost outcomes among patients undergoing common inpatient surgeries in hospitals affiliated or not affiliated with integrated delivery systems. Technical quality, as measured by operative mortality, postoperative complications, and readmissions, was generally similar for patients treated in IDS and non-IDS hospitals. Two exceptions were coronary artery bypass grafting and back surgery, for which treatment in IDS-affiliated hospitals was associated with a higher likelihood of postoperative complications and readmission (the latter difference was for back surgery only). However, though these differences were statistically significant, they were very small in magnitude and therefore of unclear clinical significance.

In terms of costs, total and component episode payments for patients treated in IDS were largely indistinguishable from those for patients undergoing surgery in non-IDS facilities. The one exception was hip replacement, for which the total episode payment for patients treated in IDS hospitals was approximately $1000 lower per episode than for patients undergoing the same procedure in non-IDS hospitals, primarily due to lower expenditures for post-discharge care.

Our study has several limitations. Because our analyses were based on administrative data, we cannot exclude the possibility that some of the variation in episode payments could be attributable to unmeasured differences in illness severity across hospitals. To minimize this risk, we applied numerous restrictions to make our procedure cohorts as homogenous as possible. We not only adjusted for measurable characteristics of patients at the time of surgery but also their expenditures in the 6 months prior to surgery. Patients at high-cost hospitals did have higher preoperative expenditures, but these differences were smaller relative to variation in episode payments. Moreover, it is likely that preoperative expenditures reflect local practice style and intensity as much as patient illness severity.

A second limitation is that there is no standardized definition for an integrated delivery system, and there may be significant variability among the IDS with respect to organizational structure, degree of financial and clinical integration, and the continuum of services provided. We could not measure and adjust for all of these important contextual factors. Moreover, our analyses include only a sample of hospitals; it is therefore possible that our findings do not generalize to the entire population of IDS-affiliated hospitals in the United States. Nonetheless, we did analyze a large number of hospitals affiliated with IDS from across the United States; as such, our results provide useful insight regarding potential benefits associated with this organizational structure for patients in need of complex, hospital-based care.

These considerations notwithstanding, results from this study have immediate implications for CMS and large private payers as they consider bundled payments around episodes of inpatient surgery. Our findings suggesting wide variation in payments imply opportunities for substantial savings for CMS and other payers, particularly if—after accounting explicitly for intentional differences in payment rates and disparities in case mix—bundled payment rates are set below the current national mean. Importantly, however, the potential savings will also depend strongly on the procedures and services selected for bundled payments programs.

In its Acute Care Episode (ACE) demonstration project involving cardiac surgery and joint replacement, CMS is bundling only payments for hospital and inpatient physician services. Because our findings indicate that outlays for post-discharge care comprise a large and highly variable fraction of total episode payments, it can be argued that strong incentives exist for CMS to expand or refine bundled payment policies to include expenditures for home health, rehabilitative, and skilled nursing services provided after hospital discharge. In fact, the national Medicare bundling pilot authorized recently by the Patient Protection and Affordable Care Act includes a single payment for both the hospitalization and subsequent post-acute care services, a modification that may strengthen the impact of this policy on the cost efficiency of surgical episodes.

Our findings related to IDS also have direct implications for CMS, policymakers, hospitals, and other stakeholders involved in developing and evaluating ACO programs. We found no evidence that IDS-affiliated hospitals have better technical quality. At the same time, total and component episode payments for patients treated in IDS were largely indistinguishable from those for non-IDS facilities. Taken together, these data suggest that greater local delivery system integration may have a limited impact on the efficiency of episodic hospital-based care. Put simply, the benefits of IDS observed for ambulatory and preventive care may not extend to patients receiving complex inpatient care.

In reality, it seems unlikely that ACOs or other payment reforms aimed at improving care coordination and shared accountability will reduce mortality or complications after major inpatient surgery. In contrast to patients with chronic medical conditions, moreover, readmissions following inpatient surgery tend to reflect the occurrence of complications rather than breakdowns in care coordination or transitions. Thus, for inpatient surgery, improvements in both quality and cost efficiency are likely to require alternatives to the suite of payment and delivery system reforms in the ACA. Given their success to date, both policymakers and hospitals should consider supporting regional collaborative improvement programs as a principal strategy for reducing morbidity, mortality, and expenditures associated with complex inpatient surgery.

Finally, though these data provide useful preliminary insight regarding the relationship between delivery system integration and surgical costs and quality, they also highlight the continued need to better understand the specific technical processes and systems of care utilized by surgeons and hospitals that provide high-quality, cost-efficient care for patients undergoing specific surgical procedures. Identification of these factors would not only allow them to be rewarded by payers and policymakers but could also facilitate widespread exportation of key determinants of high-quality and cost-efficient inpatient care.

VI. List of Publications and Products

1. Miller DC, Dimick JB, Gust C, Birkmeyer JD: Large variations in Medicare payments for surgery highlight savings potential from bundled payment programs Health Affairs 30: 2107, 2011.
2. Hollingsworth JM, Saint S, Hayward RA, Rogers MA, Zhang L, Miller DC: Specialty care and the patient-centered medical home. Medical Care 49(1): 4-9, 2011. PM20966777
3. Tan HJ, Wolf JS, Ye Z, Wei JT, Miller DC: Population-level comparative effectiveness of laparoscopic versus open radical nephrectomy for patients with kidney cancer. Cancer 117(18): 4184-4193, 2011. PM21365632
4. Tan HJ, Wolf JS, Ye Z, Wei JT, Miller DC: Complications and failure to rescue after laparoscopic versus open radical nephrectomy. J Urol 186(4): 1254-1260, 2011. PM21849185
5. Hollingsworth JM, Saint S, Sakshaug JW, Hayward RA, Zhang L, Miller DC: Physician practices and readiness for medical home reforms: policy, pitfalls, and possibilities. Health Serv Res 47: 486, 2012. PM22091559
6. Tan HJ, Hafez KS, Ye Z, Wei JT, Miller DC: Postoperative complications and long-term survival among patients treated surgically for renal cell carcinoma. J Urol 187(1): 60-6, 2012.PM22114816
7. Tan HJ, Norton EC, Ye Z, Hafez KS, Gore JL, Miller DC: Long-term survival following partial vs radical nephrectomy among older patients with early-stage kidney cancer. JAMA 307(15): 1629-1635, 2012 PM22511691
8. Jacobs BL, Miller DC: The volume outcome relationship in urology: moving the field forward. J Urol 188(6): 2037-2038, 2012. PM23000857
9. Miller DC, Ye Z, Gust C, Birkmeyer JD: Anticipating the Effects of Accountable Care Organizations for inpatient surgery. JAMA Surgery: 148(6): 549-554, 2013. PM23426556
10.Gadzinski AJ, Dimick JB, Ye Z, Miller DC: Inpatient urological surgery at critical access hospitals in the United States. J Urol 189(4): 1475-1480, 2013. PM23041344
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12.Gadzinski AJ, Dimick JB, Ye Z, Miller DC: Utilization and outcomes of inpatient surgical care at Critical Access Hospitals in the United States. JAMA Surgery 148(7): 589-96, 2013. PM23636896
13.Tan HJ, Wolf JS Jr, Ye Z, Hafez KS, Miller DC: Population-level assessment of hospital-based outcomes following laparoscopic versus open partial nephrectomy during the adoption of minimally-invasive surgery. J Urol: 191(5): 1231-1237, 2014. PM24211600
14.Gadzinski AJ, Dimick JB, Ye Z, Zeller JL, Miller DC: Transfer rates and utilization of post-acute care following surgery at Critical Access versus non-Critical Access Hospitals. JAMA Surg 2014 [Epub ahead of print].
15.Ellimoottil C, Miller DC. Anticipating the effect of the Patient Protection and Affordable Care Act for patients with urologic cancer. Urol Oncol: 32(2):55-58, 2014.
16.Ellimoottil C, Miller S, Ayanian JZ, Miller DC. Understanding the effect of insurance expansion on utilization of inpatient surgery. JAMA Surgery (In press)
17.Ellimoottil C, Miller S, Wei JT, Miller DC. Anticipating the impact of insurance expansion on inpatient urological surgery. Status: Urology Practice (In press).