Hospital Quality, Patient Risk, and Medicare Expenditures for Cancer Surgery

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Precis for use in the Table of Contents: Total episode expenditures for cancer resections were lower when care was delivered in low complication, high quality hospitals. These expenditure differences were particularly large for high risk patients, suggesting a potential benefit of selective referral for this high cost population.

Abstract

Background: Surgical resection is a cornerstone of curative-intent therapy for patients with solid organ malignancy. With increasing attention paid to costs of surgical care, there is a new focus on variation in the cost of cancer surgery. We sought to evaluate the potential interactive relationship between hospital quality and patient risk on expenditures for cancer resections.

Methods: Using 100% Medicare claims data for 2010-2013, we identified patients aged 65-99 years undergoing cancer resection. We calculated Medicare payments for the "surgical episode" from index admission through 30 days after discharge. Risk- and reliability-adjusted hospital rates of serious complications and mortality within 30 days of index operation were assessed to categorize high and low quality hospitals.

Results: There was no difference in patient characteristics between the highest and lowest quality hospitals. There were substantial increases in expenditures for procedures performed at the lowest quality hospitals for each procedure. Increased expenditures at lowest quality hospitals were found for all patients but were largest for the highest risk patients. At low quality hospitals, low risk patients undergoing pancreatectomy had payments of $29,080 versus high risk patients with average payments of $62,687, a difference of $17,762 per patient episode.

Conclusions: We found that total episode expenditures for cancer resections were lower when care was delivered in low complication, high quality hospitals. Expenditure differences were particularly large for high risk patients, suggesting that selective referral of high risk patients to high quality centers may be an effective strategy to optimize value in cancer surgery.

Keywords: Cancer Resection, Hospital Quality, Surgical Expenditures, Cost Containment, Episode Expenditures

Introduction

Much attention has focused on the costs of cancer care, as estimates predict a total of $173 billion in annual spending for the care of patients with cancer by 2020 [1]. The cost of chemotherapy administration has garnered particular interest and has been the target of bundled payment programs such as the Oncology Care Model for Medicare patients [2]. However, surgical resection is also a cornerstone of curative-intent therapy for patients with solid organ malignancy and can be particularly resource-intensive. To date, surgery for cancer has not been a primary target of cost containment efforts, but other surgical procedures have been [3]. Given the tremendous variation in cost of cancer surgery [1, 4, 5], future cost containment efforts for cancer care are likely to include surgical cancer care [6-8].

The cost of surgical resection varies by as much as 130% between hospitals [5]. Because inpatient surgical costs are largely driven by the occurrence of postoperative complications [9-13], cost variation is intimately related to hospital quality [14]. Patient age, comorbidities, and functional status may also impact the costs of care by affecting both a patient's likelihood of experiencing a complication and the difficulty of subsequent recovery. Previous studies have generally adjusted for such patient factors in order to focus on hospital comparisons [8]. However, high-risk and low-risk patients are likely to fare differently even at the same hospital. There may be an interactive effect of hospital quality and patient risk on hospital expenditures, but no prior work has addressed this question in patients undergoing cancer surgery.

To better understand the collective effect of patient risk and hospital quality on surgical costs, we studied elderly Medicare beneficiaries undergoing any of three elective cancer resections: colectomy, lung resection, or pancreatectomy. We assessed hospital variation in risk-adjusted Medicare payments for the entire episode of surgical care. We also stratified patients based on

their risk for post-operative complications, regardless of hospital effects. Finally, we quantified the interactive effect of hospital quality and patient risk in determining the cost of cancer surgery.

Methods

Data Source

From the Centers for Medicare and Medicaid Services, we used data from the Medicare Provider Analysis and Review (MEDPAR) File from 2010-2013. We used the International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) codes to identify patients undergoing elective colectomy, lung resection, and pancreatectomy for diagnoses of malignancies. We included patients aged 65-99 years with continuous Part A & B non-Health Maintenance Organization Medicare coverage for 3 months before and 6 months after the surgical procedure of interest. We excluded patients with a preoperative length of stay greater than one day and those undergoing emergent or urgent procedures in order to capture patients undergoing elective resections. Hospitals were identified by provider number in the MEDPAR file, and additional hospital information was obtained from the American Hospital Association Annual Survey [15].

Hospital Quality Assessment

We used rates of serious complications within 30 days of index operation as the primary outcome to classify high and low quality hospitals. We first identified post-operative complications using ICD-9-CM codes for the following categories of complications: anastomotic, cardiac, genitourinary, hemorrhagic, neurologic, obstruction, postoperative shock, pulmonary, splenic injury, thromboembolic, wound infection, and reoperation [16]. As in previous work, we defined “serious complications” as those associated with hospital length of stay greater than the 75th percentile for each procedure performed [10, 15, 17]. In order to further validate our

assignments as high and low quality assessments, we determined the 30-day mortality rates for the hospital quintiles.

We then performed risk and reliability adjustment of the hospital based rates of complications as described below. Hospitals were sorted into quintiles based on these adjusted complication rates. The hospitals in the lowest quintile of complications were labelled “high quality hospitals” and those in the highest quintile of complications were labeled as “low quality hospitals.”

Patient Risk Assessment

We stratified patients by risk using a model to predict likelihood of sustaining a postoperative complication. Patient comorbidity information was captured for conditions present on admission for the index hospitalization. Those in the highest quintile of risk for perioperative complications were labeled as “high risk” and those in the lowest quintile of risk were labeled as “low risk” for comparison. We then compared impact of patient preoperative risk of developing a postoperative complication on total expenditure payments in hospitals of varying quality levels.

Payment Data

We used Medicare payment data from the MEDPAR file to accurately reflect episode expenditures. Total episode payments included the index procedure with associated admission up to 30 days after discharge date. We included data from inpatient, outpatient, carrier, home health, skilled nursing facility, and long stay hospital. We then collapsed this payment data into four categories: index hospitalization, readmissions, physician services, and post-acute care services. Index hospitalization payments includes index admission and post-operative care during the initial hospital episode and readmission payments cover any additional inpatient admissions during the 30 days after index operation. Physician services payments include reimbursement for services provided by physicians or other health professions. Post-acute care

services payments include post-discharge rehabilitation services, post-discharge admission to skilled nursing facilities, and post-discharge admission to long stay hospitals.

Payments were price standardized to account for variation in Medicare reimbursement based on geography and care setting. Methods for price standardization were based on techniques described by the Dartmouth Institute [18, 19].

Statistical Analysis

Risk adjustment of complication rates was performed using a multivariable logistic regression model accounting for patient age, sex, race, comorbidities, [20, 21] and operation type to calculate a risk adjusted rate of complications for each hospital. Additionally, we included adjustments for minimally invasive techniques including laparoscopic colectomy and thoracoscopic lung resection. We also included year of operation in the regression model to account for any possible secular trends. Subsequently, we used hierarchical modeling techniques to "reliability adjust" outcomes by accounting for statistical noise [22]. Our final assignment of hospitals to quality quintiles was based on the resulting risk- and reliability-adjusted rates of serious complications.

Hospital and patient characteristics at high-quality and low-quality hospitals were compared using chi-square and Wilcoxon rank-sum tests. We compared both total Medicare payments as well as individual payment components including index hospitalization, readmissions, physician services, and post-acute care services for the entire surgical episode.

As in previous analyses [5, 10, 17, 23, 24], we used predicted total payment for each patient as the risk-adjusted payment using a linear mixed model that was controlled for patient age, gender, race and 29 Elixhauser comorbidities. We calculated the average risk-adjusted payment

for each hospital and then reported the average of these risk-adjusted hospital payments by quality quintiles. We also calculated average risk-adjusted payment by risk groups within each hospital to report payments by risk groups and hospital quality.

Results

We analyzed data on 87,369 patients undergoing colectomy at 3,576 hospitals, 66,470 patients undergoing lung resection at 1,904 hospitals, and 8,423 patients undergoing pancreatectomy at 747 hospitals (Table 1).

Hospital Characteristics

Hospitals were characterized according to their risk and reliability adjusted complication rates. For the three procedures analyzed, the lowest quality hospitals had complication rates that ranging between 1.5-2.2 times higher than those facilities in the highest quality quintile. As described above, we determined 30-day rates of mortality for each of the procedures at the high and low quality hospitals after their quality designation. For each procedure, the mortality rate was statistically significantly higher at the low quality institutions (Table 2).

High and low quality hospitals had several differences in their characteristics for each of the procedures evaluated. Low quality hospitals performing colectomy were more often teaching hospitals and larger than high quality hospitals, whereas low quality hospitals performing pancreatectomy were more often smaller with fewer operating rooms than high quality institutions. For lung resections, low quality hospitals were smaller in terms of bed size and number of operating rooms, but high quality hospitals were more often teaching institutions (Table 2).

Patient Characteristics

There was no significant difference in age for patients undergoing any of the three procedures evaluated, but there were differences in other demographics when comparing patients undergoing resections at highest and lowest quality hospitals (Table 3). The total number of patient comorbidities were not different for pancreatectomy and colectomy between high and low quality hospitals, but those undergoing lung resection at the low quality hospitals were more often multimorbid with two or more comorbidities (78% vs 74%, p<0.0001) (Table 3).

High versus Low Quality Hospital Expenditures

Procedures performed at low quality hospitals versus high quality hospitals resulted in 16%-30% higher total 30-day episode expenditures for all three procedures. For average risk patients undergoing colectomy, low quality hospitals generated substantially higher episode expenditures than high-quality, low complication hospitals ($24,406 vs $20,992, p <0.0001). Larger increases in total episode expenditures differences between low and high quality hospitals were found in patients undergoing lung resection ($27,638 vs $21,282, p <0.0001) and pancreatectomy ($45,731 vs $35,149, p <0.0001).

We found increases in rates of post-acute care services for patients undergoing colectomy and lung resection at low quality hospitals (68% vs 65% for colectomy, 68% vs 65% for lung resection), but similar rates between high and low quality hospitals after pancreatectomy. Regardless of rates of post-acute care services, low quality hospitals generated increased expenditures ($1,024 for colectomy, $1,643 for lung resection, $1,577 for pancreatectomy). Similarly, low quality hospitals had higher rates of readmission for each of the three procedures (colectomy: 13% versus 12%; lung resection: 13% versus 12%, pancreatectomy: 25% versus 22%). When patients were readmitted, they accrued similar excess expenditures for their

readmissions regardless of the quality of the hospital where their index procedure was performed (Table 4).

Increased utilization of post-acute care services and increased rates of readmissions contributed to the increased episode payments, but the dominant driver of excess expenditures at low quality hospitals was payment for the index hospitalization. We found that index hospitalization expenses generated 62-79% of the increase in expenditures across procedures for low versus high quality hospitals (Table 4). For example, a patient undergoing colectomy at a high quality hospital had an average index hospitalization payment of $14,141 whereas a similar patient at a low quality hospital generated an index hospitalization payment of $16,255, resulting in an excess of $2,114 per colectomy. More substantial increases were noted for patients undergoing lung resection ($4,154) and pancreatectomy ($8,378) at low quality hospitals.

Interaction of Hospital Quality and Patient Risk

Next, we sought to explore whether the impact of hospital quality on expenditures differed depending on patient risk. Low quality hospitals generated excess expenditures for all patient risk groups. For example, low risk patients undergoing colectomy at low quality hospitals generated $17,001 compared to $15,423 per 30-day episode at high quality institutions. Similarly, we found excess expenditures for low risk patients undergoing lung resection ($3,797) and pancreatectomy ($4,357) at low quality institutions.

Although all patient risk groups incurred higher expenditures at low quality hospitals, the impact on expenditures for high risk patients was particularly pronounced. For example, low risk patients undergoing pancreatectomy incurred 17% higher episode payments at low quality hospitals ($29,080 versus $24,723, p=<0.0001). High risk patients undergoing pancreatectomy incurred a 40% increases in total episode payments at low quality versus high quality hospitals

($62,687 versus $44,925, p=<0.0001). The episode payment increase for high risk patients receiving care at low vs high quality hospitals was significantly higher than low risk patients in similar comparisons (40% vs. 17%, p=<0.0001). Similar results were found for patients undergoing colectomy, with increased expenditures at low quality hospitals (10% increased expenditures for low risk patients, 18% increased expenditures for high risk patients, p=<0.0001) and lung resection (24% increased expenditures for low risk patients, 29% increased expenditures for high risk patients, p=<0.0001) (Table 5, Figure 1).

Discussion

Poor hospital surgical quality, as manifested by high complication rates, is directly related to excess costs of care. Previous studies have consistently shown that, for many surgical procedures [13, 14] and for cancer surgery in particular [9], the occurrence of postoperative complications drives expenditures in the inpatient setting and beyond. The notion that certain high risk patients may be both more prone to complications and experience a more difficult recovery once they occur has clinical face validity, but has not been explored in this context. In this analysis, we found that cancer resections performed at low quality hospitals generate substantial excess expenditures for all patients. However, excess expenditures were particularly pronounced when high risk patients underwent surgery at low quality hospitals. As health systems and policymakers attempt to identify targeted interventions aimed at managing the costs of healthcare, a focus on high risk patients receiving care at low-quality institutions may be warranted.

In spite of the fixed payment structure of the DRG model, we found that there is wide variation in payments for cancer surgery. Whether due to higher reimbursement for increased numbers patients meeting criteria for outlier payments due to longer hospital stays or postoperative

complications, this highlights large potential savings in the delivery surgical cancer care. As we describe, a substantial amount of this variation is attributable to preexisting cost differences between hospitals. For example, we found that high risk patients would disproportionately benefit from directed referral to high quality centers for oncologic resection. Previous work has suggested selective referral for uncommon procedures based on volume or quality rankings to improve outcomes and reduce costs of surgical care [25, 26]. This analysis highlights a particular high risk subset of the surgical population that would be most likely to benefit from referral with respect to cost for oncologic resection. Identifying this portion of the surgical population can provide a more realistic strategy for selective referral as suggesting referring all patients is not a practical strategy. This immediate solution may improve outcomes and healthcare spending for these highest risk patients, while ongoing quality improvement initiatives at low quality, higher cost hospitals could expand the network of high quality hospitals for all patients.

There are several limitations to this analysis. First, this analysis assessed patient risk using administrative data, which may incompletely capture some aspects of pre-operative risk such as performance status and frailty. Second, we adopted a payer's perspective on surgical expenditures by assessing actual Medicare reimbursements for care. Our analysis does not address other perspectives on health care cost, such as utilization and opportunity cost within a health system. We used 30-day episode payments, which may not fully represent the longer term care received after surgical resection. We focused on elderly Medicare beneficiaries undergoing three surgical resections for cancer diagnoses, and therefore our findings may not be generalizable to younger populations of patients, those undergoing other cancer resections not included in our analysis, and those with private insurance. Finally, we did not include cancer stage in our analysis or risk adjustment as this is not accurately reflected in the Medicare Provider Analysis and Review (MEDPAR) File from 2010-2013. As these patients all underwent

resection, they were likely diagnosed with localized disease. Prior work has demonstrated that adding cancer specific staging to outcomes assessments using claims data shows that there is not much benefit in measuring performance [27]. Although a similar analysis has not been done for surgical costs, we find it highly improbable that cost differences identified are due to differences in cancer stage.

Conclusions

In summary, we found that there is a significant interaction between hospital quality and preoperative patient risk that drives payments for cancer resections. The excess expenditures for procedures performed at low quality hospitals is exaggerated for high risk patients. This analysis demonstrates that those patients at highest risk for postoperative complications may stand to benefit most substantially from cost containment strategies including selective referral to high quality centers.

Figure Legend

Figure 1

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Table 1: Patient Characteristics

	Colectomy	Lung Resection	Pancreatectomy
Number of Pts, n	87,369	66,470	8,423
Age, years	77.4	74.3	74.4
Male, %	45.9	48.7	51.35
White, %	88.7	91.3	88.7
Comorbidities, %			
0-1	25.8	24.87	21.88
2	24.7	26.57	24.77
≥3	49.6	48.56	53.35
Laparoscopic/ Thoracoscopic Operation, %	40.0	46.6	N/A

Table 2: Hospital Characteristics (high/low quality)

	Colectomy				Lung Resection				Pancreatectomy			
	All Hospitals	High Quality Hospitals	Low Quality Hospitals	p-value	All Hospitals	High Quality Hospitals	Low Quality Hospitals	p-value	All Hospitals	High Quality Hospitals	Low Quality Hospitals	p-value
No. of Hospitals	3,576	716	715		1,904	381	380		747	150	149	
No. of Patients	87,369	25,070	25,913		66,470	25,962	12,797		8,423	3,873	1,662	
Bed Size												
<250	40.9	39.2	31.6	<.001	21.4	17.1	24.0	0.025	8.7	6.7	9.3	0.040
250-500	36.1	40.2	38.3		39.7	38.7	48.1		32.0	24.1	33.5	
>500	23.0	20.6	30.2		38.9	44.2	30.0		59.3	69.2	57.2	
Teaching Hospital %	54.7	54.3	64.2	<.001	92.6	76.7	60.8	0.002	90.7	94.2	91.4	0.128
Annual total inpatient surgical volume	5,446	5,146	6,748	<.0001	8,121	9,653	6,226	<.0001	11,914	11,492	13,736	0.0083
Annual total outpatient surgical volume	8,276	8,095	9,956	0.003	11,544	14,346	8,683	<.0001	15,640	12,690	18,642	0.0088
Annual total surgical volume	13,723	13,240	16,703	0.0002	19,666	23,999	14,908	<.0001	27,554	24,182	32,378	0.0052
Annual Average Procedure Specific Volume	15.7	17.0	17.0	0.915	33.2	49.4	17.6	<.0001	14.7	19.5	8.8	<.0001
Length of Stay (days)	7.2	6.4	8.1	<.0001	6.9	5.9	8.9	<.0001	12.8	11.0	16.2	<.0001
Risk-Reliability Adjusted Complication Rate, %	10.2	8.4	12.3	<.0001	8.9	6.3	13.8	<.0001	13.4	10.9	17.8	<.0001
Mortality Rate	4.0	3.8	4.2	<.0001	2.8	2.6	3.2	<.0001	3.8	3.6	4.2	<.0001

Table 3: Patient Characteristics at high vs low quality hospitals

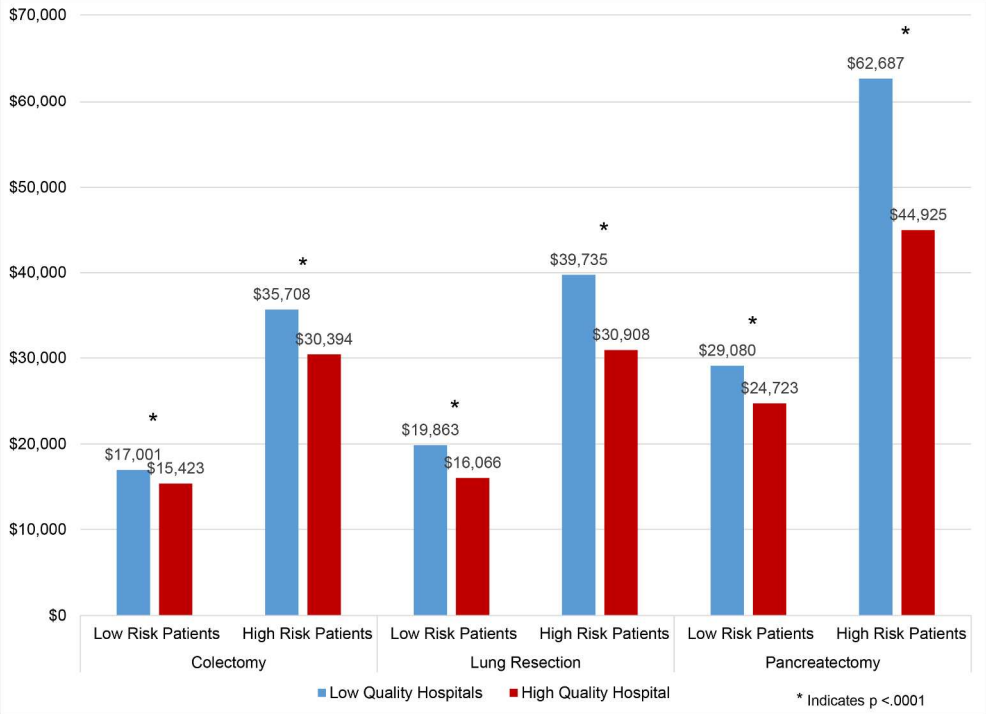
	Colectomy			Lung Resection			Pancreatectomy		
	High Quality Hospitals	Low Quality Hospitals	p-value	High Quality Hospitals	Low Quality Hospitals	p-value	High Quality Hospitals	Low Quality Hospitals	p-value
Number of Pts	26,070	25,913		25,962	12,962		3,873	1,662	
Age	77.3	77.4	0.004	74.4	74.2	0.001	74.2	74.6	0.025
Male, %	45.9	46.2	0.508	47.6	50.6	<.0001	51.9	51.1	0.578
White, %	89.6	87.6	<.0001	92.1	91.6	0.105	90.1	87.4	0.005
Comorbidities, %									
0-1	25.4	25.1	0.447	26.4	21.9	<.0001	21.7	21.3	0.730
2	24.1	25.1	0.007	27.3	25.2	<.0001	25.4	24.0	0.264
≥3	50.5	49.8	0.095	46.3	52.9	<.0001	52.9	54.8	0.212
Laparoscopic/ Thoracoscopic Approach	40.8	41.7	0.031	52.1	39.0	<.0001	N/A	N/A	N/A

Table 4: Payments for Procedures at High and Low Quality Hospitals

	Low Quality Hospitals	High Quality Hospitals	Difference in Payment	P-Value
Colectomy				
Total Episode	$24,406	$20,992	$3,414	<.0001
Index Hospitalization	$16,255	$14,141	$2,114	<.0001
Physician Services	$3,562	$3,135	$427	<.0001
Readmission (when present)	$10,171	$10,662	-$491	0.194
Post-Acute Care Services (when present)	$4,735	$3,711	$1,024	<.0001
Lung Resection				
Total Episode	$27,638	$21,282	$6,356	<.0001
Index Hospitalization	$18,961	$14,808	$4,154	<.0001
Physician Services	$4,708	$4,012	$696	<.0001
Readmission (when present)	$11,998	$10,516	$1,482	0.033
Post-Acute Care Services (when present)	$5,022	$3,378	$1,643	<.0001
Pancreatectomy				
Total Episode	$45,731	$35,149	$10,582	<.0001
Index Hospitalization	$31,049	$22,671	$8,378	<.0001
Physician Services	$7,140	$6,264	$877	0.001
Readmission (when present)	$11,290	$10,698	$592	0.570
Post-Acute Care Services (when present)	$6,313	$4,736	$1,577	0.001

Table 5: High and Low Risk Patients in High and Low Quality Hospitals

	Patient Risk	Low Quality Hospital	High Quality Hospital	Difference in Payment	P-Value
Colectomy	High Risk	$35,708	$30,394	$5,314	<.0001
	Low Risk	$17,001	$15,423	$1,578	<.0001
Lung Resection	High Risk	$39,735	$30,908	$8,827	<.0001
	Low Risk	$19,863	$16,066	$3,797	<.0001
Pancreatectomy	High Risk	$62,687	$44,925	$17,762	<.0001
	Low Risk	$29,080	$24,723	$4,357	<.0001



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