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Association of delivery system integration and outcomes for major cancer surgery

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Abstract

Background—Integrated delivery systems (IDS) are postulated to reduce spending and improve outcomes through successful coordination of care across multiple providers. Nonetheless, the actual impact of IDS on outcomes is largely unknown for complex multidisciplinary care such as major cancer surgery.

Methods—Using 2011–13 Medicare data, we identified patients who underwent surgical resection for prostate, bladder, esophageal, pancreatic, lung, liver, kidney, colorectal, or ovarian cancer. Rates of readmission, 30-day mortality, surgical complications, failure to rescue, and prolonged length of stay for cancer surgery were compared between patients receiving care at IDS versus non-IDS hospitals. Generalized estimating equations were used to adjust results by cancer type and patient and hospital-level characteristics, while accounting for clustering of patients within hospitals.

Results—We identified 380,053 patients who underwent major resection of cancer with 38% receiving care at an IDS. Outcomes for IDS did not differ from non-IDS hospitals in regards to readmission and surgical complication rates, while only minor differences were observed for 30-day mortality (3.5% vs 3.2% IDS, $p < 0.001$) and prolonged length of stay (9.9% vs 9.2% IDS, $p < 0.001$). However, after adjusting for patient and hospital characteristics, the frequencies of adverse perioperative outcomes were not significantly associated with IDS-status.

Conclusions—Our collective findings suggest that local delivery system integration alone does not necessarily impact perioperative outcomes in surgical oncology. Moving forward, stakeholders may need to focus on surgical and oncological-specific methods of care coordination and quality improvement initiatives to improve outcomes for patients undergoing cancer surgery.

Introduction

In recent years, there has been increased interest in health system integration as a means to improve quality and reduce costs associated with healthcare delivery^{1–3}. Healthcare integration has many definitions, but is generally based on financial (e.g., a single entity manages multiple facilities or provider groups) and/or functional connections (e.g., independent organizations with high levels of care coordination)⁴ across an organization. Translated into clinical practice, integration is achieved with the end goal of successful coordination of patient care across the entire continuum of specialists, primary care providers, and health centers and services⁵. While integrated delivery systems (IDS) vary widely in size and degree of integration, in general, these organizations have been associated with higher quality of care and outcomes for many conditions^{6–9}. There are several proposed explanations for these findings, including better care transition and handoffs to reduce complications and readmissions, reduction of duplicate tests and procedures, utilization of electronic medical records, and implementation of patient data and clinical guidelines within an integrated system¹⁰.

Nonetheless, the actual impact of health system integration on outcomes is largely unknown for major cancer surgery and other types of complex, multidisciplinary care. It is plausible that IDS will achieve better outcomes for these patients, as these procedures often require coordinated efforts between multiple providers during and after the surgical episode. For instance, integration within a local delivery system may allow cancer patients to benefit from the shared resources maintained by a coordinated network of multi-specialty providers¹¹. In addition, access to shared medical records and clinical data may improve care transitions and handoffs between providers that may lower rates of readmissions and prevent complications and patient mortality. On the other hand, providers in a highly integrated system may not necessarily alter their practices to accommodate better inter-professional communication and care coordination. In this scenario, patient outcomes may not vary between integrated and non-integrated delivery systems.

While previous investigators have found that integrated delivery systems have improved coordination of care for primary care and outpatient visits^{6,7,12–16}, the same effect has not been observed for surgical care or inpatient hospitalizations¹⁷. Herein, we build on this work by investigating the association between health system integration and outcomes for major cancer surgery. Specifically, we compared the rates of readmission, 30-day mortality, surgical complications, and prolonged length of stay between patients receiving care at hospitals affiliated with highly-integrated and non-integrated hospitals for cancer resection surgery. By virtue of this approach, our findings will allow policymakers and hospital administrators to achieve better insight on the effect of hospital and health system integration on the quality of surgical oncology care.

Methods

Datasets

We used three datasets, linked by hospital provider, for our analysis. First, we used the 2011–13 Medicare Provider Analysis and Review (MEDPAR) file to obtain our study

cohort, patient demographic and clinical characteristics, and the perioperative outcomes of interest. Second, we used the American Hospital Association Annual Survey to measure hospital characteristics. Finally, we identified hospital IDS-affiliation based on its listing among the top-100 integrated delivery systems ranked in *Becker's Hospital Review*, as described in previous work^{18–21}. *Becker's Hospital Review* identifies the top-100 IDS by utilizing strict selection criteria based on the financial, clinical, and operational strength of the health system, hospital and physician affiliations, and metrics from IMS Health™. IMS Health™ assesses degree of integration based on eight major domains: overall integration, integrated technology (e.g. electronic medical records) use, hospital utilization, financial stability, services provided, patient access, physicians, and contractual capabilities. For instance, among these top 100 systems is Kaiser Permanente, a network of 37 hospitals, 611 medical offices, and almost 17,000 physicians across nine states and the District of Columbia. Under the Kaiser Permanente system, integration of multiple aspects of patient care is accomplished through shared electronic medical records, implementation of multi-disciplinary care pathways, and shared financial risk among providers^{18,22–24}. Kaiser Permanente offers a variety of different group and individual plans, including coverage for patients eligible for Medicare Parts A and B²⁵.

Study population

Our study included all patients over 65 years of age who underwent major surgical resection for a single cancer diagnosis from 2011–13. Cancer diagnoses included malignancies of the prostate, bladder, esophagus, lung, liver, colon, pancreas, kidney, and ovary. We identified these patients using *International Classification of Diseases, Ninth Revision* (ICD-9) diagnosis and procedure codes from MEDPAR to confirm the cancer surgery of interest for each patient, as per previously described methods²⁶. We identified the hospital that provided surgical care from MEDPAR based on where claims pertaining to the cancer surgery originated. Patients were excluded if they did not have full enrollment data, complete claims, or Medicare Part A and B coverage. Also, we excluded patients who did not receive surgical resection for their cancers or underwent surgery for two or more malignancies less than 180 days apart. This study was deemed exempt from review by the Institutional Research Board at our institution.

Determining perioperative outcomes

Our outcomes of interest included rates of 30-day readmission and mortality, perioperative complications, and prolonged length of stay. Perioperative complications were defined using previously established methods and were identified based on whether specific claims were present for gastrointestinal, cardiac, renal, genitourinary, infectious, neurologic, wound, and technical complications occurring within 30 days of surgery^{26–28}. Prolonged length of stay was defined as a length of stay exceeding the 90th percentile length of hospitalization for each cancer-specific subgroup. We also investigated failure to rescue as a secondary outcome in our study. Failure to rescue, per previous studies, is defined as post-operative mortality after at least one complication^{29,30}.

Statistical analysis

We first performed a univariate analysis to investigate unadjusted associations between hospital IDS-affiliation and developing the perioperative outcomes of interest for all cancer surgery patients in our study cohort. Next, we stratified our analysis by individual cancer type to compare cancer-specific rates of each perioperative outcome for patients receiving care at IDS-affiliated versus non-IDS hospitals.

Following our stratified analysis, we performed a multivariable logistic regression using generalized estimating equations to compare our primary and secondary study outcomes with IDS-affiliation as the primary exposure variable, while adjusting for both patient and hospital-level characteristics and the effect of patient clustering within hospitals. Patient-level factors include age, sex, race, cancer surgery type, and comorbidities defined via the Elixhauser Comorbidity Index³¹. Hospital-level characteristics included geographic region, profit status, rural versus urban status, total annual volume of cancer surgeries, bed availability, and teaching status.

Sensitivity Analysis

Due to potential variations in the surgical volume-outcome relationship among cancer types, we calculated the Pearson's correlation coefficient between total hospital volume and hospital cancer-specific volumes.

All analyses were performed using SAS (Cary, NC) and STATA 14/SE (College Station, TX), and at the 5% statistical significance level.

Results

We identified a total of 380,053 Medicare beneficiaries who underwent major cancer resection from 2011 through 2013. Of these patients, 37.7% had surgery at a hospital affiliated with a top-100 IDS, representing 39.2% of all prostate, 35.9% bladder, 41.1% esophageal, 41.2% pancreatic, 37.3% lung, 42.5% liver, 36.9% kidney, 36.8% colorectal, and 41.6% ovarian cancer cases. In total, 92 out of the 100 IDS's listed in *Becker's Hospital Review* were represented in our cohort, and 31.0% (817 out of 2635) of the hospitals in our cohort were observed to be affiliated with an IDS.

Table 1 compares characteristics for patients treated at IDS versus non-IDS hospitals. While differences in patient age, race, cancer type, and comorbidities are significant for IDS and non-IDS hospitals, these differences are less than 1% in magnitude. No significant difference in gender distribution was observed between IDS and non-IDS hospitals. Table 2 compares the differences in hospital characteristics between IDS and non-IDS affiliated hospitals. Generally, IDS hospitals tend to be nonprofit and located in the Midwest (32.0%) and Southern (30.8%) regions. IDS hospitals were also observed to have higher surgical volumes (176 vs 130 annual cases, $p<0.001$) and greater number of hospital beds (262 vs 233 beds, $p=0.0013$) than do non-IDS hospitals.

We observed small differences in unadjusted, outcomes among patients treated at IDS versus non-IDS hospitals. Namely, 30-day mortality (3.5% vs 3.2% IDS, $p<0.001$) and prolonged

length of stay (9.9% vs 9.2% IDS, $p<0.001$) were less frequent at IDS hospitals compared with non-IDS hospitals (Table 3). No significant differences in readmission rate (12.4% vs 12.3% IDS, $p=0.33$) or perioperative complication rate (43.6% vs 43.3% IDS, $p=0.13$) were observed between non-IDS and IDS hospitals.

Cancer-stratified rates of adverse perioperative outcomes between integrated and non-integrated hospitals are shown in Figure 1. Generally, we noted minor differences in 30-day mortality, readmissions and prolonged length of stay between IDS and non-IDS hospitals for some cancers, including prostate, kidney, and colorectal. No significant differences in readmission rates between IDS and non-IDS hospitals were noted among any cancer strata. Additionally, no significant differences in readmissions, 30-day mortality, perioperative complications, and prolonged length of stay between IDS and non-IDS hospitals were shown for bladder, pancreas, liver, and ovarian cancer resection surgeries.

Results from our multivariate analyses are presented in Figure 2. After adjusting for patient and hospital-level characteristics, IDS affiliation was not associated with readmissions (OR 1.02, 95% CI 0.99 to 1.05), 30-day mortality (OR 0.99, 95% CI 0.94 to 1.05), perioperative complications (OR 1.03, 95% CI 0.99 to 1.06), or prolonged length of stay (OR 0.98, 95% CI 0.93 to 1.04), for patients undergoing major cancer surgery.

Secondary Outcomes

Unadjusted analysis initially showed lower rates of failure to rescue at IDS than at unaffiliated hospitals (7.8% vs. 7.1% IDS, $p<0.001$). However, after adjusting for hospital and patient-level risk factors, receiving care at an IDS hospital was not associated with failure to rescue (OR 0.97, 95% CI: 0.92 to 1.02).

Sensitivity Analysis

Overall, we observed evidence of consistency in surgical volume across procedures, as demonstrated by strong correlations ($r = 0.70$) between overall hospital volume and cancer-specific volumes.

Discussion

Outcomes for hospitals associated with highly integrated delivery systems did not differ from those for non-IDS hospitals in regards to readmission and surgical complication rates, while only minor differences were observed for 30-day mortality, failure to rescue, and prolonged length of stay. When we stratified outcomes by cancer type, our results demonstrated slightly improved outcomes at integrated delivery systems for certain cancers. However, after accounting for differences in the patient population and hospital characteristics, the frequencies of these adverse perioperative outcomes were not significantly associated with integration. Overall, our collective findings suggest that local delivery system integration does not necessarily impact perioperative outcomes in surgical oncology.

Our finding that hospital participation in a highly integrated health system does not independently affect perioperative outcomes for major cancer surgery is consistent with the

findings of previous investigations on the effect of integration on inpatient hospitalization and surgical outcomes^{17,19,26}. Using pre-2008 claims data, investigators reported no significant difference in operative mortality, postoperative complications, and readmissions for common, non-oncologic, inpatient surgical procedures between integrated and non-integrated hospitals—with the exception of a 0.8% difference in readmissions for colectomy patients¹⁹. For hospital-based care of patients with complex medical conditions, researchers found no difference in readmissions, mortality, and length of stay based on integration status for inpatient care of congestive heart failure¹⁷. In contrast, researchers have reported that specific delivery system characteristics, such as increased surgical volume, care transition coordination, and nationally-implemented quality improvement programs, can improve outcomes in the post-hospitalization period^{32–35}. However, these programs and policies are not unique to integrated delivery systems and may also be observed in many non-integrated, independent hospitals.

Our study has several limitations. First, we employed a definition of health system integration based on criteria set by *Becker's Hospital Review*. This methodology limits our study by excluding hospitals that are not listed in *Becker's* but do have similar systems and practices that are characteristic of IDS's, such as shared electronic medical records and communications between surgeon and primary care physician. However, *Becker's* has provided widely publicized analysis of hospital integration status, and there currently exists no other broadly validated and comprehensive measure of integration status. Second, we studied short-term perioperative outcomes. However, IDS's may be better positioned to improve long-term outcomes, care of chronic conditions, and other quality measures such as preoperative imaging and adjuvant or neoadjuvant therapy due to their focus on coordination among multiple providers^{21,36,37}. Nonetheless, reducing perioperative outcomes such as readmissions and mortality does require a degree of coordination and inter-professional communication that is a central tenant of health system integration^{38,39}. Thirdly, IDS-leakage may be a potential issue as patients, who receive routine care from a non-IDS provider, may enter and exit an IDS solely for their surgery. However, despite the possibility of IDS-leakage, our focus on the prevention of readmission, timely discharge, and recognition and management of post-operative complications are also dependent on successful care transition and coordination within the confines of an integrated hospital. Finally, because this analysis is based on MEDPAR claims, our findings may not be generalizable to patients with private insurance or those covered under Medicare Advantage. Nonetheless, Medicare Parts A and B currently provides coverage to one of the largest, most diverse patient populations in the United States, and results in this population carry wide implications for alternative models of reimbursement^{40,41}. Furthermore, older patients with more comorbidities may be more likely to benefit from care coordination and integration, so understanding its implications for this patient population has particular relevance.

Despite these limitations, our findings are relevant to multiple healthcare stakeholders that stand to benefit from improvements in complex inpatient care. For hospital administrators, we have shown that highly structured and extensive integration alone may not be sufficient to improve short-term surgical outcomes. While healthcare integration has established benefits for primary and ambulatory care, evidence of specialist and surgeon engagement in integrated systems is lacking. Recent studies suggest wide variation in the participation of

surgical specialists in accountable care organizations (ACOs)^{42,43} and poorly-defined roles for surgeons within these types of organizations⁴⁴. As such, improvements in the care of surgical patients may require additional quality improvement efforts tailored to the perioperative and inpatient settings. Our findings can also aid policymakers in their efforts to create programs and legislation to improve outcomes in a cost-efficient manner. In particular, healthcare reform over the past decade has seen widespread adoption of ACOs in order to encourage integration among health systems to improve patient outcomes.^{45,46} However, based on the currently available data, such programs in isolation alone may have a limited impact on cancer surgery outcomes^{26,47}.

Moving forward, additional research should focus on the effect of integration on long-term cancer outcomes, as well as surgical and oncological-specific methods of care coordination such as pathway implementation and care transition programs. Using these data, stakeholders can continue to enhance the delivery of healthcare to promote efficient spending and improve outcomes for patients who require complex cancer care.

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Synopsis

There is widespread interest in integrated delivery systems as a means to improve the quality of complex, multidisciplinary care such as major cancer surgery. Herein, we investigate the association between delivery system integration and perioperative outcomes for surgical oncology patients.

Figure 1. Rates of (a) Hospital Readmission, (b) Post-operative 30-day Mortality, (c) Perioperative Complications, and (d) Prolonged Length of Stay (LOS) Following Surgical Resection of Cancer by Hospital Affiliation Status with an Integrated Delivery System (IDS), 2011–2013 Medicare

Note: * indicates statistical significance at 5% level.

Figure 2. Odds Ratio of Adverse Perioperative Outcomes by Hospital Affiliation Status with an Integrated Delivery System (IDS), 2011–2013 Medicare

Outcomes include hospital readmission, 30-day mortality, perioperative complications, and prolonged length of stay (LOS) after surgical resection of solid organ cancer. Model adjusted by patient and hospital-level factors and accounts for clustering of patients within hospitals. Error bars represent the 95% confidence intervals.

Table 1

Patient Level Characteristics of Study Population, 2011–2013 Medicare.

Variable	Non-Integrated Delivery System (n= 236,644)	Integrated Delivery System (n = 143,409)	P-value
Age (years)	74.5	74.4	<0.001 ^a
% Female	41.9	42.0	0.373 ^b
Race			<0.001 ^b
% White	86.3	86.7	
% Black	8.3	7.9	
% Other Race	5.3	5.4	
Cancer Type			<0.001 ^b
Prostate (%)	39,538 (16.7)	25,472 (17.8)	
Bladder (%)	10,376 (4.4)	5,821 (4.1)	
Esophagus (%)	2,546 (1.1)	1,774 (1.2)	
Pancreas (%)	6,878 (2.9)	4,828 (3.4)	
Lung (%)	42,290 (17.9)	25,200 (17.6)	
Liver (%)	2,307 (1.0)	1,708 (1.2)	
Kidney (%)	29,371 (12.4)	17,157 (12.0)	
Colorectal (%)	93,285 (39.4)	54,294 (37.9)	
Ovarian (%)	10,053 (4.2)	7,155 (5.0)	

^aStudent T-test^bChi-Square Test

Table 2

Hospital Level Characteristics, 2011–2013 Medicare.

Characteristics	Non-Integrated Delivery System (n= 1,818)	Integrated Delivery System (n = 817)	P-value
% Teaching	33.0	37.8	0.016 ^a
% Rural	29.9	21.5	<0.001 ^a
Region			<0.001 ^a
% Northeast	19.2	12.8	
% Midwest	23.2	32.0	
% South	49.3	30.8	
% West	17.3	23.4	
Ownership			<0.001 ^a
% Public	17.0	4.6	
% Non-Profit	59.8	91.3	
% For Profit	23.2	4.0	
Mean Hospital Beds	233	262	0.0013 ^b
Mean Surgical Volume	130	176	<0.001 ^b

^aChi-Square Test^bStudent T-test

Table 3

Unadjusted Perioperative Outcomes between Integrated and Non-integrated Delivery Systems, 2011–2013 Medicare.

Perioperative Outcome	Non-Integrated Delivery System (n= 236,644)	Integrated Delivery System (n = 143,409)	P-value ^a
% Readmission	12.4	12.3	0.33
% 30-day mortality	3.5	3.2	<0.001
% Complications	43.6	43.3	0.13
% Prolonged Length of Stay	9.9	9.2	<0.001

^aChi-Square Test