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Assessing whether cancer stage is needed to evaluate measures of hospital surgical performance

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Abstract

Rational, aims and objectives: While public reports of hospital-level surgical quality measures are becoming increasingly common in healthcare, a comprehensive national assessment of surgical quality across multiple cancer sites has yet to be developed. Fee-for-service (FFS) Medicare claims present a potential resource from which to measure outcomes following cancer surgery given the national scope of patients and providers. However, due to the administrative nature of the data, clinical cancer information such as stage is not recorded. Leveraging the Surveillance, Epidemiology, and End Results (SEER) registry linked to FFS Medicare claims to analyze outcomes for patients whom we ultimately know stage information, we determined whether Medicare claims are suitable for measuring provider quality following cancer surgery by assessing the extent to which the lack of stage information modifies assessments of provider performance.

Methods: We identified patients aged 66 and older undergoing cancer surgery between 2011 and 2013 from SEER-Medicare. We compared the changes in the risk-standardized rates (RSR), decile rankings, and c-statistics with and without risk-adjustment for cancer stage for three measures of hospital performance: 30-day mortality, surgical complications and unplanned readmissions.

Results: The RSR changed by at most 11.4% for mortality, and by less than 4% for complications and readmissions, indicating that measures of hospital performance were stable with and without adjustment for stage. The relative performance of hospitals was also stable, as

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demonstrated by fewer than 20% of hospitals changing decile rank. The c-statistic declined by <2% across all measures, indicating that model fit was not substantially worsened without this information.

Conclusion: These findings support the use of FFS Medicare claims for hospital-level analyses of short-term outcomes following cancer surgery. Quality reporting based on these analyses can be used to help patients choose among hospitals and for evaluating policies to improve surgical cancer care.

Keywords

quality measurement; hospital performance; Medicare claims; cancer stage

INTRODUCTION

With upwards of 80% of cancer patients undergoing surgery and demonstrated variability in outcomes across providers, there is an opportunity to rigorously evaluate hospital performance for benchmarking against quality targets. This information can be used to inform patients' decisions regarding where to pursue care, support quality improvement efforts, and evaluate the impact of policy and large-scale quality improvements on outcomes.^{1,2} Quality measures for cancer care thus far have been primarily focused on process measures or on outcome measures for select cancer sites (commonly breast and colorectal), and a comprehensive national assessment of surgical quality across multiple cancer sites has yet to be developed.³⁻⁵

Identification of a suitable data source is an important first step in reducing the gap in quality reporting for cancer surgery. While Medicare claims have been used for several existing assessments of provider performance across other domains due to its national scope of patients and providers,⁵⁻⁷ using these data to assess the quality of surgical cancer care poses several unique challenges due to the lack of clinical cancer information recorded on administrative claims. Namely, the absence of information on disease severity challenges the adequacy of risk adjustment. It is possible that providers treating more advanced disease have worse outcomes due to their patient population as opposed to due to poor performance, and the extent to which provider-level measures are impacted by the absence of information on cancer stage is largely unknown.

We set out to assess whether hospital-level quality measures are affected by cancer stage information and leveraged the Surveillance, Epidemiology, and End Results (SEER)-Medicare linked resource to compare assessments of hospital performance at the hospital level with and without risk-adjustment for cancer stage. Although SEER-Medicare contains clinical cancer information, it is a limited resource for profiling as it only includes approximately 28% of the US population and a subset of hospitals nationally (opposed to 100% of Medicare beneficiaries if national FFS Medicare claims data are utilized).⁸ If hospital quality measures are not meaningfully altered in the absence of information on cancer stage then this provides support for Medicare claims as a suitable data source for publicly reporting outcomes to cancer patients undergoing surgery on a national scale.

METHODS

Data source

We utilized the Surveillance, Epidemiology, and End Results (SEER) registry linked to FFS Medicare claims to examine whether Medicare data are suitable for profiling the quality of hospitals' surgical cancer care. The SEER registry includes clinical information regarding the patient's cancer diagnoses as well as demographic and insurance coverage data and is linked to Medicare claims.^{8,12-14} By analyzing patients for whom we ultimately know stage information, we can compare estimates of hospital quality measures with and without information on cancer stage.

Hospital characteristics are obtained from the Healthcare Cost Report (2012) as reported in the National Cancer Institute (NCI) hospital file provided by SEER.

Surgical cohort

We identified cancer-directed surgeries occurring between January 1, 2011 and November 30, 2013. Twelve cancer sites were included and analyzed in aggregate: bones and joints, breast, colorectal, gastroesophageal, kidney, liver, lung, ovary, other gynecologic, pancreas, prostate, and sarcoma. Cancer sites in which at least 80% of surgeries could be identified in Medicare claims with fewer than 3% of surgeries to noncancer patients erroneously selected were included based on a prior validation study.¹¹ Surgeries on patients with unknown stage information or who were discharged against medical advice were excluded.

Quality measures

We evaluated whether including cancer stage in the model changed the assessment of hospital performance for three short-term surgical quality measures: (1) Mortality within 30 days of surgery. (2) Major surgical complications defined as any of pulmonary failure, pneumonia, myocardial infarction, deep venous thrombosis/pulmonary embolism, acute renal failure, hemorrhage, surgical site infection, gastrointestinal bleeding, acute liver failure or death during the surgical stay through 30 days after discharge. (3) Unplanned readmissions within 30 days of discharge from the surgical stay defined by the presence of an emergent or urgent admission type in the absence of an indication of chemotherapy, radiation therapy, transplant or rehabilitation. Surgeries resulting in death within 30 days of discharge were excluded from analyses of the unplanned readmissions measure.

Statistical analyses

For each quality measure, we implemented the following process to assess the impact of risk-adjustment for cancer stage: (1) Fit a hierarchical logistic regression model with surgeries at the same hospital clustered using a random intercept. This model was adjusted for primary cancer site, age, sex, race, Charlson comorbidity score in the year prior to surgery and American Joint Committee on Cancer (AJCC) stage (6th edition) at diagnosis and represents a measurement of hospital quality accounting for disease severity. (2) Fit the same model using only information available on Medicare claims. This model was identical to the first but does not include risk adjustment for cancer stage and represents the measurement of hospital quality in the absence of clinical cancer information. (3) Quantify

deviations in measures of hospital quality as measured by the risk-standardized rates (RSR) and in model fit as measured by the c-statistic between models (1) and (2).

The RSR is calculated by dividing the predicted value by the expected value for each hospital and multiplying by the average event rate ($\bar{y}$). A RSR greater than $\bar{y}$ indicates that the measure of performance at a given hospital is higher than expected; a RSR lower than $\bar{y}$ indicates that the performance is lower than expected.¹⁵ We computed the change in the risk-standardized rates (RSR) on absolute and percentage scales. The change in the c-statistic is also reported to assess whether additionally risk adjusting for cancer stage modifies the fit of the model; a decreased c-statistic indicates worsened model fit.

To assess the effect of stage information on the ranking of hospitals, we grouped hospitals based on the RSR and examined the consistency between the ranking based on the models with and without stage. We grouped hospitals into deciles and examined the number of hospitals that changed decile ranking after adjusting for stage.

To determine whether certain types of hospitals were more likely to be affected by lack of information on cancer stage, we applied a linear regression to each quality measure to determine whether the percentage change in RSR was associated with any of the following hospital characteristics: hospital ownership (non-profit, proprietary, government), teaching status, NCI center (clinical or comprehensive cancer center, no NCI designation), referral center classification, number of beds (tertiles) and surgical volume (tertiles). Hospitals missing information on these characteristics were excluded from this analysis (N=76; 5.3%).

This work was conducted under a data use agreement with the National Cancer Institute and was deemed exempt by the Institutional Review Board at Memorial Sloan Kettering Cancer Center due to the de-identified nature of the data. All analyses were performed in SAS v9.4 (Cary, NC).

RESULTS

There were 81,530 cancer-directed surgeries identified to 80,997 patients at 1,434 short-stay hospitals. The most common cancer sites were breast (35.2%) and colorectal (24.8%); sarcoma (0.4%) and bones and joints (0.1%) were the least common. Most patients were female (66.1%) and white (85.2%); 42.3% of surgeries were diagnosed with stage I disease (Table 1). Among these surgeries, 2.4% resulted in a death and 18.0% were followed by a surgical complication within 30 days. Of the 79,970 surgeries to patients discharged alive and without a planned readmission, 7.0% were followed by an unplanned readmission.

The median (interquartile range; IQR) RSRs for 30-day mortality was 2.35 (IQR 2.29, 2.37) and 2.35 (IQR 2.29, 2.36), with and without adjusting for stage, respectively. Not adjusting for stage did not change to the median RSR on an absolute scale (range -0.20, 0.52), and resulted in a percent change between -6.78% and 11.39%. The c-statistic decreased from 0.86 (95% confidence interval (CI) 0.85, 0.86) to 0.84 (95% CI 0.83, 0.85), corresponding to a 1.8% decrease, indicating slightly worsened model fit in the absence of stage.

Figure 1 shows the change in hospitals' continuous and decile ranking after adjusting for stage. The diameter of the bubble corresponds to surgical volume at a given hospital. The gradient indicates the number of deciles that the hospital moved: light orange indicates a consistent decile ranking across analyses, whereas red indicates a change of greater than four deciles. When considering a decile rank based on the RSR for mortality, 1,143 (79.7%) hospitals did not change in decile rank after removing risk-adjustment for stage. There were 132 hospitals (9.2%) whose ranking increased one decile, and 128 (8.9%) hospitals that decreased one decile.

The median RSR for complications was 17.95 (IQR 17.47, 18.71) adjusted for stage and 17.95 (IQR 17.43, 18.73) after not adjusting for stage. This corresponds to an absolute change between -0.45 and 0.68 , and a percent change between -2.29% and 3.30% . Not adjusting for stage decreased the c-statistic by -0.39% from 0.81 (95% CI $0.80, 0.81$) to 0.80 (95% CI $0.80, 0.81$).

The median RSR for unplanned readmissions was 7.02 (IQR $6.96, 7.16$) adjusting for stage and 7.02 (IQR $6.95, 7.16$) after removing adjustment for stage. On an absolute scale, this change is between -0.08 and 0.15 , corresponding to a -1.09% decrease to a 1.80% increase. Not adjusting for stage did not modify the c-statistic for readmissions: 0.71 (95% CI $0.71, 0.72$) with stage and 0.71 (95% CI $0.70, 0.71$) without stage. Among decile rankings for readmissions, 88.4% of hospitals did not change rank, and 11.0% changed by one decile in either direction (Table 2; Figure 1).

There were no statistically significant associations between hospital characteristics and the percent change in the RSR for mortality, surgical complications, or unplanned readmissions (results not shown).

DISCUSSION

In this study, we demonstrated that the absence of risk-adjustment for cancer stage at diagnosis did not meaningfully change absolute or relative measures of hospital performance, as assessed by the risk-standardized rate, decile ranking relative to other hospitals, and the predictive ability of the adjusted model. Changes in the measure of hospital performance were most extreme, though still not substantial, for 30-day mortality, where the RSR changed by at most 11.4% . Few hospitals changed decile ranking, and most hospitals that did change ranking only shifted one decile, demonstrating that relative measures of performance are consistent regardless of information on stage. The c-statistic decreased by at most 1.8% across the three outcomes, indicating that the absence of stage does not substantially diminish the fit of the model.

The Institute of Medicine (IOM) has called for improving the delivery of cancer care through the development and reporting of quality measures.^{16,17} Prior analyses have demonstrated that adjustment for cancer stage is not necessary for analyzing hospital-level long-term (three and five year) survival for the treatment of patients with lung, prostate, breast and colon cancer.¹⁸ We built upon this prior work by examining short-term surgical outcomes for additional cancer sites. Here we provide further evidence that despite the

absence of information on cancer stage, FFS Medicare claims are a suitable resource for responding to the IOM's call to measure quality at the hospital level to improve the delivery of cancer care. These results are consistent with previous work indicating that additional risk adjustment of cancer-specific variables does not substantially improve model fit or quality rankings for short-term outcomes following colorectal cancer surgery.^{19,20}

In conjunction with previous work by this group,¹¹ this study provides further support for the use of FFS Medicare claims to assess provider performance, moving towards the creation of a comprehensive resource reporting on hospital quality for patients with any of the cancers examined. There are several reasons such a measurement and reporting system could be of value. Quality reporting can help patients select providers based on their quality, provide feedback to those providers that will spur them to improve, and aid in the evaluation of policy changes and other interventions on the quality of surgical cancer care.

Limitations

This analysis was completed using cancer registry data linked to FFS Medicare claims and is subject to several limitations. Though this data source represents a subset of patients with cancer in the United States, prior studies have shown SEER-Medicare to be representative.⁸ Cancer stage recorded in SEER is the cancer stage at diagnosis, and it is possible that the patient's stage at time of surgery is more advanced. However, in prior validation studies, we have shown that a large majority (>80%) of the cancer-directed surgeries identified occurred within six months of diagnosis.¹¹

Though additional outcomes would have to be assessed in a similar manner, the minimal impact of adjusting for cancer stage at diagnosis on mortality, readmissions and complications indicates that the effect is likely negligible for other short-term surgical outcome measures as well. Future work may examine the validity of these conclusions for other quality measures related to cancer care.

CONCLUSIONS

Measurements of hospital quality indicators of mortality, unplanned readmissions and major complications among patients undergoing cancer-directed surgery are not meaningfully altered in the absence of information regarding cancer stage. These results support the use of FFS Medicare claims for hospital-level analyses of short-term outcomes following surgical treatment of cancer patients.

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Figure 1. Hospital ranking based on 30-day mortality (left), major surgical complications (middle) and unplanned readmissions (right)

This figure shows the decile ranking of a hospital with and without adjustment for cancer stage. The diameter of the bubble corresponds to surgical volume at a given hospital. The gradient indicates the number of deciles that the hospital moved: light orange indicates a consistent decile ranking across analyses, whereas red indicates a change of greater than four deciles.

Table 1.

Characteristics of patients with cancer-directed surgeries, 2011–2013 (N=81,530)

Characteristics	N (%)
<i>Cancer site</i>	
Bones and Joints	43 (0.1)
Breast	28,716 (35.2)
Colorectal	20,252 (24.8)
Gastroesophageal	2,198 (2.7)
Kidney	5,689 (7.0)
Liver	485 (0.6)
Lung	8,494 (10.4)
Ovary	1,741 (2.1)
Other gynecologic	4,507 (5.5)
Pancreas	1,553 (1.9)
Prostate	7,512 (9.2)
Sarcoma	340 (0.4)
<i>Year of surgery</i>	
2011	28,435 (34.9)
2012	27,121 (33.3)
2013 *	25,974 (31.9)
<i>Age at surgery (years)</i>	
65–69	19,458 (23.9)
70–74	22,444 (27.5)
75–79	17,500 (21.5)
80–84	12,571 (15.4)
85+	9,557 (11.7)
<i>Sex</i>	
Female	53,877 (66.1)
Male	27,653 (33.9)
<i>Race</i>	
White	69,476 (85.2)
Black	6,079 (7.5)
Other	5,975 (7.3)
<i>Charlson comorbidity (year prior to surgery)</i>	
0	38,831 (47.6)
1	21,151 (25.9)
2+	21,548 (26.4)
<i>AJCC Stage (6th ed.)</i>	
Stage I	34,472 (42.3)
Stage II	25,801 (31.6)
Stage III	15,814 (19.4)
Stage IV	5,443 (6.7)

* 2013 only includes surgeries discharged through November 30, 2013 to ensure 30 days of follow-up for outcome measurement.

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Table 2.

Change in the risk-standardized rate and c-statistic after adjusting for stage

30-day mortality			
	<i>Median (IQR) RSR</i>	<i>Range RSR</i>	<i>C-statistic (95% CI)</i>
With stage	2.35 (2.29, 2.37)	0.96, 4.87	0.86 (0.85, 0.86)
Without stage	2.35 (2.29, 2.36)	0.94, 5.39	0.84 (0.83, 0.85)
Absolute change	0.00 (−0.01, 0.01)	−0.20, 0.52	−0.02
% change	−0.01 (−0.43, 0.37)	−6.78, 11.39	−1.8%
Major surgical complications			
	<i>Median (IQR) RSR</i>	<i>Range RSR</i>	<i>C-statistic (95% CI)</i>
With stage	17.95 (17.47, 18.71)	9.47, 29.17	0.81 (0.80, 0.81)
Without stage	17.95 (17.43, 18.73)	9.40, 29.64	0.80 (0.80, 0.81)
Absolute change	0.00 (−0.04, 0.04)	−0.45, 0.68	0.00
% change	−0.02 (−0.25, 0.22)	−2.29, 3.30	−0.39%
Unplanned readmissions[*]			
	<i>Median (IQR) RSR</i>	<i>Range RSR</i>	<i>C-statistic (95% CI)</i>
With stage	7.02 (6.96, 7.16)	5.47, 9.52	0.71 (0.71, 0.72)
Without stage	7.02 (6.95, 7.16)	5.46, 9.60	0.71 (0.70, 0.71)
Absolute change	0.00 (0.00, 0.01)	−0.08, 0.15	0.00
% change	−0.01 (−0.07, 0.08)	−1.09, 1.80	−0.69%

* The unplanned readmissions measure excludes patients who died prior to discharge or were discharged with a planned readmission and were therefore ineligible to have an unplanned readmission.