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Risk-adjusted regional outcomes in elective medicare colorectal surgery

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ABSTRACT

Background: Regional differences in utilization of services in healthcare are commonly understood, but risk-adjusted evaluation of outcomes has not been done.
Methods: Risk-adjusted adverse outcomes (AOs) for elective Medicare colorectal resections were studied for 2012–2014. Risk-adjusted metrics were inpatient deaths, prolonged postoperative length-of-stay, 90-day post-discharge deaths, and 90-day relevant post-discharge readmissions. The nine Census Bureau regions of the U.S. were evaluated by using standard deviations of predicted adverse outcomes to evaluate observed versus expected events.
Results: Overall AO rate was 24.3% from 86,624 patients in 1497 hospitals. Region 9 (Pacific) had the best outcomes (z-score = −3.06; risk-adjusted AO rate = 22.9%) and Region 1 (New England) the poorest (z-score = +1.86; risk-adjusted AO rate = 25.4%).
Conclusions: A 4.9 SD difference exists among the best and poorest performing regions in risk-adjusted colorectal surgery outcomes. Alternative Payment Models should consider regional benchmarks as a variable for the evaluation of quality and pricing of episodes of care.
Table of contents brief abstract: Risk-adjusted Medicare outcomes of colorectal resections were evaluated by Census Regions of the U.S. Statistical differences in outcome rates indicate that national benchmarks should be considered for the evaluation of quality and pricing of episodes of care.
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Objective measures of outcomes of surgical care are used for many purposes. Public reporting of outcomes is considered important to inform consumer decisions about choosing providers for care. Objective and risk-adjusted outcomes are used by hospitals and surgeons to benchmark their performance against other facilities, and to use these measurements for monitoring improvement strategies over time. Knowledge of outcomes and costs of specific episodes are particularly important, since alternative payment models with prospective budgets will be implemented based upon effective and efficient prior patterns of care.

In previous publications of colon surgery,[1] and other major operations,[2,3] we have demonstrated that risk-adjusted outcomes are highly variable among the hospitals providing care for Medicare patients. Since Medicare has decided to use the Census Regions of the U.S. to design target payment budgets for the bundled payment program (e.g., total joint replacement surgery),[4] it is reasonable to ask whether the outcome performances by regions are comparable. Differences in adverse outcome (AO) rates by region will translate into differences in target pricing for comparable services when historical spending patterns (and complication rates) are used for pricing. Wage-price adjustments by region for Medicare payments are generally accepted, but regional differences in outcomes could influence differences in payments. To evaluate outcome differences among the Census Regions of the U.S., we examined the risk-adjusted outcomes of hospitals within each region that met specific minimum volume criteria.

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1. Methods

To evaluate risk-adjusted outcomes in elective colorectal resections, we used the 2012–2014 Medicare Limited Dataset to develop prediction models for inpatient deaths (IpD), prolonged post-operative length-of-stay outliers (prLOS), 90-day post-discharge deaths without readmission (PD90), and 90-day post-discharge readmissions (RA90) after non-associated readmission events were removed. Patients were identified with International Classification of Diseases 9th Revision-Clinical Modification (ICD-9) procedure codes of 17.31–17.39, 45.72–45.79, 48.50–48.59, 48.62, and 48.63. The procedure codes were required to have a principal ICD-9 diagnosis code of 153.0–153.9, 154.0–154.8, 211.4, 211.4, 230.3, 230.4, or 562.1–562.13. Cases were excluded if admissions were from the emergency department, age <65 years, operations were not performed on day 0, 1, or 2 of hospitalization, data elements were incomplete, or discharge was against medical advice. Cases meeting these criteria were placed into a Master Dataset for subsequent model development and hospital performance evaluation.

1.1. Risk adjustment models

Only hospitals meeting quality coding criteria using screens that we have previously developed were used in model development.[5] Stepwise logistic models were used to predict IpD, prLOS, PD90, and RA90 events after methods previously reported for colorectal resections and other surgical conditions.[1] The IpD model was developed with inpatient deaths as the dependent variable. The prLOS model was designed from live discharges among patients that had lengths-of-stay that exceeded the upper control limit in a moving-range control chart for each hospital's cases.[6] PD90 prediction models were designed from live discharges that did not have a readmission in the 90-day post-discharge period. RA90 prediction models were designed from all live discharges without PD90 events after readmissions unrelated to the index operation and hospitalization were removed. Exclusion criteria were modestly expanded from our previous exclusions, and were those that Medicare used in the Bundled Payment for Care Improvement (BPCI) project with a selected small number of additions that were added.[7] The Medicare-Severity, Diagnosis-Related Groups (MS-DRGs) of readmissions were identified. Final models were developed from over 500 risk factors fashioned from ICD-9 diagnosis codes, and specific procedure codes for colon surgery patients were added as additional variables.

Dummy variables were employed to remove hospital effects upon final models. Final models had only variables with $p \leq 0.01$. Schwarz criterion was used to avoid over-fitting final models.[8] The discrimination of final models was evaluated by c-statistics. SAS software (Version 9.4, SAS Institute, Cary, North Carolina) was used in statistical analyses.

1.2. Hospital outcomes

All hospitals with a minimum of 20 evaluable colorectal resection cases from the master dataset regardless of coding quality were identified for comparative outcomes. This minimum number of 20 cases has been our requirement for optimum control chart evaluation of prLOS. The IpD, prLOS, PD90, and RA90 prediction models were used to identify AOs for each hospital. For hospital analysis, the total number of patients with one or more AO event was tabulated. The total predicted AOs were then set equal to the number of observed events for each hospital by multiplication of the hospital-specific predicted value by the ratio of observed-to-predicted events for the entire final hospital population of patients.

A hospital-specific standard deviation (SD) of the predicted AOs was then determined by the formula $\sqrt{N{*}p{*}(1-p)}$, where p = probability of an AO that is specific for each hospital's risk profile of patients. and N = the total cases for each hospital. Division of the difference between observed and predicted AOs that is divided by the SD yields the z-score, which is the number of SDs that a facility is better (negative z-score) or poorer (positive z-score) than the population of all hospitals. The hospital-specific AO rate was then calculated by multiplication of the AO rate of the whole population of patients from all the hospitals with appropriate numbers of qualifying patients by the ratio of observed:predicted adverse events in each hospital.

1.3. Regional outcome comparisons

Hospitals were then sorted by the nine Census Bureau regions: Region 1 (New England); Region 2 (Middle Atlantic); Region 3 (South Atlantic); Region 4 (East South Central); Region 5 (West South Central); Region 6 (East North Central]); Region 7 (West North Central); Region 8 (Mountain); and Region 9 (Pacific). The East North Central Region consists of Illinois, Indiana, Michigan, Ohio, and Wisconsin as the core States of the Midwest Surgical Association. Within each region total patients, total observed AOs, and total predicted AOs were derived from the prediction models. Region-specific SDs were computed and overall region z-scores and risk-adjusted AO rates were calculated for comparison.

2. Results

There were 93,852 patients from 2010 hospitals in the Master Dataset for colorectal surgery. A total of 1555 hospitals with 78,639 patients met quality coding criteria for use in model development. A total of 21 risk factors were significant for IpD with a final c-statistic without hospital variables of 0.802. There were 40 significant risk factors for prLOS with a c-statistic of 0.682 after removal of hospital variables. A total of 16 significant risk factors were identified at the time of admission for PD90 with a c-statistic without hospitals of 0.823. PrLOS from the index hospitalization itself was an additional significant risk factor with an odds ratio (OR) of 1.32. There were 29 significant admission risk factors for RA90 with a c-statistic of 0.662. The OR for the additional inpatient risk factor of prLOS for readmissions was 1.91.

A total of 15,767 (16.8%) first readmissions were observed in the master dataset, and the MS-DRGs of these readmissions are defined in Table 1. Second or additional readmissions occurred 4672 times (22.9% of all readmissions). These additional readmissions occurred 1186 times from day 1–30, 1725 times from days 31–60, and 1761 times from days 61–90.

There was a total of 1497 hospitals with 86,624 patients for the comparative analysis of hospital with 20 or more qualifying cases. Hospitals averaged 57.9 cases with a median of 43 for the study period. Among the AOs, there were 947 IpD (1.1%), 7268 prLOS (8.4%), 762 PD90 (0.9%), and 14,552 RA90 (16.8%) patients. An additional 1130 patients died during or following readmission within the 90-day post-discharge period for total postoperative deaths including inpatient and 90-days following discharge of 2839 (3.3%). Total patients with one or more AO were 21,064 (24.3%).

There were 49 hospitals (3.3%) that had z-scores of (−) 2.0 or less. These best performing hospitals had a median z-score of (−) 2.24 and a median risk-adjusted AO rate of 10.8%. A total of 159 hospitals (10.6%) had z-scores that > (−) 2.0 but were ≤ (−) 1.0. These hospitals had a median risk-adjusted AO rate of 15.1%. There were 66 hospitals (4.4%) with z-scores greater than +2.0. These suboptimal performing hospitals had a z-score of +2.39 and a median risk-adjusted AO rate of 38.8%. A total of 209 hospitals

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