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Differences in Hospital Performance for Non-Cancer versus Cancer Colorectal Surgery

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Abstract

BACKGROUND—Considerable hospital-to-hospital variations in surgical outcomes have been reported across surgical procedures. However, it is unclear whether hospital quality rankings are consistent for non-cancer and cancer operations. We investigate the differences in hospital performance for non-cancer and cancer colorectal resections at 52 hospitals participating in the Michigan Surgical Quality Collaborative (MSQC).

STUDY DESIGN—Patients undergoing colorectal resections between 2008–2012 were identified. Hierarchical risk-adjusted models were used to evaluate hospital level 30-day morbidity, major morbidity, extended length-of-stay (LOS>75th percentile), and mortality outcomes. Hospital performance, as ranked by observed-to-expected ratios, was compared by rank-order changes, interquartile ranges (IQR) and Spearman's correlations.

RESULTS—Of the 19,990 colorectal resections, 7,292 (36.5%) were for cancer. We observed wide variations in all risk-adjusted 30-day outcomes between hospitals, but only weak correlations in cancer and non-cancer performance within hospitals. Overall hospital performance in mortality following non-cancer and cancer operations was not correlated (Spearman's rho:0.02). Of the best performing hospitals in mortality following non-cancer resections, 69% were reclassified to a worse quartile for cancer operations (median rank-change of 12.5 ranks [IQR 5–27]). Similarly, hospital performance in morbidity was only moderately correlated (rho: 0.59; p<0.001). Of the hospitals with lowest morbidity rates for non-cancer resections, 31% were reclassified. We noted a similar lack of relationship in major morbidity and extended LOS.

CONCLUSIONS—A hospital's performance ranking in risk-adjusted outcomes after non-cancer colorectal resections does not correlate to its performance for cancer-related colorectal resections. Indication for operation should be considered when leveraging risk-adjusted hospital outcomes for quality improvement efforts.

INTRODUCTION

Multiple reports have consistently demonstrated wide variation in outcomes after surgical procedures across hospitals and measuring quality using risk-adjusted outcomes has become

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widespread practice. However, the vast majority of these data are reported at the procedural level and do not uniquely distinguish between differing indications for the procedures themselves. (1–5) This makes it difficult to fully understand outcomes after colorectal resections, which are commonly performed operations at all types of hospitals and done for a wide range of indications.

Although colorectal procedures are thought of as technically similar, non-cancer and cancer patients represent distinct populations with varying risk factors and different perioperative circumstances. As of yet, there are no robust mechanisms in place to specifically assess the quality of cancer surgery care at hospitals. Current quality reports are based on the assumption that hospital performance rankings are consistent among all indications for similar procedures. (6, 7) Thus, current colorectal surgery benchmarks may not truly represent reality. Further, grouping patients with and without cancer into the same quality profiling models may obfuscate valuable information regarding best practices for non-cancer and cancer resections and respective targets for improvement.

To our knowledge, there have not been any published studies comparing hospital performance rankings for non-cancer and cancer indications across similar procedures. In this context, we investigate the differences in hospital performance when different indications are examined using risk- and reliability-adjusted short-term outcomes following colorectal resections at 52 hospitals participating in a regional collaborative in the state of Michigan.

METHODS

Data sources

The Michigan Surgical Quality Collaborative (MSQC) is a 52-hospital consortium representing diverse practice settings throughout the state. MSQC data abstraction and data quality assurance details have been described elsewhere. (8, 9) In brief, specially trained data abstractors conduct chart reviews to comprehensively collect patient demographics, preoperative risk factors and lab values, technical details of the operation, perioperative processes of care and 30-day outcomes for patients undergoing specified surgical operations utilizing a sampling algorithm that minimizes selection bias. Regular data audits ensure registry data validity. Data collection for MSQC is Institutional Review Board (IRB) exempt at participating hospitals, and the current study was deemed non-regulated by the University of Michigan's IRB.

Patient Population

Patients aged 18 years and older, who had undergone a colorectal resection based on index Current Procedural Terminology (CPT) codes at any of the 52 participating hospitals, were identified from the MSQC dataset from 2008–2012 (CPT codes 44139–44160, 44204–44213, 45110–45135, and 45395–45550). International Classification of Disease (ICD-9) codes were analyzed and patients were categorized to the cancer group if their ICD-9 codes represented any invasive or metastatic malignancy (ICD-9 codes 140–209.3), the remaining ICD-9 codes in the non-cancer category encompassed 8 different indications, namely

diverticulitis, benign neoplasms, vascular insufficiency, obstruction/volvulus, inflammatory bowel disease (IBD), hemorrhage, stoma complications and other diagnoses. Polyps with or without carcinoma in situ and benign neuroendocrine tumors were classified as benign neoplasms.

Independent Variables

Clinical and demographic data analyzed included age, race, sex, ASA class, functional status, body mass index (BMI), indication for operation (from postoperative diagnosis ICD-9 codes), type of operation (from CPT codes), complexity of the operation and concurrent procedures, and emergent status. Comorbidities included preoperative cardiac, pulmonary, gastrointestinal, renal, neurological, hematological, infectious and endocrine diagnoses. Patients may have had disseminated cancer unrelated to their colorectal resection hospitalization and were classified in the non-cancer operation cohort.

Outcome Variables

The primary outcomes of interest were any morbidity, major morbidity, extended length of stay (LOS) and mortality within 30 days of the index operation, in patients who had colorectal resections for non-cancer and cancer indications. Morbidity was defined as having documentation of at least one postoperative complication, including superficial surgical site infection (SSI), deep space SSI, organ space SSI, wound dehiscence, pneumonia, unplanned intubation, pulmonary embolism, ventilator dependence >48 hours, acute kidney injury, urinary tract infection (UTI), neurologic event, cardiac arrest, myocardial infarction, bleeding requiring transfusion, venous thromboembolism (deep vein thrombosis [DVT] or pulmonary embolism [PE]), sepsis, severe sepsis, central line associated blood stream infection, clostridium difficile infection, and anastomotic leak. Major morbidity was defined as above with the exclusion of DVT without evidence of PE, superficial SSI, deep space SSI, UTI and C. difficile infection. Patients could experience more than one of the listed complications. Conditions present preoperatively were not included as a complication since this study focuses on postoperative outcomes. Extended LOS was defined as LOS that extended beyond the 75th percentile for LOS in this cohort. Readmission data was not available for this patient population.

Statistical Analyses

Clinical and demographic variables for patients who underwent non-cancer and cancer colorectal resections were compared using chi-square tests for categorical and 2-sided t-tests for continuous variables, with significance set at a p-value <0.05. Independent variables that had a p-value <0.2 level on univariate analysis were included for potential entry in forward stepwise logistic regression models for each outcome of interest (morbidity, major morbidity, extended length of stay (LOS) and mortality within 30 days of the index operation), in addition to age, sex, race and procedure performed.

In total, 4 models were constructed with significance set at $p < 0.05$. Models were evaluated for discrimination using the c-statistic and for goodness-of-fit using Hosmer-Lemeshow (H-L) statistics. The c-statistic evaluates model discrimination and represents the area under the receiver-operator-characteristic curve. A value of 0.5 indicates that the model is equivalent

to chance while a value of 1.0 indicates perfect discrimination. In other words, the c-statistic is the probability that a random patient who experienced the outcome will have a higher risk score than a random patient who did not. The H-L statistic assess whether predictive accuracy is consistent across deciles of predicted risk. These models yielded patient-level predicted probabilities and risk scores for each outcome across all hospitals.

To account for clustering and random variation in hospital outcomes rates, hierarchical regression modeling and empirical Bayesian methods were used to ensure statistical reliability. The reliability adjustment minimizes variation due to sample size at the hospital level. Surgeon level data were not available for this analysis. Predicted probabilities were summed at the hospital level to estimate risk- and reliability-adjusted rates for each outcome of interest for cancer and non-cancer operations. For each hospital, the observed number of events (O) was divided by the risk-adjusted expected number of events (E) to produce observed-to-expected (O/E) ratios. If the 95% confidence interval of the O/E ratio did not include 1.0, then the hospital was designated as a statistically significant “outlier”. In total, 8 observed-to-expected (O/E) ratios were calculated per hospital (1 per outcome in each group).

To compare performance based on indication for resection, hospital level statistics were evaluated for each non-cancer and cancer designation. For each outcome of interest, hospitals were ranked based on their O/E ratios and divided into even quartiles of performance rankings. Spearman correlation statistics were used to compare hospital ranks in outcomes following non-cancer and cancer resections, with a Spearman’s correlation coefficient (ρ), which ranges from zero (no association) to 1 (perfect association). Differences in performance for non-cancer and cancer operations were quantified by changes in hospital rank. Absolute values for changes in hospital rank and their interquartile ranges (IQR) were calculated for each outcome of interest.

All statistical analyses were conducted using STATA special edition (version 13, StataCorp, College Station, TX).

RESULTS

Baseline Characteristics & Case Mix

In total, 19,990 colorectal resections were performed at 52 MSQC hospitals. The most commonly performed operations were open partial colectomies, followed by laparoscopic partial colectomies. Of those, 7,364 (36.8%) were cancer-directed operations. Patient-level clinical and demographic characteristics are summarized in Table 1. Overall, patients undergoing non-cancer operations had poorer functional status (partially or totally dependent functional status), higher rates of comorbid conditions (CHF, current use of cigarettes, COPD, pneumonia or ventilator dependence, renal failure/dialysis), higher ASA scores, a higher association with preoperative sepsis, and had more cases designated as emergencies. Of the 12,626 non-cancer operations, diverticulitis was the most common indication, accounting for over half of the cases. Operations for inflammatory bowel disease represented a relatively small proportion (5.9%) of the non-cancer operations.

Table 2 depicts the risk factors that were accounted for in each predictive model. Our statistical models compare favorably to other published risk-adjusted models, with all models having a c-statistic >0.7 . (10, 11)

At the hospital level, wide inter- and intra-hospital variations in performance rankings were identified across all outcomes of interest following non-cancer and cancer resections. This is demonstrated by the dramatic changes in rank relative to other hospitals and the poor correlation coefficients when comparing both indications, as summarized below.

Morbidity

Differences in hospital performance rankings for morbidity were evident when examining non-cancer vs. cancer operations. Adjusted morbidity rates varied widely between hospitals with a mean of 29.9% (range by hospital 17.6–45.3%) for non-cancer, compared to 25.3% (range by hospital 18.2–30.4%) for cancer resections ($p<0.001$). Although in aggregate, morbidity rates seem to be lower in the cancer group, this was not consistent at all hospitals, which significantly impacted rankings relative to other hospitals. In total, 8 high performing outliers were identified (Figure 1a), but only 1 of those sites performed consistently well for both non-cancer and cancer indications based on O/E ratios. Hospitals had a median rank change of 6 ranks (IQR 2–14) and only weak-to-moderate ranking correlations between indications (Spearman's ρ : 0.59, $p<0.001$). Furthermore, 31% of hospitals in the top performance quartile for morbidity following non-cancer resections were reclassified to a lower performance quartile for cancer resections (Figure 2a).

Major Morbidity

Similarly, risk-adjusted major morbidity rates were 22.3% (14.1–34.6%) for non-cancer vs. 18.8% (13.8–22.7%) for cancer. None of the 4 high performing outliers shown in Figure 1b were consistent as high performing for both indications. As demonstrated in Figure 2b, hospital ranks were weakly correlated (ρ : 0.39, $p<0.001$). There was an overall median rank change of 11 (IQR 5–16). From the top rankings quartile for non-cancer operations, 62% of hospitals were reclassified to a lower rankings quartile when cancer resections were examined.

Extended Length of Stay

Wider inter-hospital variations in adjusted extended LOS rates (26.8% [14.2–62.5%] for non-cancer vs. 21.6% [14.3–40.2%] for cancer) were seen. Only 1 of 7 hospitals with statistically significant shorter LOS after non-cancer operations maintained that performance status for cancer operations (Figure 1c). 62% of hospitals in the top rankings quartile were reclassified (Figure 2c). There was a median rank change of 11.5 (IQR 4–19) and only weak rank correlations (ρ : 0.39, p : 0.004).

Mortality

The most dramatic differences were noted in hospital performance rankings for mortality following non-cancer compared to cancer operations. Adjusted mortality rates were 6.1% (5–7.6%) vs. 3.4% (2.7–4.6%), respectively. Even though all hospitals had lower risk-adjusted mortality rates following cancer surgery, their respective performance rankings

were not correlated (ρ : 0.02, $p > 0.2$) across the two indications. There was a median change of 12.5 hospital ranks (IQR 5–27) based on indication for operation. Lastly, 69% of the top ranking hospitals in mortality dropped to a lower performance quartile (Figures 1d and 2d) when evaluating performance based on non-cancer operations to cancer operations.

Post-hoc Analyses

Overall, patients undergoing non-cancer operations appeared to be a higher risk cohort based on clinical characteristics. The differences in outcomes were attenuated after risk adjustment, but remained significant. To further test the robustness of these results, we explored the possibility that higher risk patients did not undergo elective operations and more generalized patient selection influenced hospital performance in morbidity and mortality. Sensitivity analyses excluded patients undergoing emergent operations and those with an ASA class of 4 or higher. Only minimal changes in O/E ratios for the outcomes of interest were noted and did not influence rank correlations. Another post-hoc analysis took into account the fact that benign polyps receive oncologic resections similar to those of the cancer cohort, the results were similar to the main analysis and are not reported. Similarly the effect of the formation of a new stoma on extended LOS was examined, minimal changes in risk-adjusted rates resulted without impacting ranking differences.

DISCUSSION

In our study of nearly 20,000 colorectal resections at 52 hospitals across the state of Michigan, we found wide variation in hospital-level risk- and reliability-adjusted short-term outcomes across indications. Based on O/E ratios and hospital rankings, the overwhelming majority of hospitals do not perform consistently for non-cancer vs. cancer colorectal resections in any of the outcome measures we examined, particularly mortality and major morbidity. Almost no hospitals were consistently high performers for both non-cancer and cancer operations.

Hospitals are increasingly being benchmarked against other hospitals based on risk-adjusted postoperative short-term outcomes as an indicator of surgical quality. (12, 13) Short-term outcomes are also on the agenda of national health policy, public reporting, and pay-for-performance initiatives. In this context, colorectal surgery has gained considerable attention as it accounts for approximately 10% of all general surgery operations in the US and contributes to the greatest share of adverse events. (14) Similar to previous studies, our present work shows significant variations in outcomes after colorectal surgery. However, to the best of our knowledge, our study is the first to directly compare hospital performance in non-cancer to cancer surgery, uncovering significant differences in hospital performance related to indication alone.

Most studies evaluate colorectal surgery outcomes for all patients regardless of cancer status. (1, 15, 16) For example, in their assessment of 182 National Surgical Quality Improvement Program (NSQIP) hospitals, Cohen and colleagues (1) demonstrated sizable hospital variations in LOS after colorectal surgery. Our study demonstrates substantial differences in LOS performance similar to the NSQIP study, but adds a crucial aspect in directing quality interventions towards potential target of improvements in process or

structure, that would not otherwise be identifiable if patients were grouped together irrespective of indication. In our study, the majority of the hospitals were not consistent in their extended LOS performance. This may signify that cancer patients may be staying longer at that particular hospital compared to their non-cancer counterparts, which might be due to a lack of timely coordination of multidisciplinary care or discharge location, while non-cancer patients, who do not require further therapy, return home in a timely fashion. In another NSQIP analysis, Ingraham and colleagues (16) found differences in hospital performance between emergent and non-emergent colorectal operations. The results in the present study persisted after excluding high-risk and emergent cases in the post-hoc analysis.

Other studies have specifically analyzed outcomes after colorectal resections for cancer alone. (7, 17, 18) In their SEER-Medicare study on 4,617 patients with stage I–III colon cancer at 465 hospitals, Zheng and colleagues (18) found significant inter-hospital variations in LOS and mortality rates which were attributed to the hospital center effect (HCE). HCE was used to describe variation in health outcomes that is directly attributable to the hospital at which treatment occurs, after controlling for patient-, provider-, and hospital-level characteristics. Their findings suggest that the choice of hospital affects outcomes independently of other confounding variables. In the present study, the overwhelming majority of hospitals did not perform consistently across indications. Thus, current hospital rankings based on procedural analyses only tell part of the story.

In a patient-level analysis using the Nationwide Inpatient Sample, Van Arendonk and colleagues (19) highlighted the limitations of not comparing patient outcomes across disease types, as the outcomes of colectomy varied dramatically according to the underlying diagnosis requiring surgery. Our study confirms these differences at the hospital level, and demonstrates that hospitals do not perform consistently when similar procedures for differing indications are compared. The contrasting hospital performance within different disease settings emphasizes the limitations of comparing health care quality based on patients' surgical outcomes alone, without addressing the specific disease process requiring surgery.

It will be important to determine the effect of distinguishing high or low performance rankings based on indication for the procedure to uncover the important hospital-level processes of care for distinct diseases. One explanation for disparate results may be that different surgeons at the same hospitals perform cancer resections as opposed to resections for diverticulitis. Specifically, elective cancer operations are more likely to be performed by surgical specialists (surgical oncologists or colorectal surgeons) than more urgent operations for diverticulitis, which present as “on call” cases and are not always triaged to specialists. Further, different systems of care may be in place at the same hospital for inflammatory bowel disease compared with rectal cancer even though both are examples of cases likely to be managed by colorectal surgeons, and this could account for differences in perioperative outcomes. While this is not a classic example of “confounding by indication,” which describes biased estimates of treatment effects, colorectal operations are common and the results from this study do illustrate the importance of precise measurement to avoid bias. Procedure-specific quality reports are insufficient to accurately profile hospital performance.

The American College of Surgeons has recognized the need to separately report hospital performance for cancer cases separately. For this purpose, it has developed the Oncology NSQIP National Cancer Institute Center Consortium (ONNCC). As a cancer specific quality platform, ONNCC can accurately benchmark hospital performance for cancer cases. (6) Similarly, the MSQC has begun to separately report cancer surgery outcomes to hospitals in order to better understand cancer surgery care and the unique potential targets for improvement. Echoing this, our study is the first to confirm the need for a robust cancer platform such as ONNCC, by comparing hospital-ranking differences following non-cancer and cancer resections.

Our study is not without limitations. First, as this study was limited to colorectal resections, results may not be generalizable to other types of operations. However, other gastrointestinal operations such as esophagectomy, gastrectomy (excluding bariatric procedures), hepatectomy or pancreatectomy are overwhelmingly performed for cancers or other neoplasms and do not lend themselves to the same type of comparison. Because surgeon-specific data are not included in this analysis, we are unable to define if varying practice patterns, which may be seen when comparing colorectal surgeons to acute care surgeons, can explain the differences in hospital rankings for non-cancer vs. cancer resections even if they are performed at the same hospital. Even though our methods adjusted for clustering effects within hospitals, the extent to which surgeon-specific practices for non-cancer care compared to cancer care could not be directly assessed.

Our results demonstrated substantial intra-hospitals variation in risk- and reliability-adjusted outcomes for cancer and non-cancer colorectal resections. For major morbidity and mortality measures, almost no hospitals were consistently high performers for both indications. In an era of transparency and public reporting of hospital performance, these findings show that indication-specific reporting and targeted improvement strategies may be particularly important for improving outcomes following colorectal operations.

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Figure 1.

Comparison of risk-adjusted O/E ratios and outlier status by hospital for (a) Morbidity, (b) Major morbidity, (c) Extended LOS, and (d) Mortality for non-cancer and cancer operations, respectively. Observed-to-expected ratios <1.0 indicate better than expected outcomes; ratios >1.0 indicate worse than expected outcomes. Multiplying the O/E ratio by the outcome's mean yields the respective adjusted rates. Hospitals whose 95% confidence interval does not include 1.0 are highlighted as statistically significant outliers.

Figure 2.

Comparison of changes in rank for non-cancer and cancer operations by hospital. (a) Morbidity, (b) Major morbidity, (c) Extended LOS, and (d) Mortality. Hospitals in the top performance quartile for non-cancer are in bold face. The connecting lines represent changes in rank.

Table 1

Clinicopathological characteristics of patients undergoing colorectal resections at 52 MSQC hospitals.

Demographics	Non-Cancer Operation (n= 12,626)	Cancer Operation (n=7,364)	p Value
Age, y, mean $\pm$ SD	61.3 $\pm$ 15.4	68 $\pm$ 13.4	<0.001
Gender			<0.001
Male	5,557 (44)	3,654 (49.6)	
Female	7,069(56)	3,710 (50.4)	
Race			<0.001
White	10,074 (79.8)	5,647 (76.7)	
Other	2,552 (20.2)	1,717 (23.3)	
ASA Class			<0.001
I	327 (2.6)	102 (1.4)	
II	5,296 (42)	2,711 (36.8)	
III	5,239 (41.5)	4,021 (54.6)	
IV	1,622 (12.9)	520 (7.1)	
V	142 (1.1)	10 (0.1)	
Functional Status			<0.001
Independent	12,461 (98.7)	7,314 (99.3)	
Partially dependent	83 (0.7)	37 (0.5)	
Totally dependent	71 (0.6)	10 (0.1)	
Unknown	11 (0.1)	3 (0.04)	
Body Mass Index			<0.001
Underweight	477 (3.8)	227 (3.1)	
Normal	3,660 (29)	2,247 (30.5)	
Overweight	4,000 (31.7)	2,472 (33.6)	
Obese	4,291 (34)	2,357 (32)	
Unknown	198 (1.6)	61 (0.8)	
Patient Comorbidities			
Cardiovascular			
IHD	315 (2.5)	189 (2.6)	0.755
CHF	258 (2)	114 (1.6)	0.012
Hypertension	6,796 (53.8)	4,477 (60.8)	<0.001
PVD	310 (2.5)	157 (2.1)	0.144
Pulmonary			
Dyspnea	208 (1.7)	134 (1.8)	0.365
Current smoker	3,103 (24.6)	1,271 (17.3)	<0.001
COPD	226 (1.8)	90 (1.2)	0.002
Pneumonia	80 (0.6)	9 (0.1)	<0.001

Demographics	Non-Cancer Operation (n= 12,626)	Cancer Operation (n=7,364)	p Value
Ventilator dependence	364 (2.9)	12 (0.2)	<0.001
Renal			
Dialysis	278 (2.2)	49 (0.7)	<0.001
Oncologic			
Disseminated cancer	207 (1.6)	582 (7.9)	<0.001
Weight loss	384(3)	450 (6.1)	<0.001
Hematologic			
Bleeding disorder	933 (7.4)	362 (4.9)	<0.001
Preop transfusion	98 (0.8)	55 (0.8)	0.819
DVT history	199 (1.6)	105 (1.4)	0.402
Endocrine			
Diabetes	1,972 (15.6)	1,466 (19.9)	<0.001
Steroids	969 (7.7)	168 (2.3)	<0.001
Other			
Pre-op sepsis	294 (2.3)	31 (0.4)	<0.001
Ascites	211 (1.7)	126 (1.7)	0.833
Perioperative Characteristics			
Emergency Operation	3,118 (24.7)	338 (4.6)	<0.001
Colorectal procedure			<0.001
Open partial colectomy	7,842 (62.1)	4,308 (58.5)	
Open total colectomy	502 (4)	85 (1.2)	
Lap partial colectomy	3,749 (29.7)	2,436 (33.1)	
Lap total colectomy	82 (0.7)	15 (0.2)	
Open Proctectomy	226 (1.8)	448 (6.1)	
Lap Proctectomy	19 (0.2)	71 (1)	
Other	206 (1.6)	1 (0.01)	
Concurrent procedures			
Lysis of adhesions	1,948 (15.4)	821 (11.2)	<0.001
Liver biopsy/resection	30 (0.24)	250 (3.4)	<0.001
Small bowel resection	378 (3)	186 (2.5)	0.054
Vascular resection/repair	5 (0.04)	8 (0.1)	0.065
New Stoma Formation	4,842 (38.4)	2,250 (30.6)	<0.001
Postop Diagnosis			<0.001
Malignant Neoplasm	N/a	7,364 (100)	
Diverticulitis	6,450 (51.1)		
Benign Neoplasm	2,028 (16.1)		

Demographics	Non-Cancer Operation (n= 12,626)	Cancer Operation (n=7,364)	p Value
Obstruction/Volvulus	1,361 (10.8)		
IBD (CUC or Crohn)	742 (5.9)		
Vascular insufficiency	465 (3.7)		
Hemorrhage	192 (1.5)		
Stoma complication	503 (4)		
Other	885 (7)		
Outcomes			
Morbidity	3,702 (29.3)	1,848 (25.1)	<0.001
Major Morbidity	2,752 (21.8)	1,375 (18.7)	<0.001
Extended LOS	3,244 (25.7)	1,549(21)	<0.001
Mortality	770 (6.1)	251 (3.4)	<0.001

ASA: American Society of Anesthesiologists, IHD: Ischemic Heart Disease, CHF: Congestive Heart Failure, PVD: Peripheral Vascular Disease, COPD: Chronic Obstructive Pulmonary Disease, IBD: Inflammatory Bowel Disease, CUC: Chronic Ulcerative Colitis, LOS: Length of Stay.

Table 2

Independent variables that were included in hierarchical models.

Morbidity	Major Morbidity	30-day Mortality	Extended LOS
ASA class	ASA class	ASA class	ASA class
Emergent	Emergent	Emergent	Procedure
Procedure	Weight loss	Age	Emergent
Lysis of adhesions	Preop sepsis	Vent. Dependence	CHF
Weight loss	Procedure	Disseminated CA	Weight loss
Functional Status	Functional status	Steroids	Lysis of adhesions
SB resection	Lysis of adhesions	SB resection	Steroids
Steroids	Steroids	CHF	Bleeding disorder
CHF	Age	BMI	Age
Preop sepsis	CHF	PVD	Disseminated CA
Pneumonia	SB resection	Procedure	Dialysis
HTN	Pneumonia	Dialysis	SB resection
PVD	Gender	Functional Status	Functional status
Bleeding disorder	Bleeding disorder	Gender	BMI
Vent. Dependence	PVD	Diabetes	Gender
Disseminated CA	Race	Weight loss	Pneumonia
Lymphadenectomy	Disseminated CA	Race	HTN
Age	Dialysis	Lysis of adhesions	COPD
BMI		Smoking	Preop sepsis
Race			Smoking