Obesity and Readmission in Elderly Surgical Patients

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Abstract

Introduction—Reducing readmissions has become a focus in efforts by Medicare to improve healthcare quality and reduce costs. This study aimed to determine whether causes for readmission differed between obese and non-obese patients, possibly allowing for targeted interventions.

Methods—A matched case-control study of Medicare patients admitted between 2002–2006 who were readmitted following hip or knee surgery, colectomy, or thoracotomy was performed. Patients were matched exactly for procedure, while also balancing on hospital, age and sex. Conditional logistic regression was used to study the odds of readmission for very obese cases (BMI > 35kg/m^2) versus normal weight patients (BMI of 20–30kg/m^2) after further controlling for race, transfer-in and emergency status, and comorbidities.

Results—Among 15,914 patient admissions we identified 1,380 readmitted patients and 2,760 controls. Risk of readmission was increased for obese vs. non-obese patients, before and after controlling for comorbidities (OR=1.35, P=0.003; OR=1.25, P=0.04). Reasons for readmission varied by procedure but were not different by BMI category.

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Conclusions—Obese patients have an increased risk of readmission, yet reasons for readmission in obese patients appear similar to the non-obese, suggesting that improved post-discharge management for the obese cannot focus on a few specific causes of readmission, but must provide a broad range of interventions.

Keywords

readmissions; rehospitalization; obesity; surgery

Introduction

In an effort to improve quality of care and control healthcare costs, hospital readmissions have become the target of considerable discussion. The recently passed Patient Protection and Affordable Care Act gives the Centers for Medicare and Medicaid Services the authority to financially penalize hospitals for excessive readmissions, which will include surgical patients as early as 2015.[1] The elderly accounted for 36% of healthcare expenditures in 2002 while making up only 13% of the United States population.[2] As the population continues to age, the number of elderly patients undergoing surgery is also rising.[3, 4] Surgical readmissions account for 22% of all readmissions.[5]

Obesity is a risk factor for surgical complications[6–9] and as such, may affect rates of surgical readmission as well. Medicare and other administrative claims data do not collect body mass index (BMI) for patients, thus many of the large-scale studies examining predictors of readmission have not been able to include the effect of obesity.[5, 10, 11] Studies that have included a measure of obesity have shown contradictory effects of obesity on readmission.[12–14] The Obesity and Surgical Outcomes Study[15, 16] database provides a unique dataset in which claims data are merged with chart abstracted data, allowing a detailed examination of readmissions and obesity in the elderly surgical patient.

In order to better understand why obese patients have elevated readmission rates and to prevent readmission in the obese, the aim of this study was to compare the causes of readmission for obese and non-obese elderly surgical patients.

We therefore sought to identify indications for readmission in a unique surgical cohort with a detailed evaluation of the impact of obesity on the likelihood for readmission. We hypothesized that obese patients would have an increased risk of readmission, even after controlling for other pre-operative patient comorbidities, and that the reasons for readmission would differ between obese and non-obese patients.

Methods

Study cohort and design

Approval for this study was obtained from the Institutional Review Board (IRB) of The Children's Hospital of Philadelphia as well as hospital-specific IRBs when requested. This observational multi-institutional nested matched case-control study was conducted using the Obesity and Surgical Outcomes Study database. Details of the Obesity and Surgical Outcomes Study database data have been previously described. [9, 16] In brief, the dataset contains both administrative and chart-based information on Medicare patients undergoing surgical procedures at 47 hospitals located throughout Illinois, New York, and Texas. These three states were chosen to optimize population size, obtain varied geography, and minimize managed care enrollment of Medicare patients. The dataset combined Medicare claims data and supplemental data obtained from chart review, which was provided by the individual

hospitals enrolled in the study. Supplemental chart-abstracted data included body mass index (BMI), admission vital signs and laboratory tests, and other perioperative information.

All patients between the ages of 65 and 80 who underwent one of four specific surgical procedures between 2002 and 2006 were eligible for inclusion in this study if they were continuously enrolled in fee-for-service Medicare in the three months prior to and one month following the index admission. The four specific surgical procedures were identified as follows: (1) hip replacement or revision excluding fracture (ICD-9-CM Principal Procedure codes 81.51-81.53); (2) knee replacement or revision (ICD-9-CM Principal Procedure 81.54, 81.55); (3) colectomy for cancer (ICD-9-CM Principal Procedure codes 45.7-45.79, 45.8) (ICD-9-CM Principal Diagnosis codes 153-153.9, 154-154.8, 230.3-6) and colectomy not for cancer (ICD-9- CM Principle Procedure 45.7-45.79, 45.8) and (ICD-9-CM Principal Diagnosis codes 562.1- 562.13); and (4) thoracotomy (ICD-9-CM Principal Procedure codes 32-32.9). Throughout the manuscript, these procedure groups are referred to as orthopedic (hip or knee replacement), colorectal (colectomy for cancer or colectomy not for cancer), and thoracic (thoracotomy). Patients without an available BMI after chart abstraction and patients with height (48 or 84 inches), weight (80 or 600 lbs), or BMI (>100 kg/m^2) outside a plausible range were excluded.

Available information on patients included comorbidities and APACHE score as identified and/or calculated using the merged dataset. Patient comorbidities included in this study are a history of congestive heart failure, stroke, seizure, dementia, alcohol use, drug use, electrolyte abnormalities, history of a myocardial infarction, history of arrhythmia, unstable angina, angina, hypertension, valvular disease, chronic lung disease, asthma, hepatic abnormalities, renal dysfunction, renal failure, paraplegia, collagen vascular disease, coagulation abnormality, thrombocytopenia, congenital coagulation disorder, history of smoking, pulmonary fibrosis, Cushing's disease, Graves disease, cancer, hypothyroidism, chronic peptic ulcer disease, acquired immune deficiency syndrome (AIDS), weight loss, sleep apnea, and diabetes.[9] Diabetes was determined using chart review, and was characterized into no diabetes, diabetes without medications, and diabetes with medications. Race was defined as black, white, or other as determined by Medicare claims. Index hospitalizations were defined as being an emergency if the patient's source of admission was the emergency room. Patients who had a prior hospitalization in which the discharge date was the same as or the day prior to the day of admission for the hospitalization during which the procedure was performed were identified as having been transferred-in. The patient and hospital characteristics used in the risk adjustment were assigned at the time of the index hospitalization. Patient obesity status in the index admission was classified as normal weight if the calculated BMI was as 20–30 kg/m^2 and obese if the calculated BMI was >35 kg/m^2 (exactly as in our previous work[9, 16, 17]).

Readmission was defined as hospitalization (for reason other than rehabilitation) in an acute care facility after discharge from the index admission. Hospitals classified by Medicare as short term general/specialty hospitals or critical access hospitals (excluding psychiatric or rehabilitation specific sections) were considered acute care facilities. Admission for rehabilitation was identified by a diagnosis-related group (DRG) of 462. Transfers (defined as admission on the same day as or day after discharge from index admission, in which the discharge status or admission source indicated transfer) were not considered readmissions. Patients without 30 days of follow-up were also excluded.

Matching methodology

OBSOS patients who survived to discharge from their index hospitalization, but were readmitted or died within 30 days of discharge (without readmission) were matched in a 1:2 ratio to patients who survived to discharge from index hospitalization and also survived 30

days without requiring readmission. Patients who died within 30 days of discharge without being readmitted were identified as cases, under the presumption was that readmission would have been indicated if they had presented for medical care prior to death. Patients were matched with (i) exact matching for procedure, (ii) near-exact matching and near-fine balance for hospital[18, 19], and (iii) balancing the means of age and sex[17]. Near-exact matching and near-fine balance are two forms of flexible matching that approximate exact matching and fine balance when these are not feasible.[17–20] As a result of near-exact matching, patients are matched within hospitals as often as possible, whereas as a result of near-fine balance each hospital is approximately equally represented in the case and matched control groups. These forms of matching on the hospital allow the cases and controls to be identified and matched in such a way that differences across hospitals are less likely to bias the matched analyses. In so doing, we were able to minimize practice variation across institutions between cases and controls. This allowed us to study patient characteristics with minimal noise from the hospital processes of care.

Statistical Analysis

Balance on age and sex for patients in the match were examined using the Wilcoxon rank-sum test and the Fisher exact test. Conditional logistic regression was used to test the hypothesis that severely obese patients have equal odds of readmission compared to normal weight patients. The effect of controlling for race, emergency status, and transfer status, both with and without controlling for patient comorbidities, was examined using conditional logistic regression to determine if obesity remained an independent risk factor for readmission. These analyses were repeated after excluding cases in which the patients died prior to readmission to determine the influence of that subset of patients.

The ICD9CM Principal Diagnosis code for the readmission hospitalization was determined for each patient who was readmitted. These were then grouped into similar clinical categories to determine the general reason for readmission (ie. infection, gastrointestinal complications, etc, Appendix B). The percent of readmissions due to each general reason were compared by BMI category for each procedure group. The distribution of the indications for readmission was compared between the obese and the non-obese using the Fisher exact test.

Results

Hospital Characteristics

The mean hospital size for hospitals included in this study was 423 beds (SD 285), with a mean nurse to bed ratio of 1.64 (0.44). Forty seven percent of hospitals were non-teaching (resident to bed ratio = 0) while 6% were "very major" teaching hospitals (resident to bed ratio >0.6, Table 1).

Characteristics of the study population

Of the 18,517 patients identified who met OBSOS study criteria and underwent chart abstraction, 2,481 (13%) were excluded for missing BMI, 65 for implausible height, weight, or BMI, and 57 for other significant data inconsistencies. From the remaining OBSOS study population of 15,914 patients, we identified 15,666 patients who survived to discharge from their index admission and had a full 30 days of follow-up. Fifteen percent of patients in this dataset had a BMI $\geq$ 35 kg/m^2. There was an overall 8.9% rate of readmission or death: 13.9% in patients who underwent a colectomy, 6.0% in patients who underwent hip or knee procedure, and 12.8% in patients who underwent a thoracotomy. For the subset of patients with a BMI $\geq$ 35 kg/m^2 8.7% of them were readmitted or died without readmission in the 30 days after discharge from index hospitalization.

From the 15,666 patients, we identified 1,380 patients who were readmitted or died within 30 days after discharge from index admission. Fifty-nine of the 1,380 patients died within 30 days after discharge without being readmitted. The 1,380 patients were matched to 2,760 patients who were discharged alive and did not die and did not require readmission within 30 days. The matching algorithm successfully balanced age, sex, procedures and hospital between patients who were readmitted or died and those who did not die and did not get readmitted (see Table 2). Of the patients who were readmitted or died, 15% were obese while only 12% of the non-readmitted controls were obese. Patients with a BMI greater than 35 kg/m^2 were overrepresented among cases of readmission as compared to controls, as seen in the quantile-quantile plot (Figure 1).

The overall mean time to readmission (or death) for cases was 11.3 days (SD 8.3 days). By procedure specialty, the overall mean time to readmission was: colorectal 9.6 days (1.6 days), hip or knee 12.6 days (8.7 days), and thoracotomy 11.6 days (8.4 days). Patients who were readmitted or died had a mean length of stay of 8.7 days (8.9) for their index admission while those who were discharged alive and survived 30 days without requiring readmission had a mean length of stay of 6.6 days (5.4). Overall, 11% of patients in the matched pair cohort underwent an emergent procedure: 23% of colectomies were emergent, 6% of thoracotomies, and 3% of orthopedic procedures. Patients were most commonly readmitted through the emergency department (64%), followed by physician referral (31%) and transfer from an acute care facility (2%). Readmission to the same hospital as the index procedure was most common (80% of readmissions), while 20% of readmitted patients were readmitted to a different facility.

Effect of obesity on readmission

Obese patients had a 36% increased risk of readmission before controlling for other factors (95% CI 1.12-1.66, P-value = 0.002, Table 3). After controlling for race, emergency status, and transfer status during the index admission, obese patients had 35% increased odds of 30-day readmission or death (95% CI 1.10-1.65, P-value = 0.003). After controlling for all other patient comorbidities, including the APACHE score upon the index admission, obese patients remained at 25% increased odds of readmission (95% CI 1.01-1.55, P-value = 0.04). After excluding the 59 patients who died prior to readmission and their controls, the findings were unchanged (Table 3).

Causes of readmission and association with obesity

The most common cause of readmission differed substantially by procedure specialty (Table 4). For patients undergoing colectomy, the most common causes of readmission were gastrointestinal complications and infection. After thoracotomy, patients were readmitted most often for pulmonary and cardiac complications. Orthopedic patients were most likely to be readmitted for orthopedic complications, cardiac reasons, or infection. The reasons for readmission were not significantly different between the obese and non-obese patients.

Discussion

We report that obesity increases the risk of 30-day readmission or death following surgical procedures from a variety of surgical specialties. After controlling for age, sex, procedure, hospital, emergency status, transfer status, and patient characteristics including APACHE score and comorbidities, the risk of readmission remains elevated in obese patients when compared to the non-obese. We also found that the most common causes of readmission differ by surgical procedure, indicating that readmissions after surgical procedures are likely related to the procedures rather than acute exacerbations of the patients' chronic conditions. Furthermore, the most common indications for readmission did not differ significantly by

obesity status but did differ by procedure specialty. Therefore successful speciality-specific interventions would likely result in reduced readmission rates regardless of obesity status.

Previous studies have reported that rehospitalizations in elderly surgical patients are frequently related to the initial indication for the surgical procedure.[21] And, more recently, infectious reasons, such as surgical site infections, have been found to be a leading cause of readmission in vascular surgical patients.[22] One of the largest studies to date by Jencks et. al. emphasized the frequent role of heart failure and pneumonia (suggesting need for closer medical outpatient follow-up) in the need for readmission in the post-operative period[5]. However, when broken down by procedure type, variation in reasons for readmissions by procedure type, similar to our findings, were seen.[5] By examining patterns of readmission in three distinct surgical populations in our study, we were able to extend previous findings to demonstrate that the indications for readmission were most commonly related to the surgical procedure.

Our results highlight the importance of accurate risk stratification for complications, including readmissions. The presentation of complications often occurs in the outpatient setting in current medical care paradigms,[23] and we suggest that the new interest in surgical readmissions likely represents a persistent interest in post-operative occurrences. Occurrences that previously would have happened during the index admission now occur in the outpatient setting, and when severe enough or impossible to evaluate in a timely fashion in the outpatient setting, mandate re-admission for timely management. It appears that obesity, a well-described risk factor for post-operative infectious complications,[6–8] is also an independent risk factor for readmission. Using the unique characteristics of the OBSOS dataset, we were able to tease out the relationship between surgical readmissions and obesity independent of other obesity-related comorbidities in a multi-institutional study. Given our finding of increased risk of readmission in obese patients, we believe that future risk adjustment algorithms used to determine reimbursement for readmissions must incorporate BMI when possible.

We add to the growing body of literature that encourages the federal government to consider the potential unintended consequences of penalizing providers without consideration of the patient's excessive risk due to obesity. Previous studies demonstrated an increased risk of SSI for obese patients and raised concerns about unfairly penalizing surgeons and having negative effects on obese patients' access to surgery.[24, 25] Readmission penalties are at risk for similar negative effects on providers and healthcare access for obese patients if not appropriately risk adjusted. Many studies that examine readmissions use Medicare or SEER databases because of the ability to accurately track rates of readmission to any hospital. However, studies that have used these national databases have not had the ability to study the effect of BMI due to the lack of this information in the dataset.[5, 10, 11] Two studies using cardiac surgery databases, one for the state of New York[14] and one in London,[12] found that BMI or body surface area was associated with risk of readmission, while a smaller hospital-specific study found that BMI was not associated with readmission.[13] Our study extends the results of these previous studies by using a large claims database supplemented with chart information including BMI and other physiologic data and by studying BMI as the primary predictor variable after controlling for other factors known to the surgeon and hospital at the time of preoperative evaluation.

Our findings must be placed in context. In examining a Medicare population we report only on the association between readmissions and obesity in the elderly. It is not clear that our findings will generalize to younger patients who might be more easily managed and evaluated in the outpatient setting or to other surgical procedures. However, obesity in the elderly population has increased over the last three decades, and between 2003–2006 almost

one third of the population over the age of 60 was obese.[26] Similarly, the elderly population is expected to increase to nearly 20% of the overall population by the year 2030.[26] Therefore, given the increasing proportion of health care costs likely to be consumed by the elderly obese patient, it is important to understand the outcomes and risk factors for this population.

A limitation of our study is the focus on three main procedure groups: thoracotomy, colectomy (with and without cancer) and orthopedic procedures (hip and knee replacements, without fracture). These procedures were chosen for study because they are common in the Medicare population, but there may be variations in other types of procedures we were not able to identify. Additionally, the obese patients included in this study may be healthier than other Medicare patients in that they were able to find a surgeon who felt that the benefit of surgical intervention outweighed the risks of surgery. Thus, they may represent a less risky population of obese patients than the entire population of obese patients presenting for surgical evaluation, which would bias our results towards the null.

Obesity appears to be an independent risk factor for readmission after surgery for the elderly patient. The inability to include BMI in current risk-adjustment for readmission has the potential to unfairly penalize hospitals that treat a large number of obese patients, providing disincentives for providers to care for obese patients. As the body mass index is used routinely in the process of patient care, it is easily available and should be added to the list of elements abstracted for billing purposes to allow for reasonable risk adjustment in this challenging patient population. Further study is needed to determine how best to decrease the risk of readmission for obese patients as they seem to have similar reasons for readmission.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Abbreviations used

BMI	body mass index
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
FFS	Fee-for-service

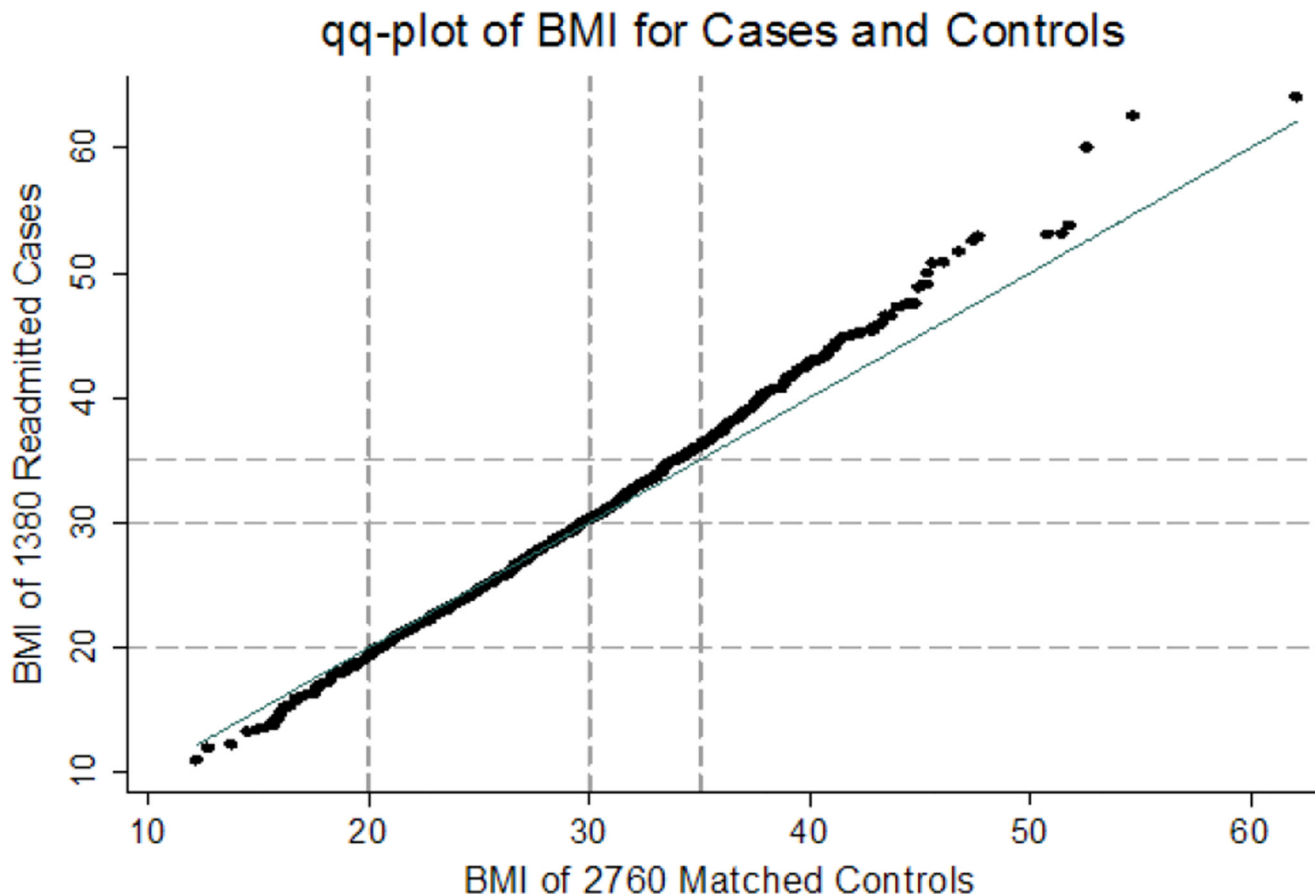**Figure 1. Quantile-quantile plot of body mass index for cases and controls**
The solid line indicates $x = y$, and dashed lines indicate BMI = 20, BMI = 30 and BMI = 35. After ordering the cases and controls, adjacent pairs of controls were averaged to allow a one-to-one plot of cases versus controls. As can be seen, patients with a BMI greater than 35 kg/m² were overrepresented among cases of readmission as compared to controls.

Table 1

Study Hospital Characteristics

Number of Hospitals	47
Size (Beds) Mean (sd)	423 (285)
Size Distribution	
0–200 (%)	15%
201–400 (%)	40%
401–600 (%)	28%
601–800 (%)	11%
>800 (%)	6%
Nurse to bed ratio [*]Mean (sd)	1.64 (0.44)
Teaching Intensity based on Resident to Bed Ratio (%)	
Non-Teaching (RB ratio = 0)	47%
Very Minor (0 < RB 0.05)	15%
Minor (0.05 <RB 0.25)	19%
Major (0.25 <RB 0.6)	13%
Very Major (0.6 < RB 1.1)	6%

[*]Full time equivalent registered nurses/number of beds

Table 2

PatientCharacteristics

Patient Characteristics	Cases (readmitted or died) N=1380	Controls N=2760	P-value
Age (years) mean	73.25	73.25	0.94 [*]
Sex			0.97 [†]
Female	51%	51%	
Male	49%	49%	
BMI category			
BMI<20	6%	5%	0.01 [†]
20 BMI <30	59%	63%	
30 BMI<35	19%	20%	
BMI 35	15%	12%	
Race			0.17 [†]
White	91%	91%	
Black	6%	5%	
Other	3%	3%	
Transfer Status			0.01 [†]
Nottransferred	99%	99%	
Transferred	1%	1%	
Emergent Status			<0.0001 [†]
Elective	86%	91%	
Emergent	14%	9%	
APACHE Score			
Mean (standard deviation)	26.8 (8.6)	25.4 (7.7)	<0.0001 [*]
Colectomy with cancer (all)	24%	24%	--
Left Colectomy	7%	7%	
Right Colectomy	15%	15%	
Total/Other	2%	2%	
Colectomy with out cancer (all)	11%	11%	--
Left	9%	9%	
Right	1%	1%	
Total/Other	1%	1%	
Hip with out fracture (all)	19%	19%	--
Total hip replacement	14%	14%	
Partial hip replacement	2%	2%	
Revision of hip replacement	3%	3%	
Knee (all)	24%	24%	--
Total knee replacement	22%	22%	
Revision of knee replacement	2%	2%	
Thoractomy (all)	22%	22%	--

Patient Characteristics	Cases (readmitted or died) N=1380	Controls N=2760	P-value
Lobectomy	13%	13%	
Pneumonectomy	1%	1%	
Wed geresection	8%	8%	
Other‡	0%	0%	

P-values compare non-obese to obese,

*
Wilcoxon's rank sum,

†
Fisher exact test,

‡
two cases and one control underwent other thoracotomy. Patients were matched with (i) exact matching for procedure, (ii) near-exact matching and near-fine balance for hospital, and (iii) balancing the means of age and sex

Table 3

The relationship between obesity and readmission controlling for differing covariates in conditional logistic models

Variables controlled for in model or match	Model 1	Model 2	Model 3
Procedure	Yes	Yes	Yes
Age	Yes	Yes	Yes
Sex	Yes	Yes	Yes
Hospital	Yes	Yes	Yes
Race	--	Yes	Yes
Emergency status	--	Yes	Yes
Transfer status	--	Yes	Yes
Comorbidities	--	--	Yes
Odds Ratio for readmission or death			
Obese:Nonobese	1.36	1.35	1.25
95% Confidence Interval	(1.12–1.66)	(1.10–1.65)	(1.01–1.55)
P-value	0.002	0.003	0.04
Odds Ratio for readmission (deaths before readmission excluded)			
Obese:Nonobese	1.35	1.34	1.23
95% Confidence Interval	(1.10–1.64)	(1.10–1.64)	(1.00–1.53)
P-value	0.004	0.005	0.05

Table 4

Reasons for readmission by procedure type

Normal Weight	Obese
BMI 20–30	BMI ≥ 35
N = 819 readmissions	N = 209 readmissions

COLECTOMY p = 0.67[†]	
N = 322	N = 49

GI Complications (33%)	GI Complications (36%)
Infection (19%)	Infection (19%)
Cardiac (9%)	Electrolyte/renal abnormality (8%)
Pulmonary (7%)	Cardiac (6%)
Electrolye/renal abnormality (7%)	Pulmonary (3%)
Bleeding (4%)	Bleeding (3%)
Urinary (3%)	Neurologic (3%)
Vascular (3%)	Ortho (3%)
Neurologic (3%)	Pain (3%)
Pain (2%)	Urinary (0%)
Psychiatric (0%)	Vascular (0%)
Ortho (0%)	Psychiatric (0%)
Other (11%)	Other (17%)

THORACOTOMY p = 0.82[†]	
N = 203	N = 31

Pulmonary (37%)	Pulmonary (44%)
Cardiac (13%)	Cardiac (22%)
GI complications (8%)	Infection (7%)
Infection (6%)	Neurologic (7%)
Bleeding (4%)	GI complications (4%)
Neurologic (3%)	Ortho (4%)
Electrolyte/renal abnormality (3%)	Bleeding (0%)
Pain (3%)	Electrolyte/renal abnormality (0%)
Psychiatric (2%)	Pain (0%)
Urinary (1%)	Psychiatric (0%)
Vascular (1%)	Urinary (0%)
Ortho (1%)	Vascular (0%)
Other (17%)	Other (11%)

ORTHOPEDIC PROCEDURE p = 0.91[†]	
N = 294	N=129

Ortho (23%)	Ortho (27%)
Cardiac (16%)	Infection (16%)

Normal Weight	Obese
Infection (14%)	Cardiac (12%)
Bleeding (9%)	GI complications (12%)
GI complications (7%)	Bleeding (10%)
Neurologic (5%)	Neurologic (4%)
Vascular (5%)	Pulmonary (4%)
Pulmonary (3%)	Vascular (3%)
Pain (3%)	Pain (3%)
Urinary (2%)	Electrolyte/renal abnormalities (2%)
Electrolyte/renal abnormalities (2%)	Urinary (1%)
Psychiatric (1%)	Psychiatric (0%)
Other (10%)	Other (9%)

[†]Fisher exact test to compare the distribution of reasons for readmission between the obese and normal weight patients. See online appendix for ICD-9 principal diagnosis codes associated with each reason for readmission.