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The Relationship Between Length of Stay and Readmissions in Bariatric Surgery Patients

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Abstract

Background—Hospital readmissions are a quality indicator in bariatric surgery. In recent years, length of stay following bariatric surgery has trended down significantly. We hypothesized that a shorter postoperative hospitalization does not increase the likelihood of readmission.

Methods—The University HealthSystem Consortium (UHC) is an alliance of academic medical centers and affiliated hospitals. The UHC's clinical database contains information on inpatient stay and returns (readmissions) up to 30 days post-discharge. A multicenter analysis of outcomes was performed using data from the January 2009 to December 2013 for patients 18 years and older. Patients were identified by bariatric procedure ICD-9 codes and restricted by diagnosis codes for morbid obesity.

Results—A total of 95,294 patients met inclusion criteria. The mean patient age was 45.4 (±0.11) years and 73,941 (77.6%) subjects were female. There were 5,423 (5.7%) readmissions within the study period. Patients with hospitalizations of 3 days and more than 3 days were twice and four times as likely to be readmitted than those with hospitalizations of one day, respectively (p<0.001).

Conclusions—Patients with longer postoperative hospitalizations were more likely to be readmitted following bariatric surgery. Early discharge does not appear to be associated with increased readmission rates.

Background

Hospital readmission rates have become a quality metric. The Affordable Care Act introduced the Hospital Readmission Reduction Program, which allows the Centers for

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Medicare and Medicaid Services (CMS) to penalize hospitals with higher than expected rates of readmission. Reducing readmissions has thus become an integral strategy in controlling costs and improving patient care.[1] Another major strategy for controlling health care costs has been to focus on decreasing the duration of hospital stay following surgical procedures. In bariatric surgery, publications describing successful 'fast track' programs for laparoscopic gastric bypass patients[2,3] have led to increasing pressure from insurance companies to discharge patients in 1 day or less.[4] There have been definite safety concerns regarding this policy.[5] What has received less attention is the possible relationship between decreased length of stay and readmissions following bariatric surgery. An emerging body of literature suggests that decreased length of stay may be associated with an increased rate of readmissions and increased overall cost of care for hospitalized patients.[6,7,8] Much of the referenced work has examined this relationship in cardiac patients, Medicare beneficiaries, and at Veteran's Hospitals. We sought to determine the relationship between length of stay following bariatric surgery and the rate of readmissions using a large national administrative database. Our hypothesis was that decreasing duration of hospital stay was not associated with an increased rate of readmission.

Methods

After institutional review board approval, a multicenter analysis of patient outcomes was performed using the University HealthSystem Consortium (UHC) clinical database (CDB/RM). The UHC is an alliance of 117 academic medical institutions and their 300 affiliated hospitals across the United States. The administrative database contains information on inpatient stay with readmission flags for returns up to 30 days post-discharge.[9] The database was queried for adult patients (18 years or older at the time of surgery) that underwent bariatric surgery from January 2009 to December 2013. Patients were selected using ICD-9 codes for laparoscopic Roux en-Y gastric bypass (LRYGB) - 4431, 4438, 4468; laparoscopic gastric banding (LAGB) – 4495; and laparoscopic sleeve gastrectomy (LSG) - 437, 4382, 4389. Patients must also have had an ICD-9 code for morbid obesity (2780, 27800, 27801) as their primary diagnosis. Additional variables collected for analysis from the database include age, race, sex, admission risk of mortality, admission severity of illness, comorbidities (#), length of stay, expected length of stay (used to calculate a length of stay index – observed/expected), readmission, time to readmission, complications, mortality, and cost.

The UHC database uses logistic regression analysis for risk adjustment of outcomes. The UHC risk-adjustment models involve 3 components: selection of a patient population to serve as the basis of the model (provide norms); use of multiple regression techniques to predict length of stay, direct cost, and probability of mortality based on the normative patient population; and assignment of an expected length of stay, direct cost, and probability of mortality to every patient in the database. UHC uses the 3M All Patient Refined-Diagnosis Related Grouper to estimate the severity of illness based on the "International Classification of Diseases, Ninth Revision, Clinical Modification" diagnosis and procedure codes. Furthermore, the Agency for Healthcare Research and Quality co-morbid states were used to estimate the illness severity by taking into account 29 specific co-morbid conditions. Each patient data point was assigned to an illness severity level according to a patient

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classification scheme that uses a combination of principal and secondary diagnosis, procedures, and specific patient factors. The 4 illness severity categories were minor, moderate, major, and extreme.

Patients were first grouped by procedure and compared using an analysis of variance (ANOVA) for continuous variables and a chi-square test was used for categorical variables. They were then grouped into readmission status and analyzed using a Student's t-test for continuous variables and a chi-square or Fisher's exact test for categorical variables. A logistic regression model was then built using a stepwise backward selection procedure. Variables not considered in the backward selection process include: time to readmission, difference between length of stay and expected length of stay, expected length of stay, length of stay index, and total cost. The reason the time to readmission variable was excluded from the model was because the variable only applied to those who were readmitted. The difference between length of stay and expected length of stay, expected length of stay, and length of stay index variables were excluded from the model because the information provided by the variables was also provided by the length of stay variable. Total cost was excluded from the model because of the range and distribution of the observations plus cost was missing in more than 3000 records. The variable for length of stay and the variable for number of comorbid conditions were discretized because the observations did not follow a normal distribution and were non-linear. Four categories were created for the length of stay variable: 1 day, 2 days, 3 days or more than 3 days. Six categories were created for the number of comorbid conditions variable: 0 conditions, 1 condition, 2 conditions, 3 conditions, 4 conditions, and more than 4 conditions. Statistical analysis was conducted using SAS 9.2 (SAS Institute, Cary, NC).

Results

A total of 95,294 patients met the inclusion criteria. The mean age of the study population was 45.6 (±0.04) years with 73,941 (77.6%) female subjects. There were a total of 5,423 (5.7%) readmissions within the study period with 83 (0.1%) reported deaths (Table 1). The majority of procedures performed during the study interval were LRYGB. When grouped by procedure, patients undergoing LRYGB experienced the highest rate of readmission followed by LSG and finally LAGB.

The characteristics of readmitted patients are presented in Table 2. Readmitted patients differed from those not readmitted in that they presented with more medical comorbidities, experienced longer primary hospitalizations, had a greater number of complications, and were more likely to have undergone LRYGB. The odds ratio for variables that correlated with increasing likelihood of readmission are depicted in Table 3. A longer duration of stay at the initial hospitalization, LRYGB surgery, increasing comorbidities, higher admission severity of illness, and postoperative complications were all associated with an increased risk of readmission. Patients successfully discharged in 1 day were most likely to have had a procedure other than LRYGB and least likely to have experienced a complication, readmission, or mortality (Table 4).

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Discussion

Using a large national dataset, we have determined that there is an inverse relationship between length of stay following bariatric surgery and hospital readmissions within 30 days of surgery. Increasing preoperative comorbidities, postoperative complications, and laparoscopic gastric bypass surgery (when compared to laparoscopic sleeve gastrectomy and adjustable gastric band placement) are also independently associated with an increased risk of readmission.

Our findings are similar to previously published literature examining hospital readmissions following bariatric surgery. Several single institution case series have identified laparoscopic gastric bypass and prolonged length of stay as significant risk factors for readmission.[10,11] Additional risk factors for readmission following bariatric surgery include patients who are unemployed, retired, disabled, or who have Medicaid or Medicare insurance.[12,13] A recently published review of 50,000 patients undergoing both laparoscopic gastric bypass and adjustable gastric band placement using BOLD (Bariatric Outcomes Longitudinal Database) revealed that LRYGB was associated with a significantly higher risk for readmission than LAGB. Prolonged length of stay (adjusted odds ratio 2.3 for both procedures) was the greatest predictor of readmission.[14] The most common reasons for readmission in the literature include post-surgical complications; poor pain control, nausea and vomiting, dehydration, and wound infections.[10–14]

A growing body of literature suggests that there may be a ‘tipping point’ with regards to length of stay and readmission risk in certain patients. Kaboli et al. reviewed more than 4 million medical admissions with subsamples of 2 chronic diagnoses (heart failure and chronic obstructive pulmonary disease) and 3 acute diagnoses (acute myocardial infarction, community-acquired pneumonia, and gastrointestinal hemorrhage) at 129 Veteran’s Hospitals over a period of 14 years. While simultaneous improvements in hospital length of stay and readmissions over 14 years was observed, hospitals with mean risk-adjusted length of stay that was lower than expected had a higher readmission rate, suggesting a modest tradeoff between hospital stay and readmission (6% increase for each day lower than expected).[6] Carey et al. estimated probability models for heart attack and for heart failure patients using generalized estimating techniques applied to hospital administrative data from California for calendar year 2008. The key independent variable was length of stay in the initial hospitalization. They found negative associations between length of stay and readmission probability, particularly in the case of heart attack. Simulated values of predicted readmissions based on a 1-day increase in length of stay yielded estimated reductions in readmission rates in the 7% to 18% range for heart attack patients and the 1% to 8% range for heart failure patients.[8] In General Surgery patients, using the NSQIP database, Tevis et al demonstrated that patients diagnosed with post discharge complications were significantly more likely to be readmitted (56%) compared with patients diagnosed with complications before discharge (7%, $P < 0.001$).[15] Independent predictors of post discharge complications included laparoscopic case, short hospital stay, preoperative dyspnea, and independent functional status. Gastrointestinal complications and surgical site infection were the most common reasons for readmission.

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This same inverse relationship between length of stay and readmissions does not appear to apply to bariatric surgery patients. Carter et al. published an analysis of nearly 10,000 patients undergoing laparoscopic gastric bypass in the 2011 NSQIP (National Surgical Quality Improvement Program) dataset and determined that the median length of stay was 2 days.[16] From this cohort, 26% of patients required > 3 days of hospitalization following the primary procedure. Patients with a length of stay longer than 3 days were significantly more likely to be readmitted to the hospital within 30-days of surgery. While the focus of our study was to look at factors associated with readmissions, Carter's study examined factors correlated with prolonged length of stay. They determined that on multivariate analysis, longer hospitalizations were predicted by diabetes, chronic obstructive pulmonary disease, bleeding diathesis, renal insufficiency, hypoalbuminemia, prolonged operative time, and resident involvement in the procedure but not with patient age, body mass index, or other comorbidities. This suggests that patient factors that are not easily modified may be associated with a prolonged length of stay and perhaps readmission. While we did not evaluate the impact of specific comorbidities on readmission rates, we did find that the number of comorbidities was predictive of readmission (odds ratio 1.4 for > 5 comorbidities compared to none). In addition, admission severity of illness (SOI) is a metric created by 3M's APR-DRG Grouper using logistic regression analysis of patient data such as age, comorbid conditions, and diagnosis. This metric has been previously validated as a predictor of patient outcomes and reflects the overall health of the individual.[17]

In our study, the lowest rates of readmission were observed in the patients discharged in the least amount of time following surgery. "Fast-tracking" patients following laparoscopic bariatric surgery is a controversial notion. While several publications have described successful fast track[2,3,18] and enhanced recovery[19] programs following laparoscopic bariatric surgery, others have cautioned that such a program applied non-selectively can lead to significant patient morbidity and even mortality. One prominent health care consulting firm has issued a guideline indicating that a goal length of stay for LRYGB should be 1 day or less.[4] Morton et al. used BOLD to determine that in 50,000 laparoscopic gastric bypass procedures, length of stay of 1 day or less was significantly associated with an increased risk of 30-day mortality (ambulatory odds ratio 13.02 and 1 day length of stay odds ration 2.02 compared to median length of stay of 2 days).[5]

While discharge in one day or less is certainly possible, median length of stay is closer to 2 days for most patients. The goal of a program or response to this study should not be to strive to discharge all patients in one day or less - the key is to discharge the right patients in the right circumstances in one day when feasible. Based on Carter's study, the right patients would lack specific comorbidities known to be associated with a longer expected length of stay (diabetes, COPD, renal insufficiency for example) and they would have undergone a technically short operation free of intraoperative difficulty with a smooth postoperative recovery. From a practical perspective and based on data in our study, patients who require > 3 days to successfully meet discharge criteria, especially if they have undergone a gastric bypass or experienced a complication are at higher risk for readmission. These patients may benefit from additional efforts to avoid readmission such as frequent post-discharge phone calls, scheduled follow-up visits at an earlier interval, or other tactics based on their medical condition and social situation. Additional strategies for potentially reducing admissions

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following bariatric surgery described in the literature include preoperative education and expectation setting, standardized discharge process, same day appointments with the ability to provide intravenous infusions if needed, ready patient access to appropriate multidisciplinary bariatric team personnel (nurse, surgeon, dietician, pharmacist, etc.), and access to a clinical decision unit for 23 hour stays rather than readmission when indicated.[5,12–16,20]

Many, if not most readmissions may be related to risk factors that cannot be modified (age and comorbidities for example). While the decision to perform a procedure known to be associated with a lower risk of readmission (laparoscopic adjustable gastric band) is theoretically a modifiable risk factor, selecting a procedure based on this fact is not medically appropriate for all patients. Each procedure has specific risks and benefits that are important to take into consideration for each patient individually, based on their medical and surgical history as well as their treatment goals. Not all readmissions are avoidable. Not all readmissions represent poor quality care either. The decision to readmit a patient recently discharged is often the best option for appropriate care. In fact, readmissions may represent an early rescue of a patient at risk for more adverse outcomes in certain cases.[21] A recent study evaluating pancreaticoduodenectomy in Medicare patients revealed that hospitals with the lowest readmission rates also had the highest mortality rates.[22] Perhaps the decision to rehospitalize patients reflects good judgment rather than poor care, and other authors have acknowledged that perhaps readmission after surgery is unavoidable.[23]

This study has several limitations. Factors that may correlate with hospital readmissions such as care protocols and pathways utilized were not available in the dataset. The UHC data is administrative and based on billing records. Readmission rates have been demonstrated to vary based on collection method (administrative vs. clinical).[24] The data in the UHC dataset is only as good as what is entered in the patient record and available for extraction by hospital coders. Clinical databases like NSQIP more accurately capture these data.[25] Regardless of these shortcomings, we feel that the size of the dataset (nearly 100,000 bariatric surgery patients) provides significant statistical power for evaluating the relationship between length of stay and readmission rates. Future studies examining this issue using the NSQIP data set or the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program data should provide additional insights into risk factors for readmission and strategies to decrease avoidable readmissions following bariatric surgery.

Conclusion

Patients with longer postoperative hospitalizations were more likely to be readmitted following bariatric surgery. Early discharge does not appear to be associated with increased readmission rates. Hospitals capable of efficiently discharging patients sooner may have other factors favoring a lower likelihood of readmission not discernable from the current data. The patients successfully discharged earlier may also be different than those who ultimately stay longer. In addition to prolonged length of stay, complications, gastric bypass, and increased number of comorbidities are also associated with an increased risk of readmission. Targeted interventions for patients with specific risk factors for readmission may be an effective strategy for reducing readmissions after bariatric surgery.

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References

1. Kocher RP, Adashi EY. Hospital Readmissions and the Affordable Care Act: Paying for Coordinated Quality Care. JAMA. 2011; 306:1794–5. [PubMed: 22028355]
2. Elliott JA, Patel VM, Kirresh A, Ashrafian H, Le Roux CW, Olbers T, et al. Fast-track laparoscopic bariatric surgery: a systematic review. Updates Surg. 2013; 65:85–94. [PubMed: 23371325]
3. McCarty TM, Arnold DT, Lamont JP, Fisher TL, Kuhn JA. Optimizing outcomes in bariatric surgery: outpatient laparoscopic gastric bypass. Ann Surg. 2005; 242:494–8. [PubMed: 16192809]
4. Milliman Company. Milliman Care Guidelines Ambulatory Care. 14. Seattle (WA): 2010.
5. Morton JM, Winegar D, Blackstone R, Wolfe B. Is ambulatory laparoscopic Roux-en-Y gastric bypass associated with higher adverse events? Ann Surg. 2014; 259:286–92. [PubMed: 24169190]
6. Kaboli PJ, Go JT, Hockenberry J, Glasgow JM, Johnson SR, Rosenthal GE, et al. Associations between reduced hospital length of stay and 30-day readmission rate and mortality: 14-year experience in 129 Veterans Affairs hospitals. Ann Intern Med. 2012; 157:837–45. [PubMed: 23247937]
7. Carey K, Lin MY. Hospital length of stay and readmission: an early investigation. Med Care Res Rev. 2014; 71:99–111. [PubMed: 24132581]
8. Carey K. Measuring the Hospital Length of Stay/Readmission Cost Trade off Under a Bundled Payment Mechanism. Health Econ. 2014 in press.
9. Sutton JM, Hayes AJ, Wilson GC, Quillin RC, Wima K, Hohmann S, et al. Validation of the University Health System consortium administrative dataset: Concordance and discordance with patient-level institutional data. J Surg Res. 2014; 190:484–90. [PubMed: 24909867]
10. Saunders J, Ballantyne GH, Belsley S, Stephens DJ, Trivedi A, Ewing DR, et al. One-year Readmission Rates at a High Volume Bariatric Surgery Center: Laparoscopic Adjustable Gastric Banding, Laparoscopic Gastric Bypass, and Vertical Banded Gastroplasty-Roux-en-Y Gastric Bypass. Obes Surg. 2008; 18:1233–40. [PubMed: 18452051]
11. Baker MT, Lara MD, Larson CJ, Lambert PJ, Mathiason MA, Kothari SN. Length of stay and impact on readmission rates after laparoscopic gastric bypass. Surg Obes Relat Dis. 2006; 2:435–9. [PubMed: 16925375]
12. Hong B, Stanley E, Reinhardt S, Panther K, Garren MJ, Gould JC. Factors associated with readmission after laparoscopic gastric bypass surgery. Surg Obes Relat Dis. 2012; 8:691–95. [PubMed: 21978746]
13. Kellogg TA, Swan T, Lesli DA, Buchwald H, Ikramuddin S. Patterns of readmission and reoperation within 90 days after Roux-en-Y gastric bypass. Surg Obes Relat Dis. 2009; 5:416–24. [PubMed: 19540169]
14. Dorman RB, Miller CJ, Leslie DB, Serrot FJ, Slusarek B, Buchwald H, et al. Risk for Hospital Readmission following Bariatric Surgery. PLoS ONE. 2012; 7:e32506. [PubMed: 22412881]
15. Tevis SE, Kohlnhofer BM, Weber SM, Kennedy GD. Post discharge complications are an important predictor of postoperative readmissions. Am J Surg. 2014; 208:505–10. [PubMed: 25150195]
16. Carter J, Elliott S, Kaplan J, Lin M, Posselt A, Rogers S. Predictors of hospital stay following laparoscopic gastric bypass: analysis of 9,593 patients from the National Surgical Quality Improvement Program. Surg Obes Relat Dis. 2014 in press.
17. Reynoso JF, Tiwari MM, Tsang AW, Oleynikov D. Does illness severity matter? A comparison of laparoscopic esophagomyotomy with fundoplication and esophageal dilation for achalasia. Surg Endosc. 2011; 25:1466–71. [PubMed: 20976492]

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18. Geubbels N, Bruin SC, Acherman Y, van de Laar A, Hoen MB, Brauw L. Fast Track Care for Gastric Bypass Patients Decreases Length of Stay Without Increasing Complications in an Unselected Patient Cohort. Obes Surg. 2014; 24:390–6. [PubMed: 24254930]
19. Lemanu DP, Singh PP, Berridge K, Burr M, Birch C, Babor R, et al. Randomized clinical trial of enhanced recovery versus standard care after laparoscopic sleeve gastrectomy. Br J Surg. 2013; 100:482–89. [PubMed: 23339040]
20. Dallal RM, Trang A. Analysis of perioperative outcomes, length of hospital stay, and readmission rate after gastric bypass. Surg Endosc. 2012; 26:754–8. [PubMed: 22011941]
21. Brown RE, Qadan M, Martin RC II, Polk HC. The evolving importance of readmission data to the practicing surgeon. J Am Coll Surg. 2010; 211:558–60. [PubMed: 20729104]
22. Hyder O, Dodson RM, Nathan H, Schneider EB, Weiss MJ, Cameron JL, et al. Influence of patient, physician, and hospital factors on 30-day readmission following pancreatoduodenectomy in the United States. JAMA Surg. 2013; 148:1095–102. [PubMed: 24108580]
23. Kent T, Sachs TE, Callery MP, Vollmer CM. Readmission after major pancreatic resection: a necessary evil? J Am Coll Surg. 2011; 213:515–23. [PubMed: 21840738]
24. Hechenbleikner EM, Makary MA, Samarov DV, Bennett JL, Gearhart SL, Efron JE, et al. Hospital readmission by method of data collection. J Am Coll Surg. 2013; 216:1150–8. [PubMed: 23583617]
25. Davenport DL, Holsapple CW, Conigliaro J. Assessing surgical quality using administrative and clinical data sets: a direct comparison of the University HealthSystem Consortium Clinical Database and the National Surgical Quality Improvement Program data set. Am J Med Qual. 2009; 24:395–402. [PubMed: 19584374]

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Table 1

Patient demographics and outcomes by type of procedure.

	LRYGB	LSG	LAGB	Total
Patients (% of total)	58,036 (60.9)	26,669 (28.0)	10,589 (11.1)	95,294 (100)
Age (years)	45.5 (±0.05)	45.5 (±0.07)	46.4 (±0.12)	45.6 (±0.03)
Female (% of group)	45,697 (78.7)	20,262(76.0)	7,982 (75.4)	73,941 (77.6)
Race				
Caucasian (%)	41,524 (72.1)	17,004 (64.7)	7,518 (71.5)	66,046 (70.0)
African-American (%)	9,916 (17.2)	5,795 (22.0)	1,805 (17.2)	17,516 (18.6)
Asian (%)	230 (0.4)	137 (0.5)	60 (0.6)	427 (0.5)
Other (%)	5,902 (10.2)	3,362 (12.6)	1,900 (17.9)	11,164 (11.7)
Unknown	464	371	70	905
Comorbidities (n)	1.93 (±0.01)	1.95 (±0.01)	1.54 (±0.01)	1.89 (±0.01)
Complications (%)	637 (1.1)	360 (1.3)	37 (0.3)	1,034 (1.1)
Length of Stay (days)	2.45 (±0.01)	2.73 (±0.01)	1.28 (±0.01)	2.36 (±0.01)
LOS Index (O/E)	1.03(±0.00)	0.91 (±0.00)	0.57 (±0.00)	--
Readmissions (%)	1,482 (5.6)	3,655 (6.3)	286 (2.7)	5,423 (5.7)
Mortality (%)	34 (0.1)	46 (0.2)	3 (0.0)	83 (0.1)

LRYGB=laparoscopic gastric bypass; LSG=laparoscopic sleeve gastrectomy; LAGB=laparoscopic adjustable gastric band; LOS Index (O/E)= length of stay index (observed to expected). All comparisons are statistically significant ($p<0.001$).

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Table 2

Characteristics of readmitted vs. non-readmitted patients

	Readmitted	Not Readmitted	*p*-value
Patients (%)	5,423 (5.7)	89,871 (94.3)	-
Age (years)	46.11 (±0.17)	45.92 (±0.11)	<0.001
Female (%)	4,315 (79.6)	69,626 (77.5)	<0.001
Race			<0.001
Caucasian (%)	3435 (63.6)	62611 (70.4)	-
African-American (%)	1413 (26.2)	16103 (18.1)	-
Asian (%)	21 (0.4)	406 (0.5)	-
Other (%)	528 (9.8)	9,869 (11.0)	-
Unknown	26	879	-
Comorbidities (n)	2.22 ± 0.21	1.87 ± 0.01	<0.001
Severity of Illness			<0.001
Mild	2643 (48.7)	53492 (59.5)	-
Moderate	2365 (43.6)	34036 (37.9)	-
Major	380 (7.0)	2249 (2.5)	-
Extreme	35 (0.6)	94 (0.1)	-
Complications	178 (3.3%)	856 (1.0%)	<0.001
Procedure			<0.001
LRYGB (%)	3,655 (67.4)	54381 (60.5)	-
LSG (%)	1,482 (27.3)	25,187 (28.0)	-
LAGB (%)	286 (5.3)	10,303 (11.5)	-
Length of Stay (days)	3.73 (±0.05)	2.32 (±0.01)	<0.001
LOS Index (O/E)	1.20±0.1	0.87±0.01	<0.001
Cost ($)	18,028 (±210)	14,325 (±101)	<0.001

LRYGB=laparoscopic gastric bypass; LSG=laparoscopic sleeve gastrectomy; LAGB=laparoscopic adjustable gastric band; LOS Index (O/E)= length of stay index (observed to expected). All comparisons are statistically significant (p<0.001).

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Table 3

The effect of select variables on the likelihood of readmission

	Odds Ratio of Readmission	Confidence Interval	*p*-value
Length of Stay			<0.001
1 Days	1.00	-	-
2 Days	1.16	1.05–1.28	-
3 Days	2.04	1.83–2.27	-
> 3 Days	3.91	3.51–4.36	-
LRYGB	1.28	1.2–1.37	<0.001
LSG	1.00		-
LAGB	0.79	0.69–0.91	<0.001
Comorbid Conditions			<0.001
0 Comorbidities	1.00	-	-
1 Comorbidity	1.10	0.99–1.21	-
2 Comorbidities	1.11	1.00–1.22	-
3 Comorbidities	1.27	1.14–1.42	-
4 Comorbidities	1.30	1.14–1.47	-
≥5 Comorbidities	1.40	1.20–1.62	-
Complications			0.03
0 Complications	1.00	-	-
1 Complication	1.26	1.04–1.52	-
2 Complications	1.91	1.21–3.03	-
≥3 Complications	2.11	0.718–6.19	-
Severity of Illness			<0.001
Mild	1.00	-	-
Moderate	1.12	1.05–1.2	-
Major	1.48	1.27–1.72	-
Extreme	2.59	1.50–4.47	-

LRYGB=laparoscopic gastric bypass; LSG=laparoscopic sleeve gastrectomy; LAGB=laparoscopic adjustable gastric band

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Table 4

Patient characteristics and outcomes based on length of stay

	1 Day	2 Days	3 Days	>3 Days
Patients (%)	21,545 (22.6)	48,234 (50.6)	15,516 (16.3)	9,999 (10.5)
Female (%)	16,385 (76.1)	37,848 (78.5)	12,226 (78.8)	7,482 (74.8)
Age (years)	45.1 (12.1)	44.8 (11.5)	46.2 (11.8)	49.8 (12.5)
Comorbidities	2.0 (1.0)	2.2 (1.1)	2.4 (1.3)	2.8 (1.5)
Race				
Caucasian (%)	15,258 (70.8)	34,003 (70.4)	10,144 (65.4)	6,641 (66.4)
African-Am. (%)	3,752 (17.4)	8,312 (17.2)	3,262 (21.0)	2,190 (21.9)
Asian (%)	94 (0.4)	222 (0.4)	63 (0.4)	48 (0.5)
Other (%)	2,123 (9.9)	5,305 (11.0)	1,885 (12.1)	1,087 (10.9)
Unknown (%)	318 (1.5)	392 (0.8)	162 (1.0)	33 (0.3)
Procedure				
RYGB (%)	7,423 (34.5)	33,782 (70.0)	10,848 (69.9)	5,983 (59.8)
LSG (%)	5,203 (24.1)	13,304 (27.6)	4,391 (28.3)	3,771 (37.7)
LAGB (%)	8,919 (41.4)	1,148 (2.4)	277 (1.8)	245 (2.5)
Complications (%)	14 (0.1)	87 (0.2)	130 (0.8)	933 (9.3)
Readmissions (%)	665 (3.1)	2,068 (4.3)	1186 (7.6)	1504 (15.0)
Mortality (%)	8 (0.0)	7 (0.0)	7 (0.0)	61 (0.6)

*All p-values significant and < 0.001