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Six-month readmissions after bariatric surgery: Results of a nationwide analysis

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A R T I C L E   I N F O

A B S T R A C T

Background: Morbidity and mortality after laparoscopic bariatric surgery have decreased steadily during the past 2 decades. National data on the rates at which these patients may require return to the hospital beyond 30 days are lacking. We aimed to determine the national burden and causes of readmission after the 3 most common bariatric procedures in the United States.
Methods: All adult patients with morbid obesity (>18 years old) who underwent a laparoscopic adjustable gastric banding, laparoscopic sleeve gastrectomy, or laparoscopic gastric bypass between 2010 and 2015 were identified using *International Classification of Diseases, Ninth Revision* codes from the Nationwide Readmission Database. The Nationwide Readmission Database permits longitudinal tracking of patients between hospital admissions and allows for nationally weighted estimates. The primary outcome was 180-day readmission; secondary outcomes included causes, mortality, time to readmission, costs, and procedures during readmission. Multivariate logistic regression models were used to determine factors associated with increased 180-day readmission after adjusting for differences in patient and hospital characteristics.
Results: Records from 228,043 patients were identified, of whom 10.1%, 36.1%, and 53.9% underwent laparoscopic adjustable gastric banding, laparoscopic sleeve gastrectomy, and laparoscopic gastric bypass, respectively. The overall 180-day readmission rate was 10.8% (laparoscopic adjustable gastric banding 8.3%, LGS 7.8% and laparoscopic gastric bypass 13.2%). Readmission analysis showed that 64.5% were directly relates directly to the index procedure, 31.2% were readmitted to a different hospital, the median time to readmission was 28 days (interquartile ratio 9–77), 23.9% had a gastrointestinal procedure, and 0.48% died within the 180-day readmissions. Factors independently associated with increased readmission were the following: greater preoperative comorbidities (Charlson Comorbidity Index ≥2, odds ratio 1.32; 95% confidence interval, 1.22–1.44); either Medicare status (1.84 [1.72–1.97]) or Medicaid status (1.60 [1.48–1.73]) relative to private insurance; moderate (1.09 [1.03–1.15]) or major (1.33 [1.13–1.56]) severity of illness relative to minor Nationwide Readmission Database-provided severity of illness; nonresident of state where they were admitted initially (1.49 [1.31–1.69]); discharge to a health care system other than home (1.70 [1.46–1.97]); short-term hospital 1.70 [1.46 –1.97]); admission to private hospital (1.11 [1.01–1.22]) relative to nonprofit hospital; prolonged duration of initial hospital stay (1.81 [1.70-1.92]); and a serious adverse event occurring during the index admission (1.20 [1.02–1.42]). Patients who were readmitted had an incremental mean difference of $15,781 (95% confidence interval, $15,168–$16,394.4; *P* < .001) in total costs.
Conclusion: Readmissions after bariatric surgery continue to occur even 6 months after discharge. Most of these readmissions were related directly to the index procedure. Almost a fourth of those

patients who were readmitted d required a procedure and almost a third presented to a different hospital than the hiatal of their initial operation. These readmissions carry a substantial burden for the health care system and may impair quality of life for patients. Strategies targeted to prevent readmissions beyond the traditional 30-day benchmark are warranted in this population.

Introduction

In the United States, the number of bariatric procedures continues to increase every year. The American Society for Metabolic and Bariatric Surgery estimated an increase in bariatric surgery from 158,000 cases in 2011 to 228,000 cases in 2017.[1] Laparoscopic gastric band (LGB), laparoscopic sleeve gastrectomy (LSG), and the laparoscopic gastric bypass (LGBP) are the most prevalent.[1] Although these procedures have proven to be safe, have low complication rates,[2] and have a short duration of hospital stay,[3] recovery may be more difficult in a proportion of patients who require a return to the hospital.

Readmission is one of the current quality metrics and a decrease in the readmission rate is one of the strategies proposed by the Centers for Medicare and Medicaid Services (CMS) in an effort to improve quality of care and to decrease healthcare cost.[4] The 30-day readmission rate after bariatric surgery has been reported to range between 4% to 10 %,[5–11] but there are recent data suggesting that the risk for readmission after bariatric procedures extends beyond the 30-day benchmark.[12] More than a third of patients present to the emergency department at least once within 1 year,[7,12] and more than a quarter (26%) get readmitted within 2 years.[6] Moreover, readmissions are costly and tend to be linked to expensive interventions. These readmissions can increase the average costs of bariatric procedures up to a 2.5-fold.[13] Although these prior studies have characterized readmissions after bariatric surgery reasonably well, the published studies have been limited by single-institution or statewide data, nationwide convenient sampling (such as the bariatric surgery database of the American College of Surgeons National Surgical Quality Improvement Program), or by the inability to track readmissions to different hospitals.

To date, there are no data on the rates at which these patients may require return to the hospital beyond 30 days from any nationally representative cohort. The objective of this study was to determine the national burden and causes of 180-day readmission after the 3 most common bariatric procedures in the United States.

Methods

Study population

Using the 2010 to 2015 Nationwide Readmission Database (NRD), we included patients undergoing bariatric procedures as defined by the *International Classification of Diseases, Ninth Revision* (ICD-9), procedure codes for laparoscopic gastric restrictive procedure (44.95, referred to as laparoscopic gastric band [LGB]), laparoscopic vertical gastrectomy (43.82, referred to as laparoscopic gastric sleeve, which we will refer to as a laparoscopic sleeve gastrectomy [LSG]) and laparoscopic gastroenterostomy (44.38, referred to as laparoscopic gastric bypass [LGBP]), who also had an ICD-9 diagnosis code of morbid obesity (278.01) during the index admission. Patients with incomplete follow up were excluded. For calendar years 2010 to 2014, data from January until June were used to allow for a follow-up of 180 days. Data from the 2015 quarter 4 were excluded for analysis because of the nationwide transition from ICD-9 to ICD-10 codes that occurred during

this period. Therefore, for calendar year 2015, only data from January until March were used. Patients aged <18 years and transfers were excluded. Patients in strata with single units were excluded to allow statistical tests in weighted analyses.

Data source

The NRD was developed through a Federal-State-Industry partnership sponsored by the Agency for Healthcare Research and Quality and is comprised of data collected from all hospitalizations occurring in each of the 27 contributing states. Unweighted, it contains data from approximately 17 million discharges each year. The NRD contains sampling weights to create national estimates of readmissions in the United States. It also comprises data on individuals of all ages and all payers plus the uninsured. There are >100 clinical and nonclinical variables available for each hospital stay, including demographics, payer, *International Classification of Diseases, Clinical Modification, Ninth Edition,* diagnosis and procedure codes, duration of stay, discharge disposition, timing between admissions for patients, identification of transfers, same-day stays, identification of patients who reside within the state, and hospital characteristics (size, teaching status, ownership status, urban-rural designation).[14]

Demographic, clinical, and hospital related characteristics

The demographic and clinical and hospital-associated variables analyzed included age, sex, payer (Medicare, Medicaid, private, self-pay, no charge, other), ZIP code income quartile (0–25th percentile, 26–50th percentile, 51–75th percentile, and 76–100th percentile), NRD-provided risk of mortality (minor, moderate, major, or extreme likelihood of dying), NRD-provided severity of illness (minor loss, moderate loss, major loss, or extreme loss of function), disposition after the index hospital stay disposition (home or routine; home with home health care; short-term hospital, skilled nursing facility, intermediate care facility, or another type of facility; against medical advice), Charlson Comorbidity Index (CCI, <2 or ≥2), prolonged duration of stay (>75th percentile), type of bariatric procedure, hospital ownership (government; private not-profit; private, invest-own), bedsize of hospital (small, medium, or large), teaching status (metropolitan nonteaching, metropolitan teaching, nonmetropolitan), and hospital urban-rural designation.

Outcome measures

The primary outcome was the 180-day readmission rate after the targeted bariatric procedures. This rate was a proportion of patients who were subsequently admitted to any hospital within 180 days of discharge among the total number patients who underwent bariatric procedures. For purposes of readmission analysis, patients who died during the index admission were excluded (n = 117, 0.001% of the entire cohort), and patients with multiple readmissions during the study period were only counted once. We identified readmissions likely related to bariatric procedures using the framework of a prior Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP)

study. We matched the diagnoses listed in their study as causes of readmissions likely related to index procedure to corresponding ICD9-CM diagnosis codes (Appendix I).[15] The percentage of readmissions all within 180 days related directly to each bariatric procedure was reported. The secondary outcomes were reason for readmission, readmission to a different hospital, days to readmission, gastrointestinal procedures category during readmission (given by the first 2 ICD-9 procedure code group), total costs, and mortality at time of readmission, all within 180 days. The reason for readmission was defined as the first NRD-defined "not chronic condition" ICD-9 diagnosis code at the time of the readmission or by the primary ICD-9 diagnosis code at the time of the readmission whenever there were no ICD-9 diagnoses codes classified as "not chronic condition." The reasons for readmission were clustered by the 3-code ICD-9 diagnosis group for ranking purposes and were stratified according to type of bariatric procedure. The 30-day readmission rate was also included as a secondary outcome given that this is the standard CMS readmission benchmark.

Inpatient utilization burden, estimation of total costs

The NRD provides charges for each admission, which were converted to costs using the provided cost-to-charge ratios of the Healthcare Cost and Utilization Project. Total costs were obtained for those patients who were readmitted by adding the cost of the index admission to the costs of their readmission within 180 days. These costs were normalized to US dollars in 2015 using the Consumer Price Index. Aggregate costs of the entire cohort and for each subgroup were estimated and annualized as a measure of inpatient utilization burden.

Statistical analysis

Descriptive statistics were used to analyze demographic, clinical, and hospital characteristics as well as for readmission rates and the most common causes for readmission. Risk-adjusted multivariable logistic regression was used to determine factors associated with increased 180-day readmission. Risk-adjusted generalized linear models followed by postestimation calculations of average marginal effects were used to obtain predicted mean differences in costs (incremental costs) with a 95% CI between nonreadmitted and readmitted patients. Potential confounders were identified a priori, and those with P values $< .20$ were included in the model. NRD survey weights were used to generate national estimates. All the analyses were performed using Stata Statistical Software, release 15 (College Station, TX). The present study was approved by the Thomas Jefferson University Institutional Review Board. Continuous variables are presented as mean (standard deviation).

Results

A total of 228,043 patients underwent laparoscopic bariatric surgery during the study period. Univariate analysis showed that patients who were readmitted were similar in age (mean [SD], 46 [12] vs 45 [12]; $P < .001$), but were more likely to have more comorbidities (CCI ≥ 2, 19.8% vs 11.5%), a greater proportion of public insurance and lesser proportion of private insurance (Medicare, 27.9% vs 16%; Medicaid, 16.1% vs 11.7%; private insurance 49.9% vs 64.6%; $P < .001$), and differed in terms of socioeconomic status given by median household income ($P < .001$). This cohort also had a greater risk of mortality and severity of illness ($P < .001$), were somewhat less likely to be residents from the same state (94.1% vs 92%; $P < .001$), less likely to be discharged home (94.6% vs

98%; $P < .001$), more likely to be admitted to a large hospital (63.5% vs 58.9%; $P < .001$), more likely to have prolonged duration of stay (31.7% vs 16.5%; $P < .001$), and have a serious adverse event during the index admission (5% vs 1.7%; $P < .001$; Table I).

Readmission rate at 30 and 180 days were 5.4% and 10.8%, respectively. The bariatric procedure with the greatest readmission rate was LGBP (13.2%), followed by LGB (8.3%) and LSG (7.8%). Readmission analyses demonstrated that 31.2% of readmissions occurred in a different hospital. The median time to readmission was 28 days (interquartile range 9–77). A total of 23.9% of patients underwent a gastrointestinal intervention at the time of readmission, most commonly operations on the stomach (39%); repair of hernia (15.9%); incision, excision, and anastomosis of intestine (10.4%); incision and excision of stomach (8.9%); other operations on abdominal region (5.8%); or operations on liver (4.9%). The mortality rate within 180-day readmissions was 0.5% (Table II). Relative to 180-day readmissions, 21% of readmissions occurred during the first week after discharge, 12% on the second week, 9% on the third week, and 7% on the fourth week, reaching about half of all readmissions (50.6%) at 30 days (Figure).

The most common causes for readmission included complication of procedure involving an implant, complication of the procedure (such as of postoperative infection, hemorrhage, hematoma, seroma, etc), disorders of fluid, electrolyte, and acid-base balance, symptoms involving the digestive system, and complications affecting the digestive or cardiac system (Table III).

Multivariate logistic regression showed the factors associated with increased 180-day readmission (Table IV). LGB and LSG were 35% and 38% less likely to be readmitted compared with LGBP. Factors independently associated with increased readmissions were a greater preoperative prevalence of comorbidities (CCI ≥ 2, OR 1.32; 95% CI, 1.22–1.43), Medicare (1.86 [1.73–1.99]) or Medicaid (1.61 [1.48–1.74]) insurance, moderate (1.09 [1.03–1.15]) or major (1.34 [1.14–1.57]) loss of function, moderate mortality risk (1.24 [1.10–1.34]), non-resident of where they were initially admitted (1.47 [1.30–1.67]), discharge to other than home ($P < .01$), admission to private invest–own hospital (1.11 [1.01–1.22]), prolonged duration of stay at the index operation (1.81. [1.70–1.92]), and a serious adverse event during index admission (1.20 [1.02–1.42]). Factors independently associated with decreased 180-day readmissions included LGB and LSG relative to LGBP, self-pay or uninsured relative to private insurance, and elective admission status (Table IV).

Inpatient utilization costs

The total mean costs for the nonreadmitted group compared to the readmitted group were $11,587 (SD $5,988.81) vs $29,856.02 (SD $31,976.39; $P < .001$). Patients who were readmitted had an incremental mean difference of $15,781 (95% CI, $15,168–$16,394.4; $P < .001$). The aggregate costs of the entire study cohort were $1.34 billion, involving $1.03 billion for the non-readmitted subgroup and $315 million for the readmitted group ($144 million during their index admission and $170 million during their readmission). This aggregate cost was annualized to $489 million involving $374 million for the non-readmitted subgroup and $114.5 million for the readmitted group ($52.5 million during their index admission and $62 million during their readmission).

Discussion

Readmissions have become particularly relevant since the Affordable Care Act mandated the CMS to establish the Hospital

Table I
Demographic, clinical, and hospital characteristics of patients undergoing bariatric procedures by readmission status at 180 days, weighted to represent national estimates

	Non readmitted		Readmitted		P value
All patients, % by row	203,501	89.24%	24,542	10.76%	
Age, mean (SD)	44.83	12	46.15	12.2	<.001
Female, % by column	158,857	78.06%	19,039	77.58%	.398
Charlson Index, % by column					<.001
<2	180,193	88.55%	19,676	8.18%	
≥2	23,308	11.45%	4,865	19.82%	
Payer, % by column					<.001
Medicare	32,497	15.97%	6,839	27.86%	
Medicaid	23,719	11.66%	3,956	16.12%	
Private insurance	131,455	64.60%	12,253	49.93%	
Self-pay	7,598	3.73%	509	2.07%	
No charge	158	0.08%	15	.06%	
Other	7,880	3.87%	965	3.93%	
Missing	194	0.10%	*	.02%	
Median household income, % by column					<.001
0–25th percentile	45,446	22.33%	6,231	25.39%	
26–50th percentile	50,372	24.75%	6,319	25.75%	
51th–75th percentile	53,974	26.52%	6,317	25.74%	
76–100th percentile	50,620	24.87%	5,303	21.61%	
Missing	3,089	1.52%	373	1.52%	
Risk of mortality, % by column					<.001
Minor likelihood of dying	189,917	93.32%	20,996	85.55%	
Moderate likelihood of dying	12,011	5.90%	2,865	11.67%	
Major likelihood of dying	1,252	0.62%	515	2.10%	
Extreme likelihood of dying	309	0.15%	164	.67%	
Severity of Illness, % by column					<.001
Minor loss of function (includes cases with no comorbidity or complications)	122,033	59.97%	12,358	5.36%	
Moderate loss of function	76,276	37.48%	10,377	42.28%	
Major loss of function	4,687	2.30%	1,522	6.20%	
Extreme loss of function	493	0.24%	283	1.15%	
Same state resident, % by column	187,268	92.02%	23,088	94.08%	<.001
Type of discharge, % by column					<.001
Home	199,717	98.14%	23,220	94.61%	
Short-term hospital	48	0.02%	25	.10%	
SNF, ICF, other	317	0.16%	231	.94%	
Home health care	3,330	1.64%	1,045	4.26%	
Against medical advice	85	0.04%	19	.08%	
Type of hospital (ownership), % by column					.051
Government, nonfederal	20,108	9.88%	2,743	11.18%	
Private, not-profit	148,238	72.84%	17,389	7.86%	
Private, invest-own	35,156	17.28%	4,410	17.97%	
Teaching status, % by column					.263
Metropolitan non-teaching	69,916	34.36%	8,294	33.80%	
Metropolitan teaching	129,320	63.55%	15,632	63.69%	
Non-metropolitan hospital	4,265	2.10%	616	2.51%	
Hospital urban-rural designation, % by column					.163
Large metropolitan areas with >1 million residents	131,738	64.74%	15,590	63.52%	
Small metropolitan areas with <1 million residents	67,498	33.17%	8,336	33.97%	
Micropolitan areas	4,265	2.10%	616	2.51%	
Hospital bed size, % by column					<.001
Small	33,376	16.40%	3,615	14.73%	
Medium	50,201	24.67%	5,340	21.76%	
Large	119,924	58.93%	15,587	63.51%	
Hospital volume					.285
Low volume	45,236	22.23%	5,636	22.96%	
High volume (>75th percentile)	158,266	77.77%	18,906	77.04%	
Prolonged duration of stay (75th percentile)	33,646	16.53%	7,772	31.67%	<.001
Serious adverse event during index admission	3,508	1.72%	1,220	4.97%	<.001

ICF, intermediate care facility; SNF, skilled nursing facility.
  * Cell with count <10, not shown as per HCUP data user agreement.

Readmission Reduction Program in 2012,[4] which decreases the payments to hospitals with high readmissions with the ultimate goal of improving quality of care. Hospital payments are expected to decrease by $566 million in the fiscal year 2019 owing to the Hospital Readmission Reduction Program.[16] This policy has stimulated national efforts to address readmissions, specifically in the bariatric surgery arena, such as the MBSAQIP initiative called Decreasing Readmissions through Opportunities Provided, which

is already showing promising results.[17] The present study provides valuable, nationally representative data that give an important perspective on the scope of readmissions.

This nationwide analysis showed that the readmission rate after bariatric surgery was 10.7% at 180 days. Of these, two-thirds are related directly to the index procedure. Just half of the readmissions were detected using the traditional metric of 30-day readmission rate. Interestingly, >30% of the 180-day readmissions occurred at a

Table II
Readmission analyses of patients undergoing bariatric procedures, weighted to represent national estimates

Outcome	LGB (n = 22,945)		LGS (n = 82,270)		LGBP (n = 122,829)		Overall (n = 228,043)		P value
30-day readmission analysis									
30-day readmission (overall), n (% of cohort)	882	(3.84%)	3,269	(3.97%)	8,260	(6.72%)	12,411	(5.44%)	<.001
180-day readmission analysis									
180-day readmission (overall), n (% of cohort)	1,906	(8.31%)	6,379	(7.75%)	16,257	(13.24%)	24,542	(10.76%)	<.001
180-day readmissions directly related to bariatric procedure, n (% of readmissions)	1,100	(57.72%)	3,969	(62.23%)	10,771	(66.26%)	15,841	(64.55%)	<.001
Readmitted to different hospital, n (% of readmissions)	788	(41.36%)	2,093	(32.81%)	4,765	(29.31%)	76,46	(31.16%)	<.001
Days to readmission, median (IQR)	38	(10–107)	29	(10–93)	29	(9–85)	30	(10–88)	<.001*
Any GI procedure during readmission, n (% of readmissions)	406	(21.30%)	1,174	(18.40%)	4,272	(26.28%)	5,852	(23.85%)	<.001
Died during readmission, n (% of readmissions)	0		30	(0.47%)	87	(0.54%)	118	(0.48%)	.324

IQR, interquartile ratio; GI, gastrointestinal.
* Weighted analysis did not allow median comparison between groups. Unweighted data was analyzed to allow median comparison.
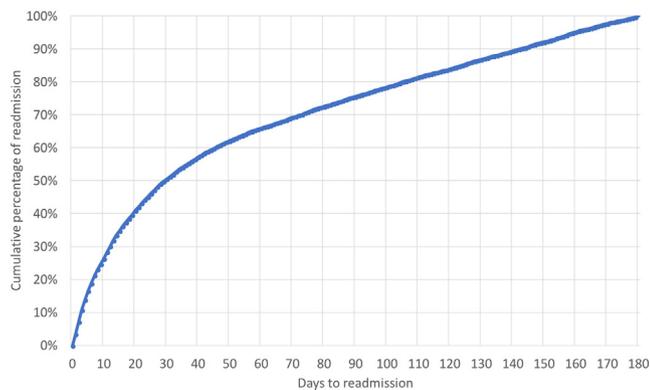

Figure. Cumulative percentage of readmissions after bariatric procedure up to 180 days.

different hospital than where the bariatric surgery took place. More than a fifth of readmitted patients required some type of gastrointestinal procedure. The costs associated with readmissions are substantial because they more than double the costs of their index admission and represent 13% of the total costs per year associated with bariatric procedures. These findings are important to consider when setting national standards for readmissions after bariatric procedures. These data provide support to the concern that conventional readmission benchmarking (30-day readmission rate) fails to capture the true morbidity and health care utilization that occurs after discharge of patients who undergo bariatric procedures. These data also show that readmissions are not uncommon and possibly should not all be considered as avoidable and taken into consideration by CMS.

These data are similar with findings from other large cohorts.[5–8,15] Rattan et al found a 4.4% rate of 30-day readmission in a large, MBSAQIP study.[15] Prior studies examining patients from the NSQIP database found a similar 30-day readmission rate after bariatric surgery (~5%).[3,5,8,18] Although these studies used large cohorts, they did not capture true 30-day readmission rates because readmissions were assessed from day of operation instead of from the day of discharge, and more importantly, they were unable to include readmissions to different hospitals. Other studies using billing data were able to capture true 30-day readmission rates, captured readmissions to different hospitals, and found similar readmission rates (~4–5%) at 30 days.[6,7] Another study found slightly lesser 30-day readmission rates

(3.8%) using a large all-payer database.[10] None of the databases queried in these important prior studies, however, were designed to be representative of the nation because they are large databases with data from institutions across the nation that participate in their program.

Our data also provide useful information on the timing of readmission because we identified a steep increase in readmissions within the first month. More than a fifth of 180-day readmissions occur during the first week of discharge. Additional studies could further characterize readmissions according to their timing to appropriately tailor interventions.

When comparing the 3 procedures (LGB, LSG, and LGBP), we found that the LGBP group had the greatest readmission rate. The latter was also independently associated with greater readmissions relative to LGB and LSG, which is comparable to data from the MBSAQIP.[15] Not surprisingly, patients with multiple comorbidities,[19] a prolonged duration of stay at the index operation,[15] Medicare or Medicaid insurance,[9,10,20,21] and serious adverse events or complications[3,8,15] during the index admission were more likely to be readmitted, which is in line with previous data. In terms of causes for readmission, our findings are also comparable to previous studies that explored this aspect.[3,12,15,20] We found that postprocedure-related complications, postoperative infection, hemorrhage, hematoma, or seroma were among the most common for all 3 procedures. Furthermore, complications of the digestive system (such as nausea, anastomosis stricture, obstruction, ileus) and disorders of fluid, electrolyte, and acid-base balance were consistently among the top causes of readmission for all 3 procedures. Using these data, clinicians could leverage selected features of the electronic medical records to flag patients at risk for readmissions and set up closer follow-up appointments, telehealth appointments, follow-up calls, and outpatient laboratory tests with the intention of capturing these predisposing risk factors, symptoms, or signs that may lead to readmission.

There was substantial morbidity associated with these procedures at the time of readmission. We found that a sizable proportion of readmitted patients (~24%) will undergo a gastrointestinal procedure, similar to a prior study that found that about 20% of readmitted patients undergo reoperation within 90-days.[22] As the safety of bariatric procedures continues to improve, it is important to recognize that the reutilization of health care and associated morbidity are important to recognize and acknowledge, and therefore, it is important to include this information when counseling patients preoperatively.

Table III
Causes of readmission at 180 days, by bariatric procedure

	LGB (N = 22,945)		LSG (N = 82,270)		LGBP (N = 122,829)	
Readmitted, N (%)	1,906	(8.31%)	6,379	(7.75%)	6,379	(13.24%)
Rank	Causes of readmission	(%)	Causes of readmission	(%)	Causes of readmission	(%)
1	Complication of procedure involving implant	(8.03%)	Complication of bariatric procedures	(10.29%)	Complications affecting specified body systems (digestive system complications, respiratory complications, other)	(8.3%)
2	Complications of procedure (postoperative infection; hemorrhage, hematoma or seroma; accidental injury to organ; postoperative shock; postoperative fistula; other)	(5.58%)	Disorders of fluid, electrolyte, and acid-base balance (volume depletion, hypopotassemia, hyponatremia, hyperpotassemia, fluid overload, hypernatremia, acidosis, alkalosis, not classified)	(8.02%)	S/P bariatric procedure	(7.3%)
3	Status post bariatric procedure	(5.58%)	Complications of procedure (postoperative infection; hemorrhage, hematoma, seroma; other; disruption of wound; persistent postoperative fistula; accidental injury to organ; foreign body accidentally left during procedure; unspecified)	(5.05%)	Complications of bariatric procedures	(6.9%)
4	Disorders of fluid, electrolyte, and acid-base balance (volume depletion, hyponatremia, hypopotassemia, acidosis, hyperpotassemia, other)	(5.14%)	Symptoms involving digestive system (nausea and vomiting, dysphagia, other)	(4.95%)	Disorders of fluid, electrolyte, and acid-base balance (volume depletion, hypopotassemia, fluid overload, acidosis, hyponatremia, hypernatremia, hyperpotassemia, mixed acid-base disorder)	(6.9%)
5	Complications affecting specified body systems (digestive system, cardiac)	(5.11%)	S/P bariatric procedure	(4.48%)	Complications of procedure (postoperative infection; hemorrhage, hematoma, seroma; accidental injury to organ; other; persistent postoperative fistula; disruption of wound; foreign body accidentally left during procedure; postoperative shock; unspecified)	(6.5%)

Whenever possible within the diagnosis group, the specific ICD-9 diagnosis codes were investigated and listed under parenthesis in descending order of frequency.

This study is not without limitations, which are intrinsic to the use of administrative data. These discharge data collected for billing and documentation purposes may lack the granularity of specific detailed clinical data, social and family history, laboratory values, pathology reports, radiologic findings, functional status, and patient-reported outcomes and may be subject to coding bias. For instance, there are some ICD-9 diagnosis codes that comprise several post-procedural complications (for instance 997.49 other digestive system complications may capture anastomotic stricture, gastrointestinal complication after bariatric surgery, hepatic failure owing to a procedure, nausea after bariatric surgery, postoperative ileus, postoperative nausea, etc), and therefore, we were unable to discern individual percentage of readmissions attributable to each of those. Other studies that had more granularity of data, however, addressed these considerations well [8,12,15,20]; indeed, our study importantly serves to provide validity to those findings for several reasons. We used a nationally representative cohort where the trend persisted, and we were able to distinguish readmissions related directly to the index bariatric operation using ICD9-CM diagnosis codes and the framework provided by the MBSAQIP. The retrospective nature of our study does, however, make it subject to misclassification and selection bias. The NRD captures hospitalizations classified as admission and therefore excludes emergency department visits and patients admitted under observation status, which underestimates the true burden of health care utilization and morbidity after discharge. Lastly, some readmissions may be related to socioeconomic circumstances, such as not being able to afford prescribed outpatient treatment, imaging, or procedures which the dataset we used does not allow to control for. Nonetheless, the present study has a very large cohort of bariatric patients ($n = 228,043$ patients), is a nationally representative cohort of patients undergoing the 3 most common bariatric procedures in the United States, includes readmissions to different-than-index-admission hospital, and captures readmissions related directly to the bariatric procedure. Furthermore, these analyses support that readmissions are prevalent beyond the 30-day benchmark because they essentially double by 6 months after discharge.

Readmissions after bariatric surgery continue to occur even 6 months after discharge. Most of them are related directly to the index procedure. Almost a fourth of those readmitted required a procedure, and almost a third presented to a different hospital from their initial bariatric operation. Readmissions after bariatric surgery are relatively common (10.8%) and carry a considerable financial burden for the health care system and may impair quality of life for patients. Strategies targeted to prevent readmissions beyond the traditional 30-day benchmark may be warranted in this population.

Funding/Support

Table IV
Factors associated with 180-day readmission after bariatric procedures

	OR	95% CI	P value
Laparoscopic bariatric procedure, % by row			
Laparoscopic band	0.65	(0.58–.73)	<.001
Laparoscopic gastric sleeve	0.63	(0.59–.67)	<.001
Laparoscopic gastric bypass	Ref.		
Age, mean (SD)	1.00	(1.00–1.00)	.075
Female, % by column	—	—	—
Charlson Index, % by column			
<2	Ref.		
≥2	1.32	(1.22–1.43)	<.001
Payer, % by column			
Medicare	1.86	(1.73–1.99)	<.001
Medicaid	1.61	(1.48–1.74)	<.001
Private insurance	Ref.		
Self-pay	0.81	(0.67–.99)	.038
No charge	1.19	(0.56–2.53)	.647
Other	1.21	(1.05–1.39)	.008
Median household income, % by column			
0–25th percentile	Ref.		
26–50th percentile	1.01	(0.93–1.09)	.897
51th–75th percentile	1.00	(0.92–1.09)	.985
76–100th percentile	0.98	(0.90–1.06)	.649
Missing			
Risk of mortality, % by column			
Minor likelihood of dying	Ref.		
Moderate likelihood of dying	1.24	(1.10–1.39)	<.001
Major likelihood of dying	1.11	(0.86–1.42)	.435
Extreme likelihood of dying	0.91	(0.49–1.69)	.761
Severity of illness, % by column			
Minor loss of function (includes cases with no comorbidity or complications)	Ref.		
Moderate loss of function	1.09	(1.03–1.1.5)	.004
Major loss of function	1.34	(1.14–1.57)	<.001
Extreme loss of function	1.58	(0.88–2.83)	.124
Same state resident, % by column			
Yes	Ref.		
No	1.47	(1.30–1.67)	<.001
Type of discharge, % by column			
Home	Ref.		
Short-term hospital	2.82	(1.32–6.03)	.007
SNF, ICF, other	2.32	(1.59–3.39)	<.001
Home health care	1.69	(1.45–1.96)	<.001
Against medical advice	1.08	(0.46–2.49)	.865
Type of hospital (ownership), % by column			
Government, nonfederal	1.03	(0.92–1.15)	.625
Private, not-profit	Ref.		
Private, invest-own	1.15	(1.05–1.26)	.003
Teaching status, % by column			
Metropolitan non-teaching	—	—	—
Metropolitan teaching	—	—	—
Non-metropolitan hospital	—	—	—
Hospital urban-rural designation, % by column			
Large metropolitan areas with >1 million residents	Ref.		
Small metropolitan areas with <1 million residents	0.96	(0.90–.96)	.899
Micropolitan areas	1.13	(0.92–1.13)	.92
Hospital bed size, % by column			
Small	0.89	(0.81–.99)	.027
Medium	0.88	(0.82–.94)	<.001
Large	Ref.		
Hospital volume			
Low volume	—	—	—
High volume (>75th percentile)	—	—	—
Prolonged duration of stay (>75th)	1.80	(1.70–1.91)	<.001
Serious adverse event during index admission	1.20	(1.02–1.42)	.024

ICF, intermediate care facility; *SNF*, skilled nursing facility.

Conflict of interest/Disclosure

Supplementary materials

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