



# Risk Factors for Readmission After Same-Day Discharge Sleeve Gastrectomy: a Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program Database Analysis

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## Abstract

**Background** Same-day discharge after sleeve gastrectomy (SG) is gaining popularity. We aimed to determine risk factors associated with readmission in patients who underwent same-day discharge SG.

**Methods** We performed a retrospective analysis of the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) database for the period 2015–2018. Patients who underwent SG and were discharged the same day of the operation were included in the analysis. Multivariable logistic regression analysis was performed to determine risk factors for readmission.

**Results** A total of 466,270 SG were performed during the study period; 14,624 (3.1%) patients were discharged the same day and were included in the analysis. Mean age was 43.4 (14.7–80) years and 11,718 (80.1%) were female. Mean preoperative BMI was  $43.7 \pm 7.4$  kg/m<sup>2</sup>. Mean operative time was  $58.3 \pm 32.4$  min. Thirty-day reoperation, reintervention, and mortality rates were 0.7%, 0.7%, and 0.1%, respectively. Readmission rates were similar in same-day discharge and inpatient SG (2.9% vs. 3%,  $p=0.5$ ). Female sex (OR 1.52, 95% CI 1.15–2.00), preoperative gastroesophageal reflux disease (OR 1.33, 95% CI 1.08–1.64), renal insufficiency (OR 3.06, 95% CI 1.01–9.32), and intraoperative drain placement (OR 1.78, 95% CI 1.37–2.31) were independent risk factors for readmission following same-day discharge SG.

**Conclusions** Same-day discharge SG appears to be safe and is associated with low readmission rates. However, the identification of preoperative and intraoperative variables associated with higher risk of readmission might help defining safer and more effective same-day discharge protocols.

**Keywords** Laparoscopic sleeve gastrectomy · Bariatric surgery · Same-day discharge · Outpatient bariatric surgery · Ambulatory sleeve gastrectomy

## Key Points

- Same-day discharge was used in 3.1% of all the SG performed in MBSAQIP centers.
- Same-day discharge after sleeve gastrectomy is associated with low readmission rates.
- Female sex, GERD, renal insufficiency, and drain placement are risk factors for readmission following same-day discharge SG.

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## Introduction

Sleeve gastrectomy (SG) is the most commonly performed bariatric operation in the USA. According to the American Society for Metabolic and Bariatric Surgery (ASMBS), SG represented almost 60% of all the bariatric operations performed in 2019 [1]. This is mainly due to its effectiveness, low postoperative morbidity, short operative time, and technical simplicity [2, 3].

In the last few years, same-day discharge (also known as day-case surgery, ambulatory surgery, outpatient surgery, or same-day surgery) has shifted from simple procedures to more complex operations such as fundoplication for gastroesophageal reflux disease, laparoscopic colectomies, and even minor hepatic resections [4–6]. In the bariatric

surgery field, a series of outpatient gastric banding, laparoscopic sleeve gastrectomy, and Roux-en-Y gastric bypass has been reported with promising outcomes [7–9]. Same-day discharge after SG has become increasingly popular as costs and staff workload might be reduced. In addition, due to the disruption in surgical care delivery due to the COVID-19 pandemic, this approach might reduce in-hospital exposure and save precious resources [10]. Several single institutional reports have shown the feasibility and safety of same-day discharge SG with low postoperative morbidity and near-zero mortality [11–16]. However, a shorter length of stay (LOS) may also result in a higher rate of postoperative complications and readmissions when compared with the classic inpatient approach [17].

Scarce evidence is available regarding potential risk factors for hospital readmission after same-day SG. Therefore, the aim of this study was to identify perioperative variables associated with unexpected readmissions after same-day discharge SG.

## Material and Methods

### Study Design and Population

This study was a retrospective registry-based analysis of patients discharged the same day of the operation after SG. The operations were performed between January 1, 2015, and December 31, 2018, at centers participating in the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP). The MBSAQIP participant use data file (PUF) prospectively collects data on several variables such as demographics, comorbidities, laboratory values, and 30-day postoperative morbidity and mortality. The definitions of each variable are available in the MBSAQIP manual [18].

In this study, patients were identified using the Current Procedural Terminology Code (CPT) for SG: 43,775. Patients who underwent SG and were discharged on the same day (postoperative day 0) were included in the analysis. Patients with LOS  $\geq$  1 day or who underwent other bariatric surgery outside of SG were excluded.

### Outcome Measurement

The outcomes of interest in this study were the following: (1) rates of readmission, reoperation, reintervention, and mortality within the 30-day postoperative period following same-day discharge SG; and (2) predictive factors associated with 30-day readmission following same-day SG.

## Statistical Analyses

The student's *t* test was used to compare continuous variables, whereas the  $\chi^2$  test was used for categorical variables. Univariate and multivariate logistic regression analyses were used to determine risk factors for readmission. A *p* value  $<$  0.05 was considered statistically significant for all tests. Statistical analysis was performed using Stata/SE 16.1 for Windows.

## Results

During the study period, a total of 466,270 SG were performed in MBSAQIP centers: 451,646 (96.9%) inpatient SG and 14,624 (3.1%) same-day discharge SG.

The proportion of patients undergoing same-day discharge SG increased significantly during the study period (2015: 2.6% vs. 2018: 3.1%,  $p <$  0.0001). A total of 14,146 (3%) patients were readmitted with similar rates among patients who underwent inpatient or same-day discharge SG (inpatient SG: 3% vs. same-day discharge SG: 2.9%,  $p =$  0.5). The mean time to readmission after same-day discharge sleeve gastrectomy was 9.6 (0–30) days. The interval time to readmission for postoperative hemorrhage and staple line leak was 3 (0–20) and 11.7 (2–29) days, respectively.

### Characteristics of the Same-Day Discharge Population

Mean age was 43.4 (14.7–80) years and 11,718 (80.1%) were female. Mean preoperative BMI was  $43.7 \pm 7.4$  kg/m<sup>2</sup>. Other procedures were performed in 59% of patients and conversions/revisions represented 6.3% of the SG performed. Surgical approach was laparoscopic in 83.1%, laparoscopic assisted in 11.1%, and robotic in 5.6% of the patients. Mean operative time was  $58.3 \pm 32.4$  min. Thirty-day reoperation, reintervention, and mortality rates were 0.7%, 0.7%, and 0.1%, respectively. A total of 431 (2.9%) patients were readmitted, from which 356 (82.6%) were related to the bariatric procedure. The most common reasons for readmission were nausea/vomiting, fluid, electrolyte, or nutritional depletion (36.6%), abdominal pain (10.2%), bleeding (7.4%), venous thrombosis requiring therapy (5.8%), staple line leak (5.6%), and pulmonary embolism (2.5%) (Table 1).

### Comparison of Baseline Characteristics and Perioperative Variables Among Readmitted and Non-readmitted Patients

On univariate analysis, female sex (80% vs. 85.6%,  $p =$  0.003), Afro-American race (18.3% vs. 26%,  $p <$  0.0001),

**Table 1** Causes for 30-day readmission following same-day discharge SG

Reasons for readmission	<i>N</i>	%
Nausea and vomiting, fluid, electrolyte, or nutritional depletion	158	36.6
Other	69	16
Abdominal pain	43	10
Bleeding	32	7.4
Vein thrombosis requiring therapy	25	5.8
Staple line leak	24	5.6
Pulmonary embolism	11	2.5
Other abdominal sepsis	10	2.3
Gallstone disease	8	1.8
Pneumonia	7	1.6
Internal hernia	5	1.2
Cardiac/Chest pain	5	1.2
Gastrointestinal perforation	4	0.9
Other respiratory failure	4	0.9
Shortness of breath	4	0.9
Renal insufficiency	3	0.7
Infection/fever	3	0.7
Medication related	3	0.7
Strictures/stomal obstruction	3	0.7
Intestinal obstruction	2	0.5
Nephrolithiasis	2	0.5
Cerebrovascular accident	1	0.2
Wound infection/evisceration	1	0.2
Myocardial infarction	1	0.2
Musculoskeletal pain	1	0.2
Gastro-gastric fistula	1	0.2
Incisional hernia	1	0.2

preoperative GERD (27.2% vs. 33.2%,  $p=0.005$ ), hypertension (40.5% vs. 46.4%,  $p=0.01$ ), renal insufficiency (0.3% vs. 1.2%,  $p=0.001$ ), steroid use (0.9% vs. 2.1%,  $p=0.02$ ), IVC filter (0.2% vs. 0.9%,  $p=0.001$ ), anticoagulation (1.2% vs. 2.5%,  $p=0.01$ ), dialysis (0.1% vs. 0.5%,  $p=0.03$ ), history of DVT (0.7% vs. 1.8%,  $p=0.008$ ), oxygen dependence (0.1% vs. 0.5%,  $p=0.04$ ), and lower hematocrit values (41.1% vs. 40.7%,  $p=0.03$ ) were more frequent among readmitted patients (Table 2).

Conventional laparoscopic approach and sleeve oversew were more frequent among the non-readmitted group. In contrast, laparoscopic assisted procedures and drain placement were more frequent in readmitted patients (Table 3).

### Predictive Factors for Readmission Following Same-Day Discharge Sleeve Gastrectomy

Multivariate logistic regression analysis showed that female sex (OR 1.52, 95% CI 1.15–2.00), preoperative

gastroesophageal reflux disease (OR 1.33, 95% CI 1.08–1.64), renal insufficiency (OR 3.06, 95% CI 1.01–9.32), and intraoperative drain placement (OR 1.78, 95% CI 1.37–2.31) were independent risk factors for readmission following same-day discharge SG (Table 4).

## Discussion

This study aimed to analyze risk factors for readmission after same-day discharge SG. We found that: (a) 3.1% of the patients undergoing SG were discharge the same day of the operation; (b) readmission rates following same-day discharge and inpatient SG were similar (2.9% vs. 3%); (c) female sex, preoperative GERD, renal insufficiency, and intraoperative drain placement were independent risk factors for readmission following same-day discharge SG.

Currently, laparoscopic SG is the most commonly performed bariatric operation in the US [1]. The short operative time, fast recovery, simple perioperative management, and very low postoperative complication rates have made this procedure ideal for day-case surgery. Same-day discharge can result in reduced costs, hospital-acquired infections, and improved patient satisfaction [19, 20]. For instance, Rebibo et al. performed a case-matched study comparing the healthcare cost of SG performed as a day case surgery or as an inpatient procedure. The overall cost per patient if the SG was performed as an outpatient procedure was reduced from 36 to 42% ( $p < 0.001$ ) compared to conventional hospitalization [20].

Multiple series (most retrospective and single-center) have shown the safety and feasibility of outpatient SG in selected patients [11–16]. For instance, Billing et al. analyzed the outcomes of 2,534 outpatient SG performed in a single ambulatory center. Readmission, reoperation, staple line leak, and mortality rates were 2.5%, 1.4%, 0.9%, and 0.1%, respectively [16]. Similarly, Lalezari and colleagues reported the outcomes of 821 ambulatory SG. 30-day overall morbidity was 2.3% and 30-day readmission was 2.1% [14]. Higher readmission rates (8.5%) were found on the series of 328 ambulatory SG published by Garofalo et al. Most of these readmissions were due to nausea/vomiting and abdominal pain [13]. We found similar readmission (2.9%), reoperation (0.7%), and mortality (0.1%) rates to those reported by Billing and Lalezari [14, 16]. In our analysis, most readmission was also related to nausea/vomiting (36.6% of readmissions) and abdominal pain (10.2% of readmissions).

The safety of same-day discharge SG, when compared to conventional hospitalization, has also been analyzed with conflicting results in the literature [17, 20–23]. Inaba et al. analyzed 85,321 SG from the 2015–2016 MBSAQIP database and found that same-day discharge SG was associated with higher overall morbidity (1.3% vs. 0.84%,  $p=0.0002$ ),

**Table 2** Baseline characteristics of patients who underwent same-day discharge SG who were readmitted and who were not readmitted

Baseline characteristics	Non-readmitted N= 14,193	Readmitted N= 431	p value
Age, years, mean $\pm$ SD	43.4 $\pm$ 11.1	44.3 $\pm$ 10.9	0.08
Female, n (%)	11,349 (80)	369 (85.6)	<b>0.003</b>
Race, n (%)			
African American	2,595 (18.3)	112 (26)	<b>&lt; 0.0001</b>
American Indian or Alaska native	51 (0.3)	2 (0.5)	0.72
Asian	64 (0.4)	3 (0.7)	0.45
Native Hawaiian or other Pacific islander	34 (0.2)	1 (0.2)	1
White	10,180 (71.7)	277 (64.3)	<b>0.001</b>
Unknown	1,269 (8.9)	36 (8.3)	0.67
Preoperative BMI, kg/m <sup>2</sup> , mean $\pm$ SD	43.7 $\pm$ 7.4	43.9 $\pm$ 8	0.56
ASA classification, n (%)			
ASA I	41 (0.3)	1 (0.2)	0.82
ASA II	3591 (25.3)	112 (26)	0.74
ASA III	10,188 (71.8)	303 (70.3)	0.50
ASA IV	347 (2.4)	15 (3.5)	0.17
Comorbidities, n (%)			
GERD	3,855 (27.2)	143 (33.2)	<b>0.005</b>
Preoperative immobilization	91 (0.6)	2 (0.5)	0.64
History of myocardial infarction	89 (0.6)	6 (1.4)	0.06
Previous PCI	162 (1.1)	9 (2.1)	0.07
Previous cardiac surgery	88 (0.6)	1 (0.2)	0.30
Hypertension	5,764 (40.6)	200 (46.4)	<b>0.01</b>
Hyperlipidemia	2,273 (16)	75 (17.4)	0.44
History of pulmonary embolism	93 (0.6)	6 (1.4)	0.06
History of deep vein thrombosis	104 (0.7)	8 (1.8)	<b>0.008</b>
Preoperative anticoagulation	175 (1.2)	11 (2.5)	<b>0.01</b>
Renal insufficiency	38 (0.3)	5 (1.2)	<b>0.001</b>
Dialysis	15 (0.1)	2 (0.5)	<b>0.03</b>
Diabetes mellitus	2,509 (17.7)	91 (21.1)	0.06
COPD	89 (0.6)	1 (0.2)	0.30
Preoperative oxygen dependent	16 (0.1)	2 (0.5)	<b>0.04</b>
Current smoker within 1 year	1,019 (7.2)	29 (6.7)	0.72
Preoperative functional health status			
Independent	14,124 (99.5)	427 (99.1)	0.16
Partially dependent	42 (0.3)	3 (0.7)	0.14
Totally dependent	27 (0.2)	1 (0.2)	0.84
OSA	4,073 (28.7)	129 (29.9)	0.57
Preoperative steroids use	136 (0.9)	9 (2.1)	<b>0.02</b>
Previous organ transplant	11 (0.1)	0 (0)	0.56
Preoperative IVC filter	27 (0.2)	4 (0.9)	<b>0.001</b>
Preoperative laboratory values, mean $\pm$ SD			
Albumin, g/dl	4.2 $\pm$ 0.4	4.1 $\pm$ 0.3	0.05
Hematocrit, %	41.1 $\pm$ 3.8	40.7 $\pm$ 3.7	<b>0.03</b>
Creatinine, mg/dl	0.8 $\pm$ 0.3	0.8 $\pm$ 0.3	0.66

ASA, American Society of Anesthesiologists; BMI, body mass index; GERD, gastroesophageal reflux disease; PCI, percutaneous coronary intervention; COPD, chronic obstructive pulmonary disease; OSA, obstructive sleep apnea; IVC, inferior vena cava

p values < 0.05 are denoted in bold

**Table 3** Operative characteristics of patients who underwent same-day discharge SG who were readmitted and who were not readmitted

Operative characteristic	Non-readmitted N=14,193	Readmitted N=431	<i>p</i> value
Revision/conversion, <i>n</i> (%)	897 (6.3)	32 (7.4)	0.35
Previous organ transplant, <i>n</i> (%)	11 (0.1)	0 (0)	0.56
Emergency case, <i>n</i> (%)	12 (0.1)	0 (0)	0.54
Surgical approach, <i>n</i> (%)			
Conventional laparoscopic	11,814 (83.2)	338 (78.4)	<b>0.009</b>
Robotic assisted	789 (5.5)	29 (6.7)	0.29
Laparoscopic assisted	1,565 (11)	64 (14.8)	<b>0.01</b>
Open	2 (0.01)	0 (0)	1
Others	23 (0.2)	0 (0)	0.4
Conversion, <i>n</i> (%)	9 (0.1)	0 (0)	0.6
Intraoperative drain placed, <i>n</i> (%)	1,458 (10.3)	74 (17.2)	<b>&lt;0.0001</b>
Operative time, min, mean ± SD	58.2 ± 32.4	60.9 ± 32.2	0.08
Other procedure, <i>n</i> (%)	8,396 (59.1)	242 (56.1)	0.21
Specialty of the physician, <i>n</i> (%)			
Bariatric surgeon	11,558 (81.4)	357 (82.8)	0.46
Gastroenterologist	1 (0)	0 (0)	1
General surgeon	99 (0.7)	3 (0.7)	0.9
Interventional radiologist	2 (0.01)	0 (0)	1
First assistant training level, <i>n</i> (%)			
PA or NP or RN	3,188 (22.5)	111 (25.7)	0.1
Resident	627 (4.4)	23 (5.3)	0.36
Fellow	310 (2.2)	4 (0.9)	0.07
Attending/bariatric surgeon	2,685 (18.9)	85 (19.7)	0.67
Attending other	578 (4.1)	13 (3)	0.27
None (no assist or scrub nurse tech/RN only)	2,944 (20.7)	88 (20.4)	0.87
Staple line reinforcement, <i>n</i> (%)	10,392 (73.2)	304 (70.5)	0.21
Sleeve oversew, <i>n</i> (%)	4,051 (28.5)	103 (23.9)	<b>0.03</b>
Swallow study performed, <i>n</i> (%)	2,877 (20.3)	104 (24.1)	0.05
Staple line checked with provocative test, <i>n</i> (%)	8,547 (60.2)	261 (60.5)	0.88

PA, physician assistant; NP, nurse practitioner; RN, registered nurse. *p* values < 0.05 are denoted in bold

readmission (2.14% vs. 1.64%,  $p=0.003$ ), and reoperation rate (0.6% vs. 0.2%,  $p<0.0001$ ) when compared to POD 1 discharge [17]. On the contrary, a propensity score-matched analysis of the same database for the 2015–2017 period, found that outpatient SG had similar 30-day morbidity (1.1% vs. 1.01%), reoperation (0.8% vs. 0.5%), leakage (0.5% vs. 0.4%), and bleeding rate (0.3% vs. 0.3%) when compared with inpatients [21]. In line with these findings, the 2015–2018 MBSAQIP database analysis performed by Barbat et al. and the Optum Pan-Therapeutics database analysis by Fortin found similar postoperative outcomes between same-day discharge and inpatient SG [22, 23]. Moreover, Fortin et al. found that the outpatient group had a lower readmission length of stay (4.6 vs. 3.2 days,  $p=0.005$ ) [23]. Likewise, we have found similar readmission rates following same-day discharge and inpatient SG (2.9% vs. 3%,  $p=0.5$ ).

The main concerns for doing same-day discharge SG are persistent vomiting leading to dehydration and the

possibility of delayed detection of lethal postoperative complications. This is probably responsible for the exceptionally low rate (3.1%) of SG performed on an outpatient basis. Postoperative nausea has been reported as one of the most frequent causes for early readmission following bariatric surgery [24]. However, with the introduction of specific anesthesia protocols and perioperative care, the readmission rate for this complication can be reduced to 0.04–0.5% [14–16]. Postoperative hemorrhage might represent one of the most important complications in this setting as it usually occurs in the immediate postoperative period. However, it is very infrequent. A recent literature review that analyzed 6,227 day-case SG found a 0.3% postoperative bleeding rate [25]. Similarly, we have found that 1.1% and 0.2% of patients who underwent same-day discharge SG were readmitted due to vomiting and bleeding, respectively. In our MBSAQIP analysis, we found that the mean time to readmission for postoperative bleeding was 3 days. It is unknown if this

**Table 4** Multivariate analysis of risk factors for readmission

Variable	OR	95% CI	<i>p</i> value
Female sex	<b>1.52</b>	<b>1.15–2.00</b>	<b>0.003</b>
Afro-American	1.39	0.97–2.01	0.07
White	0.87	0.62–1.22	0.44
GERD	<b>1.33</b>	<b>1.08–1.64</b>	<b>0.006</b>
Hypertension	1.19	0.98–1.46	0.07
History of DVT	1.51	0.64–3.56	0.34
Dialysis	1.39	0.22–8.52	0.71
Renal insufficiency	<b>3.06</b>	<b>1.01–9.32</b>	<b>0.04</b>
Preoperative anticoagulation	1.66	0.83–3.32	0.14
Preoperative oxygen dependent	1.47	0.27–8.09	0.65
Preoperative steroids use	1.96	0.98–3.90	0.05
Preoperative IVC filter	2.59	0.73–9.14	0.13
Conventional laparoscopic approach	0.79	0.62–1.01	0.06
Sleeve oversew	0.84	0.66–1.06	0.14
<b>Intraoperative drain placed</b>	<b>1.78</b>	<b>1.37–2.31</b>	<b>&lt; 0.0001</b>

GERD, gastroesophageal reflux disease; DVT, deep venous thrombosis; IVC, inferior vena cava

*p* values < 0.05 (independent risk factors) are denoted in bold

interval time might have represented a delay in the diagnosis or management of the hemorrhage. Other complications such as staple line leaks or sleeve stenosis usually develop later in the postoperative course and a same-day discharge would not affect the diagnosis nor its management. In our analysis, we found that patients with staple line leak were readmitted after a mean of 11.7 days.

Readmission rates following sleeve gastrectomy range between 2.8 and 6.5% [26–30]. Similar rates (0.6–8.5%) have been reported in same-day discharge SG series [11–16]. Many studies tried to determine risk factors for readmission following SG [26, 28–30]. The identification of specific risk factors for readmission following same-day discharge sleeve gastrectomy might help to determine which patients might benefit from closer monitoring and overnight admission. The most common independent risk factor associated with readmission across the studies was the development of postoperative complications. Other risk factors encountered were intraoperative drain placement, higher ASA class, black and Hispanic ethnicity, longer operative time, and poor baseline functional status [26, 28–30]. Similarly, we found that intraoperative drain placement was independently associated with readmissions. Intraoperative drain placement might reflect a complex case and consequently increase the risk of readmission. Historically, abdominal drainage has been used for early detection and treatment of gastrointestinal leaks. However, there is no strong evidence in the literature supporting this benefit and recent analyses suggested that routine drain placement was in fact associated with increased postoperative pain, morbidity, and readmission risk [31–33].

In our analysis, preoperative GERD was also identified as an independent risk factor for readmission. This is a very interesting finding as it is well known that SG might cause de novo GERD or worsening of pre-existing reflux symptoms [34, 35]. Female patients and those with renal insufficiency were also more frequently readmitted. The identification of these factors might warrant postoperative admission or closer outpatient follow-up. A change of plans and admission of patients who were initially scheduled for same-day discharge SG should be considered in cases in which an intraoperative drain was required or if the operation is more complex than anticipated.

This study has some limitations related to the use of the MBSAQIP PUF. Of note, the total number of patients initially intended for same-day discharge cannot be calculated and the type of center in which the procedure was performed (hospital vs. ambulatory surgery center and low vs. high volume) cannot be identified. Moreover, specific information about the patient's selection, anesthesia protocol, operative technique, perioperative care, and inclusion and exclusion criteria for same-day discharge are unknown. However, considering that scarce information is available regarding risk factors for readmission after same-day discharge SG, we believe our study contributes relevant data to this topic.

## Conclusion

Same-day discharge SG appears to be safe and is associated with low readmission rates. However, the identification of preoperative and intraoperative variables associated with higher risk of readmission might help defining safer and more effective same-day discharge protocols.

## Declarations

**Ethics Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed Consent** For this type of study, formal consent is not required. The Institutional Review Board (IRB) of our hospital approved the study.

**Conflict of Interest** The authors declare no competing interests.

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