



Readmissions After Bariatric Surgery in France, 2013–2016: a Nationwide Study on Administrative Data

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Abstract

Background Readmission rate is considered an indicator of quality of care, which is already used in some countries to impose financial penalties on hospital with readmissions in excess of the national average. Nevertheless, this indicator presents some controversial drawbacks. The objective of this study was the assessment of readmission rate after bariatric surgery.

Methods This is a retrospective observational study on a national administrative claims database, the Information Systems Medicalization Program, PMSI, which is a nationwide billing tool collecting information on all hospital discharges in France. All adult patients operated of bariatric surgery from January 1, 2013, through December 31, 2016, were included. The main outcome was unplanned 30-day readmission rate. Secondary outcome was the analysis of reasons for readmission.

Results During the study period, out of 187,000 bariatric interventions, the unplanned readmission rate was 4.7%. A significant difference was found between bariatric procedures (gastric banding 3.1%, sleeve gastrectomy 4.5%, gastric bypass 5.7%, $p < 0.001$). The most important risk factors are the Charlson comorbidity index, the occurrence of a complication after the initial intervention, and the bariatric technique type itself. The main causes of return to the hospital are abdominal pain, peritonitis, nausea/vomiting, and bleeding. After adjustment for confounders, the rate of rehospitalization varies between 1.0% and 16.0% among all French hospitals.

Conclusions Approximately 5 % of patients undergoing bariatric surgery suffered a readmission within 30 days. We identified common causes and identified patients at high risk for such an event. These information could be useful for developing strategies to improve in- and outpatient care in bariatric population.

Keywords Bariatric surgery · Obesity · Readmission · Administrative data · Hospital performance

Introduction

Bariatric surgery has undergone massive development in the last two decades, accounting for about 500,000 procedures per year since 2013 [1]. With growing attention on quality improvement, several national bariatric societies have used registries to monitor their outcomes [2]. Among surgical outcomes in the bariatric

population, hospital readmission is recognized as an important metric of quality and patient safety [3, 4]. Nevertheless, to obtain accurate benchmarking, it is important to provide reliable risk-adjusted outcome metrics and an adequate sample size. Some bariatric outcomes such as mortality or readmission rate may not have sufficient reliability to differentiate hospital performance because of low event rates and small caseloads [5].

Recently, the 30-day readmission rate after bariatric surgery has been reported to range from 2.6 [6] to 12.7% [7]. Nevertheless, the reliability of this information should be considered with caution if the data source does not have the ability to discriminate between planned and unplanned readmission or to identify patients readmitted to a non-index hospital. In this context, French national administrative data, originally collected for reimbursement purposes, may provide important information. This national healthcare database collects comprehensive data from all surgical centers and can be used to follow any single patient across different hospitals.

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The aim of this study was to investigate unplanned readmissions after bariatric surgery on a nationwide basis. We also assessed hospital performance per surgical center in relation to hospital caseload, before and after risk adjustment.

Methods

Setting and Participants

This was an observational descriptive study on the incidence of unplanned readmission after bariatric surgery.

Data were extracted from the national hospital discharge database (“Programme De Médicalisation des Systèmes d’Information,” PMSI), which is a tool for billing hospitalizations in all French hospitals, irrespective of their academic affiliation or ownership (public and private for-profit and private non-profit). Because discharge reports are mandatory and constitute the basis of hospital funding, this database is exhaustive on all reimbursed surgical interventions in the country.

In the PMSI database, data are collected as standardized discharge reports, consisting of patient demographic data (age, gender, zip code, entry, and release dates), primary and associated diagnoses based on the International Classification of Disease, 10th edition (ICD-10), and therapeutic procedures based on the Common Classification of Medical Acts (Classification Commune des Actes Médicaux, CCAM, 11th edition), which is a national standardized classification of medical procedures [8]. Each patient in the database is identified with a unique anonymous identifier, which allows for linkages between consecutive hospital stays in different hospitals. Since the individual information is anonymous and publicly available, patient consent is not required.

We included patients who underwent bariatric surgery in France in the period from January 1, 2013, to December 31, 2016. Any eligible patient was included, so no sampling was performed on the original population. We included adult patients (≥ 18 years) subjected to one of the following bariatric procedures: adjustable gastric banding (AGB), gastric bypass (GB), or sleeve gastrectomy (SG). Patients were identified in the database through the CCAM codes for bariatric procedures (Appendix 1) associated with a principal diagnosis of obesity (ICD-10 code: “E66x”). No selection was performed based on the timing of the bariatric procedure (initial intervention or revisional surgery).

Outcomes

The primary outcome of this study was unplanned readmission within 30 days of discharge from the initial hospital stay. Because the data set is comprehensive for all French hospitals, readmissions could be assessed for any hospital where the patient was readmitted (index or non-index hospital). We define the

index hospital as the center where the initial bariatric procedure took place. The secondary outcome was to explore the readmission rate per hospital before and after adjustment based on baseline patient characteristics and surgical procedure.

The classification of unplanned readmission was done first identifying all readmissions within 30 days from discharge after bariatric surgery. The variable describing patient destination after discharge was then used to identify transfers to another center that were not considered a readmission. Next, we used the principal diagnosis codes in chart reviews to exclude any types of malignancy or coding errors. Admissions in a regular follow-up day hospital setting were also identified using the principal diagnosis, i.e., the ICD-10 codes Z09.0 (“Follow-up examination after surgery for other conditions”) and Z71.3 (“Dietary counselling and surveillance”).

The causes of readmission were assessed using the principal diagnosis and grouped according to the algorithm reported in Appendix 2. Overall, morbidity was assessed by applying the same algorithm to all available ICD-10 codes (principal and associated diagnoses). Length of stay was categorized into three classes: 0 to 1 day, 2 to 7 days and > 7 days. The first category (0–1 day) is used to capture ambulatory and outpatient surgery patients. One day of hospital stay means that the patient spent one night at the hospital irrespective of the total number of hours. The cut-off of 7 days was selected according to the ASMBS definition of a major complication as “any complication that results in a prolonged hospital stay (beyond 7 days), administration of an anticoagulant, reintervention or reoperation” [9].

Confounders

Demographic data included age and gender. Age was grouped into five categories. The body mass index (BMI) is not reported in the dataset as a continuous variable but is stratified into four categories, through the ICD-10 codes “E66x” (obesity with a BMI from 30 to 40 kg/m², from 40 to 50 kg/m², > 50 kg/m², and BMI unspecified). Patients in the category “BMI unspecified” were excluded from the analysis.

Comorbidities were assessed using the Charlson comorbidity index, using the version of Quan and colleagues [10]. The final score was categorized into three groups (0, 1–2, and ≥ 3). Obstructive sleep apnea syndrome (OSAS), which is not part of the Charlson index, was included as a separate covariate. As OSAS and comorbidities included in the Charlson index are chronic diseases, they were identified using an inpatient lookback period. This means that comorbidities were not assessed only for the index hospitalization, but also using all the longitudinal patient information anterior to the index hospitalization. This approach has shown an improvement in the explanatory power of the model, in particular for readmissions [11]. As we had access to data since 2008, all patients have at least a 5-year lookback period for assessing comorbidities.

Statistical Methods

The presence of any difference in baseline characteristics between the groups with a 30-day potentially avoidable readmission and those not readmitted was tested by univariable logistic regression. A multivariable logistic regression model was then built using a stepwise backward selection procedure. For every surgical case, the expected probability of readmission was computed, leading to an expected readmission rate for each hospital. In order to assess each hospital's risk-adjusted readmission rate, we calculated the hospital-specific ratio between the observed and the expected readmission rate, multiplied by the overall readmission rate from the pooled hospital data. A general funnel plot was created to report hospital readmission rates as a function of average number of surgical cases per year. Control and warning limits were set at three and two standard deviations around the central line, respectively, using a continuity correction in the Wilson confidence limits. Poorly and highly performing hospitals were positioned above and below the two standard deviation limits, respectively.

All analyses were performed using R version 3.4.4. (R Foundation for Statistical Computing, Vienna, Austria). Data are reported according to the REporting of studies Conducted using Observational Routinely collected Data statement (RECORD statement) [12].

Results

We identified 187,273 bariatric procedures during the study period. We excluded 1182 vertical banded gastroplasty and 627 biliopancreatic diversions, as well as 448 procedures performed in non-adult patients and 859 procedures with ambiguous coding; thus, 184,157 bariatric interventions were included in the analysis. The overall 30-day readmission rate was 7.7% ($n = 14,148$). Among these readmissions, 2474 (17.4%) were excluded for coding errors, 61.7% (8730/185,477) were determined to be unplanned readmissions, and 3057 (21.6%) were considered planned readmissions.

Baseline characteristics are reported in Table 1. There were no statistically significant differences between readmitted and not readmitted patients with regard to gender and BMI. Readmitted patients had more comorbidities than non-readmitted patients (Charlson index > 0 for 15.4% vs. 11.7%, $p < 0.001$, OSAS 33.2% vs. 29.7%, $p < 0.001$), were more frequently subjected to gastric bypass (35.8% vs. 29.2%, $p < 0.001$) than gastric banding and sleeve gastrectomy, and experienced more reinterventions (15.8% vs. 9.2%, $p < 0.001$) during the initial hospital stay.

The 30-day readmission rate was 4.7% (8730/184,157). Gastric banding patients experienced the lowest readmission rate of 3.1%, followed by sleeve gastrectomy patients (4.5%) and gastric bypass (5.7%). After a backward multivariable

Table 1 Baseline characteristics of readmitted and non-readmitted patients

Covariate	Not readmitted $n = 175,427$	Readmitted $n = 8730$	p value
Gender			0.479
Female	142,362 (81.2)	7058 (80.8)	
Male	33,065 (18.8)	1672 (19.2)	
Age, year			< 0.001
18–29	36,191 (20.6)	1688 (19.3)	
30–39	47,405 (27.0)	2268 (26.0)	
40–49	48,199 (27.5)	2283 (26.2)	
50–59	32,699 (18.6)	1794 (20.5)	
≥ 60	10,933 (6.2)	697 (8.0)	
BMI, kg/m ²			0.712
30–40	59,384 (33.9)	2953 (33.8)	
40–50	99,199 (56.5)	4961 (56.8)	
> 50	16,844 (9.6)	816 (9.3)	
Charlson comorbidity index			< 0.001
0	155,047 (88.4)	7386 (84.6)	
1–2	18,357 (10.5)	1161 (13.3)	
≥ 3	2023 (1.2)	183 (2.1)	
OSAS	52,183 (29.7)	2894 (33.2)	< 0.001
Bariatric procedure			< 0.001
Gastric banding	13,858 (7.9)	440 (5.0)	
Sleeve gastrectomy	110,336 (62.9)	5168 (59.2)	
Gastric bypass	51,233 (29.2)	3122 (35.8)	
Surgical approach			< 0.001
Laparoscopic	174,433 (99.4)	8622 (98.8)	
Open	994 (0.6)	108 (1.2)	
Revisional surgery	10,455 (6.0)	750 (8.6)	< 0.001
Hospital status			< 0.001
Private, for profit	112,072 (63.9)	5206 (59.6)	
Private, non-profit	8274 (4.7)	423 (4.8)	
Public	55,081 (31.4)	3101 (35.5)	
Academic setting	25,455 (14.5)	1545 (17.7)	< 0.001
Hospital surgical volume			0.002
< 50	15,661 (8.9)	810 (9.3)	
50–99	27,870 (15.9)	1510 (17.3)	
100–149	24,545 (14.0)	1243 (14.2)	
150–199	20,860 (11.9)	1012 (11.6)	
≥ 200	86,491 (49.3)	4155 (47.6)	
Length of stay*, days			< 0.001
0–1	8481 (4.8)	321 (3.7)	
2–7	156,777 (89.4)	7140 (81.8)	
> 7	10,169 (5.8)	1269 (14.5)	
Reoperation*	16,209 (9.2)	1375 (15.8)	< 0.001
Year			0.890
2013	39,054 (22.3)	1966 (22.5)	
2014	43,286 (24.7)	2148 (24.6)	
2015	44,561 (25.4)	2229 (25.5)	
2016	48,526 (27.7)	2387 (27.3)	

BMI, body mass index; OSAS, obstructive sleep apnea syndrome

*Length of stay and reoperation are meant for the index hospitalization, i.e., the hospitalization where the bariatric procedure takes place

regression analysis, we identified several variables that were significant independent predictors. The highest adjusted ORs were identified for a Charlson Index ≥ 3 (OR 1.56, 95%CI 1.33–1.82, $p < 0.001$), for open surgery (OR 1.52, 95%CI 1.23–1.86, $p < 0.001$), and for having experienced a reintervention during the initial stay (OR 2.48, 95%CI 2.26–2.74, $p < 0.001$). The type of bariatric procedure was significantly associated with readmission. Compared with gastric banding (used as the reference), sleeve gastrectomy had an

adjusted OR of 1.35 (95%CI 1.21–1.51, $p < 0.001$) and gastric bypass an adjusted OR of 1.66 (95%CI 1.48–1.86, $p < 0.001$). All results of the multivariate analysis are reported in Table 2.

The reasons for unplanned readmissions are reported in Table 3. The most common were leak/peritonitis (16.7%), abdominal pain (12.3%), nausea and vomiting (8.6%), and bleeding (5.8%).

When all the available codes were analyzed (principal and associated diagnoses), leak/peritonitis was found in 22.7% of

Table 2 Factors associated with unplanned readmission for all inpatient surgical cases

Covariate	Odds ratio (95%CI)	<i>p</i> value	Adjusted odds ratio (95% CI)	<i>p</i> value
Sex				
Female	Reference		Reference	
Male	1.02 (0.97–1.08)	0.48	0.98 (0.93–1.04)	0.543
Age				
18–29	Reference		Reference	
30–39	1.03 (0.96–1.09)	0.44	0.96 (0.90–1.03)	0.265
40–49	1.02 (0.95–1.08)	0.64	0.91 (0.85–0.97)	0.004
50–59	1.18 (1.1–1.26)	< 0.001	0.98 (0.92–1.06)	0.647
>= 60	1.37 (1.25–1.50)	< 0.001	1.11 (1.01–1.22)	0.03
BMI, kg/m ²				
30–40	Reference		Reference	
40–50	1.01 (0.96–1.05)	0.81	0.97 (0.92–1.02)	0.206
> 50	0.97 (0.90–1.05)	0.52	0.90 (0.83–0.97)	0.01
Charlson comorbidity index				
0	Reference		Reference	
2–3	1.33 (1.25–1.41)	< 0.001	1.21 (1.13–1.29)	< 0.001
>= 3	1.90 (1.62–2.21)	< 0.001	1.56 (1.33–1.82)	< 0.001
OSAS	1.17 (1.12–1.23)	< 0.001	1.07 (1.02–1.13)	0.005
Bariatric procedure				
Gastric banding	Reference		Reference	
Sleeve gastrectomy	1.48 (1.34–1.63)	< 0.001	1.35 (1.21–1.51)	< 0.001
Gastric bypass	1.92 (1.74–2.13)	< 0.001	1.66 (1.48–1.86)	< 0.001
Surgical approach				
Laparoscopic	Reference		Reference	
Open	2.2 (1.79–2.67)	< 0.001	1.52 (1.23–1.86)	< 0.001
Revisional surgery	1.48 (1.37–1.6)	< 0.001	1.32 (1.22–1.43)	< 0.001
Length of stay*, days				
0–1	Reference		Reference	
2–7	1.2 (1.08–1.35)	< 0.001	0.96 (0.85–1.1)	0.57
> 7	3.3 (2.91–3.74)	< 0.001	1.90 (1.64–2.19)	< 0.001
Reoperation*	4.02 (3.69–4.38)	< 0.001	2.48 (2.25–2.74)	< 0.001
Year				
2013	Reference			
2014	0.99 (0.93–1.05)	0.65		
2015	0.99 (0.93–1.06)	0.84		
2016	0.98 (0.92–1.04)	0.46		

BMI, body mass index; OSAS, obstructive sleep apnea syndrome

*Length of stay and reoperation are meant for the index hospitalization, i.e., the hospitalization where the bariatric procedure takes place

Table 3 Reasons for unplanned readmissions, stratified by bariatric procedure, according to principal diagnosis codes and to any diagnosis code

Complication	Principal diagnosis code [§]					Any diagnosis code ^{§§}					Overall rank ^{**}
	Total	Gastric banding	Sleeve gastrectomy	Gastric bypass	PD code rank*	total	Gastric banding	Sleeve gastrectomy	Gastric bypass	Overall rank ^{**}	
Leak/peritonitis	1455 (16.7)	8 (1.8)	1085 (21)	362 (11.6)	1	1793 (20.6)	17 (3.9)	1308 (25.3)	468 (15.0)	1	
Abdominal pain	1072 (12.3)	45 (10.2)	549 (10.6)	478 (15.3)	2	1663 (19.1)	80 (18.2)	905 (17.5)	678 (21.7)	4	
Nausea and vomiting	752 (8.6)	57 (13)	422 (8.2)	273 (8.7)	3	1541 (17.7)	94 (21.4)	916 (17.7)	531 (17.0)	3	
Bleeding	508 (5.8)	5 (1.1)	212 (4.1)	291 (9.3)	4	1052 (12.1)	17 (3.9)	550 (10.6)	485 (15.5)	5	
Surgical site infection	258 (3.0)	4 (0.9)	157 (3.0)	97 (3.1)	5	1949 (22.3)	44 (10.0)	1243 (24.1)	662 (21.2)	2	
Post-surgical complication	234 (2.7)	7 (1.6)	145 (2.8)	82 (2.6)	6	467 (5.3)	10 (2.3)	296 (5.7)	161 (5.2)	7	
Abdominal trauma	222 (2.5)	12 (2.7)	133 (2.6)	77 (2.5)	7	329 (3.8)	16 (3.6)	200 (3.9)	113 (3.6)	9	
Intestinal obstruction	197 (2.3)	5 (1.1)	52 (1.0)	140 (4.5)	8	308 (3.5)	10 (2.3)	100 (1.9)	198 (6.3)	10	
Eso-gastric stenosis	162 (1.9)	6 (1.4)	82 (1.6)	74 (2.4)	9	221 (2.5)	7 (1.6)	117 (2.3)	97 (3.1)	13	
Nephrolithiasis	157 (1.8)	5 (1.1)	94 (1.8)	58 (1.9)	10	177 (2.0)	5 (1.1)	108 (2.1)	64 (2.0)	17	
Renal (other than nephrolithiasis)	156 (1.8)	5 (1.1)	109 (2.1)	42 (1.3)	11	570 (6.5)	13 (3.0)	402 (7.8)	155 (5.0)	6	
Gastric banding complication	106 (1.2)	61 (13.9)	29 (0.6)	16 (0.5)	12	439 (5.0)	127 (28.9)	207 (4.0)	105 (3.4)	8	
Pulmonary infection	101 (1.2)	4 (0.9)	66 (1.3)	31 (1.0)	13	299 (3.4)	16 (3.6)	182 (3.5)	101 (3.2)	12	
Thoracic pain	94 (1.1)	9 (2)	60 (1.2)	25 (0.8)	14	159 (1.8)	15 (3.4)	111 (2.1)	33 (1.1)	18	
DVT/thrombophlebitis	83 (1.0)	0 (0)	76 (1.5)	7 (0.2)	15	181 (2.1)	4 (0.9)	137 (2.7)	40 (1.3)	16	

Data are reported as *n* (%)

DVT, deep vein thrombosis

§ Principal diagnosis code, indicates the unique ICD-10 code reported as principal diagnosis in the chart reviews; §§ any diagnosis code, considers all ICD-10 reported in the chart reviews; *PD code rank, prevalence ranking according to principal diagnosis code; **overall rank, prevalence ranking according to any diagnosis code

Table 4 Morbidity and mortality during unplanned readmissions

Covariate		Whole sample (N = 8730)
Length of stay (d)	0–1	2830 (32.4)
	2–7	3941 (45.1)
	> 7	1959 (22.4)
Surgical reintervention		1413 (16.2)
Endoscopic intervention, any		670 (7.7)
Endoscopic prosthesis		477 (5.4)
Endoscopic dilation		126 (1.4)
Endoscopic hemostasis		80 (0.9)
Radiological drainage		316 (3.6)
Artificial nutrition		292 (3.3)
Blood transfusion		276 (3.2)
ICU stay		380 (4.3)
Death		32 (0.4)

Data are reported as n (%) unless otherwise reported

D, days; sd, standard deviation; ICU, intensive care unit

readmissions, abdominal pain in 16.9%, nausea and vomiting in 17.7%, and bleeding in 12.1%. Surgical site infection was

reported in 22.3% of readmissions. Gastric banding complications (ICD-10 codes T85x) were the most common reason for readmission after AGB. These codes were occasionally found after SG and GB in the case of revisional surgery (concomitant AGB removal with SG or GB). During readmission, 16.2% of patients underwent a surgical reoperation, 7.7% underwent endoscopic procedure, and 3.6% underwent radiological drainage (Table 4). Mortality was 0.4% (32/8730).

Hospital Performance

Overall, 25.9% (2263/8730) of readmissions took place in a non-index hospital. No statistical correlation was found between hospital volume and the readmission rate ($r = 0.029$, $p = 0.494$). Greater variability in study outcomes was observed in lower volume hospitals, as shown in Fig. 1. In Fig. 2, we report the hospital ranking before and after adjustment. We identified 41 hospitals (7.8%) as high performers and 88 (16.8%) as poor performers, whereas 395 (75.4%) hospitals were average performers. A total of 40 centers (7.6%) modified their ranking after adjustment.

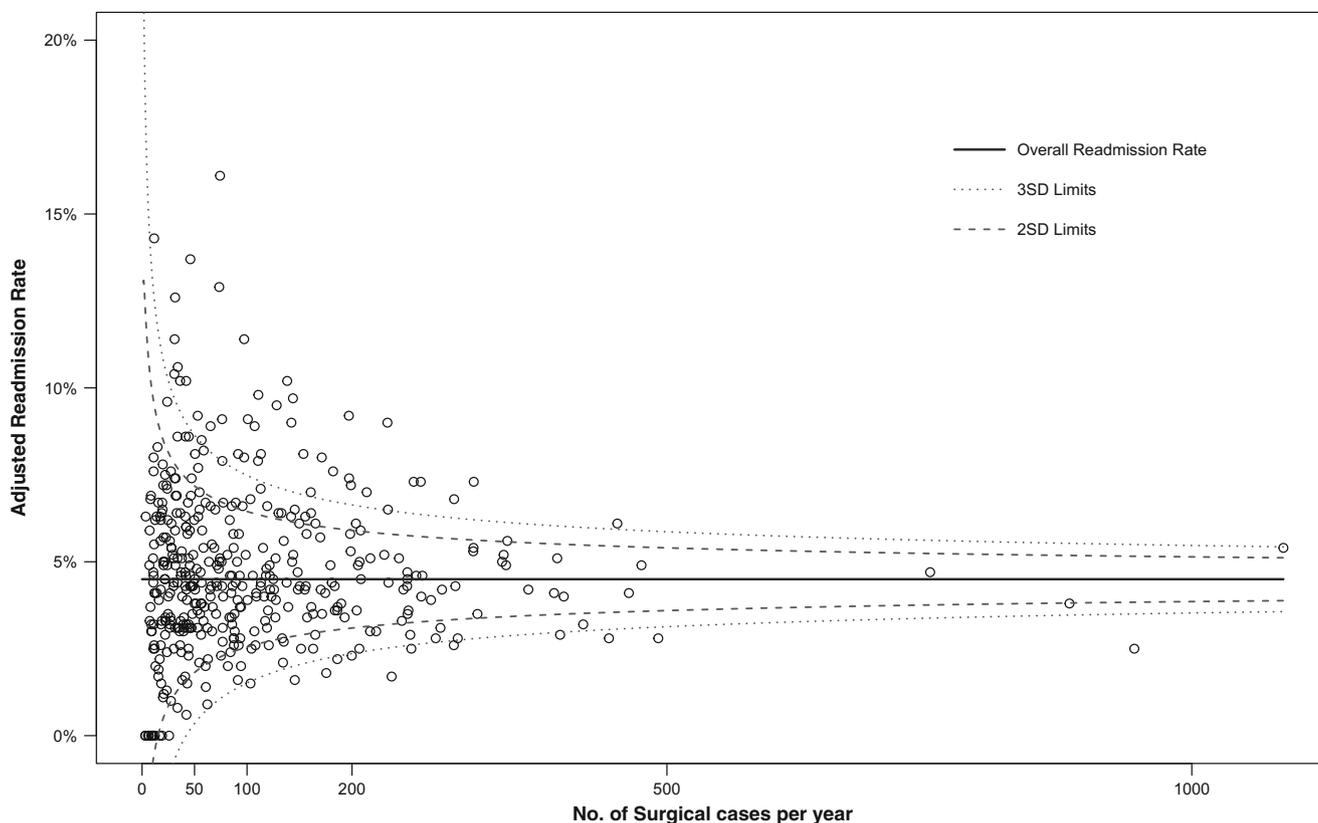


Fig. 1 Aggregated funnel plot of adjusted readmission rates in French hospitals as a function of the caseload. Readmission rate is adjusted based on patient surgical characteristics. Data are reported for hospitals performing at least 10 procedures per year on average. Two levels of

limits are set at two and three standard deviations, respectively, from the overall adjusted mean. Highly performing hospitals are positioned below the central line, while poorly performing hospitals are positioned above

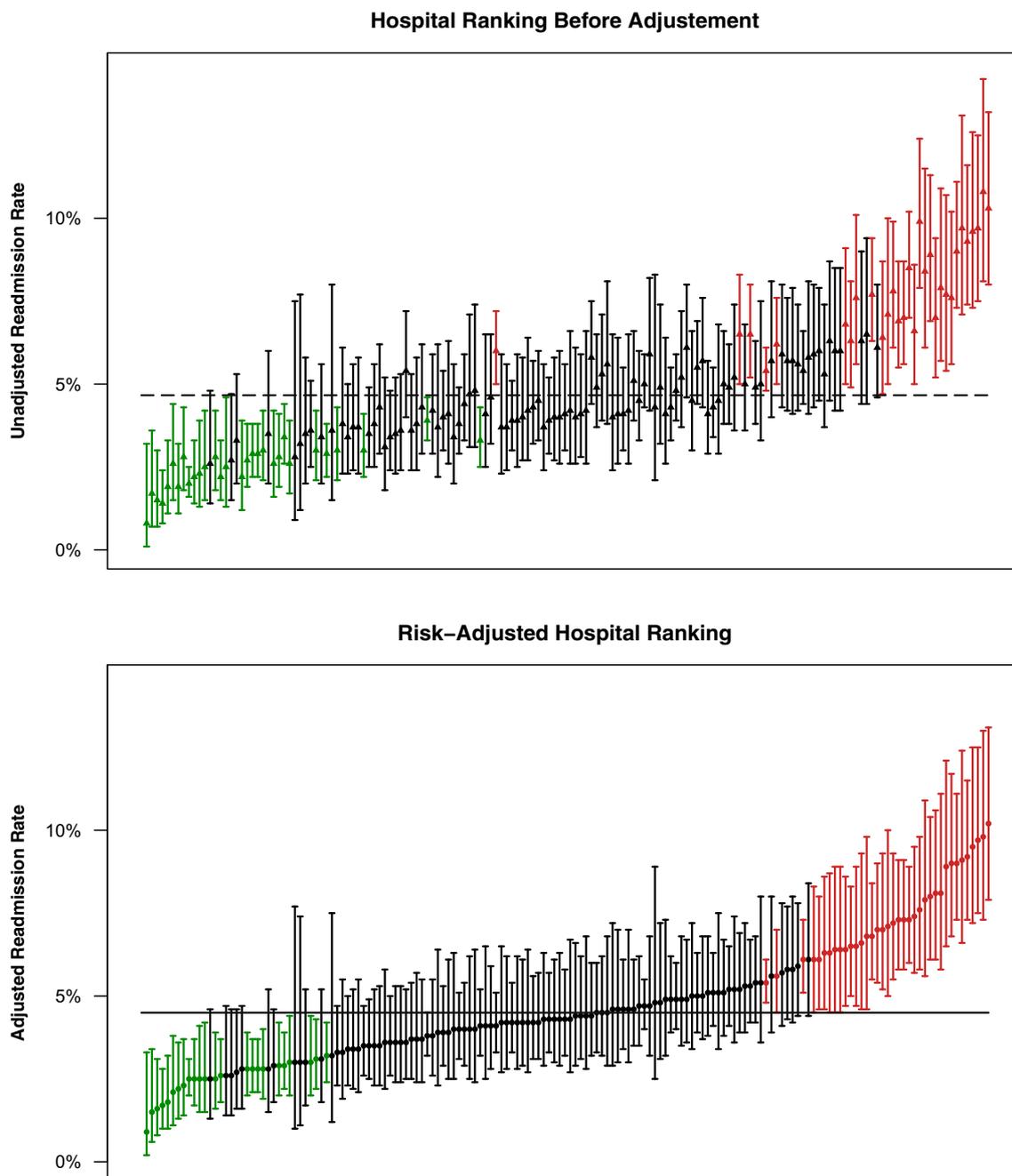


Fig. 2 Hospital performance report assessing the readmission rate before and after adjustment based on baseline patient characteristics and type of surgery (limited to hospitals with at least 100 cases/year). Triangles and dots: hospital readmission rates with 95% confidence intervals.

Horizontal line: national mean. Green: hospitals performing significantly better than the national mean. Red: hospitals performing significantly worse than the national mean. Black: no significant difference from the national average

Discussion

The readmission rate is recognized as a valuable metric for quality after surgery. Nevertheless, this measure has some problems. One major issue is the ability to identify readmission in non-index hospitals. Rates of readmission in a different hospital than the initial one have been reported up to 43% [13]; this rate was 25.9% in our analysis. Hence, single-center statistics should not

be considered reliable for this outcome. The increasing use of administrative data or registries collecting data on multiple centers can overcome this problem. The second problem is the identification of planned and unplanned readmissions, which is a complex topic strictly connected to the type and quality of the data source. If this specific information is not recorded during data collection, it has to be deducted from other information [14]. In some studies, unplanned readmissions are also referred as

“potentially preventable.” This definition outlines the burden for health care systems and the need to implement preventive interventions [15, 16].

The third problem with determining the readmission rate is the definition of the 30-day readmission rate, which should not be considered implied in all cases. Whereas most of the studies consider this to represent 30 days from discharge, the structure of some data sources (such as the ACS-NSQIP database or the MBSQIP data registry) starts computing this rate from the day of surgery [17–19]. In our case, if the outcome was set at 30 days after surgery, we would have omitted 10.2% (890/8730) of readmissions. In this study on over than 187,000 bariatric procedures, we observed an overall 30-day readmission rate of 7.7%, and, after selection, we identified 4.7% unplanned readmissions. This result is consistent with recent studies on large databases reporting readmission rates of 4.4 to 6.5% [17, 20].

Several factors have been previously associated with the readmission rate, in particular baseline patient characteristics and surgical issues. Our study found an increased risk of readmission with higher Charlson comorbidity index. It has been shown that preoperative optimization (including smoking cessation, assessment of nutritional status, control of diabetes, hypertension, pulmonary, and cardiac conditions) reduces postoperative complications. Several studies report that major complications and reintervention during the index hospitalization will increase the probability of an unplanned readmission [16, 18, 19, 21]. Our results confirm this data.

The type of bariatric procedure plays also an important role on the readmission rate, and our study confirms previous observations of a gradient going from the lowest value for AGB to the highest value for GB, with SG in the intermediate zone. In fact, patients subjected to GB have a lower probability of being readmitted in the first 30 days after surgery (1.2–4.5%) [21, 22] compared with SG (2.8–7.6%) and GB (4.9–11.6%) patients [17, 21]. The laparoscopic approach is associated with a lower readmission rate, but this covariate is losing interest, as use of the open approach is disappearing (99.4% of procedures used the laparoscopic approach in our study). On the contrary, it is likely that we will observe in the future an increase in revisional procedures; this factor is significantly associated with a worse outcome. Unfortunately, these factors associated with surgical issues may not be preventable.

The most common reasons for readmission after bariatric surgery are nausea and vomiting, abdominal pain, gastric leak/peritonitis, and bleeding. Our findings are consistent with previous studies with some differences in term of prevalence. In our study, the most common cause of readmission was gastric leak/peritonitis, which was reported in 18.0% of cases as the principal diagnosis, followed by abdominal pain (11.0%). The identification of one single cause for readmission is not straightforward. The reason for returning to the hospital is often multifactorial and it depends on the quality of coding and on the decision regarding which complication to

highlight. Furthermore, employing the principal diagnosis alone to identify reasons for readmission underestimates the real prevalence of some major complications, i.e., leak/peritonitis was observed in 18.0% of principal diagnoses but was found in 22.7% of hospital discharge reviews.

The most important strengths of this study are the comprehensiveness of the data source and the population size. The PMSI database provides access to the entire population for all health centers, either private or public. Thus, we could assess any hospitalization reducing selection bias. The structure of the database also allowed us to identify readmission to a non-index hospital and to discriminate transfer from readmission. The sample size of this study on hospital readmissions is the largest to date. Despite the potential access to data from 2007 (more than 300,000 patients), we decided to include data that were more comparable to the current practice in terms of the type of bariatric procedure and the healthcare pathway.

This study has several limitations. First, are those that concern an administrative database, in particular coding errors or coding bias associated with reimbursement strategies, lack of clinical data, and the inability to capture the effect of the surgeon’s skill on the outcome. The second limitation is the difficulty in defining the readmission cause as one single item. We decided to use the principal diagnosis in the chart review as the cause for readmission, but this is a simplification as the reasons may be multifactorial and complex. Third, we think that there are several unmeasured variables that play a role, such as surgical experience and post-discharge organization. In fact, the surgeon’s skill is associated with postoperative morbidity [23], which is related to the readmission rate, as we report in our results. However, this information is quite difficult to define and is very rarely reported. The organization of the post-discharge care may play a role in readmissions.

Conclusions and Interpretation

In conclusion, we show that one in twelve (7.7%) of patients undergoing bariatric surgery in France was readmitted within 30 days. The majority of these readmissions (61%) were classified as unplanned and considered as potentially preventable. We identified risk factors and reasons for common readmission. Some factors are considered modifiable while others are not. Hence, the readmission rate as a quality metric should be handled with caution and all available information should be considered for adjustment.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Consent Statement This article does not contain any studies with human participants or animals performed by any of the authors.

Appendix 1. Bariatric procedures: CCAM codes

Surgical procedure	Code
Adjustable gastric banding	HFMC007, HFMA009
Sleeve gastrectomy	HFFC018, HFFA011
Gastric bypass	HFCC003, HFCA001

Appendix 2. Causes of readmission: ICD-10 codes

Complications	Codes
Leak - Peritonitis	K316, K631, K632, K650, K658, K659
Abdominal pain	R100, R101, R102, R103, R104
Nausea and vomiting	K910, R11, R13
Bleeding	D62, K250, K254, K260, K270, K274, K280, K284, K290, K625, K661, K920, K921, K922, T810, Z5130
Surgical site infection	L020, L021, L022, L024, L028, L029, L030, L033, T8138, T815
Post-surgical complication	K911, K914, K918
Abdominal trauma	S0220, S0630, S0651, S0690, S1270, S202, S204, S2240, S2601, S2711, S300, S301, S308, S311, S317, S3200, S3240, S352, S358, S359, S360, S3600, S3610, S3611, S363, S3630, S3631, S3641, S3650, S366, S3670, S368, S3680, S3681, S370, S37818, S382, S390, S398, S411, S4220, S4230, S518, S5250, S540, S610, S6210, S6230, S6280, S635, S649, S660, S663, S669, S681, S701, S7230, S7270, S808, S818, S819, S8210, S8230, S8250, S827, S8280, S831, S835, S932
Intestinal obstruction	K560, K562, K564, K565, K566, K567, K660, K913
Oeso-gastric stenosis	K222, K311, K312, K315
Nephrolithiasis	N200, N201, N202, N210, N211, N23
Renal (other than nephrolithiasis)	E272, E86, N10, R33, R34, R390, R392
Gastric banding complication	T8550, T8558
Pulmonary infection	J110, J129, J13, J152, J156, J158, J159, J168, J180, J181, J188, J189, J690, J851, J853, J869
Thoracic pain	R071, R072, R073, R074
DVT/thrombophlebitis	I800, I802, I803, I808, I81

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