Original Investigation

Chronic Use of Opioid Medications Before and After Bariatric Surgery

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IMPORTANCE Obesity is associated with chronic noncancer pain. It is not known if opioid use for chronic pain in obese individuals undergoing bariatric surgery is reduced.

OBJECTIVES To determine opioid use following bariatric surgery in patients using opioids chronically for pain control prior to their surgery and to determine the effect of preoperative depression, chronic pain, or postoperative changes in body mass index (BMI) on changes in postoperative chronic opioid use.

DESIGN, SETTING, AND PARTICIPANTS Retrospective cohort study in a distributed health network (10 demographically and geographically varied US health care systems) of 11 719 individuals aged 21 years and older, who had undergone bariatric surgery between 2005 and 2009, and were assessed 1 year before and after surgery, with latest follow-up by December 31, 2010.

MAIN OUTCOMES AND MEASURES Opioid use, measured as morphine equivalents 1 year before and 1 year after surgery, excluding the first 30 postoperative days. Chronic opioid use is defined as 10 or more opioid dispensings over 90 or more days or as dispensings of at least a 120-day supply of opioids during the year prior to surgery.

RESULTS Before surgery, 8% (95% CI, 7%-8%; n = 933) of bariatric patients were chronic opioid users. Of these individuals, 77% (95% CI, 75%-80%; n = 723) continued chronic opioid use in the year following surgery. Mean daily morphine equivalents for the 933 bariatric patients who were chronic opioid users before surgery were 45.0 mg (95% CI, 40.0-50.1) preoperatively and 51.9 mg (95% CI, 46.0-57.8) postoperatively ($P < .001$). For this group with chronic opiate use prior to surgery, change in morphine equivalents before vs after surgery did not differ between individuals with loss of more than 50% excess BMI vs those with 50% or less (>50% BMI loss: adjusted incidence rate ratio [adjusted IRR, 1.17; 95% CI, 1.07-1.28] vs ≤50% BMI loss [adjusted IRR, 1.03; 95% CI, 0.93-1.14] model interaction, $P = .06$). In other subgroup analyses of preoperative chronic opioid users, changes in morphine equivalents before vs after surgery did not differ between those with or without preoperative diagnosis of depression or chronic pain (depression only [n = 75; IRR, 1.08; 95% CI, 0.90-1.30]; chronic pain only [n = 440; IRR, 1.17; 95% CI, 1.08-1.27]; both depression and chronic pain [n = 226; IRR, 1.11; 95% CI, 0.96-1.28]; neither depression nor chronic pain [n = 192; IRR, 1.22; 95% CI, 0.98-1.51); and *P* values for model interactions when compared with neither were $P = .42$ for depression, $P = .76$ for pain, and $P = .48$ for both.

CONCLUSIONS AND RELEVANCE In this cohort of patients who underwent bariatric surgery, 77% of patients who were chronic opioid users before surgery continued chronic opioid use in the year following surgery, and the amount of chronic opioid use was greater postoperatively than preoperatively. These findings suggest the need for better pain management in these patients following surgery.

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Opioid analgesics are used to manage chronic musculoskeletal and nonspecific pain. Despite a lack of evidence supporting long-term effectiveness of opioids for chronic noncancer pain,[1,2] long-term opioid use has increased recently.[3,4] Prescription opioid consumption and mortality are correlated[5,6] and opioid abuse, accidental overdose, and death have increased,[5,7,8] with overdose deaths increasing in 2010 for the 11th consecutive year in the United States.[9]

Bariatric surgery is used to treat obesity, as well as its comorbid conditions such as cardiovascular and metabolic diseases[10] and chronic pain.[11] Bariatric surgery–related weight loss is associated with improvements in osteoarthritis-associated knee pain and function[11-13] and decreased back pain in observational studies.[11,14] The effect of bariatric surgery on hip or fibromyalgia pain is less clear.[11,13,15] Because some pain syndromes are related to obesity, it is reasonable to assume that weight loss may be associated with better pain control. However, there is a paucity of information regarding chronic opioid use in the bariatric surgery population.

This study evaluated chronic use of prescribed opioids among bariatric surgery patients to determine whether opioid use was reduced after surgery. We examined changes in chronic opioid use with postoperative weight loss and examined the effect of preoperative chronic pain, depression, or both diagnoses on postoperative opioid use.

Methods

Setting and Population

This retrospective cohort study was conducted at 10 sites of the Scalable Partnering Network for comparative effectiveness research (SPAN), a network of shared clinical information from Group Health (Washington), Geisinger Health System (Pennsylvania), HealthPartners (Minnesota), Harvard Pilgrim (Massachusetts), Denver Health (Colorado); and Kaiser Permanente Colorado, Georgia, Hawaii, Northern California, Oregon, and Washington. As part of SPAN, each site built a database of obese patients who were included in this study if they underwent bariatric surgery between January 1, 2005 and December 31, 2009, were aged 21 years or older at initial surgery, and were enrolled in the health system with a drug benefit during the year before surgery and the year after surgery (ie, at least 1 year postsurgery follow-up). Individuals were excluded if all body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) measurements were less than 30 the year before surgery. This study was approved by the Kaiser Permanente Colorado institutional review board (IRB) and the requirement for informed consent was waived. Participating sites either ceded IRB oversight to the Kaiser Permanente Colorado IRB or obtained approval from the IRB of their respective sites.

Exposure and Outcome

The exposure was bariatric surgery, with the date of surgery being the index date for ascertaining presurgery and postsurgery time periods. The primary outcome was opioid use, measured as total morphine equivalents during the time periods.

Opioid Use

Opioid dispensings were identified from pharmacy information contained in the database. Patients were classified as having chronic, some, or no opioid use based on total oral and transdermal opioids dispensed in the year before bariatric surgery. Chronic opioid use was defined as a patient having either 10 or more opioid dispensings over 90 or more days or at least a 120-day supply of opioids dispensed sometime in the year before bariatric surgery.[3,16] Some opioid use was defined as 1 to 9 dispensings or a 1- to less than a 120-day supply dispensed. If no opioids were dispensed, the patient was classified as having no use. When an individual was dispensed both short- and long-acting opioids the same day or received 2 dispensings of the same opioid type the same day, the dispensing with the greatest supply was used for calculations.

Postoperative day 0 was defined as the date of bariatric operation. Opioids use during postoperative days 0 through 29 was excluded in calculating level of use because these days were potentially associated with acute postoperative pain management (eFigure 1 in Supplement shows perioperative dispensings used in determining excluded days). To include the same number of calendar days in the periods before and after surgery, the first 30 days of the presurgery year were also excluded (ie, per-day dispensings on days −335 through −1 and days 30-364 were used in classifying opioid use).

Morphine Equivalents

Each individual's daily morphine equivalents were determined for short-acting opoids (US Drug Enforcement Agency Schedule II or Non-Schedule II) or long-acting ones (eTable 1 in Supplement). First, morphine equivalents per dispensing were calculated by multiplying the quantity dispensed by the milligram strength per dosage unit dispensed and then multiplying by the opioid-specific morphine equivalents conversion factor.[3,16] Second, total daily morphine equivalents were calculated by dividing the total morphine equivalents per dispensing by the total of days supply that was dispensed. Third, these daily morphine equivalents were applied across the corresponding days. If an individual had opioids available from multiple dispensings on the same day, morphine equivalents were summed for that day.

For primary analysis, morphine equivalents were calculated from days −335 through −1 and days 30 through 364. If an individual had opioid dispensings days −365 through −336 or 0 through 29, any days' supply that overlapped into days −335 through −1 or 30 through 364, respectively, was included in daily morphine equivalents calculations. For secondary analyses, morphine equivalents through postsurgery days 730 (2 years) and 1094 (3 years) were calculated.

Covariates

The covariates used in this study were the SPAN network site and patient age, sex, race/ethnicity, education, income, tobacco use, BMI before and after surgery, bariatric procedure type, surgery year, outpatient visits during the year before surgery, insurance, and bariatric surgery reintervention or inpatient surgery after bariatric surgery. Covariates were extracted from information in each patient's electronic health record and electronic administrative databases. Race/ethnicity was extracted from the electronic health record to the SPAN database in accordance with the categories included in the National Institutes of Health policy and guidelines on including women and minorities as subjects in clinical research.[17] Race/ethnicity was assessed because obesity treatment with bariatric surgery and the diagnosis and management of chronic pain may vary by race/ethnicity.[18-20] Other covariates included presurgery diagnoses of substance abuse, anxiety disorders, and depression (eTable 2 in Supplement), chronic pain (≥2 coded diagnoses over ≥90 days)[21,22] (eTable 3 in Supplement), Quan comorbidity score (Quan adaptation of the Elixhauser index, a comorbidity measurement tool with range from 0 to 31 clinical conditions; lower numbers reflect fewer comorbidities),[23] and dispensings of antidepressants, anxiolytics, sedative/hypnotics, nonnarcotic analgesics, muscle relaxants, oral corticosteroids, antiepileptics, or other adjunctive pain medications (eTable 4 in Supplement). One year postsurgery weight loss was defined 2 ways: percent absolute BMI change from presurgery[10] and percent excess BMI lost[24,25] (BMI of 25 considered zero excess). Weight recorded closest to 1 year after surgery was used to determine weight loss.

Statistical Analysis

Kruskal-Wallis and χ^2 tests were used to compare covariate distribution across the 3 presurgery opioid use groups. To examine longitudinal trends, fitted penalized b-spline curves of daily morphine equivalents before and after surgery were plotted for each group.

Further analyses assessed the presurgery chronic opioid use group. Paired *t* tests and Wilcoxon sign-rank tests were used to compare number of opioid dispensings, total opioid days' supply, daily morphine equivalents, and mean potency of opioids dispensed (measured by morphine conversion factor) before and after surgery. Opioid types used before and after surgery were described. For the primary analysis, generalized estimating equations (GEEs) were used to assess change in opioid use after surgery, adjusting for covariates. GEE models with a negative binomial distribution were used to estimate adjusted incidence rate ratios (IRRs) of morphine equivalents in 1, 1 to 2, and 1 to 3 years after surgery vs the year prior to surgery. Because cohort members had differential follow-up time beyond 1 year after surgery, we applied an offset for the log of person-time for each individual for the 1- to 2-year and 1- to 3-year analyses. Each individual's time was censored at disenrollment, death, loss of drug benefit, or study end date (December 31, 2010), whichever occurred first.

In preliminary models, all presurgery covariates with bivariable associations of *P* values less than .20 were considered. Variable reduction due to collinearity was the primary method of model refinement; 1 variable of each correlated pair was excluded if Pearson correlation coefficients were 0.3 or greater and −0.3 or less or κ coefficients 0.2 or greater. Presurgery diagnoses correlated with medication use and diagnoses, except substance abuse, were removed. In final models, an indicator variable for bariatric reintervention or inpatient surgery after bariatric surgery was added. Two-way interactions with time after bariatric surgery vs time before, and surgery year and type were tested. Results were not clinically significant and these interactions were excluded from final models.

In preplanned secondary analyses, the associations between weight loss and opioid use overall and relative morphine equivalents change 1 year after surgery in patients with presurgery and postsurgery weight data were compared. Multivariate GEEs were used to assess adjusted morphine equivalents change after surgery, association of weight loss with opioid use, and possible effect modification of weight loss and change in morphine equivalents after surgery. The Quasi-Akaike Information Criterion was used to determine whether percent excess or absolute BMI loss yielded best model fit. In another preplanned secondary analysis, interactions were assessed between postsurgery change in morphine equivalents and preoperative depression, chronic pain, or both diagnoses. Post-hoc subanalyses included evaluating change in morphine equivalents by bariatric surgery type and postsurgery change in morphine equivalents and other pain medications in patients with presurgery musculoskeletal pain diagnoses.

All *P* values were 2-sided and a *P* value of less than .05 was considered statistically significant. All analyses were conducted using SAS version 9.2 (SAS Institute Inc).

Results

The final study population included 11 719 patients. During the year before bariatric surgery, 56% (95% CI, 55%-57%; n = 6576) of patients had no opioid use, 36% (95% CI, 35%-37%; n = 4210) had some opioid use, and 8% (95% CI, 7%-8%; n = 933) had chronic opioid use. Characteristics and unadjusted comparisons of individuals with presurgery opioid use classified as chronic, some, or none are in **Tables 1** and **2**. Among individuals with chronic opioid use before surgery, 77% (95% CI, 75%-80%; n = 723) continued chronic use the year after surgery, while 20% (95% CI, 17%-22%; n = 182) changed to some use, and 3% (95% CI, 2%-4%; n = 28) had no opioid use.

Opioid use increased in the 933 patients who were chronic opioid users before surgery. The adjusted IRR for morphine equivalents postoperatively, compared with preoperative levels, was 1.13 (95% CI, 1.06-1.20) in the first year after surgery and 1.18 (95% CI, 1.11-1.26) 3 years after surgery (**Table 3**). In preoperative chronic users, mean daily morphine equivalents increased from 45.0 mg (95% CI, 40.0-50.1) the year before surgery to 51.9 mg (95% CI, 46.0-57.8) the year after surgery (**Table 4**; **Figure**) ($P < .001$). After surgery, chronic opioid users were dispensed higher potency opioids than before surgery (mean morphine conversion factor 1.13 [95% CI, 1.09-1.17] after vs 1.08 [95% CI, 1.05-1.12] before; $P = .003$) (eTable 5 in Supplement) and opioid use shifted from non-Schedule II to short-acting and long-acting Schedule II opioids (eTable 6 in Supplement).

One-year presurgery and postsurgery BMIs were available for 647 (69%) chronic users. Of 286 individuals without available BMIs, 138 (48%) were from 2 sites. Baseline characteristics for patients with and without presurgery and postsurgery BMIs available are shown in eTable 7 (in Supplement).

Table 1. Unadjusted Characteristics of Individuals With Bariatric Surgery, Aged 21 and Older, With and Without Chronic Opioid Use[a]

Sociodemographic and Clinical Characteristics	All Patients (N = 11 719)	Opioid Use Prior to Bariatric Surgery: None (n = 6576)	Some (n = 4210)	Chronic (n = 933)
Age at surgery, median (5th-95th percentile), y	47 (29-63)	46 (28-63)	48 (29-64)	51 (33-65)
Women	9538 (81)	5293 (80)	3508 (83)	737 (79)
Race/ethnicity				
Black	990 (8)	555 (8)	375 (9)	60 (6)
White	7021 (60)	3765 (57)	2596 (62)	660 (71)
Hispanic, any race	1148 (10)	660 (10)	410 (10)	78 (8)
Other race/ethnicity[b]	442 (4)	269 (4)	148 (4)	25 (3)
Not available	2118 (18)	1327 (20)	681 (16)	110 (12)
Tobacco use				
Ever	2816 (24)	1394 (21)	1083 (26)	339 (36)
Never	3768 (32)	2175 (33)	1332 (32)	261 (28)
Not available	5135 (44)	3007 (46)	1795 (43)	333 (36)
<High school education, median (5th-95th percentile), %[c]	12 (3-40)	12 (2-40)	13 (3-40)	14 (3-41)
Family income, median (5th-95th percentile), $[c]	57 857 (30 063-96 160)	59 185 (30 417-97 567)	57 242 (29 821-95 397)	54 451 (29 375-90 930)
Insurance				
Medicare	333 (3)	128 (2)	124 (3)	81 (9)
Medicaid	64 (<1)	27 (<1)	30 (<1)	7 (<1)
Commercial	10 605 (91)	6095 (93)	3787 (90)	723 (77)
Multiple or other types	586 (5)	243 (4)	235 (5)	108 (12)
Not available	131 (1)	83 (1)	34 (<1)	14 (2)
BMI, median (5th-95th percentile)[d]				
Before surgery	44 (36-58)	44 (35-61)	44 (36-58)	44 (36-58)
1 Year after surgery	31 (24-43)	31 (24-43)	31 (24-43)	31 (23-46)
No. of comorbidities in the year before surgery[e]	3 (1-7)	3 (1-6)	3 (1-7)	4 (1-8)
Selected diagnoses in the year before surgery				
Chronic pain[f]	4853 (41)	1921 (29)	2266 (54)	666 (71)
Depression[g]	2942 (25)	1470 (22)	1171 (28)	301 (32)
Anxiety[g]	1766 (15)	839 (13)	710 (17)	217 (23)
Substance abuse[g]	874 (7)	364 (6)	351 (8)	159 (17)
Bipolar disorder[g]	227 (2)	85 (1)	107 (3)	35 (4)
PTSD[g]	137 (1)	62 (1)	53 (1)	22 (2)
Outpatient visits in the year before surgery, median (5th-95th percentile)	12 (4-35)	10 (4-30)	14 (4-41)	16 (5-48)
Type of surgery				
Lap Roux-en-Y gastric bypass	7488 (64)	4255 (65)	2669 (63)	564 (60)
Laparoscopic band	1750 (15)	1065 (16)	571 (14)	114 (12)
Open RYGB	1375 (12)	723 (11)	504 (12)	148 (16)
Other or more than 1 type	839 (7)	399 (6)	363 (8)	77 (8)
Gastric sleeve	267 (2)	134 (2)	103 (2)	30 (3)
First bariatric surgery reintervention after initial bariatric procedure[h]	1515 (13)	765 (12)	582 (14)	168 (18)[i]
First inpatient surgery (not bariatric) after initial bariatric procedure[h]	382 (3)	158 (2)	156 (4)	68 (7)[j]
Incident chronic pain diagnoses in the year after surgery[f]	1471 (13)	883 (13)	477 (11)	111 (12)

Abbreviations: BMI, body mass index; PTSD, posttraumatic stress disorder; RYGB, Roux-en-Y gastric bypass.

[a] All *P* values were less than .001 except median BMI before surgery (*P* = .69) and median BMI after surgery (*P* = .001). BMI is calculated as weight in kilograms divided by height in meters squared. Kruskal-Wallis tests were used for continuous variables and χ^2 tests for categorical variables. Data were reported as No. (%) unless otherwise indicated.

[b] American Indian or Alaskan Native, Asian or Pacific Islander, and multiracial individuals were categorized as other race/ethnicity due to small numbers.

[c] Data available for percent of community members older than 25 years with 12 or fewer years of education (n = 11 493); data available for individuals for median family income (n = 11 495) (Census 2000 data).

[d] For BMI before surgery, n = 7366 and for BMI after surgery, n = 7136.

[e] Quan comorbidity index was used to report available data (n = 11 685 patients) (Quan adaptation of the Elixhauser index, a comorbidity measurement tool with range from 0 to 31 clinical conditions; lower numbers reflect fewer comorbidities).[23]

[f] Data indicate 2 or more coded diagnoses at least 90 days apart.

[g] Data indicate 1 or more coded diagnoses during the year prior to surgery.

[h] Event was 15 through 364 days after initial bariatric procedure.

[i] Rates of reinterventions among chronic opioid users: endoscopy (57%), other (24%), hernia (9%), laparoscopy or laparotomy (6%), percutaneous endoscopic gastrostomy (PEG) tube (2%), removal (1%), or revision (<1%).

[j] Rates of inpatient surgeries among chronic opioid users: cardiovascular (30%), digestive (22%), musculoskeletal (21%), nerve (7%), respiratory (7%), urinary (4%), skin (4%), female genital (2%), blood/lymph (1%), maternity/delivery (1%).

Table 2. Drug Classes Used by Bariatric Surgery Patients (Aged ≥21 y) With and Without Chronic Opioid Use[a]

Characteristic	All Patients (N = 11 719)	Opioid Use Prior to Bariatric Surgery: None (n = 6576)	Some (n = 4210)	Chronic (n = 933)
No. of unique nonopioid drug classes dispensed, median (5th-95th percentile)				
During year before surgery	4 (0-11)	3 (0-9)	5 (0-12)	7 (2-15)
During year after surgery	3 (0-10)	2 (0-8)	3 (0-10)	6 (1-14)
Use of selected other analgesic and adjunctive pain medication classes the year before surgery, No. (%)[b]				
Antidepressant	4507 (39)	2084 (32)	1813 (43)	610 (65)
Antiepileptic	1047 (9)	353 (5)	452 (11)	242 (26)
Antianxiety	1693 (14)	586 (9)	781 (19)	326 (35)
Oral corticosteroid	644 (6)	226 (3)	315 (7)	103 (11)
Muscle relaxant	1156 (10)	252 (4)	606 (14)	298 (32)
Nonnarcotic analgesic[c]	4887 (42)	985 (15)	3030 (72)	872 (93)
Use of selected other analgesic and adjunctive pain medication classes the year after surgery, No. (%)[b]				
Antidepressant	4131 (35)	1870 (28)	1681 (40)	580 (62)
Antiepileptic	1032 (9)	362 (6)	433 (10)	237 (25)
Antianxiety	1949 (17)	720 (11)	856 (20)	373 (40)
Oral corticosteroid	448 (4)	151 (2)	222 (5)	75 (8)
Muscle relaxant	968 (8)	289 (4)	445 (11)	234 (25)
Nonnarcotic analgesic[c,d]	5880 (50)	2514 (38)	2536 (60)	830 (89)

[a] All P values were less than .001. Kruskal-Wallis tests were used for continuous variables and χ^2 tests for categorical variables.

[b] Data indicate at least 2 dispensings during the year. Use of other analgesics and adjunctive pain medications among individuals with chronic opioid use prior to bariatric surgery and who had chronic pain diagnoses before surgery is reported in eTable 8 in Supplement.

[c] Data include use as a single agent or combination products.

[d] Data in table include days 0 through 30. If postoperative days 0 through 30 are excluded, the No. (%) of patients in this category were 3805 (32) for all, 1213 (18) for no opioid use, 1808 (43) for some opioid use, and 784 (84) for chronic opioid use.

Table 3. Unadjusted and Adjusted Incidence Rate Ratios for Total Morphine Equivalents After Bariatric Surgery vs 1 Year Before Surgery Among Patients With Chronic Opioid Use Before Bariatric Surgery

	Total Morphine Equivalents	Total Person-Days	Unadjusted IRR (95% CI)[b]	Unadjusted P Value	Adjusted[a] IRR (95% CI)[b]	Adjusted[a] P Value
Primary analysis: all patients with chronic opioid use before surgery (n = 933)[c]						
1 year before surgery	14 074 721	312 555	1 [Reference]		1 [Reference]	
1 year after surgery	16 218 653	312 555	1.15 (1.08-1.23)	<.001	1.13 (1.06-1.20)	<.001
1 to 2 years after surgery	32 513 049	597 620	1.19 (1.11-1.28)	<.001	1.17 (1.09-1.24)	<.001
1 to 3 years after surgery	44 171 494	782 434	1.20 (1.11-1.30)	<.001	1.18 (1.11-1.26)	<.001
Secondary analysis: patients with all covariate data available (n = 618)[c]						
1 year before surgery	9 043 376	207 030	1 [Reference]		1 [Reference]	
1 year after surgery	10 097 452	207 030	1.12 (1.04-1.20)	<.001	1.13 (1.05-1.22)	<.001
Secondary analysis: patients with before- and after-surgery BMI data available (n = 647)[c]						
≤50% Excess BMI loss (n = 180)[d]						
1 year before surgery	3 284 947	60 300	1 [Reference]		1 [Reference]	
1 year after surgery	3 299 119	60 300	1.00 (0.89-1.13)	.94	1.03 (0.93-1.14)	.56
>50% Excess BMI loss (n = 467)[d]						
1 year before surgery	5 831 462	156 445	1 [Reference]		1 [Reference]	
1 year after surgery	6 891 537	156 445	1.18 (1.08-1.30)	<.001	1.17 (1.07-1.28)	<.001

Abbreviations: BMI, body mass index; IRR, incidence rate ratio.

[a] Adjusted for patient age on surgery date, sex, race/ethnicity (with American Indian or Alaskan Native, Asian or Pacific Islander, and multiracial race/ethnicities collapsed into 1 category), type of insurance on surgery date, site, type of bariatric surgery, number of ambulatory visits in year prior to surgery (log-transformed), diagnosis of substance abuse in year prior to surgery, use of antiepileptic medications in year prior to surgery (≥2 dispensings), use of corticosteroids in year prior to surgery (≥2 dispensings), use of muscle relaxants in year prior to surgery (≥2 dispensings), any nonnarcotic analgesic use in year prior to surgery (alone or in combination with opioids; ≥2 dispensings), median BMI group in year prior to surgery, whether the person underwent a bariatric surgery reintervention (any setting) or any inpatient surgery in the spans of 15 to 364, 15 to 729, or 15 to 1094 days after bariatric surgery (depending on analysis). For covariates with missing values, unknown is populated as the missing value.

[b] IRRs show the number of morphine equivalents per person-day in time periods shown after surgery compared with the year prior to surgery. IRRs are calculated using generalized estimating equation modeling and specifying a negative binomial distribution and an offset for log of person-time.

[c] Time periods are defined as 1 year before surgery (−335 days through −1 day from surgery), 1 year after surgery (30 through 364 days from surgery), 1 to 2 years after surgery (30 through 729 days from surgery), 1 to 3 years after surgery (30 through 1094 days from surgery).

[d] BMI is calculated as weight in kilograms divided by height in meters squared.

Adjusted relative postoperative increases in total morphine equivalents did not differ between individuals who lost more than 50% excess BMI vs 50% or less (>50% excess BMI loss [adjusted IRR, 1.17; 1.07-1.28] vs ≤50% excess BMI loss [IRR, 1.03; 95% CI, 0.93-1.14; Table 3] and model interaction *P* value was .06. However, individuals who lost more than 50% of their initial excess BMI used fewer morphine equivalents overall before and after surgery than those who lost 50% or less excess BMI (IRR, 0.7; 95% CI, 0.52-0.98).

Neither preoperative depression nor chronic pain diagnoses influenced changes in preoperative to postoperative chronic opioid use. The IRR for preoperative vs postoperative morphine equivalents for depression was 1.08 (95% CI, 0.90-1.30), for chronic preoperative pain (IRR, 1.17; 95% CI, 1.08-1.27), for patients with both depression and pain (IRR, 1.11; 95% CI, 0.96-1.28), and patients with neither depression or chronic preoperative pain (IRR, 1.22; 95% CI, 0.98-1.51). The IRRs among patients with depression, chronic pain, or both diagnoses did

Table 4. Opioid Dispensings During the Year Before and the Year After Bariatric Surgery Among Patients With Chronic Opioid Use Before Surgery

Analyses	Before Surgery[a]	After Surgery[b]	*P* Value[c]
Primary: patients with chronic opioid use before surgery (n = 933)[d]			
Daily morphine equivalents, mean (95% CI)	45.0 (40.0-50.1)	51.9 (46.0-57.8)	<.001
Daily morphine equivalents, median (5th-95th percentile)	21 (5-162)	22 (1-202)	.008
Total days' supply dispensed, mean (95% CI)	265.5 (255.5-275.4)	265.3 (252.7-277.9)	.98
Total days' supply dispensed, median (5th-95th percentile)	247 (70-549)	255 (7-643)	.29
Secondary: patients with chronic opioid use before surgery and with before- and 1-year after-surgery BMI data available (n = 647)			
>50% Excess BMI loss after surgery (n = 467)			
Daily morphine equivalents, mean (95% CI)	37.3 (32.1-42.5)	44.1 (38.1-50.0)	<.001
Daily morphine equivalents, median (5th, 95th percentile)	19 (5-123)	20 (1-188)	.009
Total days' supply dispensed, mean (95% CI)	256.0 (242.4-269.6)	262.8 (245.0-280.6)	.36
Total days' supply dispensed, median (5th-95th percentile)	235 (70-512)	255 (9-625)	.79
≤50% Excess BMI loss after surgery (n = 180)			
Daily morphine equivalents, mean (95% CI)	54.5 (38.7-70.2)	54.7 (38.8-70.6)	.94
Daily morphine equivalents, median (5th-95th percentile)	24 (5-177)	25 (1-167)	.67
Total days' supply dispensed, mean (95% CI)	276.2 (253.3-299.1)	265.9 (240.8-291.0)	.31
Total days' supply dispensed, median (5th-95th percentile)	269 (67-536)	264 (6-577)	.17

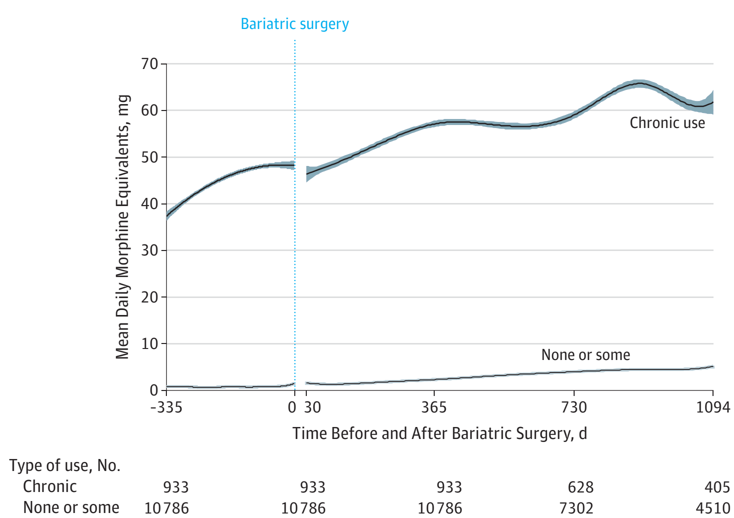
[a] Indicates −335 days through −1 day from surgery.

[b] Indicates 30 days through 364 from surgery.

[c] *P* values were calculated using the matched *t* test for means and the Wilcoxon sign rank test for medians.

[d] Total morphine equivalents among the subset of individuals with chronic opioid use prior to bariatric surgery and who had chronic pain diagnoses before surgery are reported in eTable 8 in Supplement.

Figure. Smoothed Average Daily Morphine Equivalents Used Before and After Bariatric Surgery for Groups With Chronic, Some, or No Opioid Use Before Surgery



Longitudinal trends were examined using fitted penalized b-spline curves of daily morphine equivalents used by each group before and after surgery. The tinted bands show 95% CIs for the fitted daily mean morphine equivalent estimates.

not differ significantly from the IRR in patients with neither condition (model interactions for depression [*P* = .42], pain [*P* = .76], and for both [*P* = .48]).

In the post-hoc subanalyses by procedure type, the IRRs for morphine equivalents used before surgery vs after surgery were 1.18 (95% CI, 1.09-1.27) for lap Roux-en-Y gastric bypass (RYGB), 1.17 (95% CI, 1.01-1.37) for open RYGB, and 1.08 (95% CI, 0.95-1.22) for lap band. These IRRs were not statistically different from each other (lap RYGB [*P* = .22] and open RYGB [*P* = .38]), compared with lap band. Results of the post-hoc analysis of other analgesics and adjunctive pain medications in subgroups with different pre-surgery pain diagnoses are in eTable 8 (in Supplement).

Discussion

Of the individuals in this demographically and geographically distributed US bariatric surgery population, 8% used opioids chronically in the year before surgery. Among presurgery chronic users, 77% continued chronic opioid use after surgery. Relative to the year before surgery, opioid use among chronic opioid users before surgery increased by 13% the first year after surgery and by 18% across 3 postsurgery years.

We anticipated weight loss after bariatric surgery would result in reduced pain and opioid use among patients with chronic pain. However, patients with and without preoperative chronic pain, depression diagnoses, or both had similar increases in postoperative chronic opioid use after surgery as those without chronic pain or depression. One possible explanation is that some patients likely had pain unresponsive to weight loss but potentially responsive to opioids.[26] We did not observe a differential increase in opioid use after surgery vs before between individuals who lost more than 50% excess BMI vs 50% or less, also contrary to our expectations.

Multiple factors likely contribute to increasing chronic opioid use over time. Obese individuals demonstrate more pain sensitivity and lower pain detection thresholds than those who are not obese and altered pain processing persists after bariatric surgery.[27] Contributing factors not unique to the bariatric surgery population include long-term opioid use possibly leading to tolerance, with need to take higher dosages to achieve equianalgesia and escalating dosages possibly increasing pain sensitivity, even when the initial cause has resolved.[28,29]

To our knowledge, this is the first population-based, longitudinal assessment of long-term opioid use for chronic noncancer pain among individuals undergoing bariatric surgery. Our findings must therefore be interpreted within the context of information from the general (obese plus nonobese) population. That 8% of our bariatric surgery population used opioids chronically exceeds the 3% observed in the general population.[3] We found 77% continued chronic use for years postoperatively, exceeding the 56.1% to 68.4% found to continue opioids long term in general-population studies.[16,30] Our finding that average daily morphine equivalents among chronic users was 51.9 is consistent with findings of other studies.[3,31]

Among the general population, many individuals using opioids chronically continue to experience pain and activity limitations.[32] Effective pain management in the bariatric surgery population is even more challenging because nonselective nonsteroidal anti-inflammatory agents are avoided,[33] and while acetaminophen can be used, it is less efficacious. Thus, prescribers have fewer medication options for bariatric surgery patients with pain. Regardless, opioid use should be undertaken with awareness of risks and close monitoring.[34] Notably, chronic users in this study frequently had risk factors for misuse (eg, substance abuse, mental health diagnoses).[35-37]

Strengths of this study are inclusion of 11 719 individuals, defined follow-up, and application of stringent definitions and validated techniques to determine opioid use and morphine equivalents. A potential limitation is the days' supply decision rules; however, our approach may underestimate morphine equivalents so the interpretation of our results does not change. Because direct linkage between opioid dispensing and indication for use was not available, interpretation of these findings should be limited to temporal changes in opioid use relative to bariatric surgery. This study was not designed to assess clinical or safety outcomes, nor did it assess the obese population overall. Nevertheless, these results are consistent with general population findings of increasing yearly morphine equivalents over time.[3,4]

In conclusion, in this cohort of patients who underwent bariatric surgery, there was greater chronic use of opioids after surgery compared with before. Preoperative chronic opioid users required increased morphine equivalents after surgery. These findings suggest the need for proactive management of chronic pain in these patients after surgery.

ARTICLE INFORMATION

Author Contributions: Dr Raebel had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Raebel, Newcomer, Reifler, Boudreau, Elliott, DeBar, Ahmed, Bayliss.
Acquisition of data: Raebel, Newcomer, Boudreau, Elliott, DeBar.
Analysis and interpretation of data: Raebel, Newcomer, Reifler, Boudreau, Elliott, DeBar, Ahmed, Pawloski, Fisher, Donahoo, Bayliss.
Drafting of the manuscript: Raebel, Newcomer, Elliott, Ahmed, Donahoo, Bayliss.
Critical revision of the manuscript for important intellectual content: Raebel, Newcomer, Reifler, Boudreau, Elliott, DeBar, Ahmed, Pawloski, Fisher, Donahoo, Bayliss.
Statistical analysis: Raebel, Newcomer, Reifler.
Obtained funding: Bayliss.
Administrative, technical, or material support: Boudreau, Elliott, Donahoo.
Study supervision: Raebel, Boudreau, Bayliss.

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