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REPORTS OF ORIGINAL INVESTIGATIONS

A retrospective study of opioid prescribing patterns at hospital discharge in surgical patients with obstructive sleep apnea

Étude rétrospective des schémas de prescription d'opioïdes au congé de l'hôpital chez les patients chirurgicaux ayant un syndrome d'apnée-hypopnée du sommeil

Samir M. Kendale, MD · Jing Wang, MD, PhD · Jeanna D. Blitz, MD · Steven Calvino, MD · Germaine Cuff, PhD · Nicholas Barone, MD · Andrew D. Rosenberg, MD · Lisa Doan, MD

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Abstract

Purpose *Obstructive sleep apnea (OSA) is a risk factor for complications with postoperative opioid use, and in those patients with known or suspected OSA, minimization of postoperative opioids is recommended. We hypothesize that despite these recommendations, surgical patients with known or suspected OSA are prescribed postoperative opioids at hospital discharge at similar doses to those without OSA.*

Methods *This was a retrospective analysis of the electronic health records of surgical patients from 1 November 2016 to 30 April 2017 at a single academic institution. Patients with a known diagnosis of OSA or a STOP-Bang score ≥ 5 were compared with those without OSA for the amount of postoperative discharge opioid medication using multivariable linear regression.*

Results *Of the 17,671 patients analyzed, 1,692 (9.6%) had known or suspected OSA with 1,450 (86%) of these patients discharged on opioid medications. Of the 15,979 patients without OSA, 12,273 (77%) were discharged on opioid medications. The total median [interquartile range (IQR)] oral morphine equivalents (OME) for all patients was 150 [0-338] mg and for patients with known or suspected OSA was 160 [0-450] mg, an unadjusted comparison showing an 18% difference in OME (95% confidence interval [CI], 3% to 35%; P = 0.02). The analysis, after adjusting for confounders, showed no significant difference in the amount of opioids prescribed to OSA or non-OSA patients (8% difference in total OME; 95% CI, −6% to 25%; P = 0.26).*

Conclusion *This study shows that surgical patients at risk for OSA or confirmed OSA are prescribed opioids at similar rates and doses upon discharge despite guidelines that recommend minimizing opioid use in OSA patients. These findings indicate a need to implement different strategies to reduce the prescription of opioids to patients with OSA.*

S. M. Kendale, MD (✉) · J. Wang, MD, PhD ·
J. D. Blitz, MD · StevenCalvino, MD · G. Cuff, PhD ·
N. Barone, MD · A. D. Rosenberg, MD · L. Doan, MD
Department of Anesthesiology, Perioperative Care and Pain Medicine, NYU Langone Medical Center, New York University, 550 First Avenue, New York, NY 10016, USA
e-mail: Samir.Kendale@nyumc.org

Résumé

Objectif *Le syndrome d'apnée-hypopnée du sommeil (SAHS) est un facteur de risque de complications avec l'utilisation des opioïdes postopératoires. Chez les patients ayant un SAHS connu ou suspecté et il est recommandé de réduire autant que possible les opioïdes au cours de cette période. Nous avons formulé l'hypothèse que, malgré ces recommandations, les patients chirurgicaux ayant un SAHS connu ou suspecté se voient prescrire des opioïdes postopératoires au congé de l'hôpital aux mêmes posologies que les patients sans SAHS.*

Méthodes *Une analyse rétrospective des dossiers de santé électroniques de patients chirurgicaux a été menée dans un établissement universitaire sur la période du 1er novembre 2016 au 30 avril 2017. Les patients ayant un diagnostic connu de SAHS ou un score STOP-Bang ≥ 5 ont été comparés à l'aide d'une régression linéaire multifactorielle aux patients sans SAHS pour ce qui concernait la quantité de médicaments opioïdes postopératoires prescrits au moment du congé.*

Résultats *Parmi les 17 671 patients analysés, 1 692 (9,6 %) avaient un SAHS connu ou suspecté et 1 450 (86 %) de ces patients ont reçu leur congé avec une prescription d'opioïdes. Parmi les 15 979 patients sans SAHS, 12 273 (77 %) ont reçu leur congé avec des médicaments opioïdes. La médiane totale (écart interquartile - EIQ) des équivalents de morphine orale (EMO) pour tous les patients était de 150 (0 à 338) mg; pour les patients ayant un SAHS connu ou suspecté, les valeurs étaient de 160 (0 à 450) mg, une comparaison non ajustée montrant une différence de 18 % pour les EMO (intervalle de confiance [IC] à 95 % : 3 % à 35 %; P = 0,02). Après ajustement des facteurs confondants, l'analyse n'a pas mis en évidence de différences entre les quantités d'opioïdes prescrites aux patients avec ou sans SAHS (différence de 8 % des EMO totaux; IC à 95 % : -6 % à 25 %; P = 0,26).*

Conclusion *Cette étude montre que les patients chirurgicaux à risque de SAHS ou ayant un SAHS confirmé reçoivent des prescriptions d'opioïdes à la même fréquence et pour les mêmes doses au moment de leur congé en dépit des lignes directrices recommandant de limiter l'utilisation des opioïdes chez les patients avec SAHS. Ces constatations indiquent la nécessité de mettre en œuvre différentes stratégies pour réduire la prescription d'opioïdes chez les patients présentant un SAHS.*

The current opioid epidemic has increased the need for a close examination for postoperative prescribing patterns, especially for patients who are at higher risks for developing opioid-related complications. Obstructive sleep apnea (OSA) is characterized by episodes of complete or partial obstruction of the upper airway during sleep. The apnea-hypopnea index (AHI), the number of apnea and/or hypopnea events per hour of sleep, is often used to characterize the severity of OSA.[1] In the Wisconsin Sleep Cohort Study, the prevalence of AHI > 5, which was the cutoff for mild OSA, was 9% for females and 24% for males, and the prevalence of AHI > 15, which was the cutoff for moderate OSA, was 4% for females and 9% for males.[2,3] The estimated prevalence of OSA has substantially increased over time in the United States,[4,5] likely in part due to rising rates in obesity. In addition, OSA often goes undiagnosed. In a study of a general population undergoing elective surgery of various types, 38% of those without a pre-existing diagnosis of OSA were subsequently found to have AHI > 15 on polysomnography.[6] Other studies have also shown a high rate of undiagnosed OSA in surgical patients.[7,8]

Obstructive sleep apnea may be associated with an increased risk of perioperative complications, including respiratory and cardiac events.[9-15] Opioids can be associated with ventilatory impairment in all patients, including respiratory depression and upper airway obstruction.[16-18] Breathing is altered in the postoperative period such that AHI is greatest on the third postoperative night in patients with OSA.[19] Factors associated with increased postoperative AHI include preoperative AHI and postoperative opioid dose.[20] In studies of critical respiratory events associated with opioid use, OSA has been identified as a risk factor.[21-23] As such, several guidelines recommend assessing for the risk of OSA preoperatively.[24,25] For those with diagnosed or suspected OSA, guidelines recommend postoperative pain regimens that minimize the use of opioids.[25] The Society for Ambulatory Anesthesia advises against ambulatory surgery if pain control cannot be provided with predominantly non-opioid techniques in patients with OSA.[26]

The purpose of this retrospective review was to evaluate opioid prescribing patterns upon discharge in surgical patients with and without OSA. We hypothesized that despite the recommendation to minimize opioid use in patients with OSA, patients with OSA are prescribed opioids upon discharge at a similar total dose and rate as those without OSA. Specifically, our primary outcome was the difference in total oral morphine equivalents (OMEs) prescribed, and our secondary outcome was the incidence of a new discharge prescription of any opioid medication.

Methods

The Institutional Review Board at the New York University School of Medicine determined that this analysis did not constitute human subject research and thus did not require review. This manuscript adheres to the applicable STROBE guidelines. The study design was a retrospective analysis of an electronic database of non-obstetric, non-cardiac surgical patients aged > 18 yr from 1 November 2016 to 30 April 2017 at a single large academic institution. Gastroenterology, pulmonology, and pediatric oncology cases were not included as they are typically not associated with a discharge prescription for opioids. Pediatric patients were excluded as STOP-Bang scores have not been well validated in these patients.

Data were extracted from the electronic medical record (EMR) and anesthesia information management system (AIMS), both of which are under the same platform (EPIC Systems, Verona, WI, USA), and combined to include the following information: date of surgery, date of discharge, surgical service, patient demographics (age and gender), anesthesia type, procedure location, diagnosis of OSA, preoperative STOP-Bang score, preoperative medications, and discharge medications. Within these data, surgical service is specific to the type of surgery; for example, craniotomies fall under the category of "Neurosurgery –

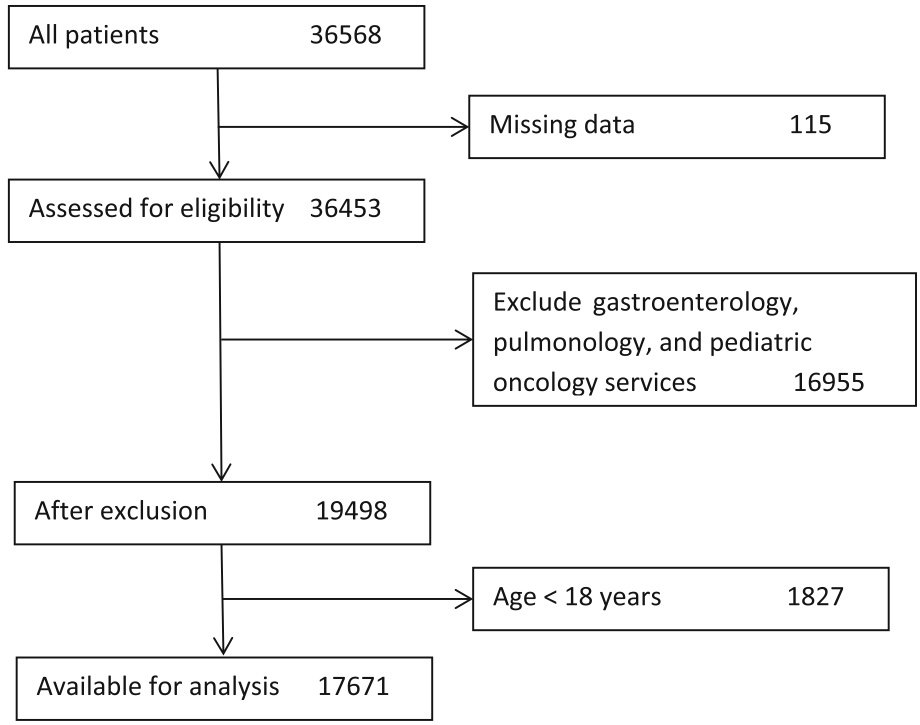

Figure Flow chart for exclusion of data. Gastroenterology, pulmonology, and pediatric oncology cases were excluded because of low rates of discharge prescription on opioids

Craniotomy". This was preferable to a broader definition of surgical service as different procedures within a surgical service may vary significantly, as a spine surgery will have different postoperative pain requirements compared with a craniotomy, though both would be within the surgical service of "Neurosurgery". Anesthesia type was based on the final type of anesthesia indicated within the AIMS.

A reported history of OSA and whether or not the patient was compliant with continuous positive airway pressure (CPAP) therapy at home was documented in the EMR under the medical history section of the record. All patients were identified as at risk for OSA using the STOP-Bang screening tool.[27] Patients who received a score ≥ 5 were considered at risk for having significant sleep apnea; this cut-off has been shown to identify patients with high probability of moderate or severe OSA.[28] The STOP-Bang screening tool was readily accessible electronically and is included in the pre-anesthesia evaluation template within our institution's electronic health record. All patients seen in our preoperative evaluation clinic (PEC) preoperatively are screened using the STOP-Bang tool irrespective of surgery type or surgical location. Patients who have not visited our PEC prior to surgery would have a STOP-Bang score entered into the pre-anesthesia assessment note by the anesthesiologist on the day of surgery. Patients with STOP-Bang scores ≥ 5 are flagged in our EMR.

We considered any patient with a diagnosis of OSA within the EMR or with a STOP-Bang score ≥ 5 to potentially be at risk for complications from opioid medications. Preoperative and discharge medications were available with the generic or trade medication name. Medications prescribed at discharge included dosing information and quantity supplied. Cases with missing values were excluded.

The primary outcome was the total opioid doses prescribed, which was calculated as the total number of pills or volume of solution prescribed converted to OME (i.e., *total* OME). The *daily* OME was calculated by extracting the maximum daily converted opioid amount from the prescription text. If multiple opioids were prescribed, the totals were summed. The following conversions were used for OMEs: oxycodone, 1.5; hydromorphone, 4; hydrocodone, 1.5; tramadol, 0.1; codeine, 0.15; oxymorphone, 3.[29,30] The secondary outcome was the incidence of a new discharge prescription of any opioid medication. These medications included: oxycodone, hydromorphone, hydrocodone, tramadol, oxymorphone, and morphine. A medication was considered "new" if it was not included within the medication list upon patient admission. A thorough medication reconciliation is performed upon admission and discharge to ensure accuracy of the medication list.

Statistical analysis

Descriptive values are described using mean (standard deviation [SD]) for normally distributed data, median [interquartile range (IQR)] for nonparametric data, or number and percentage for categorical data. Normality of continuous variables was determined by qq plot and histogram visualization and the Shapiro-Wilk test.

Patients with or without OSA were compared for the primary endpoint of total OME (used as the dependent variable) using linear regression analysis. Because of the highly right-skewed distribution of the total OME inclusive of zeros, the dependent variable underwent a log plus one transformation. Total daily OME was also examined using the same analysis.

Odds ratios (OR) and 95% confidence intervals (CI) were determined for the dichotomous dependent variable of new discharge on an opioid medication by multivariable logistic regression adjusting for confounders including: age, sex, anesthesia type, surgical type/service, same day surgery, and procedure location. The log-linear regression analysis also included the presence of preoperative opioids on the medication list as a covariate. All the confounders were included as categorical variables, except that age was included as a continuous quantitative variable. Age was included as a variable to consider the potential for different prescribing patterns across ages. Anesthesia type was included to account for those that received a regional anesthetic. Different surgical procedures have different postoperative pain profiles, so including surgical service was essential. Likewise, same-day surgeries and procedures at varying locations may have different prescribing patterns based on established policies. The associations between age (the only continuous variable) and the logit were assessed to satisfy the assumption of linearity. Presence or absence of OSA or STOP-Bang ≥ 5 was considered the primary "exposure". Use of a CPAP device was included as an interaction term with the exposure variable. We assessed model covariates for collinearity and assessed for removal variables with variance inflation factors > 4. $P < 0.05$ was considered significant.

The binary outcome of prescription of opioid on discharge for the secondary analysis had over 13,000 events, and the multivariable model had 53 parameters, which was appropriate under the rule of thumb that each parameter should be estimated using at least ten events. When considering class imbalance, the outcome non-event (not discharged on opioid medication) had over 3,500 events, which satisfies the rule of thumb as well.

Because of the potential disparity between patients with a preexisting diagnosis of OSA and those with a STOP-Bang score ≥ 5, a sensitivity analysis was conducted in which the exposure variable was either diagnosis of OSA or STOP-Bang score ≥ 5 in two separate analyses with total OME as the dependent variable. The remainder of the model was identical to that used in the primary analysis. Additional sensitivity analyses controlling for the same confounders as in the primary and secondary analyses (total OME and prescription of opioid, respectively) were only performed on the subset of patients who received outpatient surgery, as defined by discharge on the same day as admission. The remainder of the model was identical to that used in the primary analysis with the omission of the "same day" variable. A final sensitivity analysis was performed only including those patients that received postoperative opioids. This analysis was done using log-transformed linear regression controlling for the same covariates as in the primary analysis. All statistical operations were done using the R statistical software (R Foundation for Statistical Computing, version 3.1.2, Vienna, Austria).

Results

There were 36,568 patients included in the initial data set. After exclusion of those cases missing body mass index (BMI), pediatric cases, and the other previously denoted surgical services, 17,671 cases remained (Figure). Patient characteristics are detailed in Table 1.

There were 13,986 discharge opioid medication prescriptions, with oxycodone (alone or in combination with acetaminophen) being the most common medication (11,249 cases, 80%), followed by tramadol (2,610 cases, 19%) (Table 2). Amongst the 8,348 ambulatory surgery patients, 4,543 (45%) were discharged with oxycodone, while hydrocodone was the second most common medication prescribed (858 cases, 10%) (Table 3). Surgical types that prescribed the lowest rates of opioids were vascular (30%), gynecology (19%), and ophthalmology (2.3%). There were 629 (3.6%) patients on CPAP.

The median [IQR] total OME for patients without OSA or STOP-Bang ≥ 5 was 150 [0-338] mg, while the total OME for patients with OSA or STOP-Bang ≥ 5 was 160 [0-450] mg. The median [IQR] daily OME for patients without OSA or STOP-Bang ≥ 5 was 45 [30-90] mg, and the daily OME for patients with OSA or STOP-Bang ≥ 5 was 60 [30-90] mg. An unadjusted univariate comparison showed an 18% difference in total OME (95% CI, 3% to 35%; $P = 0.02$) and a 17% difference in daily OME (95% CI, 12% to 21%; $P < 0.001$). The adjusted log-linear regression analysis did not show significance for total OME (8% difference in total OME; 95% CI, -6% to 25%; $P = 0.26$) but did show a significant difference in daily OME (5.0% difference in daily OME; 95% CI, 1.0% to 9.2%; $P = 0.01$) when comparing those with a diagnosis of OSA or a STOP-Bang score ≥ 5 to those without OSA. The interaction term with CPAP was not significant for either analysis ($P = 0.24$ and $P = 0.38$, respectively).

Table 1 Patient demographics

	All patients (n = 17,671)	Without OSA (n = 15,979)	With OSA (n = 1,692)	P value
Age (yr)	56 [42-67]	55 [41-67]	59 [50-67]	< 0.001
Sex (male)	8,222 (47)	7,139 (45)	1,083 (64)	< 0.001
Body mass index (kg·m^{-2})	27 [24-32]	27 [24-31]	35 [29-40]	< 0.001
Anesthesia type				< 0.001
Combined spinal-epidural	30 (0.17)	27 (0.17)	3 (0.18)	
Epidural	15 (0.08)	13 (0.08)	1 (0.06)	
General	11,532 (65)	10,389 (65)	1,143 (68)	
Monitored anesthesia care	2,256 (13)	2,106 (13)	150 (8.9)	
Peripheral regional block	1,869 (11)	1,761 (11)	108 (6.4)	
Spinal	1,970 (11)	1,683 (11)	287 (17)	
Surgical service				< 0.001
General – bariatrics	553 (2.9)	308 (1.9)	245 (14)	
General – endocrine	101 (0.57)	95 (0.59)	6 (0.35)	
General – pediatrics	2 (0.01)	0 (0)	2 (0.12)	
General – robotics	84 (0.48)	78 (0.49)	6 (0.35)	
General – surgical oncology	130 (0.74)	128 (0.80)	2 (0.12)	
General – transplant	102 (0.58)	92 (0.58)	10 (0.59)	
General – wound care	35 (0.20)	33 (0.21)	2 (0.12)	
General	2,090 (12)	1,928 (12)	162 (9.6)	
Gynecology – oncology	102 (0.58)	98 (0.61)	4 (0.24)	
Gynecology – robotics	131 (0.74)	124 (0.78)	7 (0.41)	
Gynecology	662 (3.7)	643 (4.0)	19 (1.1)	
Neurosurgery – movement disorder	37 (0.21)	34 (0.21)	3 (0.18)	
Neurosurgery – craniotomy	458 (2.6)	426 (2.7)	32 (1.9)	
Neurosurgery – pediatrics	54 (0.31)	42 (0.26)	12 (0.71)	
Neurosurgery – spine	382 (2.2)	326 (2.0)	56 (3.3)	
Ophthalmology	574 (3.2)	547 (3.4)	27 (1.6)	
Orthopedics – foot	450 (2.5)	423 (2.6)	27 (1.6)	
Orthopedics – hand	1,260 (7.1)	1,193 (7.5)	67 (4.0)	
Orthopedics – pediatrics	9 (0.05)	9 (0.06)	0 (0)	
Orthopedics – shoulder/elbow	73 (0.41)	68 (0.43)	5 (0.30)	
Orthopedics – spine	1,130 (6.4)	997 (6.2)	133 (7.9)	
Orthopedics – sports	2,718 (15)	2,534 (16)	184 (11)	
Orthopedics – tumour	62 (0.35)	61 (0.38)	1 (0.06)	
Orthopedics – total joint	2,948 (17)	2,555 (16)	393 (23)	
Orthopedics – trauma/fracture	435 (2.5)	405 (2.5)	30 (1.8)	
Otolaryngology – head & neck	37 (0.21)	33 (0.21)	4 (0.24)	
Otolaryngology	524 (3.0)	490 (3.1)	34 (2.0)	
Plastic – cosmetic	90 (0.51)	87 (0.54)	3 (0.18)	
Plastic – craniofacial	17 (0.10)	14 (0.09)	3 (0.18)	
Plastic – oral surgery	48 (0.27)	47 (0.29)	1 (0.06)	
Plastic – reconstructive	312 (1.8)	297 (1.9)	15 (0.89)	
Thoracic	331 (1.9)	300 (1.9)	31 (1.8)	
Thoracic – robotics	64 (0.36)	57 (0.36)	7 (0.41)	
Urology – robotics	259 (1.5)	231 (1.4)	28 (1.7)	
Urology	720 (4.1)	653 (4.1)	67 (4.0)	

Table 1 continued

	All patients (n = 17,671)	Without OSA (n = 15,979)	With OSA (n = 1,692)	P value
Vascular	650 (3.7)	587 (3.7)	63 (3.7)	
Unknown	29 (0.16)	28 (0.18)	1 (0.06)	

Data are presented as mean (standard deviation) or median [interquartile range] where indicated

For each surgical service, only patients ≥ 18 yr are included. IQR = interquartile range; OSA = obstructive sleep apnea

Table 2 New opioid medications prescribed to patients on discharge

Opioid medication on discharge	All patients	Without OSA	With OSA	P value
Oxycodone	11,249 (81)	10,116 (81)	1,133 (77)	< 0.001
Oxymorphone	24 (0.17)	21 (0.15)	3 (0.20)	0.89
Hydromorphone	1,850 (13)	1,628 (13)	222 (15)	< 0.001
Tramadol	2,610 (18)	2,251 (18)	359 (24)	< 0.001
Hydrocodone	1,616 (11)	1,382 (11)	234 (16)	< 0.001
Methadone	76 (0.52)	61 (0.46)	15 (0.95)	< 0.001
Tapentadol	48 (0.35)	39 (0.32)	9 (0.62)	0.04
Morphine	1,621 (12)	1,406 (11)	215 (15)	< 0.001
Fentanyl	594 (4.3)	554 (4.5)	40 (2.8)	0.02

Frequencies (%) will not total 100% as patients may be prescribed more than one new medication upon discharge. OSA = obstructive sleep apnea

Table 3 New opioid medications prescribed to ambulatory surgery patients on discharge

Opioid medication on discharge	All patients	Without OSA	With OSA	P value
Oxycodone	4,543 (83)	4,260 (82)	283 (87)	0.01
Oxymorphone	2 (0.02)	2 (0.02)	0 (0)	1.00
Hydromorphone	616 (11)	587 (11)	29 (8.3)	0.37
Tramadol	394 (6.8)	360 (6.6)	34 (9.6)	0.01
Hydrocodone	858 (15)	815 (15)	43 (13)	0.48
Methadone	22 (0.32)	18 (0.28)	4 (0.96)	0.03
Tapentadol	7 (0.13)	7 (0.14)	0 (0)	1.00
Morphine	359 (6.8)	327 (6.5)	32 (10)	0.01
Fentanyl	418 (7.8)	402 (8.0)	16 (5.1)	0.13

Frequencies (%) will not total 100% as patients may be prescribed more than one new medication upon discharge. OSA = obstructive sleep apnea

Of the 17,671 patients analyzed, there were 1,692 (9.6%) patients who had OSA or STOP-Bang ≥ 5. Of these patients, 177 (11%) were on preoperative opioids, and 1,141 (67%) were discharged on opioid medications. Of the 15,979 patients without OSA, 1,078 (6.7%) were on preoperative opioids, and 10,692 (67%) were discharged on opioid medications. A univariate regression analysis with the presence of OSA or a STOP-Bang ≥ 5 as independent variables and the presence of preoperative opioids as the dependent variable resulted in an OR of 1.6 (95% CI, 1.4 to 1.9; P < 0.001). A univariate regression analysis with presence of OSA or STOP-Bang ≥ 5 as an independent variable and discharge on opioid medications as the dependent variable resulted in OR of 1.0 (95% CI, 0.9 to 1.1; P = 0.72). The multivariable regression analysis adjusting for confounders resulted in an OR of being prescribed discharged opioid medication of 1.00 (95% CI, 0.98 to 1.03; P = 0.84) for patients with known or

Table 4 Results of adjusted analyses of discharge prescription opioid doses in relation to obstructive sleep apnea diagnosis and STOP-Bang criteria

	% Difference in OME (95% CI)	*P* value
OSA + STOP-Bang ≥ 5	8% (−6% to 25%)	0.26
OSA only	9% (−6% to 28%)	0.26
STOP-Bang ≥ 5 only	3% (−23% to 39%)	0.83
Ambulatory subset (OSA + STOP-Bang ≥ 5)	−9% (−29% to 17%)	0.79
Only patients prescribed opioids (OSA + STOP-Bang ≥ 5)	109% (104% to 114%)	< 0.001

CI = confidence interval; OME = oral morphine equivalents (mg); OSA = obstructive sleep apnea

suspected OSA compared with those without OSA. The interaction term with CPAP was also not significant ($P = 0.16$). No variance inflation factors were greater than 4, suggesting negligible collinearity.

There were 1,452 (8.2%) patients with a preexisting diagnosis of OSA and 239 (1.4%) patients with only a STOP-Bang score ≥ 5 without a preexisting diagnosis of OSA. The sensitivity analysis resulted in no difference (9.3% difference in OME; 95% CI, −6.3% to 28%; $P = 0.26$) in total morphine equivalents for patients with a diagnosis of OSA. The results for patients with only a STOP-Bang score ≥ 5 without a diagnosis of OSA were also not significant (3% difference in OME; 95% CI, −23% to 39%; $P = 0.83$).

There were 8,348 cases in the outpatient subset, 468 (5.6%) of which had OSA or STOP-Bang ≥ 5. Of these patients, 313 (67%) were discharged on opioid medication. Of the 9,095 patients without OSA, 4,996 (64%) were discharge on opioid medications. The same analysis performed on the outpatient subset did not show a significant difference in OME (−9% difference in OME; 95% CI, −29% to 17%; $P = 0.79$), although the interaction term with CPAP suggested a significant interaction (123% difference in OME; 95% CI, 9% to 356%; $P = 0.03$). The secondary multivariable analysis performed on the outpatient subset resulted in an OR of 0.99 (95% CI, 0.94 to 1.03; $P = 0.52$), although the interaction term with CPAP suggested a significant interaction (OR, 1.2; 95% CI, 1.02 to 1.32; $P = 0.024$), indicating that those patients with OSA on CPAP more frequently received opioids compared with those not on CPAP.

Excluding the patients who did not receive a prescription for opioids, 11,853 (67%) cases remained, and the median [IQR] total OME was 263 [150-450] mg. The median [IQR] total OME in patients with known or suspected OSA was 300 [150-450] mg and for patients without OSA was 240 [150-450] mg. The sensitivity analysis in which only patients who received a postoperative opioid prescription were included reflected an increase in OME in patients with OSA or STOP-Bang ≥ 5 of 109% (95% CI, 104% to 114%; $P < 0.001$), although the interaction term with CPAP was not significant (92% increase in OME; 95% CI, 78% to 108%; $P = 0.31$), indicating that a history of CPAP use was not related to the dose of opioid prescribed upon discharge in patients with OSA. There was also a significant difference in daily OME between patients with or without OSA or STOP-Bang ≥ 5 (106% increase in daily OME; 95% CI, 102% to 110%; $P = 0. 002$). Results of all discharge opioid dose analyses are summarized in Table 4.

Discussion

This study shows that patients with OSA or STOP-Bang ≥ 5 do not receive a different amount of total opioid upon discharge (8% difference in OME; 95% CI, −6% to 25%; $P = 0.26$) and are as likely to be discharged home on opioid medications after surgery as patients without OSA (OR, 1.00; 95% CI, 0.98 to 1.03; $P = 0.84$). Including only those patients that received a discharge prescription for opioids, patients with or at risk of OSA were prescribed a greater total amount of opioid (109% difference in OME; 95% CI, 104% to 114%; $P < 0.001$), with a significant difference in daily OME as well, suggesting that the difference shown may be related to the daily prescription of opioid as opposed to the duration of expected use. These results do not apply to gastroenterology, obstetric, or cardiovascular procedures. In the subset of patients undergoing ambulatory surgeries, those with or at risk of OSA are also discharged home on opioid medications at a similar rate as those without OSA.

Our results show that despite the known adverse effects of opioid medications on patients with OSA, there is no apparent difference in discharge prescribing patterns of opioid medications and possibly more opioid given to patients with or at risk of OSA if opioids are prescribed. The analysis also suggests that OSA patients on CPAP having outpatient surgery were associated with increased prescription of opioids and in greater amounts. This may occur because of an assumption that patients with greater BMI require greater amounts of opioids, or prescriber-level assumptions regarding opioid prescription, which would not be captured in this analysis. There also may be a lack of recognition of the risks associated with opioid use in OSA patients or lack of recognition of the condition itself as when STOP-Bang $\geq$ 5 without an official diagnosis of OSA in the medical record.

The proportion of patients with presumed OSA in our population (9.2%) is similar to that found in other studies of OSA in the perioperative period,[11,31] although those studies indicated the prevalence of diagnosed OSA, while this study combines patients with an OSA diagnosis and STOP-Bang scores $\geq$ 5. Our results here are novel in that no other studies to our knowledge have systematically examined postoperative discharge opioid prescribing patterns in patients with or at risk of OSA. These data suggest that the current practice guidelines and studies available in the anesthesiology literature may not be sufficient for changing practice if they are not instituted in a multidisciplinary approach.

Opioids have been implicated in postoperative complications in patients both with and without OSA,[21,22,32,33] although no studies have directly evaluated the impact of opioids on post-discharge complications in patients with OSA. Of particular concern is that patients with OSA or STOP-Bang $\geq$ 5 were prescribed opioids at a similar rate for ambulatory surgeries and at a greater rate and quantity in OSA patients on CPAP. Presumably patients who had surgery with an inpatient stay were assessed for opioid response after many doses prior to discharge. Patients who undergo ambulatory surgeries are monitored postoperatively for a limited time prior to the greatest changes in postoperative breathing patterns, which can persist as late as 72 hr after surgery.

There are a number of limitations to this study. Primarily, as this study was retrospective in design, there may be variables that were not accounted for in the study design. In this regard, the goal of our current analysis was to identify a potential opioid prescribing pattern in OSA patients, and a retrospective study allows us to achieve this goal relatively efficiently. In our statistical analysis, we have made efforts to control for foreseeable variables including age, gender, and surgery types. The relatively large sample size also supports our analysis. Another limitation of our study is the inclusion of the patients with STOP-Bang $\geq$ 5 in addition to those with a diagnosis of OSA. While the STOP-Bang score is a relatively sensitive questionnaire, it has a poor specificity of only 35-42% depending on the severity of OSA.[34] Therefore, this study may have included patients who ultimately may not have a diagnosis of OSA by polysomnography. Nonetheless, we included these patients as in our clinical practice at our institution, in accordance with ASA guidelines, we cautiously treat patients with a high STOP-Bang score as if they had a presumptive diagnosis of OSA.[25] In addition, a significant percentage of patients with OSA are undiagnosed, so although our criteria in this study may potentially be over-inclusive, they are likely to include a greater percentage of patients who otherwise would not have been classified as having OSA.[6] Additionally, in the preoperative setting, it may be inefficient from a cost perspective to screen all high-risk patients with polysomnography, and thus a practical clinical indicator such as the STOP-Bang score is commonly used. We also performed the sensitivity analysis separating the diagnoses to explore this issue. A third limitation of this study is that we did not examine patient utilization of discharge opioids and adverse outcomes associated with post-discharge opioids in OSA patients. Such data are difficult to extract from our current EMR. Nevertheless, they provide important insights into the actual utilization of postoperative opioids. Future studies are thus needed to analyze these outcomes related to post-discharge opioid use in OSA surgical patients.

In the context of the opioid epidemic, it is important to recognize the current state of postoperative prescribing patterns, especially in patients with OSA who are at increased risks for respiratory complications. Our study provides important data in this regard. Our results show that OSA patients are as likely as patients without OSA to receive opioid prescriptions for their postoperative pain. These data indicate a need to implement strategies and policies to mitigate the prescription of opioids to patients with OSA, perhaps with incorporation of multimodal analgesic approaches and including educating those providers who actually write the discharge prescription about the potential adverse effects. This may take the form of prescriber education, protocol-based guidelines, or informatics-based interventions such as EMR clinical decision support tools.

Conflicts of interest None declared.

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Author contributions All authors aided in manuscript preparation. *Samir M. Kendale* and *Lisa Doan* helped to design the study and collect and analyze data. *Jing Wang*, *Jeanna D. Blitz*, *Steven Calvino*, and *Germaine Cuff* helped design the study. *Nicholas Barone* helped to collect and analyze data. *Andrew D. Rosenberg* conceived and helped design the study.

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