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Use of Prescription Opioids before and After an Operation for Chronic Pain (Lumbar Fusion Surgery)

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1. INTRODUCTION

Increased use of prescription opioids over the past 2 decades has been associated with major increases in opioid-related overdoses and addiction treatment [28,30]. One response has been closer examination of factors leading to opioid initiation, including analgesic prescriptions following surgical procedures [1,7,31].

Many studies of postoperative opioid prescribing have included surgical procedures not primarily performed for chronic pain symptoms, such as cataract surgery, transurethral prostate resection, cesarean section, or thyroidectomy [1,7,31]. Surgical procedures for patients with chronic painful conditions, such as many orthopedic procedures, pose additional challenges, because many patients receive long-term opioids prior to surgery.

Spine surgery, in particular, may be associated with a high risk of preoperative and persistent postoperative opioid use [7,23]. Lumbar fusion surgery for degenerative spinal disorders is usually undertaken to treat chronic back pain, and is more invasive than decompression surgery alone. Nationally, the number of spinal fusion operations has tripled in the past 2 decades [17].

Patients considering fusion surgery often expect to discontinue opioids after surgery. For example, among patients scheduled to undergo lumbar fusion surgery for degenerative disc disease, over 90% “considered continued narcotic requirements to be neither an expected nor

acceptable outcome” [8]. However, recent studies find 30–60% of patients receiving long-term opioids following spine surgery [4,12,24]. Preoperative opioid use is consistently a major predictor of long-term postoperative use [2,4,12].

However, data on long-term opioid use following spine or other orthopedic surgery are often limited by reliance on patient self-report [4], continual insurance enrollment [12,24], or relatively small patient samples [4,26]. For spinal fusion surgery, few data address how preoperative dosage may influence the likelihood of long-term postoperative opioid use or the ability to reduce dosage, what fraction of those with no pre-operative opioid use initiate long-term use postoperatively, or how perioperative opioid management influences the likelihood of long-term postoperative use.

We used a state hospital discharge registry linked with statewide prescription drug monitoring program (PDMP) data to identify lumbar fusion operations and opioid prescription fills regardless of insurance coverage or source of prescriptions. We addressed the following questions: (1) What fraction of patients undergoing lumbar fusion surgery have short-term or long-term opioid use prior to and after surgery? (2) Among patients with long-term preoperative opioid use, what fraction discontinues, reduces dosage, maintains the same dosage, or increases dosage postoperatively? (3) Among patients with only short-term or no opioid use prior to surgery, what fraction initiates long-term use postoperatively? (4) What patient demographics, clinical characteristics, procedural factors, and opioid prescribing patterns predict long-term postoperative opioid use?

2. METHODS

Study activities were approved by Institutional Review Boards at Oregon Health & Science University and the Public Health Division of the Oregon Health Authority, where the PDMP is housed.

Data preparation

Data were obtained from the Oregon PDMP and linked to the statewide hospital discharge registry. Preparation of the research database has been described in detail elsewhere [15,27]. Oregon’s PDMP is maintained by a commercial vendor, who uses a largely deterministic, proprietary algorithm for linking filled prescriptions for individual patients. This procedure may not always uniquely identify patients in the face of misspellings, nicknames, transposed characters, name changes, or changes in residence. An analyst at the Public Health Division therefore used probabilistic linking software (the Link King v7.1.21) to match individuals within the PDMP and between the PDMP and the hospital registry, using name, birthdate, and ZIP Code. Because of the sensitivity of opioid use, the analyst then removed all identifiers for patients, prescribers, and pharmacies.

Inclusion and Exclusion of procedures

We used diagnosis-related group (DRG) codes 453, 454, 456, 459, and 460 to identify adults undergoing lumbar fusion procedures with admission dates between October 2012 and September 2013. If a patient had more than 1 eligible procedure, we counted only the first, so each patient is represented only once. These codes exclude procedures performed

primarily for scoliosis, malignancy, infection, or those involving nine or more vertebrae. Procedures in DRGs 453, 454, and 455 were labeled as “complex fusions”, because they include combined anterior and posterior fusion procedures. Cases in DRGs 453, 454, and 459 are defined as having complicating conditions. We then linked operations with International Classification of Diseases version 9, Clinical Modification (ICD-9-CM) codes indicating lumbar spine diagnoses of herniated disc, probable degenerative changes, spinal stenosis, possible instability, nonspecific back ache, or sequelae of previous back surgery. Only these diagnoses were included. ICD-9-CM codes were grouped into these diagnostic categories using a previously described approach [10]. These conditions are largely related to degenerative spinal changes. Because multiple diagnoses for a single patient were common, we tabulated patients according to the likely primary reason for performing a fusion procedure. For this purpose, we adapted a previously developed hierarchy [22], classifying patients by the highest-numbered diagnosis in this list: (1) non-specific diagnoses, (2) degenerative spinal changes, (3) herniated disc, (4) sequelae of prior surgery, (5) lumbar stenosis, (6) possible instability (mostly spondylolisthesis). We excluded patients under the age of 18 years and those with diagnoses of fractures, inflammatory spondylopathies, cancer, or spinal infection (Figure 1).

Filled Prescriptions

Using PDMP data, we identified outpatient opioid prescriptions filled during the 7 months prior to index hospitalization and 7 months following it. We used Food and Drug Administration (FDA) National Drug Codes to identify opioid prescriptions. Tramadol was not included in the PDMP during study years, and we excluded combination buprenorphine-naloxone preparations. We used conversion reference tables from the Centers for Disease Control (CDC) to calculate morphine milligram equivalents (MME) for each prescription. We also identified benzodiazepine use in the 7 months before and following hospitalization.

We defined a “perioperative period” as the 30 days before and 30 days after index hospitalization. We separately examined the 180 days prior to and 180 days following the perioperative period. We defined short-term preoperative opioid use as any opioid prescription filled within 30 days before the index hospitalization, but with none in the previous 180 days. Short-term postoperative use was any outpatient prescription for opioids filled in the 30 days immediately following index hospitalization, but with none in the 180 days after that. Thus, short-term use meant opioids filled only in the perioperative period.

Long-term preoperative opioid use was defined as at least 4 opioid fills in the 7 months prior to index hospitalization, with at least 3 fills in the 180 days prior to the perioperative period. Long-term postoperative use was at least 4 opioid fills in the 7 months following index hospitalization, with at least 3 of those more than 30 days after hospitalization. These definitions of long-term use were consistent with a definition of 6 fills in 12 months which has been used in previous studies, and which was associated with a 7-fold increase (vs. those with fewer fills) in hospitalizations with opioid-related adverse events [15,25].

Some patients who received opioids would not fit our definitions of short-term or long-term use. For example, a patient with 2 prescriptions prior to the perioperative period, or one who had a single prescription in the preoperative 30 days and a single prescription prior to that,

would meet neither definition. We labeled such patients as having “episodic” opioid use. Our data included only outpatient prescription fills. Opioids used during inpatient care, or provided from the hospital at discharge, were not identified in our data.

The “long-term preoperative cumulative dose” was defined as the sum of all MMEs prescribed in the 180 days prior to the perioperative period. The “long term postoperative cumulative dose” was defined as the sum of all morphine milligram equivalents filled in the 180 days following the perioperative interval. These definitions of cumulative dose excluded medications during the perioperative period, when greater analgesic doses are usually necessary and expected. A cumulative dose exceeding 16,200 MMEs in 180 days (an average of 90 MMEs/day) was defined as “high dose” [16]. A change from preoperative cumulative dose to postoperative cumulative dose of 10% was considered an increase or a decrease. A change of < 10% was considered a stable dose. Changes in opioid doses were based on cumulative MMEs filled during the 180 days before and the 180 days following the perioperative interval. All definitions were established prior to data analysis.

Comorbid conditions

We calculated the ICD-9-CM version of the Charlson comorbidity index [14] using diagnoses recorded in the index hospital discharge record.

Analysis

Characteristics of patients who did or did not become long-term postoperative opioid users were compared with chi-square statistics, rank-sum tests, or t-tests as appropriate. Independent predictors of long-term postoperative opioid use were identified using multivariable logistic regression. Candidate predictors included patient demographic characteristics; comorbidity score; surgical procedure characteristics; and features of preoperative and perioperative opioid prescribing. The final regression model included all these variables, so predictors of long-term use were adjusted for possible confounding by each of these features. To assess the impact of opioid dose on predicting long-term use, we first constructed a logistic model without dosing information, but with an indicator for whether the patient received long-term preoperative opioids. We then constructed a second logistic model incorporating preoperative and perioperative opioid dose information. The distribution of opioid doses was right-skewed. Rather than identifying and removing outliers to use dose as a continuous variable, we decided to keep all patients in the study and categorize cumulative opioid doses into quartiles. This mitigates any effect of patients with very high doses and allows the relationship to vary arbitrarily in the logit (i.e. does not assume linearity in the logit). Dividing into quartiles also helped to facilitate clinical understanding of the results, as opposed to determining odds ratios for every milligram increase in dose. Regarding surgical indications, we combined the least specific diagnoses (non-specific, miscellaneous, and degenerative changes) as a reference category, due to small numbers in the non-specific category. Statistical tests were two-sided and significance was defined as $p < 0.05$; analyses were performed using SAS v.9.3. Model fit was assessed with the Hosmer-Lemeshow statistic and the area under a receiver operating characteristic curve (AUC) distinguishing those who exhibited long-term postoperative opioid use from those who did not.

We also conducted a sensitivity analysis using an alternative definition of long-term opioid use: at least 3 opioid fills in the 7 months prior to index hospitalization, with at least 2 fills in the 180 days prior to the perioperative period. Long-term postoperative use was at least 3 opioid fills in the 7 months following index hospitalization, with at least 2 of those more than 30 days after hospitalization. The results of this sensitivity analysis were qualitatively the same as our base case analysis, and are not presented here.

3. RESULTS

Patients and Procedures

There were 2,491 patients who underwent an eligible fusion operation and all were included. Over half (59.7%) were female, 45.8% were aged ≥ 65 years, and only 12.6% were aged < 45 years. Reflecting the Oregon population, 93.5% were white (Table 1).

The majority of surgical procedures (n= 2,113; 84.8%) were classified in DRG 460: ‘fusion without major complicating conditions’. Next most frequent (n=207; 8.3%) was “combined anterior and posterior fusion without complicating conditions”. Overall, 6.9% of procedures were coded with complications (DRGs 453, 454, and 459). Combined anterior and posterior procedures (with or without complications) accounted for 12.9% (n= 320).

The most common primary reason for surgery was “possible instability” (n=1,479, 59.4%) which was mainly spondylolisthesis (n = 1,421, or 96.1% of the category). Degenerative spinal changes accounted for 12.0% (n=299). Spinal stenosis primarily accounted for 298 procedures (12.0%), and herniated disc for 256 cases (10.3%). There were 133 cases (5.3%) with diagnosis codes indicating sequelae of previous back surgery, and the remainder (1.0%) fell into miscellaneous or non-specific diagnostic categories (Table 1).

Opioid use

More patients received long-term opioids following spinal fusion surgery than before. Overall, 1,045 patients received preoperative long-term opioids, and 1,094 received long-term postoperative opioids. Among patients receiving long-term preoperative opioids, 806 (77.1%) continued long-term postoperative use, and 144 (13.8%) had episodic postoperative use. Only 95 (9.1%) discontinued opioids or had short term postoperative use only (Table 2). Among those with long-term postoperative use were 352 receiving high-dose opioids (32.2%) (Table 1).

There were 609 (24.5%) patients with episodic preoperative opioid use, and 133 patients (5.3%) with short-term preoperative opioid use. Another 704 (28.3%) had no opioid use in the 7 months prior to hospitalization. Among patients with no preoperative opioid use, 90 (12.8%) received long-term postoperative opioids (Table 2).

Opioid dosage

Among the 1,045 patients with long-term pre-operative opioid use, 34.4% received a lower comparative dose postoperatively, and 9.1% discontinued opioids after the perioperative period. However, 44.8% received a higher dose postoperatively, and 11.8% received an equivalent dose. Among patients with episodic preoperative opioid use, 13.0% decreased

dosages postoperatively, and 41.4% received no opioids beyond the perioperative interval. However, 41.7% increased cumulative doses after the perioperative interval (Table 3).

Predictors of long-term postoperative opioid use

In simple bivariate comparisons between those who did or did not receive long-term postoperative opioids, younger age, urban residence, indication for surgery, complex fusion procedures, preoperative benzodiazepine use, and all opioid prescribing variables were significantly associated with greater long-term postoperative use (Table 1). Long-term postoperative opioid users had higher comorbidity scores (0.62 vs. 0.53, $p=0.009$).

In regression models, 21 patients with missing age data were excluded. In our first logistic regression model, excluding opioid dose variables, long-term preoperative opioid use was the strongest predictor of long-term postoperative use, with an odds ratio (OR) of 10.8 (95% CI 8.2, 13.2) (Table 4). Any preoperative use of benzodiazepines was also significant (OR 1.49; 95% CI 1.20, 1.85). Patient gender and urban residence were not statistically significant. Increasing age was monotonically associated with lower risk of long term opioid use, and increasing Charlson comorbidity score was monotonically associated with increasing risk. Complex fusion procedures were no longer associated with long-term opioid use after adjustment for other factors. The AUC was 0.82.

In our second regression model, incorporating opioid dose information, patient demographics, urban or rural residence, and surgical indication were not independently associated with long-term postoperative opioid use (Table 5). Preoperative long-term opioid use remained a significant independent predictor of long-term postoperative use (OR 1.68, 95%CI 1.19, 2.34), but the opioid dose variables now showed the strongest associations, in dose-response fashion. The strongest predictor was cumulative opioid dose in the 7 months prior to surgery. There was a monotonic increase in the odds of long-term postoperative use with increasing preoperative dose, with OR 15.47 (95% CI 8.53, 28.06) in the highest quartile (cumulative doses >8,100 MMEs in the previous 7 months, or a mean daily dose > 39 MME) (Table 4). Even after adjusting for cumulative preoperative opioid dose, the total MME prescribed in the 30-day immediate postoperative period remained significantly associated with long-term opioid use, again in dose-response fashion. In the highest quartile (cumulative dose >3,300 MMEs, or a mean daily dose >110 MME) the OR was 7.96 (95% CI 4.25, 14.91).

The number of opioid prescribers in the 30-day immediate postoperative period was also significantly associated with odds of long-term opioid use, even after adjustment for the dosing variables, in a “dose-response” fashion. After adjusting for opioid dosing and numbers of prescribers, preoperative benzodiazepine use was no longer associated with the probability of long-term opioid use. The Hosmer-Lemeshow goodness-of-fit index for this model was acceptable at 0.85, and the AUC improved to 0.90.

4. DISCUSSION

More patients received long-term opioids following spinal fusion surgery than before surgery. Most patients receiving long-term preoperative opioids continued, and 57%

maintained the same dose or increased their dose by more than 10% following the perioperative interval. Furthermore, almost 13% of patients who received no preoperative opioids ended up receiving long-term postoperative opioids. The strongest independent predictors of long-term postoperative opioid use were the cumulative preoperative dose and the cumulative dose of opioids prescribed in the immediate postoperative (30 days post-discharge) interval.

Our findings are consistent with other studies indicating that long-term opioid use is common both before and after lumbar surgery, and that pre-operative long-term opioid use is a powerful predictor of long-term postoperative use [4, 12]. Our data further suggest the importance of both the cumulative preoperative dose and the cumulative dose in the immediate postoperative period. The latter may argue for devising anesthetic and operative techniques that minimize postoperative opioid use [13, 19], along with greater use of non-pharmacologic and non-opioid medication strategies for pain management [29]. Strategies to help patients taper opioids in the immediate postoperative period and attention to the amount of opioids prescribed are also likely to be helpful.

Other investigators have noted that pre-surgical opioid use predicts several other adverse outcomes, including worse surgical site pain; increased hospital length of stay; delayed return to work, greater surgical complications, and adverse functional outcomes [2, 5, 21]. Together with the increased likelihood of long-term opioid use, and the paucity of evidence for efficacy of long-term opioids [11], these findings suggest that minimizing long-term opioids for back pain may be important. An association of preoperative opioid use with anxiety and depression also suggests that addressing mood disorders may be important in minimizing opioid use [3].

Surgical patients in general appear often to receive excessive postoperative opioid prescriptions, exceeding requirements for analgesia [6, 18, 21]. In a study of women following cesarean section, the quantity of opioids prescribed exceeded the amount consumed by a substantial margin. Smaller opioid prescriptions were associated with lower consumption, but no worse pain scores or satisfaction [6]. Our findings suggest that minimizing the postoperative dose may also help to reduce the likelihood of long-term use. Our data further suggest that minimizing the number of opioid prescribers in the perioperative period may help minimize this risk, a concern noted with other orthopedic procedures [26].

Our results, and others, indicate that discontinuation of long-term opioids following spinal fusion surgery is not the norm. One explanation would be that many patients do not achieve the expected pain relief from surgery. However, the fact that preoperative opioid use is a major predictor of long-term postoperative use suggests opioid dependence may be equally or more important, making postoperative discontinuation or dose reduction more difficult. Patients considering fusion surgery for degenerative conditions should be informed that discontinuation of long-term opioid medications is an unlikely result.

Our study has the advantage of representing a true population-based sample, regardless of insurance coverage or sources of payment. Use of the PDMP assured identification of all

prescriptions filled, even with insurance changes or out-of-pocket payments. This measure of opioid use does not depend on patient recall or continuous insurance coverage.

However, there are important limitations as well. We cannot know whether patients consumed the medications they received. Patient race and ethnicity are not routinely collected with consistent methods. Controlled prescriptions not filled by a licensed Oregon outpatient pharmacy were not captured in the PDMP. We had no information on inpatient opioid prescribing, and have not characterized the impact of individual clinician prescribing habits. The definitions of long-term postoperative opioid use are not standardized, although our results are consistent with studies using other definitions. In 2014, Oregon had relatively high use of prescription opioids compared with most other states [9], and we cannot know how well our results generalize to other states.

In summary, lumbar fusion surgery infrequently reduced the use of opioid therapy postoperatively, especially among those receiving long-term opioids preoperatively. Among opioid-naïve patients undergoing surgery, there was a substantial risk of initiating long-term opioid use. Patients should be well informed and have realistic expectations regarding opioid use when considering lumbar fusion surgery. Clinicians treating patients with back pain may need to give greater attention to minimizing long-term opioid use; addressing mood disorders; minimizing post-operative opioid use; and minimizing numbers of opioid prescribers in the perioperative setting. In predicting prolonged postoperative opioid use, prior prescription opioid exposure may be more important than patient characteristics or surgical complexity, and is a factor that clinicians control.

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Joshua Van Otterloo and Sara Hallvik had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Richard Deyo, Sara Hallvik, Miguel Marino, and Joshua Van Otterloo are responsible for the data analysis.

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Figure 1.
Selection of study patients

Table 1

Demographic, clinical, and prescription features of full patient sample and patients with or without long term post-operative opioid use (percents are column percents)

	Full Sample (n=2,491)	No long-term postoperative opioid use (n=1,397)	Long-term postoperative opioid use (n=1,094)	p-value *
Sex, Female, n (%)	1,486 (59.7)	833 (59.6)	653 (59.7)	0.98
Age category, n (%) [†]				
18–44	310 (12.6)	133 (9.7)	177 (16.2)	<0.001
45–54	412 (16.7)	169 (12.3)	243 (22.2)	
55–64	616 (24.9)	309 (22.5)	307 (28.1)	
65–74	763 (30.9)	502 (36.5)	261 (23.9)	
75+	369 (14.9)	263 (19.1)	106 (9.7)	
Race, n (%)				
American Indian or Alaska Native	29 (1.2)	13 (0.9)	16 (1.5)	0.06
Asian	36(1.5)	25 (1.8)	11 (1.0)	
African American	22 (0.9)	7 (0.5)	15 (1.4)	
Native Hawaiian or Pacific Islander	3 (0.1)	1 (0.07)	2 (0.2)	
White	2,328 (93.5)	1,313 (94.0)	1,015 (92.8)	
Ethnicity, n (%) [‡]				
Hispanic or Latino	70 (2.8)	40 (2.9)	30 (2.7)	0.3
Not Hispanic	2,378 (95.5)	1,338 (95.8)	1,040 (95.1)	
Residence, n (%) [‡]				
Rural	1,017 (41.2)	579 (42.1)	438 (40.0)	<0.001
Urban	1,316 (53.3)	684 (49.7)	632 (57.8)	
Indication for Surgery (Diagnosis), n (%)				
Nonspecific backache, miscellaneous	26 (1.0)	12 (0.9)	14 (1.3)	<.0001
Probable degenerative changes	299 (12.0)	151 (10.8)	148 (13.5)	
Herniated disc	256 (10.3)	119 (8.5)	137 (12.5)	
Sequelae of previous back surgery	133 (5.3)	53 (3.8)	80 (7.3)	
Spinal stenosis	298 (12.0)	176 (12.6)	122 (11.2)	
Possible instability	1,479 (59.4)	886 (62.4)	593 (54.2)	
Comorbidity				
Comorbidity Score, mean (SD)	0.57 (0.86)	0.53 (0.82)	0.62 (0.90)	0.009
Surgery features				
Complex fusion procedure [‡] , n (%)	320 (12.9)	159 (11.4)	161 (14.7)	0.01
Procedure with complications [§] , n (%)	171 (6.9)	90 (6.4)	81 (7.4)	0.4
Opioid prescribing features				
Long term pre-hospital opioids, n (%)	1045 (58.5)	239 (30.5)	806 (80.3)	<0.001

	Full Sample (n=2,491)	No long-term postoperative opioid use (n=1,397)	Long-term postoperative opioid use (n=1,094)	p-value *
Total pre-hospital MME's ^{//} (7 mos), median (IQR) [¶] (median MME/day)	950 (4,950) (4.5/d)	200 (1,020) (0.95/d)	5,175 (13,140) (25/d)	<0.001
MME in 30 days post-hospital, median (IQR) (median MME/day)	1,600 (2,413) (53/d)	960 (975) (32/d)	3,000 (3,950) (100/d)	<0.001
Preoperative benzodiazepine, n (%)	743 (29.8)	303 (21.7)	440 (40.2)	<0.001
Opioid prescribers in 30 days post-op, median (IQR)	2.00 (2.00)	1.00 (1.00)	3.00 (2.00)	<0.001
High dose opioids (cumulative MME 16,200) in 7 months after surgery, n (%)	355 (14.3)	3 (0.26)	352 (32.2)	<0.001

* Comparing patients with or without long-term postoperative opioid use; t-test or chi-square.

[†] 21 missing age category; 73 unknown or other race; 43 unknown ethnicity; 158 residence unknown or outside Oregon.

[‡] Combined anterior and posterior fusion, DRGs 453, 454, 455

[§] DRGs 453, 454, 459

^{//} MME = milligram morphine equivalents

[¶] IQR = Interquartile range

Table 2

Pre-hospitalization and post-hospitalization opioid use (n = 2,491). Tabulated numbers are frequency counts (column %)

Post-hospitalization opioid use	Pre-hospitalization opioid use			
	None, n=704	Short term only, n=133	Episodic, n=609	Long term, n=1,045
None [*] , n=220	109 (15.5)	35 (26.3)	60 (9.85%)	16 (1.5)
short term only [†] , n=649	340 (48.3)	38 (28.6)	192 (31.5)	79 (7.6)
episodic [‡] , n=528	165 (23.4)	29 (21.8)	190 (31.2)	144 (13.8)
long term [§] , n=1,094	90 (12.8)	31 (23.3)	167 (27.4)	806 (77.1)

^{*} No opioid fills in the in the 7 months post-hospitalization

[†] Some opioids in the 30 days post-hospitalization, none in the subsequent 6 months

[‡] Patients who do not meet definitions of no opioid use, short term opioid use, or long term opioid use

[§] At least 4 opioid fills in 7 months after surgery, at least 3 of which were >30 days after surgery.

Table 3

Postoperative change from cumulative preoperative opioid dose among long-term and episodic preoperative opioid users.*

Post-hospitalization opioid dose, 6 months following the perioperative interval	Pre-hospitalization opioid use	
	Episodic use [†] n=609	Long-term use [‡] n=1,045
No opioids after the perioperative interval, n (column %)	252 (41.4)	95 (9.1)
Decreased dosage by >10%, n (column %)	79 (13.0)	359 (34.4)
Same dose as pre-hospitalization (< 10% change), n (column %)	24 (3.9)	123 (11.8)
Increased dose by >10%, n (column %)	254 (41.7)	468 (44.8)

* Cumulative doses calculated using prescriptions filled in the 6 months preceding the perioperative interval and 6 months following the perioperative interval (excluding the perioperative interval of 30 days pre-hospitalization and 30 days post hospitalization)

[†] Patients who do not meet definitions of no opioid use, short term opioid use, or long term opioid use

[‡] At least 4 opioid fills in 7 months before surgery, at least 3 of which were >30 days before hospitalization.

Table 4

Multivariable logistic model without dosing information, predicting long term post-operative opioid use, n = 2,470^{*}.

Independent Variables	Odds Ratio	95% CI	p-value
Sex, Female	1.00	0.82, 1.23	0.97
Age category			
18–44	Reference		<0.001 [†]
45–54	1.11	0.77, 1.60	
55–64	0.87	0.62, 1.22	
65–74	0.52	0.37, 0.73	
75+	0.45	0.30, 0.67	
Non-white Race	0.99	0.65, 1.50	0.95
Hispanic Ethnicity	1.05	0.56, 1.96	0.91
Residence			
Rural	Reference		
Urban	1.13	0.92, 1.38	0.23
Missing	0.51	0.30, 0.87	0.013
Indication for Surgery (Diagnosis)			
Probable degenerative changes, nonspecific backache, miscellaneous	Reference		
Herniated disc	1.33	0.89, 2.00	0.17
Sequelae of previous back surgery	1.77	1.06, 2.96	0.03
Spinal stenosis	0.95	0.64, 1.40	0.78
Possible instability	1.08	0.80, 1.46	0.62
Comorbidity score			
0	Reference		0.005 [†]
1	1.21	0.96, 1.52	
2	1.30	0.88, 1.90	
3+	1.83	1.12, 2.99	
Complex fusion	1.06	0.76, 1.47	0.57
Procedure with complications	1.06	0.69, 1.62	0.76
Received long term preoperative opioids	10.80	8.23, 13.21	<0.001
Any preoperative benzodiazepine use (7 mo)	1.49	1.20, 1.85	0.004

^{*} Excludes 21 patients with missing age

[†] p-value is a test for trend

Table 5

Multivariable logistic model with dose information, predicting long term post-operative use, n = 2,470*.

Independent Variables	Odds Ratio	95% CI	p-value
Sex, Female	1.14	0.90, 1.45	0.27
Age category			
18–44	Reference		0.79 [†]
45–54	1.31	0.85, 2.55	
55–64	1.20	0.80, 1.81	
65–74	1.03	0.68, 1.54	
75+	1.36	0.85, 2.19	
Non-white Race	1.33	0.84, 2.12	0.23
Hispanic Ethnicity	1.18	0.59, 2.35	0.64
Residence			
Rural	Reference		
Urban	1.14	0.91, 1.44	0.26
Missing	0.59	0.31, 1.13	0.11
Indication for Surgery (Diagnosis)			
Probable degenerative changes, nonspecific backache, miscellaneous	Reference		
Herniated disc	1.12	0.70, 1.81	0.64
Sequelae of previous back surgery	1.38	0.75, 2.55	0.30
Spinal stenosis	0.96	0.61, 1.51	0.86
Possible instability	1.07	0.74, 1.52	0.73
Comorbidity score			
0	Reference		0.005 [†]
1	1.22	0.94, 1.59	
2	1.32	0.86, 2.03	
3+	2.09	1.21, 3.62	
Complex fusion	1.055	0.72, 1.54	0.69
Procedure with complications	1.07	0.65, 1.77	0.78
Received long term preoperative opioids	1.68	1.19, 2.34	0.004
Total preoperative MME's [‡] (7 Mos.), quartiles			
0	Reference		<.001 [†]
1 – 750 (mean 0.005 – 3.6/day)	1.41	0.99, 2.00	
751 – 2350 (mean 3.6 – 11.2/day)	2.56	1.77, 3.69	
2351 – 8100 (mean 11.2 – 38.6/day)	6.54	4.15, 10.30	
8101 (mean 38.6/day)	15.47	8.53, 28.06	
Total MME in 30 days postoperative, in quartiles			
0	Reference		<.001 [†]
1–887 (mean 0.03 – 29.6/day)	1.93	1.21, 3.07	

Independent Variables	Odds Ratio	95% CI	p-value
888–1600 (mean 29.6 – 53.3/day)	2.52	1.53, 4.14	
1601–3300 (mean 53.3 – 110/day)	3.92	2.23, 6.68	
3301 (mean 110/day)	7.96	4.25, 14.91	
Any preoperative benzodiazepine use (7 mo)	1.09	0.85, 1.41	0.50
Opioid prescribers in 30 days post-op			
1	Reference		<.001 [†]
2	1.701	1.21, 2.39	
3	2.065	1.38, 3.09	
4+	5.047	3.17, 8.04	

* Excludes 21 patients with missing age

[†] p-value is a test for trend

[‡] MME = milligram morphine equivalents