

Correlation Between 24-Hour Predischarge Opioid Use and Amount of Opioids Prescribed at Hospital Discharge

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IMPORTANCE The United States is experiencing an opioid abuse epidemic. Opioid overprescription by physicians may contribute to this epidemic.

OBJECTIVES To determine if there was a correlation between a postoperative patient's 24-hour predischarge opioid use and the amount of opioids prescribed at hospital discharge and to determine the number of patients who used no opioids prior to discharge but were still prescribed opioids after hospital discharge.

DESIGN, SETTING, AND PARTICIPANTS This cross-sectional study performed a retrospective record review of 18 343 postoperative patients at Boston Medical Center and Lahey Hospital and Medical Center–Burlington Campus who were discharged home after a postoperative inpatient admission of at least 24 hours. Data collection spanned from May 22, 2014, to June 30, 2016, in the Boston Medical Center data set and from March 23, 2015, to September 7, 2016, in the Lahey Hospital and Medical Center–Burlington Campus data set.

EXPOSURES Surgery requiring a postoperative inpatient hospital stay longer than 24 hours.

MAIN OUTCOMES AND MEASURES The main outcome measures were the patient's 24-hour predischarge opioid use and the total quantity of opioids prescribed at hospital discharge. Potential overprescription was defined as the number of patients who used no opioids in the 24 hours prior to hospital discharge but were still prescribed opioids after hospital discharge.

RESULTS Among the 18 343 patients (10 069 women and 8274 men; mean age, 52.2 years) who underwent 21 452 surgical procedures, there was wide variation in the amount of opioids prescribed at hospital discharge given a postoperative patient's 24-hour predischarge opioid use. A total of 6548 patients (35.7%) used no opioids in the 24 hours prior to hospital discharge; however, 2988 of these patients (45.6%) were prescribed opioids at hospital discharge, suggesting potential overprescription. Services that had the highest rates of potential overprescription (obstetrics [adjusted odds ratio (AOR), 3.146; 95% CI, 2.094-4.765] and gynecology [AOR, 2.355; 95% CI, 1.663-3.390], orthopedics [AOR, 0.943; 95% CI, 0.719-1.242], and plastic surgery [AOR, 0.733; 95% CI, 0.334-1.682]) generally had the highest rates of patients still using opioids at hospital discharge. Pediatric surgery was the only service that did not have any cases of potential overprescription (AOR, 2.09×10^{-7} ; 95% CI, 0.000-0.016).

CONCLUSIONS AND RELEVANCE Opioids are not regularly prescribed in a patient-specific manner to postoperative patients. Potential opioid overprescription occurs regularly after surgery among almost all surgical specialties.

JAMA Surg. 2018;153(2):e174859. doi:10.1001/jamasurg.2017.4859
Published online December 13, 2017.

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The United States is experiencing an opioid abuse epidemic, with 19 000 opioid-related deaths a year.¹ In Massachusetts, 1531 residents died of overdose of prescription opioids and heroin in 2015, a 431% increase from the 355 deaths confirmed in 2000.² This number corresponds to an incidence of 24.6 deaths per 100 000 residents, which is higher than the national mean number of deaths from overdose of opioids (14.7 deaths per 100 000 residents).¹

More concerning is the role that physicians, surgeons, and other health care professionals likely play in contributing to this epidemic.³ The National Survey on Drug Use and Health has shown that 4 of 5 current heroin users report that their opioid use began with prescription opioid analgesics.⁴ In addition, 70.3% of the opioids used for nonmedical purposes are obtained from a friend or relative, suggesting that the overprescription of opioid pain relievers may contribute to this epidemic.⁵

Evidence from the surgical literature suggests that overprescription of opioids may occur after surgery.⁶⁻⁸ Furthermore, the amount of opioids prescribed after certain low-risk surgical procedures has been increasing during the past decade,⁹ and surgery itself has been implicated as a risk factor for long-term opioid use.¹⁰⁻¹³

We reviewed the medical records of 18 343 postoperative patients to determine if there was any correlation between a patient's opioid use prior to hospital discharge and the amount of opioids prescribed at hospital discharge. In particular, we sought to characterize a subset of patients who used no opioids prior to hospital discharge but were still prescribed them at hospital discharge, suggesting potential overprescription.

Methods

Study Design

This study was designed as a cross-sectional study of patients undergoing inpatient surgery. We sought to analyze the association between a postoperative patient's 24-hour predischarge opioid use and the quantity of opioids prescribed at hospital discharge. The Boston University Medical Center Institutional Review Board and Lahey Clinic Institutional Review Board approved this study, both of which included a waiver of patient consent for acquisition of data.

Setting

Two Massachusetts medical centers from separate health systems were involved in this study: Boston Medical Center (BMC) and Lahey Hospital and Medical Center-Burlington Campus (LHMC-B). Boston Medical Center is an urban safety-net hospital and level 1 trauma center, and LHMC-B is a suburban community-based hospital and level 2 trauma center. Boston Medical Center routinely cares for obstetric and pediatric patients, whereas LHMC-B does not. Lahey Hospital and Medical Center-Burlington Campus has an acute pain consultation service, whereas BMC does not.

Data Sources

Data were obtained through retrospective database queries of the electronic medical records of BMC and LHMC-B. Both in-

Key Points

Question Is a postoperative patient's 24-hour predischarge opioid use correlated with the amount of opioids prescribed at hospital discharge?

Findings In this cross-sectional study that included 18 343 postoperative patients from 2 Massachusetts medical centers, there was wide variation in the amount of opioids prescribed at hospital discharge given a patient's individual 24-hour predischarge opioid use. Of the patients who no longer used opioids prior to hospital discharge, 45.6% were nonetheless prescribed opioids at hospital discharge.

Meaning Potential overprescription of opioids occurs frequently among postoperative patients; improved opioid prescribing practices are needed to administer opioids in a more patient-specific manner.

stitutions currently use the same electronic medical record application (Epic, Epic Systems Corp). Data collection spanned from May 22, 2014, to June 30, 2016, for the BMC data set and from March 23, 2015, to September 7, 2016, for the LHMC-B data set.

Income data for each patient's home zip code was obtained via the Internal Revenue Service, Statistics of Income division.¹⁴ Distance from the hospital was calculated from the patient's home zip code to the hospital where the surgery was performed.

Patient Selection Criteria

Inclusion criteria consisted of any patient who underwent surgery during an inpatient admission with a postoperative length of stay longer than 24 hours who was subsequently discharged home. Exclusion criteria consisted of patients discharged to a skilled nursing or rehabilitation facility and surgical subspecialties with fewer than 5 cases.

Opioid Dose Calculations

For the patients in this study, the amount of short-acting opioid medications that were administered to the patient during the admission and the amount of opioids prescribed at hospital discharge were recorded. For comparison purposes, opioids were converted to equianalgesic doses of morphine sulfate (morphine milligram equivalents [MMEs]) using standard ratios.¹⁵ Long-acting opioids (methadone hydrochloride, buprenorphine hydrochloride, transdermal fentanyl citrate patches, and extended-release formulations of any opioid) were excluded because their administration was primarily indicated for long-term maintenance and not related to acute postoperative pain.^{16,17} Intraoperative or immediate perioperative opioid doses (intraoperative administrations, intravenous fentanyl, and patient-controlled analgesia) were also excluded because these doses do not accurately represent the type of analgesia that patients receive just prior to hospital discharge and at home. Opioids given intrathecally, intrarticularly, or through epidurals were also excluded because their effects were generally not still present during the predischarge period, in addition to the difficulty of converting

these doses into MMEs. This study focused on opioid use and did not specifically investigate the use of nonopioid analgesics or multimodal regimens.

Excluding extended-release formulations of opioids may affect a patient's opioid use and prescription and may potentially affect the rates of potential overprescription. However, we found that only 2.0% of admissions (400 of 20 035) had an extended-release opioid administered in the 24 hours prior to hospital discharge and that inclusion of these medications in our calculations had only a minor association with overall 24-hour predischarge opioid use (4.2%; 33 MME without extended-release opioids vs 35 MME with extended-release opioids), total opioids prescribed (3.9%; 343 MME without extended-release opioids vs 357 MME with extended-release opioids), and potential overprescription rate (-0.1%; 3051 of 6981 [43.70%] with extended-release opioids vs 3038 of 6957 [43.67%] without extended-release opioids).

Excluding patient-controlled analgesia and intravenous fentanyl doses could also affect the amount of opioids administered in the 24 hours before discharge and thus affect the potential rate of overprescription. Nonetheless, we found that 92.3% of admissions (14 093 of 15 275) in which patient-controlled analgesia or fentanyl had been used did not feature any doses administered in the final 24 hours before hospital discharge and that including these doses had a minimal association with the potential rate of overprescription (0.1% decrease, from 43.7% [3051 of 6981] to 43.6% [2949 of 6763]).

Potential Opioid Overprescription

Few guidelines have been established to recommend the quantity of opioids a patient should be prescribed at hospital discharge, making an objective assessment of overprescription or underprescription difficult. We defined a patient as no longer using opioids if he or she did not receive any short-acting opioids in the 24 hours prior to hospital discharge. We chose to define potential overprescription using the relatively conservative criteria of being prescribed opioids despite no longer using any opioid medications during the 24 hours prior to hospital discharge. We are aware that this definition may underestimate the actual prevalence of overprescription because patients who used minimal opioid medications (ie, 5 mg of oxycodone hydrochloride within 24 hours of hospital discharge) but were prescribed an excessive amount at hospital discharge (300 mg of oxycodone hydrochloride) would not be captured by this criteria. Requiring that a patient use no opioids during the 24 hours prior to hospital discharge to be considered for potential overprescription also prevents the classification of delayed-onset pain secondary to the fading effects of any regional nerve blocks because patients who started using opioids just prior to hospital discharge would be excluded.

Statistical Analysis

For comparison of continuous data, a 2-tailed *t* test was performed. Correlation was calculated using either the Pearson or Kendall correlation coefficients with a 2-tailed test for significance. *P* < .05 was considered statistically significant.

Linear regression analysis was performed via log transformations ($\log [x + 1]$) of opioid use during the 24 hours before

hospital discharge and the quantity of opioids prescribed at hospital discharge. Binomial logistic regression analysis was performed for patients who did not use any opioids during the 24 hours before hospital discharge. The dependent variable was whether the patient was prescribed opioids (potential overprescription) or not prescribed opioids. For categorical values (hospital, sex, regional or epidural anesthesia, insurance, and surgical service), we chose the following reference values: BMC, male, no regional or epidural anesthesia, Medicare, and general surgery. All statistical analysis was performed using R statistical software, version 3.3.2, with the `openxlsx`, `tidyr`, `parallel`, `beepr`, `ggmap`, and `matrixStats` extension packages.¹⁸

Results

Surgical Patient Characteristics at BMC vs LHMC-B

A total of 18 343 patients who had 21 452 surgical procedures during 20 035 admissions with a postoperative length of stay of at least 24 hours met our admission criteria (Table 1). Compared with patients undergoing surgery at LHMC-B, patients at BMC were more likely to be younger (44.7 vs 61.1 years), female (6144 of 9795 [62.7%] vs 3925 of 8548 [45.9%]), reside in a lower-income area (\$41 000 vs \$57 000), live closer to the hospital (43 vs 82 km), and rely on government-assisted insurance or be uninsured (58% vs 7% Medicaid or uninsured) (eTable in the Supplement).

Association Between Predischarge Opioid Use and Amount Prescribed at Hospital Discharge

We found a wide variation in the amount of opioids prescribed at hospital discharge for any 24-hour predischarge amount of opioid use. For all amounts of opioids used in the 24 hours before hospital discharge, patients were prescribed a mean of 343 MME (range, 0-37 500 MME) (Table 1). Performing a log transformation of both the predischarge opioid use and quantity of opioids prescribed at hospital discharge revealed 3 distinct clusters (Figure 1).

The largest cluster, representing 11 603 of 20 035 admissions (57.9%), consisted of patients who used opioids before hospital discharge and were discharged with a prescription for opioids (Figure 1). A regression analysis of this cluster showed that there was a subtle association between the log units of predischarge opioid use and the log units of the quantity of opioids prescribed at hospital discharge (Figure 1). Nevertheless, this model was able to account for only 11% of the variance in this cluster.

The second cluster consisted of patients who were not discharged with a prescription for opioids, representing 5383 of 20 035 admissions (26.9%) (Figure 1). Most of these patients (3930 [73.0%]) did not receive opioids at hospital discharge because they had no predischarge opioid use. The remainder of the group was discharged home without a prescription for opioids despite using them before hospital discharge. Although we were unable to ascertain the exact underlying reasons, we speculate that no prescription occurred owing to reasons such as patient or clinician preference or already having a supply of opioids from prior to surgery.

Table 1. Demographics, Opioid Use, and Opioid Prescription

Demographic	Postoperative Length of Stay >24 h	No Opioids Within 24 h Before Discharge	Not Overprescribed	Potential Overprescription	P Value ^a
Patients, No.	18 343	6548	3691	2988	<.001
Admissions, No.	20 035	6981	3930	3051	.49
Surgical procedures, No.	21 452	7607	4346	3261	<.001
Age, mean (range), y	52.2 (0 to 101)	58.6 (0 to 101)	59.7 (0 to 101)	57.4 (4 to 100)	<.001
Male, No. (%)	8274 (45.1)	3463 (52.9)	2068 (56.0)	2988 (49.4)	<.001
Body mass index, mean (range) ^b	29.8 (9.8 to 80)	28.5 (9.8 to 80)	27.9 (9.8 to 70.5)	29.3 (12.9 to 80)	<.001
Medicaid or uninsured, No. (%)	6343 (34.6)	1632 (24.9)	877 (23.8)	778 (26.0)	.02
Median income by zip code (in 1000), mean (range), \$	48 (19 to 175)	51 (19 to 139)	52 (22 to 139)	50 (19 to 139)	<.001
Distance to hospital, mean (range), km	60 (0.6 to 5044)	61 (0.6 to 4985)	59 (0.6 to 4976)	63 (1.1 to 4985)	.49
Procedures with regional or epidural anesthesia, No. (%)	3117 (14.5)	625 (8.2)	212 (4.9)	413 (12.7)	<.001
Length of procedure, mean (range), min	143 (0 to 1437)	129 (1 to 1437)	95 (1 to 1437)	175 (1 to 778)	<.001
Length of stay, mean (range), d	5 (1 to 302.4)	5.7 (1 to 302.4)	6.1 (1 to 302.4)	5.2 (1 to 200)	<.001
Length of stay after surgery, mean (range), d	4.4 (1 to 294.4)	4.9 (1 to 294.4)	5 (1 to 294.4)	4.8 (1 to 200)	.38
Opioid consumption and prescription					
Discharges home with opioids, No.	14 652	3051	0	3051	<.001
24-h Predischarge opioid use, mean (range), MME	33 (0 to 1365)	0 (0 to 0)	0 (0 to 0)	0 (0 to 0)	NA
Opioid discharge quantity, mean (range), MME	343 (0 to 37 500)	150 (0 to 13 500)	0 (0 to 0)	343 (34 to 13 500)	<.001
Total opioids prescribed, MME	6 881 492	1 045 616	0	1 045 616	<.001
Last opioid from surgery, mean (range), d	3.4 (-20 to 122)	2.4 (-20 to 122)	2.2 (-20 to 122)	2.6 (-8.5 to 106)	.02
Last opioid from discharge, mean (range), d	-1 (-172 to 0)	-2.7 (-172 to 0)	-3.2 (-172 to 0)	-2.3 (-123 to 0)	<.001

Abbreviations: MME, morphine milligram equivalents, NA, not applicable.

^a Not overprescribed vs potential overprescription.

^b Calculated as weight in kilograms divided by height in meters squared.

The third cluster consisted of patients who had no opioid use before hospital discharge but were prescribed opioids at hospital discharge (Figure 1). We termed this anomaly as potential opioid overprescription; this group represented 15.2% (3051 of 20 035) of all admissions.

Potential Overprescription of Opioids at Hospital Discharge

As patients who no longer use opioids for 24 hours have likely recovered from their acute postoperative pain, we found it peculiar that a substantial amount of these patients were still being prescribed opioids at hospital discharge. Of the 20 035 admissions with a postoperative length of stay longer than 24 hours, 6981 (34.8%) did not have any opioid medications administered during the last 24 hours before hospital discharge (Table 1). However, 3051 of these admissions (43.7%) had a mean of 343 MME prescribed at hospital discharge, suggesting that these patients were potentially overprescribed opioids. This occurrence accounted for 15.2% (1 045 616 of 6 882 016 MME) of all opioids prescribed in our cohort.

There are, however, certain situations when prescribing an opioid may be indicated despite a patient not using any opioids prior to hospital discharge, such as for patients living a far distance from the hospital or for patients whose pain is cur-

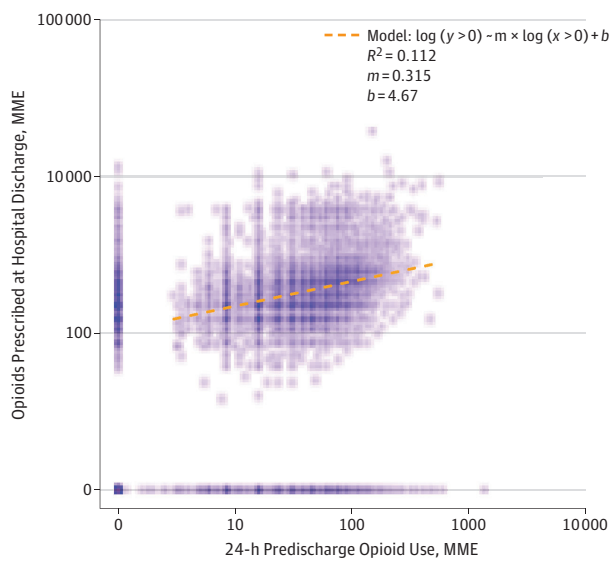
rently controlled by regional nerve blocks that may wear off after hospital discharge. We found that patients who were potentially overprescribed opioids lived a similar mean distance from the hospital compared with those who were not overprescribed opioids (63 vs 59 km; $P = .49$).

Use of regional or epidural anesthesia was more common for patients who were potentially overprescribed opioids compared with patients who were not (413 of 3261 [12.7%] vs 212 of 4346 [4.9%]; $P < .001$) (Table 1). However, most surgical procedures (2848 of 3261 [87.3%]) that resulted in potential overprescription were performed without regional or epidural anesthesia.

Risk Factors for Potential Overprescription of Opioids

Using logistical regression, we sought to identify any possible risk factors for overprescription of opioids. Surgical service was most significantly associated with potential overprescription, with ophthalmology and pediatric surgery being associated with a lower risk of overprescription and obstetrics and gynecology associated with the highest risk of overprescription (Figure 2). Patients who were insured through worker's compensation or automobile insurance were also associated with increased odds of potential overprescription. Aside from insurance status and surgical service, there were

Figure 1. Amount of Opioids Used 24 Hours Before Hospital Discharge vs Quantity Prescribed at Discharge



The opioid discharge quantity is compared with the patient's 24-hour predischARGE use. Note the log axes. Each point represents an individual admission, and clusters of densely spaced points are represented by darker shades. The central cluster represents patients who used opioids before hospital discharge and were discharged with a prescription for opioids. The orange dashed line represents a linear regression of the log transformation of discharge quantity as a function of the log transformation of predischARGE opioid use for this cluster (values >0), excluding the zero effects along the x-axis and y-axis. The cluster along the x-axis represents patients who were not prescribed opioids at hospital discharge. The cluster along the y-axis represents patients who were potentially overprescribed opioids (no predischARGE use but prescribed opioids at hospital discharge). MME indicates morphine milligram equivalents.

no particularly large associations of any patient demographic factors with the odds of potential overprescription.

Potential Overprescription by Service

Further investigating the pattern of potential overprescription, we analyzed the prevalence of potential overprescription by surgical service (Table 2). Of the services with more than 5 cases in our series, only BMC's pediatric surgery service did not have any cases of potential overprescription. Obstetrics and gynecology had the highest rates of potential overprescription. Regional or epidural anesthesia was commonly used in the obstetrics service (1662 of 1889 procedures [88.0%]), suggesting that this practice may be a factor underlying the prescription of opioids to patients who did not receive any before hospital discharge. However, epidural anesthesia and regional anesthesia were less frequently used in other services with high rates of potential overprescription (gynecology, 130 of 1025 [12.7%]; orthopedics, 854 of 2971 [28.7%]).

Patients used and were prescribed opioids after percutaneous or scope-based procedures performed by medical services, albeit at a lower rate than more traditional surgical services. In these cases, opioids may have been prescribed if the procedure was more invasive than a standard diagnostic pro-

cedure (eg, colonoscopy with biopsy or tumor embolization) or if the presenting symptom was pain (eg, gallstones).

Overall, we found a strong correlation between services with higher rates of patients who were still using opioids at hospital discharge having higher rates of potential overprescription (Pearson correlation coefficient $r = 0.79$) (Figure 3). No significant correlation was found when patients were similarly grouped by insurance status (Pearson correlation coefficient $r = 0.38$; $P = .12$).

Discussion

This study shows that the prescription of opioids is only moderately correlated with a patient's 24-hour predischARGE opioid use. To our knowledge, this is the first study to examine the association of predischARGE opioid use with the amount of opioids prescribed at hospital discharge across all types of inpatient surgical procedures. We found a subtle, nonlinear association between these 2 factors that is likely some form of a power law.¹⁹ Although we were unable to fully ascertain the factors underlying this association, we speculate that this association may reflect the general clinical judgment of clinicians regarding a patient's likely opioid use.

To our knowledge, this study is also the first to highlight the problem of potential opioid overprescription at our institutions. Although in most cases (3560 of 6548 [54.4%]) clinicians did not prescribe opioids to patients who no longer used opioids before hospital discharge, a significant proportion of patients (2988 of 6548 [45.6%]) not using any opioids before hospital discharge were nevertheless potentially overprescribed opioids at hospital discharge (2988 of all 18 343 admissions [16.3%]).

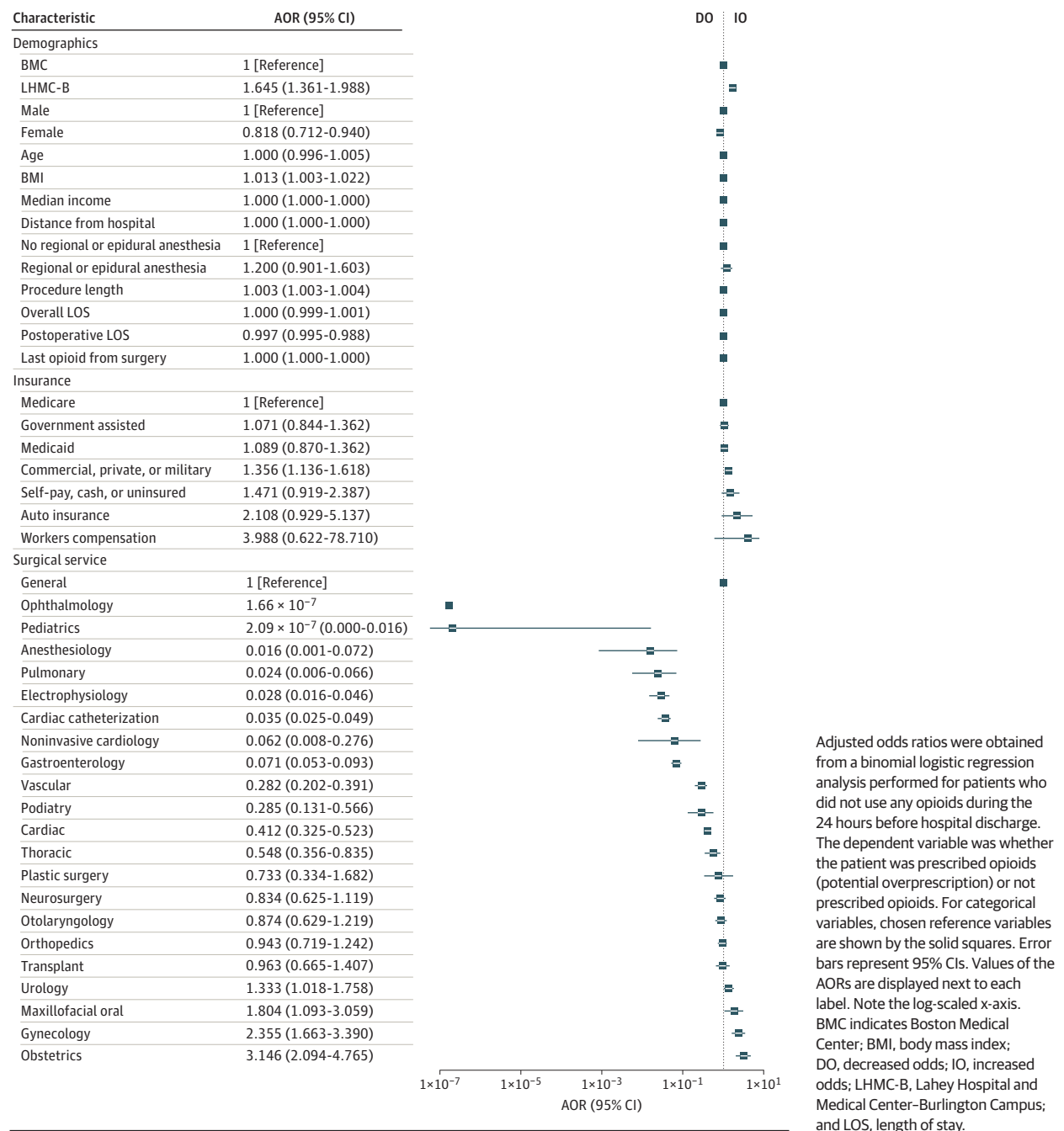
Patients who do not use any opioids prior to hospital discharge have a higher likelihood of being potentially overprescribed opioids if they underwent a procedure performed by a surgical service that frequently discharged patients using opioids prior to hospital discharge (Figure 3). These findings suggest that prescribers of all specialties may not be able to easily identify patients who are no longer using opioids at hospital discharge, particularly those prescribers who routinely discharge patients still using opioids.

Strengths and Limitations

The strengths of this study are its broad sample size, encompassing patients of all demographic and insurance types, among all surgical specialties at 2 medical centers with differing patient populations. This study also examined opioid use throughout a patient's hospital stay, a longer period than most other studies that examined opioid use only in the postanesthesia care unit or through only the first postoperative day.

Limitations of this study include its retrospective nature, its geographical limitation to eastern Massachusetts, and its inability to fully account for any opioid-sparing effects of non-opioid analgesics. All data used in this study were collected on a prospective basis as part of standard medical documentation practices, minimizing any potential selection, informa-

Figure 2. Adjusted Odds Ratios (AORs) for Potential Overprescription



tion, or recall biases. Regarding the effects of nonopioid analgesics, patients are routinely prescribed these types of medications as first-line treatment for pain at both hospitals. Any effects of these analgesics should theoretically be reflected in the patient’s opioid use, although we were unable to specifically study these effects.

Other Cases of Excessive Opioid Prescription

Several studies have highlighted the prevalence of excess prescription of opioids after surgery, demonstrating that 70% to 80% of patients do not fill or finish their opioids prescribed at

hospital discharge and that a significant amount of opioids prescribed at hospital discharge go unconsumed.^{6-8,20-22} Additional studies have also reported wide variation in the amount of opioids prescribed for any single procedure as well as across different clinicians.^{3,8}

To our knowledge, only 1 other study has previously examined both a patient’s 24-hour predischarge opioid use and the amount of opioids prescribed at hospital discharge.²⁰ Similar to our findings, that study also reported a poor correlation between predischarge opioid use and the amount of opioids prescribed at hospital discharge because they found no

Table 2. Opioid Consumption and Prescription by Surgical Service and Insurance Type

Characteristic	Postoperative Length of Stay >24 h, No.	No Opioids Within 24 h Prior to Discharge, No. (%)	No Opioids Within 24 h Prior to Discharge and Discharged Without Opioids, No.	Potential Overprescription, No. (%)
Service				
Anesthesiology (BMC)	224	136 (60.7)	133	3 (2.2)
Cardiac				
BMC	297	114 (38.4)	63	51 (44.7)
LHMC-B	918	430 (46.8)	181	249 (57.9)
Cardiac catheterization (LHMC-B)	995	805 (80.9)	751	54 (6.7)
Electrophysiology (LHMC-B)	414	360 (87.0)	336	24 (6.7)
Gastroenterology				
BMC	254	161 (63.4)	147	14 (8.7)
LHMC-B	1194	879 (73.6)	794	85 (9.7)
General				
BMC	2627	656 (25.0)	312	344 (52.4)
LHMC-B	2061	822 (39.9)	206	616 (74.9)
Gynecology				
BMC	746	184 (24.7)	51	133 (72.3)
LHMC-B	279	109 (39.1)	18	91 (83.5)
Maxillofacial oral (BMC)	644	99 (15.4)	33	66 (66.7)
Neurosurgery				
BMC	668	163 (24.4)	87	76 (46.6)
LHMC-B	689	176 (25.5)	54	122 (69.3)
Noninvasive cardiology (LHMC-B)	28	19 (67.9)	17	2 (10.5)
Obstetrics (BMC)	1889	374 (19.8)	96	278 (74.3)
Ophthalmology (BMC)	29	15 (51.7)	14	1 (6.7)
Orthopedics				
BMC	1540	155 (10.1)	62	93 (60.0)
LHMC-B	1431	227 (15.9)	78	149 (65.6)
Otolaryngology				
BMC	602	254 (42.2)	178	76 (29.9)
LHMC-B	195	68 (34.9)	13	55 (80.9)
Pediatrics (BMC)	91	75 (82.4)	75	0
Plastic surgery				
BMC	88	16 (18.2)	5	11 (68.8)
LHMC-B	124	19 (15.3)	8	11 (57.9)
Podiatry (BMC)	221	96 (43.4)	79	17 (17.7)
Pulmonary (LHMC-B)	127	90 (70.9)	85	5 (5.6)
Thoracic (BMC)	431	138 (32.0)	88	50 (36.2)
Transplant				
BMC	168	77 (45.8)	50	27 (35.1)
LHMC-B	324	103 (31.8)	16	87 (84.5)
Urology				
BMC	434	115 (26.5)	61	54 (47.0)
LHMC-B	1064	399 (37.5)	73	326 (81.7)
Vascular				
BMC	339	105 (31.0)	68	37 (35.2)
LHMC-B	317	168 (53.0)	114	54 (32.1)
Total	21 452	7607 (35.5)	4346	3261 (42.9)

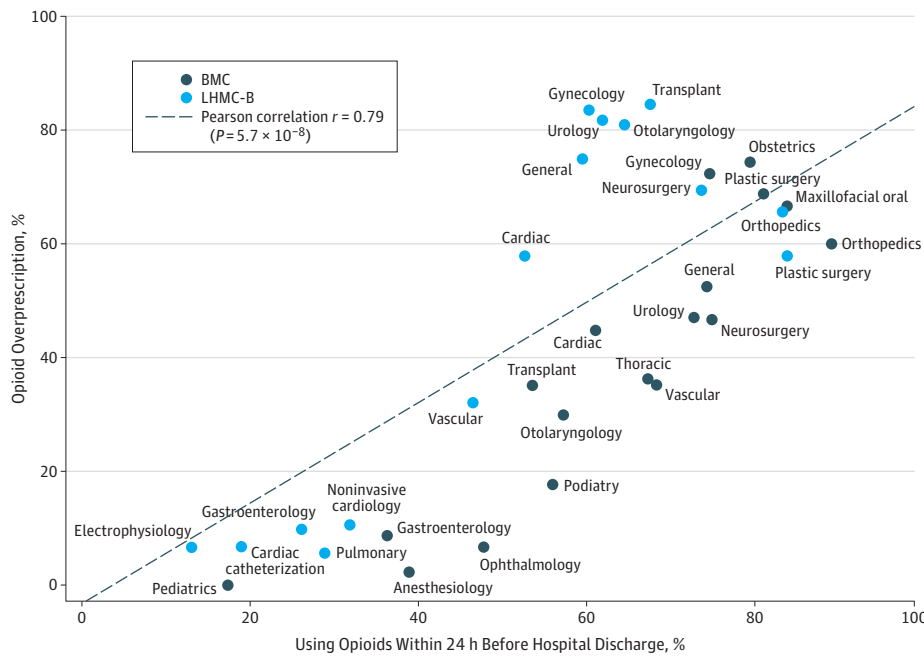
(continued)

Table 2. Opioid Consumption and Prescription by Surgical Service and Insurance Type (continued)

Characteristic	Postoperative Length of Stay >24 h, No.	No Opioids Within 24 h Prior to Discharge, No. (%)	No Opioids Within 24 h Prior to Discharge and Discharged Without Opioids, No.	Potential Overprescription, No. (%)
Insurance				
Automobile insurance				
BMC	176	30 (17.0)	9	21 (70.0)
LHMC-B	35	5 (14.3)	3	2 (40.0)
Commercial/private/military				
BMC	2405	585 (24.3)	293	292 (49.9)
LHMC-B	4790	1746 (36.5)	919	827 (47.4)
Government-assisted health care				
BMC	172	34 (19.8)	15	19 (55.9)
LHMC-B	1058	634 (59.9)	392	242 (38.2)
Medicaid				
BMC	6076	1509 (24.8)	839	670 (44.4)
LHMC-B	662	217 (32.8)	120	97 (44.7)
Medicare				
BMC	1872	656 (35.0)	400	256 (39.0)
LHMC-B	3516	2047 (58.2)	1294	753 (36.8)
Self-pay, cash, or uninsured				
BMC	489	116 (23.7)	45	71 (61.2)
LHMC-B	42	19 (45.2)	14	5 (26.3)
Workers compensation				
BMC	102	3 (2.9)	1	2 (66.7)
LHMC-B	57	6 (10.5)	2	4 (66.7)
Total	21 452	7607 (35.5)	4346	3261 (42.9)

Abbreviations: BMC, Boston Medical Center; LHMC-B, Lahey Hospital and Medical Center-Burlington Campus.

Figure 3. Potential Overprescription Rate by Service vs Percentage of Patients Using Opioids at Hospital Discharge



The potential overprescription rate by surgical service is compared with the percentage of patients who still used opioids within 24 hours before hospital discharge. Each point represents a single surgical service. The dashed line is a linear fit of the different points, weighted by the number of surgical procedures performed by each service. BMC indicates Boston Medical Center; LHMC-B, Lahey Hospital and Medical Center-Burlington Campus.

significant difference in the amount of opioids prescribed at hospital discharge between their “high-use” and “low-use” cohorts.

Reasons for Potential Overprescription

Although most physicians and other health care professionals are well aware of the need to prescribe opioids judiciously, there is little evidence available to help guide the quantity of opioids that a patient will use after surgery, especially after major inpatient procedures.^{7,8,23} Thus, it is generally up to individual clinicians to prescribe an appropriate quantity of opioids at their discretion.

Our finding that services with higher rates of patients who were still using opioids at hospital discharge had higher rates of potential overprescription suggests a possible service-based cultural bias toward overprescribing or perhaps an inability to effectively identify patients who are no longer using them. We did not find any nonsurgical patient demographic factors that had a considerable effect on the odds of potential overprescription.

Patients who were overprescribed opioids often underwent longer procedures in our data set (175 vs 95 minutes), a factor that has been previously associated with increased opioid use.²⁴ In addition, the services with higher rates of potential overprescription (obstetrics and gynecology, general surgery, and orthopedic surgery) are generally associated with more painful operations.²⁵ This finding suggests that prescribers who routinely care for patients undergoing more invasive surgical procedures may be more accustomed to regularly pre-

scribing opioids and thus may be less vigilant about identifying patients who are not taking opioids at the time of hospital discharge.

Areas for Improvement

To prescribe opioids more accurately, a better understanding of opioid use after surgery is needed. In this study, we performed a broad analysis across more than 20 surgical specialties. However, the course of postoperative pain varies with type of procedure²⁵ and patient demographic factors²⁶; thus, further investigation is necessary into how these factors affect patients in a more specific manner. Although several studies have found that most patients only fill a single prescription for opioids after surgery,^{6-8,20-22} it has been reported that patients may use opioids for more than 1 month after surgery,¹³ with some going on to become long-term users.¹⁰⁻¹² Therefore, further in-depth research into patients' postoperative pain experience and opioid use should reveal a better understanding of the quantity of opioids used for adequate, but not excessive, pain control.

Conclusions

This study found broad variation in opioid prescribing across multiple surgical specialties at our institutions. Opioids were not prescribed in a patient-specific manner to postoperative patients. Finally, we found that potential overprescription occurs regularly after surgery.

ARTICLE INFORMATION

Accepted for Publication: August 20, 2017.

Published Online: December 13, 2017.
doi:10.1001/jamasurg.2017.4859

Author Contributions: Dr Chen had full access to all 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: Chen, Tornetta.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Chen, Tornetta.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Chen, Tornetta.

Obtained funding: Chen, Tornetta.

Administrative, technical, or material support: All authors.

Study supervision: All authors.

Conflict of Interest Disclosures: Dr Tornetta reported serving as a consultant for Smith & Nephew and Exploramed. No other disclosures were reported.

Funding/Support: Funding for this study was provided by a Patient Safety Grant from the Committee of Interns and Residents (Boston Medical Center chapter).

Role of the Funder/Sponsor: The funding source had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Additional Contributions: Linda Rosen, BSEE, MSEE, Boston Medical Center, and Fred Shorten, BS, Lahey Hospital and Medical Center, assisted with data collection. They were not compensated for their contributions.

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