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Opioid analgesic use after ambulatory surgery: a descriptive prospective cohort study of factors associated with quantities prescribed and consumed

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ABSTRACT

Objectives To prospectively characterise: (1) postoperative opioid analgesic prescribing practices; (2) experience of patients undergoing elective ambulatory surgeries and (3) impact of patient risk for medication misuse on postoperative pain management.

Design Longitudinal survey of patients 7 days before and 7–14 days after surgery.

Setting Academic urban safety-net hospital.

Participants 181 participants recruited, 18 surgeons, follow-up data from 149 participants (82% retention); 54% women; mean age: 49 years.

Interventions None.

Primary and secondary outcome measures Total morphine equivalent dose (MED) prescribed and consumed, percentage of unused opioids.

Results Surgeons postoperatively prescribed a mean of 242 total MED per patient, equivalent to 32 oxycodone (5 mg) pills. Participants used a mean of 116 MEDs (48%), equivalent to 18 oxycodone (5 mg) pills (~145 mg of oxycodone remaining per patient). A 10-year increase in patient age was associated with 12 (95% CI (−2.05 to −0.35)) total MED fewer prescribed opioids. Each one-point increase in the preoperative Graded Chronic Pain Scale was associated with an 18 (6.84 to 29.60) total MED increase in opioid consumption, and 5% (−0.09% to −0.005%) fewer unused opioids. Prior opioid prescription was associated with a 55 (5.38 to −104.82) total MED increase in opioid consumption, and 19% (−0.35% to −0.02%) fewer unused opioids. High-risk drug use was associated with 9% (−0.19% to 0.002%) fewer unused opioids. Pain severity in previous 3 months, high-risk alcohol, use and prior opioid prescription were not associated with postoperative prescribing practices.

Conclusions Participants with a preoperative history of chronic pain, prior opioid prescription, and high-risk drug use were more likely to consume higher amounts of opioid medications postoperatively. Additionally, surgeons did not incorporate key patient-level factors (eg, substance use, preoperative pain) into opioid prescribing practices. Opportunities to improve postoperative opioid prescribing include system changes among surgical specialties, and patient education and monitoring.

Strengths and limitations of this study

- We executed the study in a real-life setting and gave no guidance to prescribing surgeons about the study objectives.
- We studied the postoperative pain management strategies across a variety of surgical subspecialties, surgeons, and procedures.
- Generalisability of this study may be limited because of the study's small size at a single academic urban safety-net hospital.
- We did not validate accuracy of self-reported data on pre-existing and postoperative pain and medication taken.
- We did not collect data on long-term outcomes (eg, continuation of opioid-based pain treatment, opioid medication misuse, diagnosis or recurrence of opioid use disorder).

INTRODUCTION

Prescription opioid misuse is a major public health problem. Therapeutically prescribed opioid analgesics constitute the single largest source of misused opioids, and opioid prescribing by physicians increased dramatically from the late 1990s until the mid-2010s when it began to level off.[1–4] Opioid analgesics prescribed for postoperative and acute pain management can lead to patients' long-term opioid use,[5–12] which may be associated with development of opioid use disorder and other opioid medication adverse events.[12–23]

In addition to inducing long-term use and potential addiction, unused opioid pills prescribed for surgical procedures are available for misuse by the patient, friends or family. In fact, most individuals who misuse opioids obtain them from friends or family.[13 24] Numerous studies have found that a majority of patients report having unused or unfilled prescriptions postoperatively.[25–29]

Wide variations in opioid prescribing for the same procedure also support the concept that postoperative opioid prescribing is not evidence based and may result in excess opioid prescribing with unknown benefits in pain outcomes.[30]

In a national survey of adults prescribed opioids, nearly half reported having no recollection of receiving information on safe medication storage or disposal.[31] Among those with leftover medications, 62% reported keeping them for future use.[32–34] Bicket *et al* performed a systematic review of unused opioid analgesics postoperatively and found that 67%–97% of patients report unused opioids, with 42%–71% of prescribed opioid tablets remaining unused.[25] Furthermore, two prior studies that examine storage of excess medications found that a minority of patients stored the medications in safe manner, and even fewer planned to dispose of unused medications using US Food and Drug Administration-recommended methods.[23 24]

Patient-associated factors may potentially impact surgeons' postoperative prescribing practices, as well as patients' opioid medication-taking behaviours. A history of chronic pain is associated with more opioid medication use postoperatively.[35–38] There is also evidence of racial and ethnic disparities in opioid prescribing (eg, black race has been shown to be associated with fewer opioids prescribed compared with white race).[39] A history of chronic opioid use is associated with greater postoperative opioid use.[40 41] Opioid-tolerant patients require longer durations of high-dose postoperative opioid use to achieve the same level of pain relief as non-opioid-tolerant patients taking opioids postoperatively.[42 43] Patients reporting depression are more likely to use opioids postoperatively in an non-prescribed manner,[44 45] and anxiety is associated with prolonged postoperative opioid usage.[43] Moreover, little is known about if, what and to what degree patient-associated factors impact surgeons' postoperative prescribing practices.

Using data collected prospectively from patients undergoing elective ambulatory surgery, we analysed the associations between participants' sociodemographic factors, high-risk substance use and chronic pain on (1) surgeons' opioid prescribing patterns, (2) participants' plans for postoperative opioid use, and (3) plans for remaining opioid disposal. To assess potential risk factors for postoperative medication misuse and look for correlations with surgeons' postoperative pain prescribing practices, we collected preoperative data on participants' baseline mental health status, prior prescription opioid use, and high-risk substance use.

METHODS

Study design

This was a 1-year, prospective study of surgeons' postoperative opioid prescribing practices for participants undergoing elective ambulatory surgery in spring 2015. A study research assistant (RA) assessed participants over the phone or in person in the 7 days leading up to the scheduled surgery. Follow-up assessment occurred between 7 and 14 days postoperatively via telephone.

Patient and public involvement

Patients were first involved in the research when recruited and informed verbally about the details of the study. Research questions and outcome measures were developed by several members of the research team (CWS, JL, OR, IH, DM). These questions and measures were informed by team members' priorities, experience, and preferences. Patients and the public were indirectly involved in the design of this study through careful monitoring of the issues and challenges associated with their recent surgeries and, when appropriate, specific questions were fashioned to optimally characterise their concerns. Patients were contacted and introduced to the study RA by the recruiting physician during their medical visits. Patients were then provided a brief overview of the study; if they were interested in participating, they were referred to the study RA to receive more verbal information about the study. If interested, the patients underwent a formal informed consent process as previously approved by the Boston University Medical Center/Boston Medical Center Institutional Review Board. Once consented, patients were enrolled into the study. As part of the study, participants were informed about the degree of burden of the intervention and time required to participate in the research. Participants were not involved in our wider plan to disseminate the study results to participants and relevant wider patient communities.

The purpose of this study was to pilot a procedure intended to recruit a larger number of subjects for use in a larger programme of research. Simultaneously, we used other data gathered from this investigation to establish power calculations for a later and larger full-scale study. We have also used this work to evaluate the financial, technical, administrative, and logistic feasibility of a full-scale study, including issues of data collection, protocol adherence, and questionnaire design. The sample size was based on and justified by these results. This article will inform the probable impact that the pilot study will have on future research decisions.

Sample

The recruitment process began with identifying ambulatory procedures that were most likely to generate at least moderate postoperative pain (identified by DM) to increase the likelihood that patients would likely be considered for receipt of postoperative opioid medication treatment. We excluded cancer-related procedures and those not expected to generate significant postoperative pain (eg, endoscopy). Next, we identified and recruited 18 surgeons among nine selected surgical specialties (colorectal surgery, general surgery, gynaecology, oral surgery, orthopaedic surgery, otolaryngology, podiatry, trauma, and urology) from a single academic urban safety-net hospital (see table 1) because they typically performed these moderate to severely painful procedures. All surgeons agreed to participate in the study. To reduce selection bias, surgeons only received a broad

Table 1 Participant characteristics (N=149)

Characteristic	
	Mean (SD)
Age (years)	49 (14.8)
	Per cent
Female	53.5
Race and ethnicity*	
Non-Hispanic white	44.2
Non-Hispanic black	34.0
Hispanic	15.0
Other	6.8
Education*	
High school or less	31.5
Some college or more	68.5
Annual individual income ≤$40 000†	55.6
Public health insurance	63.3
Pain in last 3 months (GCPS)*	
Highly disabling, highly limiting	24.2
Highly disabling, moderately limiting	17.5
Low-disabling, high intensity	32.2
Low-disabling, low intensity/no pain	26.2
Believed surgery would relieve pain*	53.9
Surgical specialty	
General	30.7
Urology	18.7
Otolaryngology	13.3
Orthopaedic	13.3
Podiatry	10.0
Maxillofacial oral	8.0
Gynaecology	6.0
Prior opioid prescription (<3 months)	17.3
CAGE-AID-positive	26.7
High-risk alcohol use (AUDIT)*	5.4
Illicit substance use (DUDIT)	18.0

*≤10% of data missing.
†>10% of data missing.
AUDIT, Alcohol Use Disorders Identification Test; CAGE-AID, Cut, Annoyed, Guilty, Eye-opener; DUDIT, Drug Use Disorders Identification Test; GCPS, Graded Chronic Pain Scale.

background of the study (ie, that participants would be interviewed about their preoperative and postoperative pain management).

We then identified potential participants via their electronic health records (EHRs). An RA generated a list of patients who were scheduled to have elective surgery in predesignated categories between 14 and 23 days in the future; thus, this was a convenience sample of patients who planned to undergo ambulatory procedures expected to generate at least moderate postoperative pain. Eligibility criteria were: age 18–89 years, English comprehension, an active telephone line in the EHR, and availability to complete a follow-up telephone interview 2 weeks after surgery. We generated a personalised study introduction letter for each patient. Each surgeon was asked to remove patients from potential study participation that they judged would not be able to comply with the study procedures due to cognitive or language abilities (ie, understanding of English). The surgeon signed the letter for each approved patient before the study team mailed it to the patient. This process and surgeons' limited information about the study enabled them to efficiently remove any patients they did not feel would be appropriate for the study without bias.

The letter patients received included a high-level description of the study, indicating that each participant would be interviewed as to his or her preoperative and postoperative pain management for the identified surgery. The letter also included an 'opt-out' choice that required the participant to call the study team 1 week before the planned surgery to avoid undesired contact. To capture postoperative pain management practices, the letter included a study brochure and a 'pain diary', which the participant was advised to use to record pain, prescription medicine use, and over-the-counter medicine use during the 10 days after the surgery if he or she was eventually enrolled in the study.

Starting 7 days before planned surgical procedures, the RA contacted patients to obtain their consent to participate in the study and administer the baseline assessment. The consent form also included a brief description of the study's purpose; specifically, 'The goal of this study is to learn how surgeons prescribe pain medications and how patients use them after surgery.' The RA reminded participants to fill out the pain diary to improve recall and accuracy at the follow-up assessment. The RA collected follow-up data over the phone between 7 and 14 days postoperatively using an interviewer-administered questionnaire.

Data collection

Preoperative baseline patient-reported data included: demographics (age, gender, race/ethnicity); chronic pain severity and function in the past 3 months per the Graded Chronic Pain Scale's (GCPS) standard categories of disability, intensity and functional limitations; and high-risk alcohol and drug use (Alcohol Use Disorders Identification Test (AUDIT) and Drug Use Disorders Identification Test (DUDIT), respectively).[46–48] Postoperative patient reported data included: postoperative pain via a postoperative pain scale with a 0 (no pain relief) to 10 (complete pain relief) scale, adapted from Albi-Feldzer *et al*;[32 49–52] Timeline Follow-Back (TLFB) of total opioids consumed and pain rating on each day; prescription opioid misuse via the Prescription Opioid Misuse Index[53] and Prescription Misuse Questionnaire;[54] substance use since surgery; and intentions for leftover medication storage and disposal (concepts based on Winstock *et al*).[51] In addition, participants verified pain medication data extracted from the EHR.

EHR data included date of surgery, surgery type, and detailed opioid prescriptions, as well as any history of

opioid prescription prior to surgery. To determine the total amount of opioid medications prescribed at the time of surgery, we calculated a total morphine equivalent dose (total MED) for all prescribed opioid medications as the number of pills multiplied by the MED of the opioid.[55]

Outcomes

The primary and secondary outcome measures for this analysis included: (1) amount of opioid analgesic medications prescribed for postoperative pain management as calculated by total MED (source: EHR); (2) opioids consumed over the 10-day postoperative period (total MED) (source: TLFB); and (3) per cent of unused opioids after the 10-day postoperative period (sources: EHR and TLFB). We obtained the per cent of unused opioids by subtracting reported total MED consumed from total MED prescribed for each participant, then divided by total MED prescribed. We converted opioid amounts from total MED back to oxycodone-equivalent 5 mg pills to make the data more clinically accessible. We used the highest possible dose interpretable when surgeons prescribed a dosing range for these analyses.

Additional outcome measures included age, gender, race/ethnicity (white, black, and 'other' (ie, mixed race/ethnicity)), and high-risk alcohol and drug use in the past month (AUDIT score greater than 15, DUDIT score greater than 9).

Analysis

We included only participants for whom we had follow-up data in this analysis. The available number of patients recruited from 18 surgeons during the study period determined the size of this convenience sample. Two-sided type-I error rates of 0.05 along with 95% CIs were used to assess the statistical significance of associations. We used multivariable linear regression, adjusted for surgical specialty as fixed effects, to analyse associations of sociodemographics, chronic pain, and high-risk substance use with all outcomes. We calculated intraclass correlations to partition variance in each outcome attributable to surgical specialties.

RESULTS

Population and demographics

We enrolled 181 participants in the study and analysed data on the 149 participants who completed follow-up assessments (see figure 1 for study enrolment schema). The participants were 54% women, 44% white, 34% black, and 22% 'other' (ie, mixed race/ethnicity). The mean age was 49 years, and 69% of participants had some postsecondary education (table 1).

Participants' pain, substance use and mental health

At baseline, 24% of participants had highly disabling and severely limiting pain; 18% had highly disabling and moderately limiting pain; 32% had low-disabling and highly intense pain; and 26% reported low-disabling and low-intensity pain or no pain. At baseline, 5% of participants indicated high-risk alcohol use including dependence (AUDIT), and 18% reported use of illegal drugs or prescribed drugs for non-medical reasons (DUDIT) (table 1).

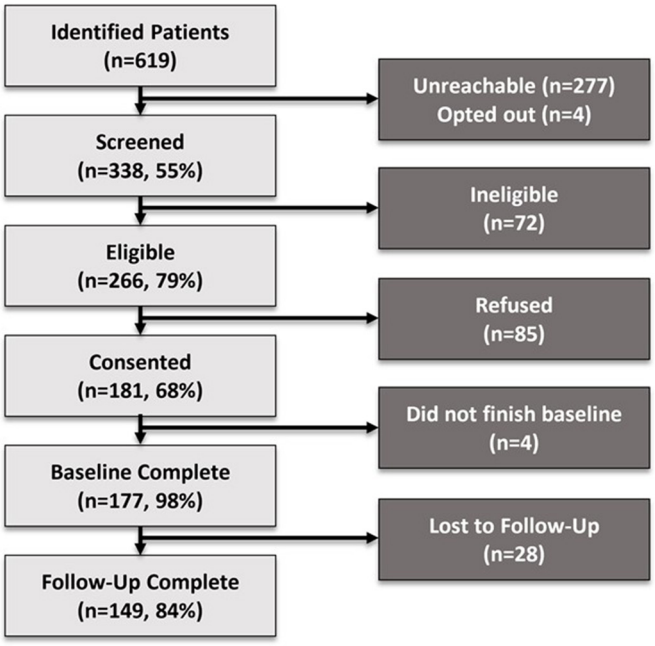

Figure 1 Study enrolment and schema.

Surgeon's postoperative prescribing practices

Surgeons prescribed opioids for postoperative pain to 95% of participants; 85% of these participants received either oxycodone or oxycodone with acetaminophen. Surgeons prescribed a mean of 242 total MED per patient during the postoperative period, the equivalent of 32 oxycodone (5 mg) pills. In total, surgeons prescribed 36 273 total MED, the equivalent of 4836 oxycodone (5 mg) pills. Participants reported using a mean of 116 total MED (48%), or the equivalent of 18 oxycodone (5 mg) pills. We estimate about 145 mg oxycodone pills of leftover medication per patient (table 2). Non-opioid medication prescription and use were not the focus of this study; therefore, we did not analyse this domain as part of this pilot study.

Effectiveness of pain management and use of prescribed opioid pain medication

At follow-up, using the Postoperative Pain Scale, 32% of participants rated the effectiveness of their pain relief as complete (10), 36% as high (7–9), 24% as moderate (4–6), 5% as low (1–3), and 3% as ineffective (0). Nearly one-quarter (22%) of participants reported that they would have liked more pain treatment than received. For opioid medication taken postoperatively, 13% reported taking 0 total MED, 44% took 1–100 total MED, 24% took 101–200 total MED, 13% took 201–300 total MED, and 6% took more than 300 total MED over the 10-day

Table 2 Postoperative opioid medications prescribed and consumed, and effectiveness of pain control (N=149)

Variable	
Opioid medication type prescribed*	**N (%)**
Oxycodone	128 (85.3)
Hydrocodone	7 (4.7)
Hydromorphone	5 (3.3)
Codeine	3 (2.7)
No prescription	8 (5.3)
Effectiveness of pain control, on scale of 0–10†	
Complete (10)	48 (32.7)
High (7–9)	53 (36.1)
Moderate (4–6)	35 (23.8)
Low (1–3)	7 (4.8)
Ineffective (0)	4 (2.7)
	Mean (SD)‡
Total MED prescribed	241.8 (128.1)
Total MED consumed	
Total MED consumed§	104.2 (112.3)
Total MED unused¶	165.7 (111.8)
Total MED unused (%)¶	64.2 (40.0)

*Accounts for multiple prescriptions (ie, does not sum to 100%).
†≤10% of data missing.
‡Total MED: dose per pill multiplied by total number of pills prescribed.
§Excludes participants with missing opioid consumption information.
¶Excludes participants with no leftover medications.
MED, morphine equivalent dose.

period (figure 2). Of participants taking any opioid analgesic medication, 14% reported taking them more often than prescribed and 10% reported needing an early refill. Most participants (76%) reported that they had pain medication leftover; 33% of these participants reported intentions to use a safe means of disposal (eg, flushing down the toilet, giving to the police), while 48% planned to keep (33%) or continue taking (15%) their medications. The remaining participants with leftover medications reported plans to throw them away (6%) or did not know their plans (5%) (figure 3).

Associations of patient factors with amount of opioids prescribed and used

On average, a 10-year increase in patient age was associated with 12 total MED fewer prescribed opioids (p<0.01). Each one-point increase in the preoperative GCPS was associated, on average, with an increase in opioid consumption by 18

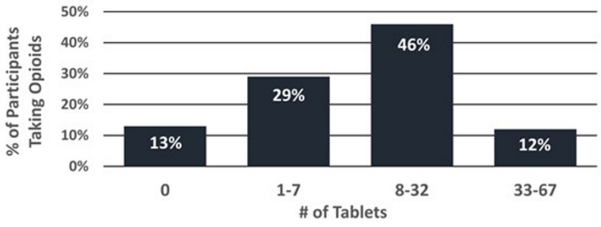

Figure 2 Oxycodone 5 mg equivalent pills taken in postoperative period (n=133).

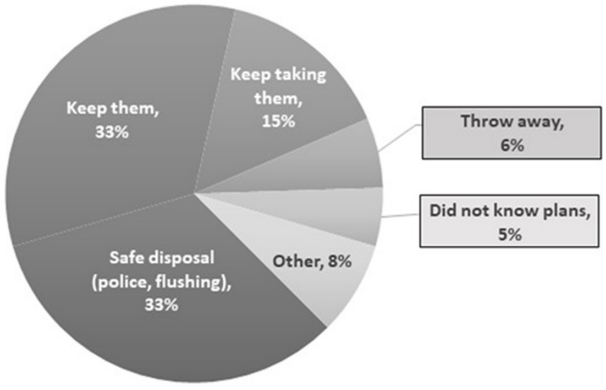

Figure 3 Plan for leftover medication at follow-up (n=113).

total MED (p<0.01), and 5% fewer unused opioids (p=0.03). Prior opioid prescription was associated with an increase in opioid consumption by 55 total MED (p=0.03), and 19% fewer unused opioids (p=0.03). High-risk drug use, on average, was associated with 9% fewer unused opioids (p=0.05) (table 3). The term 'fewer unused opioids' indicates that the population in question consumed more opioids when compared with the reference group.

The following factors were not associated with postoperative prescribing practices: pain severity in last 3 months (adjusted OR (aOR) 5.49, 95% CI (−9.97 to 20.95)); high-risk alcohol use (aOR −20.77, 95% CI (−68.99 to 27.45)); high-risk drug use (aOR 15.88, 95% CI (−33.12 to 64.89)) and prior opioid prescription (aOR 30.82, 95% CI (−14.25 to 75.89)).

DISCUSSION

Principal findings

In a convenience sample of patients receiving ambulatory surgery at an academic urban safety-net hospital, we found that participants reported well-controlled pain relief postoperatively and, on average, received twice as many opioid analgesics as they consumed postoperatively. Our study corroborates past studies documenting that patients use substantially fewer opioids than prescribed following surgery.[25–29] We extend those findings by prospectively identifying that surgeons do not vary the amount of opioids prescribed on the basis of key baseline characteristics and that these characteristics are associated with postoperative opioid consumption.

Limitations and strengths

Our pilot study had several limitations. First, the generalisability of this study may be limited because of (1) its relatively small size at a single academic urban safety-net hospital, (2) the small proportion of individuals who completed follow-up assessments (see figure 1), (3) the high proportion of participants who reported chronic pain prior to the surgery, and (4) the study did not include non-English speakers. Second, our data about the amount of medication taken and its effectiveness were obtained by patient report; we did not conduct objective tests to ascertain accuracy of self-reported data. Third, we did not differentiate between pre-existing pain and pain directly related to the indication for surgery. Last,

Table 3 Patient factors associated with prescribed, consumed and unused opioids (adjusted models)*

	Total MED prescribed (N=150)			Total MED consumed (N=138)			% of unused opioids (n=121)		
Variable	β (SE)	P value	95% CI	β (SE)	P value	95% CI	β (SE)	P value	95% CI
Age (increment per year)	**−1.20 (0.43)**	**0.006†**	**−2.05 to 0.35**	0.09 (0.66)	0.87	−1.06 to 1.25	−0.0004 (0.003)	0.88	−0.006 to 0.005
Gender									
Male (reference)	Reference	Reference	Reference	0.00 (0.00)	Reference	Reference	0.00 (0.00)	Reference	Reference
Female	−29.31 (16.06)	0.07	−60.79 to 2.17	−20.39 (24.57)	0.41	−68.55 to 27.77	−0.07 (0.06)	0.22	−0.19 to 0.04
Race/ethnicity									
Non-Hispanic white (reference)	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Non-Hispanic black	26.80 (15.22)	0.08	−3.04 to 56.63	1.30 (20.84)	0.95	−39.55 to 42.15	0.02 (0.06)	0.77	−0.11 to 0.14
Hispanic	−21.86 (21.15)	0.30	−63.32 to 19.60	−16.00 (23.29)	0.49	−61.65 to 29.65	0.01 (0.09)	0.91	−0.16 to 0.18
Other	−37.91 (30.45)	0.22	−96.69 to 22.67	−12.60 (23.29)	0.66	−68.01 to 42.80	−0.20 (0.14)	0.15	−0.48 to 0.07
Pain									
Pain severity (last 3 months)	5.49 (7.89)	0.49	−9.97 to 20.95	**18.22 (5.81)**	**0.002†**	**6.84 to 29.60**	**−0.05 (0.02)**	**0.03‡**	**−0.09 to 0.005**
Prior opioid prescription	30.82 (22.99)	0.18	−14.25 to 75.89	**55.10 (25.37)**	**0.03‡**	**5.38 to 104.82**	**−0.19 (0.08)**	**0.03‡**	**−0.35 to 0.02**
Substance use									
High-risk alcohol use (AUDIT)	−20.77 (24.60)	0.40	−68.99 to 27.45	−17.60 (20.52)	0.39	−57.82 to 22.63	−0.09 (0.10)	0.39	−0.20 to 0.11
High-risk drug use (DUDIT)	15.88 (25.00)	0.52	−33.12 to 64.89	23.84 (21.75)	0.27	−18.79 to 66.48	**−0.09 (0.05)**	**0.05‡**	**−0.19 to 0.002**

Bold text is significant at at least α=0.05.
*All models adjusted for surgical subspecialty.
†Significant at α=0.01.
‡Significant at α=0.05.
AUDIT, Alcohol Use Disorders Identification Test; DUDIT, Drug Use Disorders Identification Test; MED, morphine equivalent dose.

we have no long-term data to determine what percentage of patients continued to receive long-term opioid-based pain treatment (either new or part of a continuation of preoperative chronic pain management with opioid medications), exhibited opioid medication misuse, or developed a diagnosis or reoccurrence of opioid use disorder.

Using analysis of variance to calculate the variation of portioning of total MED attributable to the specialty level (both between and within specialty) versus the patient level, surgical specialty was found to explain a high proportion of variance of prescribing (data not reported here). The prescribing patterns of these surgeons likely reflect their typical approach to postoperative pain management, which is likely based on their experiences and perceptions of the pain that their patients typically experience postoperatively. Because of the small number of surgeons in each specialty in this study, the findings cannot be generalised to any specific specialty pattern on a large scale. However, it points to the likelihood that the culture in a local department or specialty influences prescribing patterns. In academic medical centres, residents often write the prescriptions and likely learn the types and amounts of medications to prescribe from more senior trainees, which then establishes unofficial but routine and standard prescription practices over time.[5]

Strengths and weaknesses in relation to other studies

The finding that the total amount of opioids consumed was unrelated to the total amount of opioids prescribed supports the argument that prescribing is directed more so by habitual practices than by patient circumstances. Individual physicians may have prescribing patterns that lead to higher or lower intensity prescribing, which Barnett *et al* found to predict long-term opioid use.[56] Efforts by systems and groups of surgeons to target postoperative prescribing have markedly decreased prescriptions nationally.[57 58] Whether this leads to optimised postoperative pain management is the subject of other research studies.

Important differences and meaning in the results

Screening for individual patient factors to guide postoperative pain management may assist surgeons in determining appropriate postoperative pain management practices while minimising the potential harm from opioid medications. These risks include: the development, unmasking or worsening of substance use disorders; diversion; or overdose. We found that older participants were prescribed fewer opioid medications (lower total MED) compared with younger participants, perhaps reflecting surgeons' adjusted prescribing practices per the susceptibility of older patients to delirium, falls, or other age-related concerns. We observed that higher postoperative opioid consumption was positively correlated with patients' preoperative pain and prior therapeutic opioid use. Not surprisingly, the percentage of unused opioid medications was predicted by patient report of pain severity in the last 3 months, prior opioid prescriptions, and a history of high-risk drug use as detected by the DUDIT. Although certain preoperative risks (eg, pain severity in the last 3 months, prior opioid prescription, and high-risk alcohol or drug use) were not associated with postoperative prescribing practices, this may be due to small numbers, low statistical power and the heterogeneity of the sample. The process of identifying such risks could be incorporated into routine preoperative testing.

Participants reported a variety of strategies to handle their leftover medications; one-third reported intentions to dispose of them safely, and more than half indicated plans to keep their medications for potential future use. This latter behaviour, while there were minimal pills remaining for each patient, amounts to a large public health threat with risk of potential diversion or misuse of these leftover medications.[59]

Future research directions

As the aim of this pilot study was to generate hypotheses, we envision the results from this convenience sample as informative of future research endeavours. Because postoperative opioid prescribing by surgeons remains incompletely studied, this pilot study represents an opportunity to test and refine optimal postoperative pain management strategies.[51] Additionally, effective methods to educate patients on safe disposal need to be studied. Patient education could be incorporated into preoperative planning for surgery, along with testing best approaches for possible future implementation. Despite recent policy efforts (ie, regulations and guidelines) to establish appropriate levels of opioid prescribing, there remains an urgent need to expand surgeon training, establish a systematic preoperative patient screening mechanism for key risk factors, and educate patients and set realistic expectations for postoperative pain management. A comprehensive and systematic approach that employs a robust patient-centred preoperative and postoperative pain management system to optimise the balance between pain control and opioid prescribing risk management is needed. Future areas for research include further investigation into the associations between preoperative behavioural health factors (eg, anxiety, depression, substance use disorder, other social determinants of health); development, implementation, and testing of targeted educational materials for patients on appropriate postoperative pain management (ie, consumption, dosage, storage and disposal); and training, guidelines, and screening tools for comprehensive preoperative risk evaluation and preparation and postoperative prescribing of opioids and non-opioid alternatives for surgeons. Use of EHR-based clinical decision support tools for determining pain management approaches is another area of interest for future research. For example, surgeons and anaesthesiologists use frailty assessments (eg, Clinical Frailty Scale) to preoperatively assess elderly patients and develop appropriate postoperative pain management plans.[60] Given the increased use of such tools with corresponding technological advances (eg, machine learning, artificial intelligence), it is important to understand the value of these tools in effectively guiding surgeons' prescribing and pain management practices.

CONCLUSION

Participants with a preoperative history of chronic pain, prior opioid prescription or a history of high-risk drug use were more likely to consume higher amounts of opioid medications postoperatively. Additionally, surgeons did not appear to incorporate key patient-level factors (eg, substance use, preoperative pain) into opioid prescribing practices. Opportunities to improve postoperative opioid prescribing include system changes among surgical specialties along with targeted patient education and monitoring.

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