



Presented at the Academic Surgical Congress 2019

Opioid utilization in minimally invasive versus open inguinal hernia repair



Ariel W. Knight, MD^{a,*}, Elizabeth B. Habermann, MPH, PhD^b, Daniel S. Ubl, MPH^b,
Martin D. Zielinski, MD, FACS^a, Cornelius A. Thiels, DO, MBA^{a,b}

^a Department of Surgery, Surgical Outcomes Program, Mayo Clinic, Rochester, MN

^b The Robert D. and Patricia E. Kern Center for the Science of Health Care Delivery, Mayo Clinic, Rochester, MN

ARTICLE INFO

Article history:

Accepted 9 May 2019

Available online 20 June 2019

ABSTRACT

Background: Open inguinal hernia repair is thought to cause worse postoperative pain than minimally invasive surgery, and thus patients are often prescribed more opioids at discharge. This study evaluates opioid use in inguinal hernia repair patients to optimize discharge prescribing practices for this common procedure.

Methods: Opioid-naïve adults undergoing open or minimally invasive surgery inguinal hernia repair were identified prospectively from 3 centers to complete a 29-question telephone interview after discharge as part of a larger initiative. Opioid prescription and consumption data were converted into morphine milligram equivalents and compared between minimally invasive surgery and open inguinal hernia repair. Univariate χ^2 , Fisher exact test, univariate, and multivariable logistic regression were used. **Results:** Of 249 contacted patients, 195 (74%) completed the survey ($n = 97$ open, $n = 98$ minimally invasive surgery). Patients undergoing open inguinal hernia repair were slightly older (71 vs 65 years, $P < .001$) and less likely to be female (3% vs 17%, $P = .001$) than minimally invasive surgery patients. Open patients were more likely to have a unilateral inguinal hernia repair (95% open vs 52% minimally invasive surgery, $P < .001$). Discharge pain scores using the 10-point, patient-reported Numeric Pain Rating scale were similar (open 2.3 ± 1.7 vs minimally invasive surgery 2.4 ± 1.6 ; $P = .80$), and most patients were satisfied with postoperative pain control (open 86% vs minimally invasive surgery 95%; $P = .13$). Open inguinal hernia repair patients were just as likely to receive opioids at discharge as those undergoing minimally invasive surgery inguinal hernia repair (98% vs 91% minimally invasive surgery; $P = .06$) and were prescribed similar amounts of opioids (open 155 [IQR 113, 225] morphine milligram equivalents vs 150 [IQR 100, 210] minimally invasive surgery; $P = .08$). There was no difference in opioid use by approach (open 15 [IQR 0, 60] morphine milligram equivalents vs 9 [IQR 0, 50] minimally invasive surgery; $P = .33$). More than one-third of patients used no opioids (open 38% vs minimally invasive surgery 44%; $P = .42$). Bilateral repair was not associated with increased opioid use (univariate odds ratio 1.23, $P = .58$). On multivariable analysis, low discharge pain and normal body mass index were independently associated with needing no opioids at discharge. Overall, 75% of prescribed opioids remained unused at time of survey, yet only 12% of patients had disposed of unused opioids at the time of survey. **Conclusion:** Postdischarge opioid utilization was clinically similar between patients undergoing open and minimally invasive surgery inguinal hernia repair and those requiring unilateral or bilateral repair. Given that more than one-third of patients required no opioids after discharge, 0 to 8 tablets of 5 mg oxycodone is sufficient for most opioid-naïve patients undergoing inguinal hernia repair.

© 2019 Elsevier Inc. All rights reserved.

Support provided by the Mayo Clinic, Rochester, MN, Robert D. and Patricia E. Kern Center for the Science of Health Care Delivery (to Drs Ubl and Habermann).

Presented at the 14th Annual Academic Surgical Congress in Houston, Texas from February 5–7, 2019.

* Reprint requests: Ariel W. Knight, MD, Mayo Clinic, 200 First St SW, Rochester, MN 55905.

E-mail address: knight.ariel@mayo.edu (A.W. Knight).

Introduction

In the United States, approximately 800,000 people undergo inguinal hernia repair annually, thus making inguinal hernia repair one of the most common procedures performed by general surgeons.¹ The various types of operative approaches for repair of

inguinal hernias have evolved in recent years from a standard open repair to also include minimally invasive repairs.

Prior work has demonstrated that minimally invasive (MIS) repairs are associated with less pain postoperatively than open repairs.^{2–7} This difference may be related to a smaller incision size and decrease in the both division of muscle fibers and mobilization of the spermatic cord with minimally invasive approaches. There are a paucity of data comparing pain experience and opioid requirements in patients undergoing unilateral versus bilateral inguinal hernia repair regardless of operative approach. Currently, most studies focus on patients' subjective pain experience rather than objective measures of postoperative usage of pain medications.^{2–7}

Multiple studies have clearly demonstrated that opioids are over-prescribed routinely after common surgical procedures.^{8–13} Our group and others have developed evidence-based, procedure-specific guidelines for prescribing opioids to help guide surgeons in prescribing opioids after surgery, including inguinal hernia repair.^{9,12,14} Our institutional guidelines were adopted and rolled out in February of 2018. Despite these guidelines in our institutions, substantial variations exist in both prescribing practices and consumption. Our previous work suggests that even with inguinal hernia repair, the number of morphine milligram equivalents (MME) consumed by opioid-naïve patients after discharge ranges from 0 to >700.⁸ These findings and the variability in operative approaches support the concept that inguinal hernia repair is an ideal procedure for which to further optimize postoperative opioid-prescribing practices.

As such, we utilized prospectively collected data from 3 academic medical centers (Mayo Clinic Arizona, Mayo Clinic Florida, and Mayo Clinic Rochester) from patients undergoing open or minimally invasive inguinal hernia repair to evaluate their postoperative pain experience, including opioid consumption after discharge. Our primary goal in this study was to further optimize opioid prescribing practices for patients undergoing inguinal hernia repair.

Methods

Patients undergoing elective minimally invasive and open inguinal hernia repairs at 1 of 3 affiliated hospitals across the United States were prospectively identified during a larger initiative previously published by the authors of this study.⁹ The 3 academic centers were Mayo Clinic Arizona, Mayo Clinic Florida, and Mayo Clinic Rochester. As part of this initiative, adult (age ≥ 18) patients undergoing elective inguinal hernia operations between March 13, 2017, and January 19, 2018, were identified. Patients undergoing an inguinal hernia repair, as defined using Current Procedural Terminology (CPT) procedure codes for laparoscopic (CPT 49650) and open (CPT 49505) inguinal hernia repair, were prospectively extracted electronically from institutional databases and subsequently reviewed to confirm authenticity of the cohort. Unilateral and bilateral hernia repairs were included, whereas recurrent, strangulated, or incarcerated hernia repairs were excluded. Patients who reported taking opioids within 30 days of operation or if medication reconciliation revealed an opioid prescription provided within 30 days of operation were also excluded. Accordingly, all remaining patients were considered to be opioid-naïve. Additional exclusions included emergent procedures, procedures combined with other major operations, and patients who underwent a second operation before the survey. Lastly, patients with international addresses or those who are non-English-speaking, currently hospitalized, refused state of Minnesota research authorization, or were deceased were excluded.

Survey methods have been described previously in full.⁹ Patients who were identified for inclusion were contacted by the Mayo Clinic Survey Research Center at 21 to 35 days after discharge

and asked to complete a 29-question survey by phone. The survey was designed to ask patients to report the number of opioids the patient consumed after discharge, refills, and their experience with pain control. Patients could report up to 3 opioid prescriptions, including combination products and Tramadol. Patients were also asked to report if they received a refill and if or how they had disposed of their unused medications.

Opioids prescribed and consumed were converted into oral MME.¹⁵ Additional data on patient demographics, and patient reported pain scores were abstracted from the medical record. Pain scores are collected routinely throughout the perioperative period using the 10-point, patient-reported Numeric Pain Rating scale and were reported as mean \pm standard deviation using the following 3 time periods: (1) preoperative pain score: the most recent pain score in the 30 days preceding operation; (2) maximum pain score: highest pain score from the time of operation to the time of discharge (includes pain scores in recovery and on the outpatient floor); and (3) discharge pain score: the last pain score at the time of discharge. Consistent with prior publications, a 75% cutoff was used when determining the number of tablets of pain medications that would be needed to provide adequate pain control after discharge.^{9,14,16}

The primary outcome was opioid consumption after discharge reported in MME as median and interquartile range (IQR). Univariate analysis compared patients who underwent open versus MIS inguinal hernia repair and patients who underwent unilateral versus bilateral repair. Opioid utilization was grouped into top quartiles for univariate and multivariable analyses to allow for comparison between patients who used a top quartile (Q4) MME and those who used fewer opioids (Q1–3) and a comparison of patients who used no opioids compared with those who used opioids after discharge. χ^2 and Fisher exact tests were utilized to compare categorical variables, and the Kruskal-Wallis and Wilcoxon rank-sum tests were utilized for continuous variables.

The initial initiative was conducted for quality improvement and deemed exempt by our Institutional Review Board; subsequent Institutional Review Board approval, however, was obtained to retrospectively review the collected data. Statistical analysis was performed using version 9.4 of SAS (SAS Institute Inc., Cary NC).

Results

Of the 262 patients contacted, 208 (79%) responded. Of the surveyed patients, 13 were excluded owing to having a combined procedure or not undergoing the intended procedure. The final cohort of 195 patients included 97 open inguinal hernia repairs and 98 MIS inguinal hernia repairs. Median overall age was 68 years (59,75) with 10% being female. Almost all patients underwent outpatient IHR ($n = 193$, 99%). Across all repairs, 94% of patients received an opioid prescription at discharge (median MME prescribed 150 [IQR 100, 225]).

Patients were surveyed at median 26 (IQR 23, 30) days after discharge from the hospital. At the time of survey, only 1 patient had utilized any opioids within the previous 3 days. The overall patient cohort stopped utilizing opioids 3.2 ± 4.0 days after the inguinal hernia repair. The median amount consumed was 15 (IQR 0, 55) MME resulting in a median of 113 (IQR 50, 188) MME remaining at the time of survey. These medians do not sum to 150 owing to skewed data. Only 2 patients (1.0%) required an opioid prescription refill at the time of survey, and 91.6% of patients had opioids left over at the time of survey. The majority of patients kept their remaining opioids (77%), whereas a small number of others discarded the medication by throwing it in the trash (6%) or flushing it down the toilet (3%). Only one patient returned their

Table I
Description of patients surveyed undergoing MIS versus open inguinal hernia repair

	All (n = 195)	MIS (n = 98)	Open (n = 97)	P value
Age (y)	68 (59,75)	65 (57,71)	71 (62,77)	<.001
Male (%)	175 (90%)	81 (83%)	94 (97%)	.001
BMI (kg/m ²)	26.3 (23.9,28.7)	25.9 (23.9,28.8)	26.8 (23.9,28.6)	.57
Depression/anxiety diagnosis (%)	17 (9%)	5 (5%)	12 (12%)	.07
Smoker within 1 year of operation (%)	10 (5%)	6 (6%)	4 (4%)	.75
Outpatient procedure (%)	193 (99%)	98 (100%)	95 (98%)	.25
Bilateral repair (%)	52 (27%)	47 (48%)	5 (5%)	<.001

Age and BMI are presented as median (IQR). Gender, depression/anxiety diagnosis, smoking status, outpatient procedure, and bilateral repair are presented as a raw number (percentage).

Table II
Opioid consumption after discharge between patients undergoing open versus MIS and unilateral versus bilateral inguinal hernia repair

	All (n = 195)	Approach			Laterality		
		MIS (n = 98)	Open (n = 97)	P value	Unilateral (n = 143)	Bilateral (n = 52)	P value
Opioids prescribed at discharge (%)	184 (94%)	89 (91%)	95 (98%)	.06	135 (94%)	49 (94%)	1.0
Opioid refill required (%)	2	0	2	.25	2	0	1.0
Postoperative day of opioid cessation	3.2 ± 4.0	2.8 ± 2.0	3.5 ± 4.8	.30	3.2 ± 4.4	3.0 ± 3.1	.75
MME prescribed	150 (100,225)	150 (100,210)	155 (112,225)	.08	150 (100,225)	150 (106,218)	.63
MME consumed	15 (0,53)	9 (0,50)	15 (0,60)	.33	15 (0,45)	25 (0,60)	.31
MME remaining at survey	113 (50,188)	113 (30,180)	120 (55,195)	.45	120 (50,195)	113 (50,175)	.79
Consumed zero MME (%)	80 (41%)	43 (44%)	37 (38%)	.42	62 (43%)	18 (35%)	.27

Postoperative day of opioid cessation is presented as mean ± standard deviation. Opioids prescribed at discharge and consumed zero MME are presented as a raw number (percentage). MME prescribed, consumed, and remaining at survey are presented as median (IQR).

medication to a pharmacy. The remaining 13% patients handled their remaining opioids by other various means.

Postdischarge opioid consumption in open versus MIS inguinal hernia repair

Table I compares patients undergoing open inguinal hernia repairs versus MIS inguinal hernia repairs. Notably, patients in the open cohort were somewhat older (median 71 [IQR 62, 77] years) compared with the MIS (median 65 [IQR 57, 71] years, $P < .001$). Patients in the open cohort were more likely to be male (open 97% vs MIS 83%, $P = .001$), but body mass index (BMI) was similar. Patients were just as likely to be prescribed opioids regardless of the operative approach and were prescribed similar amounts of opioids independent of approach (Table II). Patients who underwent both open and MIS repair stopped utilizing opioids at a similar postoperative interval (open 3.5 ± 4.9 days vs MIS 2.8 ± 3.0 days, $P = .30$) and consumed a similar number of MME (median open 15 [IQR 0, 60] vs MIS 9 [IQR 0, 50], $P = .33$). Clinically, this difference in opioid utilization between open and MIS repairs corresponds to a difference of <5 mg tablet of oxycodone. Both patient groups also had similar amounts of unused MME at the time of postoperative survey (open 120 [IQR 55, 195] vs MIS 113 [IQR 30, 180], $P = .45$). Similar percentages of both patient groups did not utilize opioids postoperatively (open 38% vs MIS 44%, $P = .42$).

Impact of bilateral inguinal hernia repair

The vast majority of bilateral repairs were performed via an MIS approach (90.4%). Independent of approach, patients who underwent a unilateral inguinal hernia repair were just as likely to be prescribed opioids postoperatively as those who underwent a bilateral inguinal hernia repair (unilateral 94% vs bilateral 94%, $P = 1.0$; Table II). Both groups were prescribed similar amounts of opioids (unilateral 150 [IQR 100, 225] vs bilateral 150 [IQR 106, 218], $P = .63$) and had similar opioid utilization after discharge (unilateral 15 [IQR 0, 45] vs bilateral 25 [IQR 0, 60], $P = .31$).

Clinically, this difference in opioid utilization between unilateral and bilateral corresponds to a difference of <2 5 mg tablets of oxycodone. Both groups ceased opioid consumption at a similar postoperative time interval (unilateral 3.2 ± 4.4 days vs bilateral 3.0 ± 3.1 days, $P = .75$). Both groups had similar amounts of unused MME at the time of postoperative survey (unilateral 120 [IQR 50, 195] MME vs bilateral 113 MME [IQR 50, 175], $P = .79$). Similar percentages of both patient groups did not utilize any opioids postoperatively (unilateral 43% vs bilateral 35%, $P = .27$).

Patient experience

When asked about their experience with their postdischarge pain control, 90.7% of all inguinal hernia repair patients reported being very or somewhat satisfied with their pain control, only 7.3% reported being somewhat or very dissatisfied, and 2.1% were neither satisfied nor dissatisfied. The percent of patients who were satisfied with their pain control did not vary between MIS and open patients ($P = .13$). Across all patients, 40.2% reported being prescribed too much pain medication at discharge, whereas 53.7% reported being prescribed just the right amount, and 6.1% reported being prescribed not enough. The percent of patients who reported not being prescribed enough pain medications after discharge was slightly greater in the open group (10.7%) compared with MIS (1.3%, $P = .02$). The majority of patients (86.1%) reported using the nonprescription pain medications, which our institution routinely recommends after discharge, whereas only 48.2% reported using alternative pain control strategies like acupuncture, meditation, or heat or cold therapies after discharge. No difference in rates of usage of nonprescription and alternative pain control was seen between MIS and open patients (open 85% vs MIS 88%, $P = .53$) or unilateral versus bilateral repair (unilateral 84% vs bilateral 92%, $P = .16$). When comparing patient experience in patients undergoing bilateral versus unilateral repair, there was no difference in overall satisfaction with postdischarge pain control or percent of patients who felt they had not been prescribed enough pain medications (unilateral 89% vs bilateral 96%, $P = .37$).

Table III

Univariate logistic regression demonstrating the odds of patients utilizing the lowest (Q1) and highest (Q4) amount of opioids postoperatively

	Odds of lowest quartile (Q1) consumed (vs Q2–4)		Odds of highest quartile (Q4) consumed (vs Q1–3)	
	OR [95% CI]	P value	OR [95% CI]	P value
Operative details				
MIS (vs open)	1.27 [0.72–2.25]	.42	0.83 [0.43–1.61]	.59
Bilateral (vs unilateral)	0.69 [0.36–1.34]	.27	1.23 [0.59–2.54]	.58
Age group (y)				
60–79 vs 80+	0.86 [0.34–2.17]	.75	1.64 [0.45–6.01]	.45
40–59 vs 80+	0.51 [0.17–1.50]	.22	3.46 [0.87–13.73]	.08
18–39 vs 80+	0.53 [0.13–2.40]	.43	2.0 [0.33–11.97]	.45
Male (vs female)	0.67 [0.26–1.69]	.39	1.30 [0.41–4.11]	.65
BMI ≥ 30 (vs < 30)	0.18 [0.06–0.54]	.002	2.95 [1.31–6.66]	.009
Discharge pain score ≥ 5 (vs < 5)	0.17 [0.04–0.77]	.021	2.42 [0.86–6.75]	.09

Table IV

Multivariate logistic regression demonstrating the odds of patients utilizing the lowest (Q1) and highest (Q4) amount of opioids postoperatively

	Odds of lowest quartile (Q1) consumed (vs Q2–4)		Odds of highest quartile (Q4) consumed (vs Q1–3)	
	OR [95% CI]	P value	OR [95% CI]	P value
Operative details				
MIS (vs open)	1.22 [0.64–2.31]	.55	0.81 [0.39–1.66]	.57
Age group (y)				
60–79 vs 80+	0.99 [0.37–2.63]	.98	1.48 [0.39–5.60]	.57
40–59 vs 80+	0.61 [0.19–1.94]	.41	2.89 [0.68–12.21]	.15
18–39 vs 80+	0.41 [0.09–1.98]	.27	2.39 [0.37–15.27]	.36
Male (vs female)	0.51 [0.17–1.47]	.21	1.50 [0.44–5.16]	.52
BMI ≥ 30 (vs < 30)	0.18 [0.06–0.57]	.003	2.49 [1.05–5.89]	.04
Discharge pain score ≥ 5 (vs < 5)	0.17 [0.04–0.80]	.03	2.01 [0.67–6.03]	.22

Opioid recommendations and identification of high and low opioid utilizers

Using existing criteria, we determined the number of 5 mg oxycodone tablets required to provide adequate pain control after discharge to the majority of patients undergoing inguinal hernia repair was 8 tablets. The absolute number needed varied by > 2 tablets regardless of approach (MIS or open) or laterality (unilateral or bilateral) and was not statistically different between groups; however, given that a third to one-half of patients required no opioids after discharge, additional comparative analysis was done to identify patients who consumed no opioids (quartile 1) after their inguinal hernia repair (Table III). This analysis suggested that patients who did not require opioids after discharge were more likely to have a lower BMI. In addition, patients who did not require opioids after discharge had lesser maximum pain scores during their hospitalization and lesser discharge pain scores. Conversely, patients who consumed the greatest amount of opioids (quartile 4) after inguinal hernia repair were more likely to be younger with a higher BMI and have a greater median maximum pain score during their hospitalization.

Multivariable logistic regression was done to identify factors associated with low (0) and high opioid use after discharge after controlling for age, sex, BMI, discharge pain score, and operative approach (Table IV). Age and sex were not associated with high or low postoperative opioid consumption after discharge. BMI ≥ 30 was associated with decreased likelihood of Q1 (0) opioid consumption compared with patients with BMI > 30 . Discharge pain score of ≥ 5 was also associated with being less likely to require no opioids after discharge. A high discharge pain score was the only factor associated with a patient more likely to require more opioids after discharge. Lastly, operative approach (MIS versus open) was

not associated with high (Q4) or low (Q1) postoperative opioid consumption after discharge.

Discussion

Both opioid consumption after discharge and patient experience with postdischarge pain control after elective inguinal hernia repair were similar across operative approaches (MIS versus open) and laterality (unilateral versus bilateral). Our analysis was able to identify factors associated with and not associated with but often assumed to contribute to high and low post-discharge opioid consumption. These data should help guide practices to optimize opioid prescribing in patients undergoing inguinal hernia repair which is one of the most common elective general surgery procedures performed in the United States.

Our work also adds to the current body of literature comparing open and MIS approaches to inguinal hernia repair. Although many other studies have reported less postoperative pain after a MIS compared with open inguinal hernia repair, our study did not demonstrate any clinically important difference in the duration of opioid use or number of opioids consumed after discharge.^{2–7} To our knowledge, unlike our study, no previous studies have included objective measures of opioid use in their analyses. As such, our study should further inform future postoperative prescribing practices to minimize administration of unnecessary opioids. Furthermore, opioid-naïve patients should henceforth be counseled that postoperative pain in the acute recovery period is equivalent between open and MIS inguinal hernia repair, and as such, this should not influence the choice of operative approach.

Other studies that have compared open or minimally invasive inguinal hernia repair note similar postoperative quality of life measures, but consistently observe that patients undergoing an MIS

approach return to work earlier than those undergoing an open approach.^{2–7} None, however, discuss perioperative patient experience with adequacy of pain control, nor do they compare unilateral versus bilateral repairs directly. Such as other studies, a minority of our study population underwent bilateral repair, and of these, a majority had an MKS approach. As such, these results may not be generalizable to patients undergoing bilateral open repair, and thus further study is warranted. Thus far, there has been no demonstrable difference in pain experience between MIS unilateral versus bilateral inguinal hernia repair.^{17–19} Despite patients undergoing unilateral repair being more likely to report not being prescribed enough opioids postoperatively (unilateral 8% vs bilateral 0%, $P = .04$), there was no significant difference in postoperative opioid requirements, refills required, or duration of postoperative opioid use between unilateral and bilateral patients. This discrepancy may warrant further study of patient experience and expectations.

Brummett et al found that general surgery patients were prescribed a median of 225 MMEs (approximately 30.5 mg oxycodone tablets) after both major and minor procedures, which likely correctly reflects overprescription of opioids postoperatively.¹⁴ They did not, however, make recommendations for optimizing prescribing practices nor did they include inguinal hernia repair in their analysis. Hill et al demonstrated that a total of 15.5 mg oxycodone tablets were sufficient for the vast majority of patients undergoing a variety of general surgery procedures, but they also did not specifically evaluate inguinal hernia repair.¹² Scully et al found that patients utilized opioids after inguinal hernia repair for 6.3 ± 6.5 days and recommended that general surgery patients receive a 4- to 9-day opioid supply.²⁰ This mean duration is nearly twice that in our study and may overestimate postoperative opioid requirements. Mylonas et al prescribed patients 10 opioid tablets after elective open inguinal hernia repair in opioid-naïve patients and found that a similar percentage (60%) did not utilize opioids postoperatively.²¹ They also found that 86% of patients utilized ≥ 4 opioid tablets postoperatively, suggesting that prescribing practices may be optimized even further. More recent recommendations endorse prescription of 10.5 mg oxycodone tablets after inguinal hernia repair but do not account for an MIS or open approach.¹⁶ Although all of these sources demonstrate opioid overprescribing and recommend more prudent administration postoperatively, they may still overestimate opioid requirements and duration of therapy needed. Our analysis demonstrates that institutional guidelines such as these could further be refined to recommend a maximum of 8.5 mg oxycodone tablets be prescribed for patients undergoing inguinal hernia repair. Furthermore, our data did not support adjusting the number of opioids prescribed based on approach (open versus MIS) or laterality (unilateral versus bilateral). Given that 40% of patients consumed no opioids after discharge, our data suggest that patients with low discharge pain scores and normal BMI, who can tolerate acetaminophen and nonsteroidal anti-inflammatory drugs, may not require any opioids after discharge. The association of greater opioid use with higher BMI is not entirely clear, but we hypothesize that this association may be due to increased tissue dissection and additional retraction required to achieve an adequate repair.

Nine out of 10 patients had leftover opioids at the time of our survey, and the majority of patients kept their extra medication. Our study did not take into account individual patients' rationale for doing so, but this likely exposes a deficit in our preoperative education, namely that addressing proper handling of excess medication that is no longer needed. Patients and their close contacts will benefit from having further knowledge and more readily available resources by which to dispose of prescription medications appropriately that are no longer needed. Although the majority of our patients utilized nonopioid-based pain control medications that we recommend routinely, only half utilized adjunctive pain control

techniques like hot and cold therapy. Although data on the benefit of these adjuncts are limited, they are low cost and safe, and therefore this topic would be an ideal target for improved patient education.

Although our study was prospective and multicenter in nature, this study does have limitations. The patients were not randomized to undergo either an open or minimally invasive repair. As such, preoperative discussions regarding postoperative pain expectations may introduce a cognitive bias into patient-reporting and potentially opioid use. Although we had a relatively high response rate at 77%, responder bias may be present. Operative approaches and postoperative prescribing guidelines were not standardized across institutions at the time of this initiative and may have influenced the results. Furthermore, we did not capture data regarding the intraoperative use of local anesthesia, which may have influenced postoperative opioid consumption. Our institutions routinely use bupivacaine during inguinal hernia repair. This topic of adjunctive local anesthesia will be a useful data point to consider in future studies and may be one to look toward eventually standardizing in our clinical practice. Our study also excluded patients undergoing emergent inguinal hernia repair and those taking opioids before operation, and thus our results may not be applicable to these populations. Bilateral open repair was also relatively rare and were performed primarily laparoscopically and therefore difficult to control for in our analysis. We performed a power analysis before completing this initiative, which estimated that 50 patients within each subset would be sufficient to capture any clinically important differences. In addition, our data only captured patient's experiences with pain in the acute postoperative period, and therefore we are unable to evaluate the impact of approach on chronic pain after inguinal hernia repair. Notably however, all but one patient was off opioids at the time of survey. It may be useful in future surveys to determine whether patients were reluctant to utilize prescribed opioids for individual reasons, for example fear of dependence or undesired side effects, which may have influenced their reported use.

Based on our findings, we recommend that patients who are expected to have low opioid utilization (those with low pain scores at discharge and normal BMI) be recommended to use alternate acetaminophen 1,000 mg every 6 hours with ibuprofen 600 mg every 6 hours scheduled for postdischarge pain. In the remainder of patients, we recommend patients also be prescribed a total of 8.5 mg oxycodone tablets (or its equivalent) as needed for breakthrough pain in addition to the scheduled over the counter medications. These recommendations apply to all opioid-naïve patients undergoing an elective open or laparoscopic inguinal repair including those undergoing bilateral repair. Adjunctive, nonpharmacologic strategies are also encouraged.

In conclusion, we have determined typical postoperative opioid requirements in opioid-naïve patients undergoing elective inguinal hernia, which will further inform preoperative surgeon-patient discussions, patient expectations, and prescribing practices. Surprisingly, both patient experience with their pain control and opioid utilization were similar in patients undergoing open and MIS elective inguinal hernia repairs, and future opioid prescribing practices should reflect these findings.

Disclosure

The authors have no relevant financial disclosures.

References

1. Rutkow IM. Demographic and socioeconomic aspects of hernia repair in the United States in 2003. *Surg Clin North Am.* 2003;83:1045–1051.
2. Vogt DM, Curet MJ, Pitcher DE, Martin DT, Zucker KA. Preliminary results of a prospective randomized trial of laparoscopic onlay versus conventional inguinal herniorrhaphy. *Am J Surg.* 1995;169:84–89.

3. Myers E, Browne KM, Kavanaugh DO, Hurley M. Laparoscopic (TEP) versus Lichtenstein inguinal hernia repair: A comparison of quality-of-life outcomes. *World J Surg.* 2010;34:3059–3064.
4. Neumayer L, Giobbie-Hurder A, Jonasson O, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. *N Engl J Med.* 2004;350:1819–1827.
5. Kockerling F, Stechemesser B, Hukauf M, Kuthe A, Schug-Pass C. TEP versus Lichtenstein: Which technique is better for the repair of primary unilateral inguinal hernias in men? *Surg Endosc.* 2016;30:3304–3313.
6. Bittner Iv JG, Cesnik LW, Kirwan T, Wolf L, Guo D. Patient perceptions of acute pain and activity disruption following inguinal hernia repair: A propensity-matched comparison of robotic-assisted, laparoscopic, and open approaches. *J Robot Surg.* 2018;12:625–632.
7. EU Hernia Trialists Collaboration. Laparoscopic compared with open methods of groin hernia repair: Systematic review of randomized controlled trials. *Br J Surg.* 2000;87:860–867.
8. Thiels CA, Anderson SS, Ubl DS, et al. Wide variation and overprescription of opioids after elective surgery. *Ann Surg.* 2017;266:564–573.
9. Thiels CA, Ubl DS, Yost KJ, et al. Results of a prospective, multicenter initiative aimed at developing opioid-prescribing guidelines after surgery. *Ann Surg.* 2018;268:457–468.
10. Larach DB, Waljee JF, Hsou-Mei H, et al. Patterns of initial opioid prescribing to opioid-naïve patients. *Ann Surg.* [Epub ahead of print]
11. Cron DC, Lee JS, Dupree JM. Provider characteristics associated with outpatient opioid prescribing after surgery. *Ann Surg.* [Epub ahead of print]
12. Hill MV, Stucke RS, Billmeier SE, Kelly JL, Barth RJ. Guideline for discharge opioid prescriptions after inpatient general surgical procedures. *J Am Coll Surg.* 2018;226:996–1003.
13. Howard R, Fry B, Gunaseelan V, et al. Association of opioid prescribing with opioid consumption after surgery in Michigan. *JAMA Surg.* 2018;e184234.
14. Brummett CM, Waljee JF, Goesling J, et al. New persistent opioid use after minor and major surgical procedures in US adults. *JAMA Surg.* 2017;152:e170504.
15. Agency Medical Directors' Group Opioid Dose Calculator v2.01. Available at: <http://agencymeddirectors.wa.gov/Calculator/DoseCalculator.htm>. Accessed January 2, 2019.
16. Opioid Prescribing Recommendations After Surgery. Available at: <https://opioidprescribing.info>. Accessed January 2, 2019.
17. Gass M, Rosella L, Banz V, Candinas D, Güller U. Bilateral total extraperitoneal inguinal hernia repair (TEP) has outcomes similar to those for unilateral TEP: Population-based analysis of prospective data of 6,505 patients. *Surg Endosc.* 2012;26:1364–1368.
18. Jacob DA, Hackl JA, Bittner R, Kraft B, Kockerling F. Perioperative outcome of unilateral versus bilateral inguinal hernia repairs in TAPP technique: Analysis of 15,176 from the Herniamed Registry. *Surg Endosc.* 2015;29:3733–3740.
19. Wauschkuhn CA, Schwarz J, Boekeler U, Bittner R. Laparoscopic inguinal hernia repair: Gold standard in bilateral hernia repair? Results of more than 2800 patients in comparison to literature. *Surg Endosc.* 2010;24:3026–3030.
20. Scully RE, Schoenfeld AJ, Jiang W, et al. Defining optimal length of opioid pain medication prescription after common surgical procedures. *JAMA Surg.* 2018;153:37–43.
21. Mylonas KS, Reinhorn M, Ott LR, Westfal ML, Masiakos PT. Patient-reported opioid analgesic requirements after elective inguinal hernia repair: A call for procedure-specific opioid-administration strategies. *Surgery.* 2017;162:1095–1100.