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Featured Article

A multi-center analysis of cumulative inpatient opioid use in colorectal surgery patients

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ABSTRACT

Background: There are little data on risk factors for increased inpatient opioid use and its relationship with persistent opioid use after colorectal surgery.

Methods: We identified colorectal surgery patients across five collaborating institutions. Patient comorbidities, surgery data, and outcomes were captured in the American College of Surgeons National Surgical Quality Improvement Program. We recorded preoperative opioid exposure, inpatient opioid use, and persistent use 90–180 days after surgery.

Results: 1646 patients were analyzed. Patients receiving ≥250 MMEs (top quartile) were included in the high use group. On multivariable analysis, age <65, emergent surgery, inflammatory bowel disease, and postoperative complications, but not prior opioid exposure, were predictive of high opioid use. Patients in the top quartile of use had an increased risk of persistent opioid use (19.8% vs. 9.7%, $p < 0.001$), which persisted on multivariable analysis (OR 1.48; $p = 0.037$).

Conclusions: We identified risk factors for high inpatient use that can be used to identify patients that may benefit from opioid sparing strategies. Furthermore, high postoperative inpatient use was associated with an increased risk of persistent opioid use.

Summary

This study is an analysis of patients undergoing colorectal surgery at 5 hospitals and identifies risk factors for high cumulative inpatient opioid and persistent opioid use at 90–180 days after surgery. Surgeons can use these data to identify patients that may benefit from opioid sparing strategies after colorectal surgery.

Introduction

The opioid epidemic is currently one of the most challenging public health crises facing the United States. The United States Department of Health and Human Services has recently elevated the opioid epidemic to the level of a public health emergency. In 2016 alone, approximately 42,000 people died from opioid overdose and an estimated 40% of overdose deaths involved a prescription opioid.[1] Surgeons wrote approximately 10% of the 289 million opioid prescriptions in the US in 2012, and 36% of all prescriptions written by surgeons were opioid pain medications.[2] These prescription opioids catalyze the epidemic by not only putting individual surgical patients at risk, but also their local communities, as 69% of people that have abused opioid medications have received the medication from a friend or relative, most of whom were prescribed the medication by a physician.[3] Amongst surgeons, gastrointestinal surgeons are the third highest prescribers of opioids, after orthopedic surgeons and neurosurgeons,[4] and the rate of persistent opioid use after colectomy has been

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reported to be as high as 10–14%.[5,6]

We have previously reported on risk factors for persistent opioid use after colorectal surgery, and found that pre-operative opioid use and high number of pills upon discharge were associated with persistent use at 90–180 days.[7] These findings have been corroborated in the literature, as opioid use prior to surgery has been shown across multiple studies to be associated with an increased risk for persistent use long after surgery.[8–10] A handful of studies have implicated increased quantity of perioperative opioid use as a risk factor for persistent postoperative use,[11–13] however many of these studies include opioid use during the weeks before surgery as a component of the calculation, which may be out of the surgeon's control. Interestingly, there has been little focus on patterns of postoperative inpatient use and any association it may have with either preoperative opioid exposure or the risk of persistent opioid use post-discharge. Importantly, approximately 99% of patients undergoing elective inpatient surgery are administered opioids during their hospitalization.[14] As surgeons explore how they can become part of the solution for the opioid epidemic, knowledge of which patients are at risk for high inpatient opioid consumption and what relationship exists between in-hospital postoperative opioid consumption and the risk of long-term opioid use remains critical.

The current study builds upon our previous analysis[7] with detailed inpatient opioid documentation to achieve two aims: (1) to characterize colorectal surgery patients receiving higher amounts of inpatient opioids after surgery and (2) evaluate the relationships between high inpatient use, preoperative opioid exposure, and subsequent risk for persistent opioid use.

Methods

Data source and patient selection

Patients were identified from The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database from 2015 to 2017 at five institutions (two academic, three community) participating in a regional Colorectal Surgery Collaborative in Massachusetts as previously described.[7] Briefly, the collaborative hospitals capture 100% of their colorectal procedures in the ACS NSQIP. The ACS NSQIP is a validated, risk-adjusted, national database, which collects patient data including demographics and medical comorbidities as well as operative and postoperative outcomes. Importantly, all five centers utilize an identical ERAS protocol with opioid sparing strategies including preoperative Tylenol and gabapentin, routine postoperative transverse adominis plane blocks, epidural catheters for open cases, and frequent postoperative Toradol use. Patient controlled anesthesia (PCA) is discouraged and typically reserved for patients with previous opioid use. A detailed description of the utilized ERAS protocol has been previously published.[15] Patients were included if they underwent colectomy identified using Current Procedural Terminology codes 44212, 44211, 44210 (laparoscopic total abdominal colectomy with proctectomy), 44208, 44207, 44206, 44205, 44204 (laparoscopic partial colectomy), 44160 (open partial colectomy), 44158, 44157, 44156, 44155 (open total abdominal colectomy with proctectomy), 44151, 44150 (open total abdominal colectomy without proctectomy), 44147, 44146, 44145, 44144, 44143, 44141, 44140 (open partial colectomy). Patients with abdominoperineal resections were excluded in order to prevent confounding from perineal wound complications. The resultant database was then linked to the inpatient and outpatient pharmacy databases from all five institutions. Patients with missing pharmacy information and inpatient mortality were excluded from the analysis. PCA self-administered doses were not recorded by the electronic medical record, therefore PCA use was treated as a categorical variable. The study was reviewed and approved by the hospitals' Institutional Review Boards.

Variables and outcomes

Inpatient opioid use was quantified by adding all recorded opioid administrations (frequency and dose) over the course of the hospitalization, starting at the time of surgery (including intraoperative administration). To account for variation in type of opioid medication prescribed, all medications were converted to morphine milligram equivalents (MME). Epidural-catheter infused opioids and PCA use were treated as categorical variables and were not included in the calculation. The total quantity of MMEs administered over the course of the hospitalization was then calculated for each patient and high-users were defined as patients in the highest quartile of use, which was $\geq$250 MMEs over the course of the hospital stay.

We recorded variables on demographics (age, gender, race, body mass index, opioid naivety, and American Society of Anesthesiologists (ASA) class), medical comorbidities (diabetes, hypertension, cancer, and chronic obstructive pulmonary disease), operative factors (emergency case, indication for procedure, wound class, open or minimally invasive procedure, and ostomy creation) and postoperative factors (length of stay, discharge disposition, and readmission).

Persistent opioid use was defined as a new opioid prescription between 90 and 180 days after discharge from the index operation as previously described.[7] This definition has become standard in the surgical and pain literature.[5] Opioid naivety was defined as having no opioid medications prescribed in the year prior to colectomy – this was identified using both the health system electronic health record and insurance claims for opioid prescriptions.

Statistical analyses

All statistical analyses were completed using IBM SPSS Software version 25 (SPSS Inc., Chicago, IL). Categorical variables are expressed as percentages and were compared in univariable analysis using chi-square tests. Continuous variables are expressed either as means with standard deviations and were compared in univariable analysis using independent two sample t-tests, or as median with interquartile range and compare using nonparametric Mann-Whitney *U* test. Multivariable logistic regression predicting MME $\geq$250 (i.e. top quartile of use) was performed using variables with a p-value <0.10 in the univariable analysis. ASA $\geq$3 was included as a marker of comorbid status, and specific comorbidities were excluded from the model. Surgical site infections were not included in the model as they were captured in the any complication outcome. Opioid naïve status was forced into the model. Of note, variables that pertained to the post-discharge course (i.e. readmission within 30 days and persistent opioid use) were not included. Similarly, a multivariable logistic regression model predicting persistent use was performed using variables <0.10 in the univariable analysis. $P < 0.05$ was considered statistically significant for all tests run and two-sided *p*-values were used for all tests.

Results

Clinical and perioperative characteristics by inpatient opioid use quartile

A total of 1646 patients underwent colectomy and/or proctectomy with complete inpatient pharmacy data during the study

period. Cumulative use ranged from 0 to 40,004 MMEs, however 97% of patients used 1000 MMEs or less. The general distribution of cumulative inpatient opioid use for patients is shown in Fig. 1. Median cumulative use was 119 MMEs (IQR 60–250 MMEs), and use was positively skewed and non-normally distributed (Shapiro-Wilk test of normality = 0.146, $p < 0.001$).

Patients were stratified into quartiles based on total inpatient MMEs. Patients in the highest quartile (MME ≥250) were compared to the middle two quartiles (MME 60–249) and the lowest quartile of use (MME ≤ 60). Summary statistics of the groups can be found in Table 1. Patients in the high use group were less likely to be older than 65 years and significantly more likely to have a number of comorbidities including ASA 3 or greater, prior tobacco use, COPD, and prior steroid use. In regard to perioperative factors, high users were significantly more likely to have had an emergent case with a dirty wound classification and stoma formation. They were significantly less likely to have had minimally invasive surgery, and conversely were more likely to have had epidural anesthesia. Notably, high users had seemingly more complicated postoperative courses, with significantly higher rates of any complication (35/6% vs 14.5% vs 7.7%, $p < 0.001$), readmission within 30 days (16.1% vs 9.7% vs 6.5% $p < 0.001$), and longer length of stay (mean 11.4 vs 4.0 vs 4.4, $p < 0.001$). Interestingly, rates of opioid naivete were similar between high users and the comparison group (45.5% vs 45.1% vs 39.0%, $p = 0.089$), however persistent opioid use was significantly greater in the high use group (19.8% vs 11.1% vs 7.0%, $p = 0.001$).

Multivariable model predicting highest quartile of inpatient opioid use

In order to identify predictors of high cumulative inpatient use, compared patients in the highest quartile of use (410 patients) to the remainder of the cohort (1236 patients). We created a multivariable binary logistic regression model to identify predictors of high use (Table 2). After adjusting for covariates, age ≥65 was negatively associated with high cumulative use, while emergency case status, Crohn's disease, ulcerative colitis, postoperative complications, and length of stay were associated with greater risk for top quartile of cumulative use.

Clinical and perioperative characteristics of persistent opioid users

The incidence of new persistent opioid use in this population was 12.2% (201 patients). The comparison group of patients that did not develop persistent opioid use included 1445 patients. Summary statistics are displayed in Table 3. Patients with persistent postoperative opioid use were more likely to have an ASA class of 3 or greater and have preoperative steroid use. Patients in the persistent opioid use group had significantly more stomas created (34.3% vs 19.0%, $p < 0.001$), and had slightly higher rate of emergency surgery. In regard to postoperative outcomes, patients with persistent opioid use tended to have more total complications (2% vs 16.7%, $p < 0.0015$). The majority of these complications were surgical in nature including wound infection and deep organ space infection, both of which were found at higher rates in persistent opioid users. Similarly, this group also had longer average LOS, was less likely to be discharged home from the hospital, and more likely to be readmitted within 30 days. Opioid naïve patients comprised a significantly higher proportion of the non-persistent use group (46.5% vs 22.9%, $p < 0.001$). Furthermore, persistent users were significantly more likely to be in the top quartile of use when compared to non-persistent users (40.3% vs 22.8%, $p < 0.001$). Fig. 2 depicts the relationship between inpatient use (represented as MMEs and number of 5 mg oxycodone pills) and the incidence of persistent opioid use, demonstrating a general increase in incidence of persistent use with an increase in inpatient use. The median total inpatient MMEs administered was almost two-fold higher in the persistent use group compared to the non-persistent use group (Mann U Whitney, $p < 0.001$).

Multivariable model predicting persistent opioid use

Multivariable analysis of risk factors for persistent use was performed to adjust for preoperative, intraoperative, and postoperative factors. While length of stay showed a positive correlation with total quantity of MMEs administered, these variables were not colinear and were both included in the models (tolerance = 0.978, variable inflation factor = 1.023). After risk adjustment using binomial regression, age ≥65 (OR 0.62, 95%CI

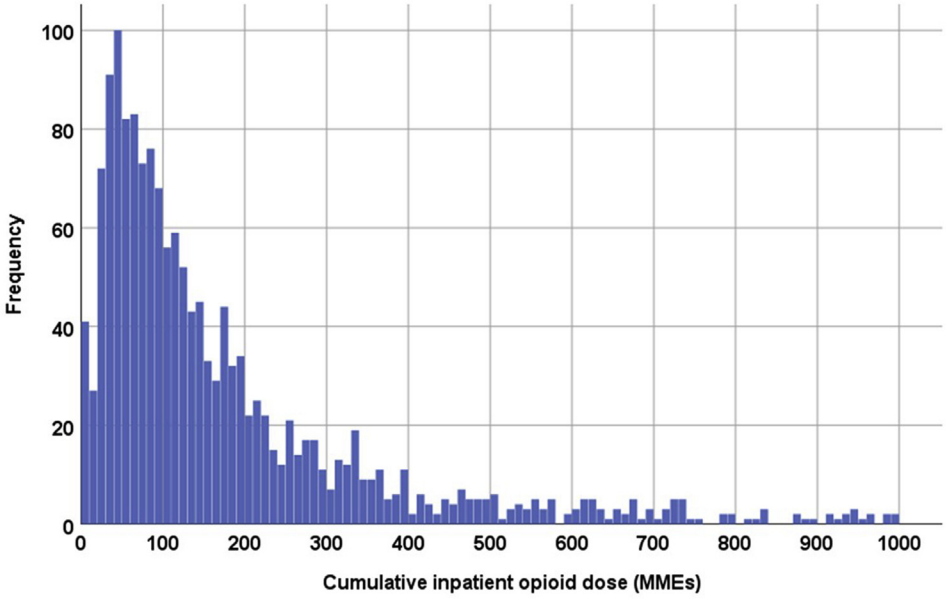

Fig. 1. Histogram showing distribution of patients and associated cumulative inpatient opioid dose (MMEs) for patients using <1000 MMEs (approximately 95% of cohort).

Table 1
Patient characteristics, perioperative factors, and 30-day outcomes.

Patient Characteristics	Inpatient MME ≤60 (N = 413) n (%)	Inpatient MME 60–249 (N = 823) n (%)	Inpatient MME ≥ 250 (N = 410) n (%)	P-value
Age >65	230 (55.7)	321 (39.0)	120 (29.3)	<0.001
Female	214 (51.8)	437 (53.1)	209 (51.0)	0.765
Race				0.063
White	355 (86.0)	729 (88.6)	349 (85.1)	
African/American	14 (3.4)	22 (2.7)	19 (4.6)	
Asian	17 (4.1)	39 (4.7)	21 (5.1)	
Hispanic	16 (3.9)	14 (1.7)	5 (1.2)	
Other	11 (2.7)	19 (2.3)	16 (3.9)	
Indication for surgery				<0.001
Diverticulitis	65 (15.7)	181 (22.0)	72 (17.6)	
Crohn's	5 (1.2)	33 (4.0)	33 (8.0)	
Ulcerative Colitis	12 (2.9)	21 (2.6)	34 (8.3)	
Colorectal Cancer	212 (51.3)	328 (39.9)	104 (25.4)	
Other	119 (28.8)	260 (31.6)	167 (40.7)	
Comorbidities				
Diabetes	50 (12.1)	83 (10.1)	52 (12.7)	0.322
Smoking	28 (6.8)	84 (10.2)	60 (14.6)	0.001
COPD	11 (2.7)	21 (2.6)	25 (6.1)	0.003
Steroid use	25 (6.1)	80 (9.8)	88 (21.6)	<0.001
ASA 3 or greater	193 (46.7)	383 (46.5)	231 (56.3)	0.003
Operative/Peri-operative factors				
Emergency case	14 (3.4)	55 (6.7)	69 (16.8)	<0.001
Wound contamination				<0.001
Clean/contaminated	340 (82.3)	648 (78.7)	254 (62.0)	
Contaminated	33 (8.0)	88 (10.7)	57 (13.9)	
Dirty	40 (9.7)	87 (10.6)	99 (24.1)	
Minimally invasive surgery	263 (63.7)	422 (51.3)	129 (31.5)	<0.001
Stoma created	56 (13.6)	140 (17.0)	148 (36.1)	<0.001
Epidural analgesia	8 (1.9)	55 (6.7)	118 (28.8)	<0.001
PCA	126 (30.5)	369 (44.8)	201 (49.0)	<0.001
Post-operative outcomes				
Any Complication	32 (7.7)	119 (14.5)	146 (35.6)	<0.001
Surgical Site Infection				
Wound infection	10 (2.4)	47 (5.7)	70 (17.1)	<0.001
Organ space infection	5 (1.2)	29 (3.5)	54 (13.2)	<0.001
Readmission w/in 30 days	27 (6.5)	80 (9.7)	66 (16.1)	<0.001
Discharged Home	369 (89.3)	743 (90.2)	338 (82.4)	<0.001
Length of stay (mean ±SD)	4.4±5.3	5.0±4.5	11.4±11.2	<0.001
Opioid naïve	188 (45.5)	371 (45.1)	160 (39.0)	0.089
Persistent opioid use	29 (7.0)	91 (11.1)	81 (19.8)	0.001

Table 2
Multivariable binary logistic regression model predicting high inpatient opioid use.

Variable	OR (95% CI)	P-value
Age >65	0.37 (0.27–0.52)	<0.001
Race		
White	Reference	Reference
African/American	1.10 (0.53–2.27)	0.798
Asian	1.06 (0.58–1.95)	0.841
Hispanic	0.43 (0.11–1.61)	0.210
Other	1.04 (0.47–2.27)	0.931
Indication		
Diverticulitis	Reference	Reference
Crohn's	2.42 (1.29–4.57)	0.006
Ulcerative colitis	2.57 (1.29–5.17)	0.008
Colorectal Cancer	0.75 (0.49–1.16)	0.194
Other diagnosis	1.02 (0.68–1.52)	0.940
ASA 3 or greater	1.16 (0.86–1.57)	0.331
Emergency case	1.88 (1.13–3.13)	0.014
Wound contamination		
Clean/contaminated	Reference	Reference
Contaminated	0.83 (0.53–1.30)	0.414
Dirty	1.06 (0.68–1.63)	0.808
Minimally invasive surgery	0.88 (0.64–1.21)	0.436
Stoma created	1.34 (0.94–1.91)	0.108
Epidural	9.24 (6.14–13.91)	<0.001
PCA	1.30 (0.97–1.73)	0.082
Any complication	2.03 (1.44–2.86)	<0.001
Discharged Home	1.29 (0.79–2.08)	0.322
Length of stay	1.13 (1.10–1.16)	<0.001
Opioid naïve	0.92 (0.69–1.22)	0.570

0.44–0.89; p = 0.009), ASA ≥ 3 (OR 1.74 95%CI 1.23–2.47; p = 0.002), opioid naïve status (OR 0.35, 95%CI 0.25–0.51; p < 0.001) and presence in the top quartile of inpatient use (OR 1.48, 95%CI 1.03–2.15; p = 0.037) were significantly associated with persistent opioid use (Table 4).

Discussion

In this study, we used an expanded group of patients from our previous study[7] with detailed medication documentation to quantify inpatient postoperative opioid use after colectomy and identified risk factors for high inpatient cumulative use. We found that patients in the top quartile of inpatient use were younger, but had more preoperative comorbidities and were more likely to have complicated perioperative courses with higher rates of emergent, non-minimally invasive surgery, any complication, readmission, and longer lengths of stay. Surprisingly, preoperative opioid use, defined as any opioid prescription in the year prior to surgery, was not associated with being in the top quartile of cumulative inpatient use on univariable or multivariable analysis. We further aimed to expand upon our previous analysis of persistent opioid use in colorectal surgery patients and identify whether high inpatient use was associated with persistent opioid use. In this cohort, persistent opioid use was significantly positively associated with presence in the top quartile of inpatient use and negatively associated with opioid naïve status.

Table 3
Patient characteristics, peri-operative factors, and 30-day outcomes by persistent use.

Patient Characteristics	No Persistent Use (N = 1445) n (%)	Persistent Use (N = 201) n (%)	P-value
Age >65	604 (41.8)	67 (33.3)	0.02
Female	689 (47.7)	97 (48.3)	0.878
Race			0.079
White	1265 (87.5)	168 (83.6)	
African/American	48 (3.3)	7 (3.5)	
Asian	64 (4.4)	13 (6.5)	
Hispanic	26 (1.8)	9 (4.5)	
Other	42 (2.9)	4 (2.0)	
Indication for surgery			<0.001
Diverticulitis	288 (19.9)	30 (14.9)	
Crohn's	64 (4.4)	7 (3.5)	
Ulcerative Colitis	49 (3.4)	18 (9.0)	
Colorectal Cancer	572 (39.6)	72 (35.8)	
Other	472 (32.7)	74 (36.8)	
Comorbidities			
Diabetes	164 (11.3)	21 (10.4)	0.705
Smoking	143 (9.9)	29 (14.4)	0.049
COPD	53 (3.7)	4 (2.0)	0.221
Steroid use	152 (10.6)	41 (20.5)	<0.001
ASA 3 or greater	679 (47.0)	128 (63.7)	<0.001
Operative/Peri-operative factors			
Emergency case	110 (7.6)	28 (13.9)	0.002
Wound contamination			0.036
Clean/contaminated	1103 (76.3)	129 (69.2)	
Contaminated	155 (10.7)	23 (11.4)	
Dirty	187 (12.9)	39 (19.4)	
Minimally invasive surgery	737 (51.0)	77 (38.3)	0.001
Stoma created	275 (19.0)	69 (34.3)	<0.001
Epidural analgesia	155 (10.7)	26 (12.9)	0.373
PCA	594 (41.1)	102 (50.7)	0.010
Post-operative outcomes			
Any Complication	241 (16.7)	56 (27.9)	<0.001
Surgical Site infection			
Wound infection	98 (6.8)	29 (14.4)	<0.001
Organ space infection	69 (4.8)	19 (9.5)	0.010
Readmission w/in 30 days	136 (9.4)	37 (18.4)	<0.001
Discharged Home	1281 (88.7)	168 (83.6)	0.038
Length of stay	6.0±7.1	9.2±9.9	<0.001
Opioid Naïve	673 (46.5)	46 (22.9)	<0.001
Median inpatient MME (IQR)	112 (57–222)	193 (91–456)	<0.001
% in top quartile	329 (22.8)	81 (40.3)	<0.001

Data on inpatient postoperative opioid use and risk factors for high cumulative use are scarce in the literature of any surgical specialty. A handful of studies using the Premier Inpatient Database, which captures inpatient charges for almost 25% of all admissions in the country, have quantified inpatient postoperative use after colectomy and reported ranges similar to our study.[16–18] However, these studies are limited in that they lack important variables such as preoperative opioid use, co-existing patient comorbidities, surgical details, and subsequent persistent opioid use. Our study benefitted from precise documentation of opioid administrations for patients at hospitals in the colorectal surgery collaborative combined with granular clinical data captured by NSQIP.

On review of the literature, we identified one study with similar granular pre- and perioperative variables, as well as calculations of cumulative inpatient opioid use for general surgery patients: Newhook et al.[19] described inpatient opioid use and risk factors for increased use after pancreatectomy in a cohort of 158 patients. They found that preoperative opioid exposure and longer LOS were associated with increased inpatient opioid use. We similarly found that longer LOS was a risk factor for high cumulative use, however we also identified risk factors such as age, emergency case, and postoperative complications. Interestingly, we did not find a relationship between prior opioid prescription and high inpatient use. This may be due to the fact that the rate of prior opioid prescriptions was much higher in our study (>50%) and likely represents a heterogenous group of infrequent and frequent opioid users. It is unclear why the rates of prior use in our cohort are higher than the rates of 20–38% previously described in the literature,[20–22] however given the data source, we are confident in its accuracy. Taken together, our data begin to highlight potential risk factors for increased opioid use, and may inform surgeons on which patients may benefit most from opioid sparing strategies.

We next evaluated whether increased postoperative inpatient opioid use was associated with an increased risk for persistent opioid use. In our cohort, 12.2% of patients were still using opioids between 90 and 180 days after their surgery. The rate of persistent use in our study is similar to the rates of persistent use from previously published data.[5,6] Importantly, the rate of persistent use was significantly higher in patients who were in the top quartile of cumulative inpatient use (19.8% vs 9.7%), even after adjusting for patient and perioperative variables on multivariable analysis. Opioid naïve patients were at decreased risk for persistent use, also consistent with previous reports in the literature.[8–10]

To our knowledge, this is the first study specifically examining the relationship between inpatient postoperative opioid consumption and the risk for persistent use in adult patients undergoing abdominal surgery. On review of the literature, we identified only a small number of studies of patients undergoing abdominal surgery that provided some analysis of postoperative inpatient

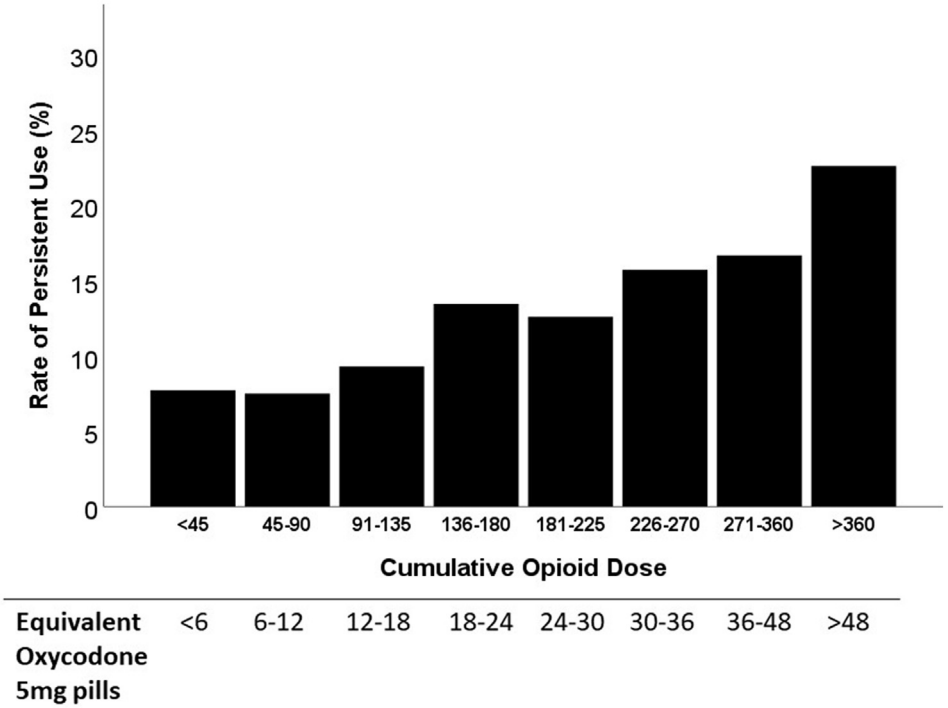

Fig. 2. Bar graph depicting cumulative inpatient opioid dose in MMEs (x-axis) as well as equivalent oxycodone 5 mg pills (beneath x-axis) by risk of persistent opioid use (y-axis).

opioid administration. A small single-center retrospective study on pediatric patients[23] and a large retrospective study of gynecologic patients[24] both found that higher amounts of inpatient opioids after surgery were associated with increased risk for postoperative persistent use long after discharge. We also identified one similar study in the orthopedic surgery literature in which increased inpatient opioid consumption (>500 MMEs) was associated with continued opioid use at 6 months.[25] This risk was enhanced by previous opioid use, as was also the case in our study. While an explanation for the association between increased inpatient use and persistent use is not clear and there is lack of high quality data to suggest causation, it is hypothesized that postoperative consumption of high doses of opioids may lead to opioid-induced hyperalgesia, and then the subsequent requirement of higher doses of opioids.[26] Similarly, some pain specialists have suggested that high levels of postoperative pain leads to neuroplastic changes that result in persistent allodynia and hyperalgesia, thereby placing patients at risk for persistent opioid use.[27]

While previous studies have important differences from the current study, taken together, they begin to illuminate the potential importance of discretion in how opioids are prescribed to postoperative patients in the inpatient setting. In an ideal world, postoperative pain should be minimized; however, when considering the mounting evidence that postoperative opioid consumption may negatively impact surgical outcomes[28] and can potentially increase risk for persistent opioid use, there is justification for surgeons to focus on methods to minimize contributions to this national epidemic.

It is important to highlight that given the lack of data regarding inpatient postoperative opioid consumption, there have been no recommendations or guidelines put forth by major regulatory bodies. For example, in the authors' state of Massachusetts, one of the geographic areas most affected by the opioid epidemic, the Substance abuse, Treatment, Education and Prevention legislation was passed in 2016 that strictly regulated opioid prescribing by healthcare providers, including surgeons. While the legislation contains mandates for postoperative discharge prescriptions, there is no recommendation regarding minimization of inpatient opioid administration. In conjunction with the usual opioid sparing measures such as regional anesthesia, the literature is beginning to support complete opioid-free analgesia regimens after a variety of surgical procedures.[16,29] In fact, recent reports of opioid-free analgesia may foreshadow an impending fundamental shift in the

Table 4
Multivariable model for persistent opioid use.

Variable	OR (95% CI)	P-value
Age ≥65	0.62 (0.44–0.89)	0.009
Race		
White	Reference	Reference
African/American	0.82 (0.35–1.92)	0.649
Asian	1.28 (0.67–2.45)	0.455
Hispanic	2.95 (1.26–6.90)	0.013
Other	0.64 (0.22–1.89)	0.418
Indication		
Diverticulitis	Reference	Reference
Crohn's	0.66 (0.26–1.64)	0.368
Ulcerative colitis	2.20 (1.01–4.78)	0.047
Colorectal Cancer	1.30 (0.78–2.14)	0.315
Other diagnosis	1.30 (0.80–2.10)	0.292
ASA 3 or greater	1.74 (1.23–2.47)	0.002
Emergency case	1.44 (0.80–2.57)	0.221
Wound contamination		
Clean/contaminated	Reference	Reference
Contaminated	0.92 (0.54–1.55)	0.743
Dirty	1.03 (0.61–1.73)	0.922
Minimally invasive surgery	0.85 (0.60–1.22)	0.377
Stoma created	1.37 (0.92–2.03)	0.122
PCA	1.23 (0.89–1.69)	0.207
Any complication	1.11 (0.74–1.66)	0.625
Discharged Home	0.97 (0.58–1.62)	0.908
Length of stay	1.01 (0.99–1.04)	0.170
Opioid naïve	0.35 (0.25–0.51)	<0.001
Top quartile of use (MME ≥ 250)	1.48 (1.03–2.15)	0.037

analgesia paradigm that will become necessary to completely eliminate the myriad of negative effects associated with opioids. A recent report demonstrated that <5% of colectomy patients in the United States participated in an opioid-free analgesia regimen, highlighting tremendous opportunity for growth.[30] These efforts will likely build on the increasing number of colectomy patients enrolled in an enhanced recovery after surgery (ERAS) protocol which also helps to curtail inpatient opioid consumption, as opioid restriction is one of the central tenets of ERAS philosophy.[31]

This study has several limitations. First, it is retrospective in nature which may account for some of the between group differences (for example, higher rates of epidural use in the high use group). Second, details of preoperative opioid use are limited to whether or not a patient received a prescription – it is unknown if patients were true chronic users, received a one-time prescription, or how much of the prescription was actually consumed. Third, we were not able to quantify opioid consumption in patients using PCAs, potentially biasing results. In addition, we were not able to describe some covariates that have been shown to correlate with opioid use such as socioeconomic status, and compliance with enhanced recovery after surgery (ERAS) pathways. Finally, it is important to recognize that colectomy patients often undergo planned subsequent operations such as stoma reversal. Opioid prescriptions after a subsequent operation may mark certain patients as persistent users that are not truly persistent users; however, the rates of persistent use in this study mirror the rates described in other studies. Despite these limitations and in light of the results from our study, we believe that this is a subject that is certainly in need of more data – we strongly encourage future studies to specifically evaluate the relationship between quantity of inpatient opioids consumed and risk for persistent use.

Conclusion

In this study, we identify a number of risk factors for increased postoperative opioid use in colorectal patients, including longer hospitalization, pre-existing comorbidities, open surgery, emergent status, and surgical complications. Furthermore, we demonstrated that patients in the top quartile of cumulative postoperative opioid consumption have an increased risk for persistent opioid use, when accounting for patient factors, operative factors, and postoperative complications. This underscores the importance of minimization of opioid use through the entire perioperative course, especially in patients with prior exposure, surgical complications, and prolonged hospitalization. It also suggests the need for development of longer-lasting postoperative narcotic-sparing strategies, beyond the current ERAS efforts that are mostly focused on the first 24–48 h after surgery.

Presentation

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Declaration of competing interest

The authors have no related conflicts of interest to declare.

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