# Results of a Prospective, Multicenter Initiative Aimed at Developing Opioid-prescribing Guidelines After Surgery

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**Objective:** The aim of this study was to conduct a prospective, multicenter survey of patients regarding postoperative opioid use to inform development of standardized, evidence-based, procedure-specific opioid prescribing guidelines.

**Summary of Background Data:** Previous work has shown significant variation in the amount of opioids prescribed after elective procedures, calling for optimization of prescribing.

**Methods:** Adults (n = 3412) undergoing 25 elective procedures were identified prospectively from 3 academic centers (March 2017 to January 2018) to complete a 29-question telephone interview survey 21 to 35 days postdischarge (n = 688 not contacted, n = 107 refused). Discharge opioids were converted into Morphine Milligram Equivalents (MMEs).

**Results:** Of the 2486 patients who completed the survey, 91.2% received opioids at discharge [median 225 (interquartile range, IQR 125 to 381) MME]. A median of 43 (0 to 184) MMEs were consumed after discharge with 77.3% of patients having leftover opioids at the time of the survey. In total, 61.5% of prescribed opioids were unused; 31.4% of patients used no opioids, and 52.6% required <50 MME. Overall, 90.6% of patients were satisfied with their postdischarge pain control. While 28.3% reported being prescribed too many opioids, 9.0% felt they were not prescribed enough. Only 9.6% of patients disposed of remaining opioids. Of the 2068 opioid-naive respondents (83.2%), 33.6% consumed no opioids (range 5.2% to 80.0% by procedure) and 57.0% (65.7% nonorthopedic) consumed <50 MME. Utilization data and predictors of low/high opioid consumption informed development of postoperative prescribing guidelines.

**Conclusion:** A large proportion of postoperative patients reported using no or few opioids following discharge. Guidelines were developed to minimize opioid prescribing and identify patients requiring low doses or additional multimodal pain control.

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Despite increased awareness, the prescription opioid epidemic continues to exert devastating effects on the United States and has even been implicated in the declining life expectancy.[1–3] Surgeons are responsible for a significant number of opioid prescriptions,[4] and a substantial number of overdose deaths can be linked to opioid prescriptions written by surgeons.[5] The variability in opioid prescribing by surgeons has now been well established, signaling a need for standardization.[6–9] However, while small studies have hinted at appropriate postoperative dosing,[10–13] most prescribing practices at discharge are not evidence-based.

Our institution is committed to optimizing opioid prescribing for our surgical patients. Our previous work demonstrated wide variability in the amount of opioids prescribed within and across procedures at the time of discharge, identifying a need for standardized, procedure-specific prescribing guidelines.[7] However, determining the amount of opioids patients actually consumed after discharge was necessary to characterize the optimal amount to prescribe. Therefore, we developed a patient-focused survey across twenty-five elective procedures and three centers to describe patient-reported opioid use and pain management following discharge after surgery. Using this patient-provided data, we developed evidence-based, procedure-specific prescribing guidelines.

## METHODS

### Cohort

We prospectively identified adult patients undergoing 1 of 25 elective procedures across 3 of our institution's hospitals in 3 states (Arizona, Florida, and Minnesota) from March 13, 2017, to January 19, 2018. Patient data and Current Procedural Terminology (CPT) procedure codes were prospectively electronically extracted from institutional databases and subsequently reviewed to confirm authenticity of the cohort. See Table 1 for procedure list. Patients were excluded if the procedure was combined with other major operations or if the patient had a second operation before the survey. Patients with international addresses, non-English speaking, currently hospitalized, or deceased were excluded.

Information regarding patients identified for inclusion was provided to the Mayo Clinic Survey Research Center (SRC). We initially intended to implement quota sampling, with a target number of 100 completed telephone interviews per procedure and 2500 total patients. Eligible patients were selected each week from hospital procedure lists using stratified simple random selection without replacement. When 100 surveys were completed for a procedure, patients undergoing that procedure were no longer eligible for routine sampling. However, some procedures accrued greater or fewer than 100 completed surveys due to either concurrent

**TABLE 1.** Description of Patients Surveyed Across all 25 Procedures

| | All n = 2486 |
|---|---|
| Demographics | |
| Age, median [IQR] (year) | 64 [54–72] |
| Age (category, year) | |
| 18–39 | 205 (8.2%) |
| 40–59 | 735 (29.6%) |
| 60–79 | 1349 (54.3%) |
| 80+ | 197 (7.9%) |
| Sex, female | 1298 (52.2%) |
| Male | 1188 (47.8%) |
| Race/ethnicity | |
| Non-Hispanic white | 2300 (92.5%) |
| Black | 52 (2.1%) |
| Other | 134 (5.4%) |
| BMI, median [IQR] | 28.8 [25.2–33.1] |
| BMI, ≥30 | 1061 (42.7%) |
| <30 | 1425 (57.3%) |
| Patient factors | |
| Admission type | |
| Inpatient | 1182 (47.5%) |
| Outpatient | 1304 (52.5%) |
| LOS, median [IQR] | 1 [0–2] |
| Cancer diagnosis (Yes, day) | 881 (35.4%) |
| No | 1605 (64.6%) |
| Anxiety diagnosis (Yes, day) | 283 (11.4%) |
| No | 2203 (88.6%) |
| Depression diagnosis (Yes, day) | 312 (12.6%) |
| No | 2174 (87.4%) |
| Preoperative opioid user (Yes, day) | 418 (16.8%) |
| No | 2068 (83.2%) |
| Procedure type | |
| Carotid endarterectomy | 73 (2.9) |
| Parathyroidectomy | 108 (4.3) |
| Arteriovenous fistula creation | 63 (2.5) |
| MIS partial colectomy with anastomosis | 70 (2.8) |
| Carpel tunnel release | 128 (5.1) |
| Breast lumpectomy ± sentinel node | 111 (4.5) |
| MIS cholecystectomy | 138 (5.6) |
| MIS inguinal hernia repair | 107 (4.3) |
| Ovarian cancer cytoreduction | 58 (2.3) |
| Open inguinal hernia repair | 109 (4.4) |
| Simple mastectomy ± sentinel node | 76 (3.1) |
| MIS hysterectomy | 139 (5.6) |
| MIS low anterior resection ± diverting ileostomy | 25 (1.0) |
| MIS prostatectomy | 105 (4.2) |
| MIS nephrectomy | 100 (4.0) |
| Knee arthroscopic meniscectomy | 112 (4.5) |
| Open pancreaticoduodenectomy | 40 (1.6) |
| MIS lung wedge resection | 110 (4.4) |
| Tonsillectomy | 60 (2.4) |
| Rotator cuff surgery | 129 (5.2) |
| Lumbar laminotomy/Laminectomy | 91 (3.7) |
| Open lung lobectomy | 43 (1.7) |
| Lumbar fusion | 75 (3.0) |
| Total hip | 202 (8.1) |
| Total knee | 214 (8.6) |
| Discharge opioid prescriptions | |
| Discharge prescription | |
| Opioids | 2266 (91.2%) |
| No opioids | 220 (8.8%) |
| MME prescribed, median [IQR] | 225 [125–381] |
| MME consumed, median [IQR] | 42 [0–184] |
| MME remaining, median [IQR] | 113 [23–225] |
| Opioid refill, Yes | 321 [12.9] |
| No | 2165 [87.1] |

BMI indicates body mass index; IQR, interquartile range; LOS, length of stay; MIS, minimally invasive surgery; MME, Morphine Milligram Equivalents.

institutional quality improvement efforts requiring ongoing sampling of orthopedic procedures, or when additional cases from the higher-volume procedures were needed to meet the SRC weekly quota for number of calls.

## Survey

In collaboration with the SRC, a 28-question survey was developed to assess the amount of opioids consumed of each opioid prescription (Questions 2 to 17), duration of use of prescription pain medications (Questions 18 to 19), refills and patients' experience with refills (Questions 20 to 21), as well as patient's perceptions of pain control after discharge (Questions 22 to 24). Patients were asked about nonprescription and alternative pain control (Questions 25 to 26) and what was done with their remaining medication (Question 27) [Supplemental File 1, http://links.lww.com/SLA/B451]. The survey was pre-tested with 30 patients and modified based on feedback from patients and SRC phone interviewers.

Due to the media coverage of the opioid crisis, we anticipated the survey content may induce social desirability bias, whereby respondents answer questions on opioid use in a manner perceived as socially desirable. Traditionally, self-administered paper surveys are preferred over telephone and in-person interviews for sensitive topics.[14] However, we felt that a mail survey would allow respondents time to perseverate on their answers, which could also lead to bias compared with an unexpected telephonic interview collecting unprompted and spontaneous responses. Furthermore, it was critical for patients to complete survey within 3 to 4 weeks of discharge to minimize recall bias.

Call attempts were made at 21 to 35 days following discharge. Patients were phoned once daily in the event of a nonresponse until their window for survey ended, including weekday daytime, weekday nighttime, and 1 weekend attempt. This initiative was conducted for quality improvement and was exempt by our Institutional Review Board. Consent was obtained informally at the start of the survey (Question 1).

## Opioid Prescriptions and Usage

Medical records were abstracted to identify discharge opioid prescriptions, including liquids and tablets, while topical agents were excluded. Discharge prescriptions were defined in a similar manner to our previous work.[7] For analysis, opioid prescriptions and consumption were converted into oral Morphine Milligram Equivalents (MMEs).[15] We separately reported the absolute number of unused opioids.

Patients were asked to report opioid utilization for up to 3 different opioid prescriptions; less than 0.1% of patients received 4 or more prescriptions. Patients were asked to count how many opioids remained. When the bottle was not available or had been disposed of, or in the case of liquids, the patients were asked to estimate. Patients who responded ''Yes'' to question 28 (''Were you taking prescription pain medications prior to your most recent surgery?'') were defined as preoperative opioid users. Opioid refills were identified by responding ''Yes'' to question 20 of the survey (''Did you receive any prescription pain medications after leaving the hospital?'').

## Patient, Procedural, and Pain Score Data

Patient factors were abstracted from medical records and grouped for analysis. Primary postoperative diagnoses, recorded using International Classification of Diseases (ICD), Tenth Revision codes, were grouped into cancer versus noncancer diagnoses, while anxiety and depression diagnoses were assessed within 6 months of procedures. Prolonged length of stay (PLOS) was defined as any postoperative LOS within the fourth quartile (Q4) within each procedure, accounting for procedural variation.

Patient-reported Numeric Pain Rating Scale (NPRS) scores were abstracted for the 30 days before surgery through day of discharge. Pain

score variables were defined as 1) preoperative pain score: The most recent pain score in the 30 days preceding surgery; 2) Maximum pain score: highest pain score from day of admission through day of discharge; and 3) Discharge pain score: the last pain score from the day of discharge. Pain scores were reported as mean ± standard deviation and grouped into binary categories for multivariable analysis.

## Statistical Analysis

Univariate comparisons of patient characteristics, pain experience, opioid prescription, and opioid consumption were conducted. Opioid-prescribing and consumption comparisons were made overall and for an opioid-naive subset. MME prescribed and consumed were reported as median, interquartile range (IQR). Patients who were prescribed no opioids and received no refills, or reported using no opioids, were defined as using no opioids. For univariate and multivariable analyses, MME utilization was additionally grouped into top quartiles by procedure, to compare patients who used a "top quartile" (Q4) MME to those using less opioids (Q1–3), allowing opioid consumption to be defined by procedure, rather than imposing the same definition across all procedures. Similar analyses compared patients who used a "bottom quartile" (Q1) MME to those using more opioids after discharge (Q2 to 4).

Chi-square and Fisher exact tests compared categorical variables, while Kruskal-Wallis and Wilcoxon Rank-Sum tests compared continuous variables. Each multivariable model adjusted for statistically significant ($P < 0.05$) univariate factors. No significant interactions were seen in the top quartile model, but there was a moderate interaction between diagnosis of anxiety and depression ($P = 0.06$) and cancer and anxiety ($P = 0.05$) in the bottom quartile module.

A sensitivity analysis was conducted removing patients who were still taking opioids at the time of survey, which showed no change in the overall outcomes and therefore were not included. Additional sensitivity analyses used preoperative pain score and max pain score as predictors of high and low opioid utilization in multivariable logistic regressions. Pain score at discharge was the strongest predictor and was therefore included in the final model.

A Kaplan-Meier analysis analyzed duration of opioid use, with the event defined as the patient-reported day postsurgery. Patients who were not prescribed opioids had an event on day zero. If a patient did not report duration of opioid use, zero-consumers were assigned a duration of opioid use equivalent to their postoperative LOS, while non-zero consumers were assigned the median duration of opioid use for their respective procedure. Patients still taking opioids were censored on the date of survey.

Individual survey question response rate was ≥90% for all questions except of Question 18 (81.9%), Question 25 (85.6%), and Question 27 (79.3%). We were unable to determine opioid utilization (insufficient/missing data Question 2 to 17) in 90 patients (3.6% of cohort). Missing patient characteristics were reported if present and categorical variables were used to account for any missing data in the multivariable analysis. Comparison of the survey responders versus the nonresponders is shown in Supplemental File 2, http://links.lww.com/SLA/B476.

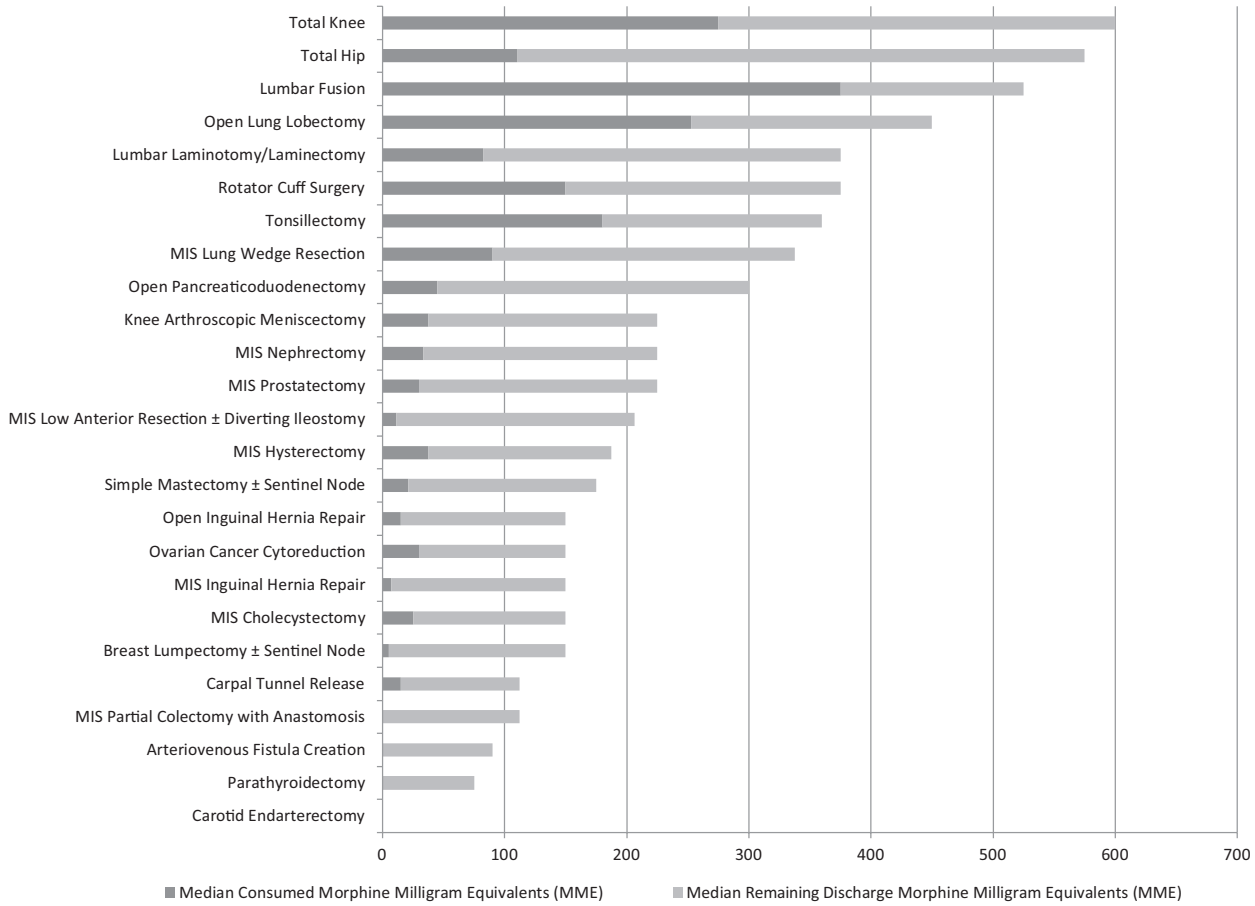


**FIGURE 1.** Amount of opioids prescribed versus used in opioid-naive patients after discharge for 25 elective procedures.

Statistical analysis was performed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

## Procedure-specific Guideline Development

Multidisciplinary teams including representatives from surgery, pain medicine, nursing, physician assistants/nurse practitioners, pharmacy, and data science reviewed the patient survey data to inform the development of guidelines for opioid prescribing at discharge. Recognizing patient variability, 3 dosing groups were developed per procedure: low, standard, and high. Separate guidelines for orthopedic procedures were developed.

A literature review was conducted to incorporate external prospective data,[6,16,17] and the procedures list was modified and expanded based on input from surgeons to cover a broader variety of procedures than those surveyed. The low/no opioid dosing group was developed based on the findings that a significant percent of patients require no opioids at discharge. The standard dosing group was developed based on an MME amount that should provide enough pain medications for 80% of the middle 2 quartiles of patients. The high-dose opioid dosing group was developed by using the median MME needed to provide 50% of the top quartile of patient's cohort with enough opioids. This lower cutoff was used to account for the fact these guidelines do not apply to outliers taking high doses of opioids preoperatively.

# RESULTS

## Overall Cohort

We identified 3412 surgical patients who underwent 1 of 25 elective procedures at 3 centers from March 13, 2017, to January 19, 2018. Of these, 2566 completed our survey, resulting in a response rate of 75.2%. Of the 846 nonresponders, 688 did not answer the call (20.2% of all sampled), 107 refused (3.1% of all sampled), 21 were physically/mentally unable to participate, and the remaining 30 either had no telephone number listed, language/hearing barriers, or were deceased. After excluding patients with reoperations (n = 22) and combined operations not identified on initial screening (n = 58), the final cohort consisted of 2486 patients and is described in Table 1. The numbers of patients per procedure ranged from 25 to 214 (mean 99.4 responses per procedure). Patients were surveyed at mean $26.9 \pm 4.2$ days after discharge.

## Opioid Prescriptions and Usage

Nearly all (91.2%) patients surveyed received opioids at discharge. The median MME prescribed was 225 (IQR 125 to 381) with a median of 43 (IQR 0 to 184) MME consumed after discharge, resulting in a median of 113 (IQR 23 to 225) MME remaining at the time of survey; these medians do not sum to 225 due to skewed data. One-third of patients (31.4%) consumed no opioids after discharge and 52.6% consumed less than 50 oral MME. In total, 61.5% of MME prescribed were unused at the time of survey and 77.3% of patients had opioids leftover at the time of survey. Across the cohort of responders, 55,199 opioid pills remained unused at the time of survey. The patient-reported refill rate was 12.9% overall (0.0% for arteriovenous fistula to 48.0% for lumbar fusion).

## Patient Experience and Disposal

Nearly all patients (90.6%) reported being either very satisfied or somewhat satisfied with their postdischarge pain control, 6.5% reported being somewhat or very dissatisfied, and 3.0% being neither satisfied nor dissatisfied. About 28.3% of patients reported being prescribed too many opioids at discharge, 62.7% reported being prescribed the right amount,

**TABLE 2.** Opioid Consumption After Discharge

| | Opioid-naive and Preoperative Users | Opioid-naive Only | | |
|---|---|---|---|---|
| Procedure | Median [IQR] Oral MME Consumed | Median [IQR] Oral MME Consumed | Consumed Zero Oral MME (%) | Consumed <50 Oral MME (%) |
| All | 42.5 [0–184.375] | 30 [0–150] | 679 (33.6) | 1147 (57.0) |
| Carotid endarterectomy | 0 [0,0] | 0 [0,0] | 56 (80.0) | 63 (90.0) |
| Parathyroidectomy | 0 [0–23.75] | 0 [0–20] | 50 (53.2) | 83 (88.3) |
| Arteriovenous fistula creation | 0 [0–25] | 0 [0–22.5] | 35 (62.5) | 50 (89.3) |
| MIS partial colectomy with anastomosis | 0 [0–75] | 0 [0–75] | 33 (53.2) | 42 (67.7) |
| Carpal tunnel release | 15 [0–60] | 15 [0–60] | 38 (37.3) | 74 (73.3) |
| Breast lumpectomy ± sentinel node | 0 [0–20] | 5 [0–17.5] | 51 (49.0) | 92 (88.5) |
| MIS cholecystectomy | 36.25 [0–90] | 25.415 [0–67.5] | 37 (34.9) | 71 (67.0) |
| MIS inguinal hernia repair | 7.5 [0–50] | 7.5 [0–45] | 46 (45.1) | 77 (75.5) |
| Ovarian cancer cytoreduction | 30 [0–112.5] | 30 [0–108.75] | 19 (38.8) | 29 (60.4) |
| Open inguinal hernia repair | 15 [0–71.25] | 15 [0–56.25] | 39 (39.0) | 72 (72.0) |
| Simple mastectomy ± sentinel node | 22.5 [0–108.75] | 21.25 [0–112.5] | 26 (37.1) | 44 (62.9) |
| MIS hysterectomy | 45 [0–150] | 37.5 [0–138.75] | 34 (30.4) | 64 (57.1) |
| MIS low anterior resection ± diverting Ileostomy | 22.5 [0–150] | 11.25 [0–165] | 10 (50.0) | 12 (60.0) |
| MIS prostatectomy | 30 [0–112.5] | 30 [0–112.5] | 34 (34.7) | 60 (61.2) |
| MIS nephrectomy | 42.5 [0–150] | 33.75 [0–140] | 28 (32.6) | 50 (58.1) |
| Knee arthroscopic meniscectomy | 45 [7.5–112.5] | 37.5 [7.5–112.5] | 21 (21.4) | 55 (56.7) |
| Open pancreaticoduodenectomy | 67.5 [0–300] | 45 [0–300] | 15 (45.5) | 18 (54.5) |
| MIS lung wedge resection | 90 [0–262.5] | 90 [0–262.5] | 26 (28.3) | 41 (44.6) |
| Tonsillectomy | 180 [120–405] | 180 [120–405] | 3 (5.2) | 8 (14.0) |
| Rotator cuff surgery | 158.75 [67.5,300] | 150 [75–292.5] | 5 (5.2) | 22 (22.9) |
| Lumbar laminotomy/Laminectomy | 105 [7.5–225] | 82.5 [7.5–195] | 11 (21.2) | 23 (44.2) |
| Open lung lobectomy | 300 [52.5–382.5] | 252.5 [50–375] | 6 (16.2) | 9 (24.3) |
| Lumbar fusion | 408.75 [150–589.375] | 375 [96–555] | 3 (9.1) | 7 (21.2) |
| Total hip | 185 [22.5–375] | 110 [7.5–297.5] | 34 (24.6) | 53 (38.4) |
| Total knee | 312.5 [97.5–525] | 275 [75–475] | 19 (12.8) | 28 (18.8) |

IQR indicates interquartile range; MIS, minimally invasive surgery; MME, Morphine Milligram Equivalents.

and 9.0% reported not being prescribed enough. The range of patients who felt they were prescribed too many opioids at discharge ranged from 6.3% after pancreaticoduodenectomy to 46.0% after MIS inguinal hernia repair. Nonprescription pain medications were used by 79.9% of the cohort, while 42.2% reported using alternative nonmedication-based pain control strategies.

The majority of the 321 of patients who required a refill found it either very or somewhat easy to obtain a refill (79.6%), while 16.3% found it somewhat or very difficult. Patients who required a refill reported lower adequacy of pain control (mean $7.1 \pm 2.3$) than those who did not need a refill (mean $8.1 \pm 2.0$, $P < 0.001$) and were less likely to report being very or somewhat satisfied with their pain control (74.1% vs 93.0% no refill, $P < 0.001$). However, only 6.6% of patients who required a refill were very dissatisfied with their pain control.

Of the 1485 patients who were no longer taking opioids at the time of survey and had left over opioids, 1328 (89.4%) still possessed their remaining opioids. Twelve patients (0.8%) did not know where the remaining opioids were located and 2 patients (0.1%) reported sharing remaining opioids with others. The remaining 143 (9.6%) respondents had disposed of them: 54 (3.6%) threw them in the trash, 48 (3.2%) flushed them down the toilet, 34 (2.3%) returned them to a pharmacy, hospital, or government office, 6 (0.4%) left them at a rehabilitation facility, and 1 (0.1%) patient buried them. Compared with patients who reported disposing of their medications, patients who did not dispose of their medications were more likely to have longer postoperative LOS, have a cancer diagnosis, and have lower discharge pain ($P < 0.05$), while no difference was seen with regard to age or sex ($P > 0.05$).

## Opioid-naive Patients

Of the 2068 opioid-naive patients (vs 16.8% preoperative users), 91.2% (n = 1885) received opioids at discharge [median 225 (IQR 113 to 375) prescribed]. Among naive patients, a median of 30 MME (IQR 0 to 150) were consumed with 33.6% consuming no opioids after discharge and 57.0% consuming less than 50 oral MMEs. Figure 1 shows the median number of opioids prescribed and consumed at the time of survey among naive patients after discharge for 25 elective procedures. Analysis of opioid-naive patients demonstrated that the number of opioid-naive patients consuming no opioids at discharge ranged from 5.2% to 80.0% by procedure (Table 2). There was significant variation in the number of MME consumed within each procedure (Fig. 2).

Opioid-naive patients reported taking pain medications for a median of 4 (IQR 4 to 5) days after surgery with 90.7% reporting discontinuing opioids before the time of survey. Kaplan-Meier analysis demonstrates days to cessation of opioid usage in opioid-naive patients by procedure (Fig. 3A) and demonstrated that 53.1%, 64.2%, and 73.8% of patients reported being off opioids at 3, 5, and 7 days after surgery, respectively. Arteriovenous fistula, carotid

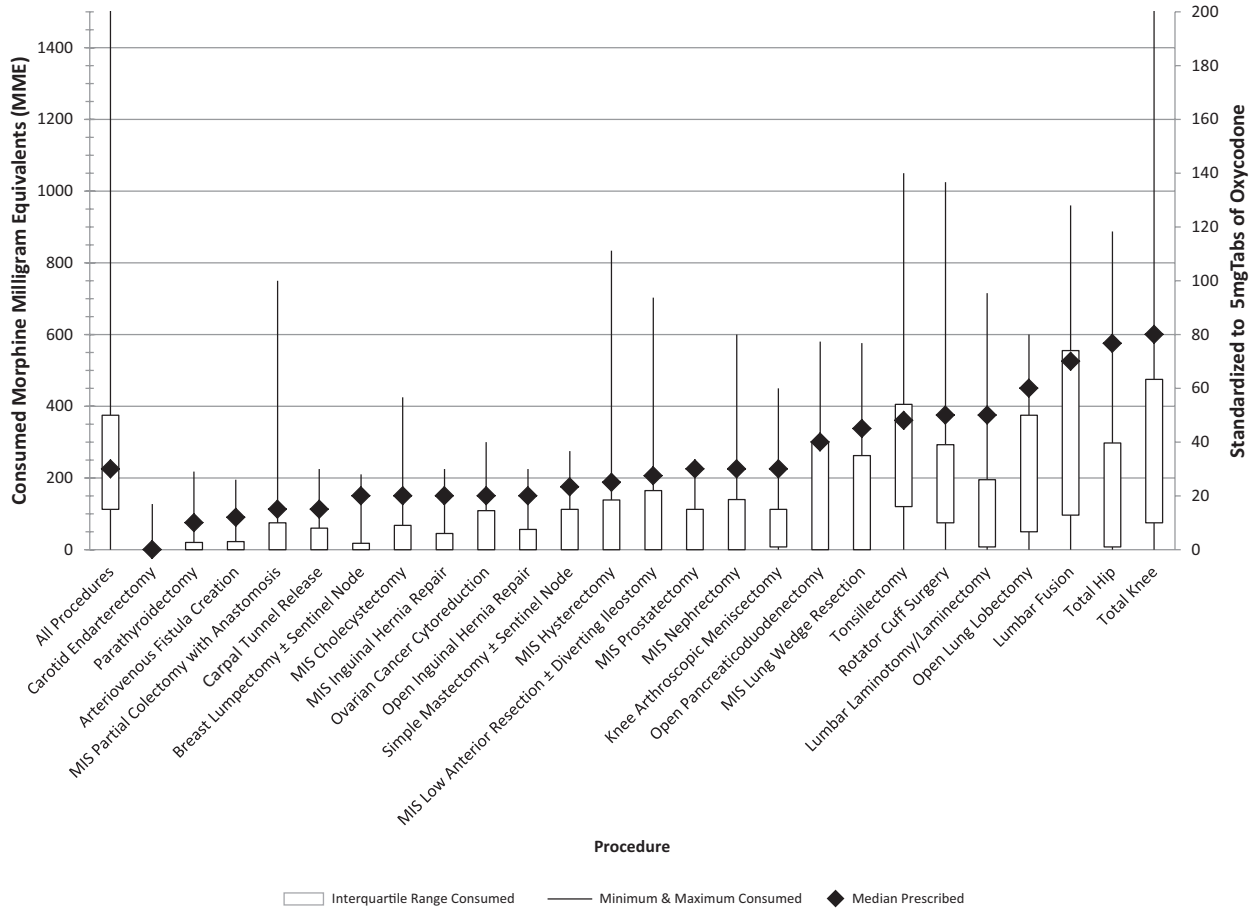


**FIGURE 2.** Variation in number of opioids consumed in opioid-naive patients.

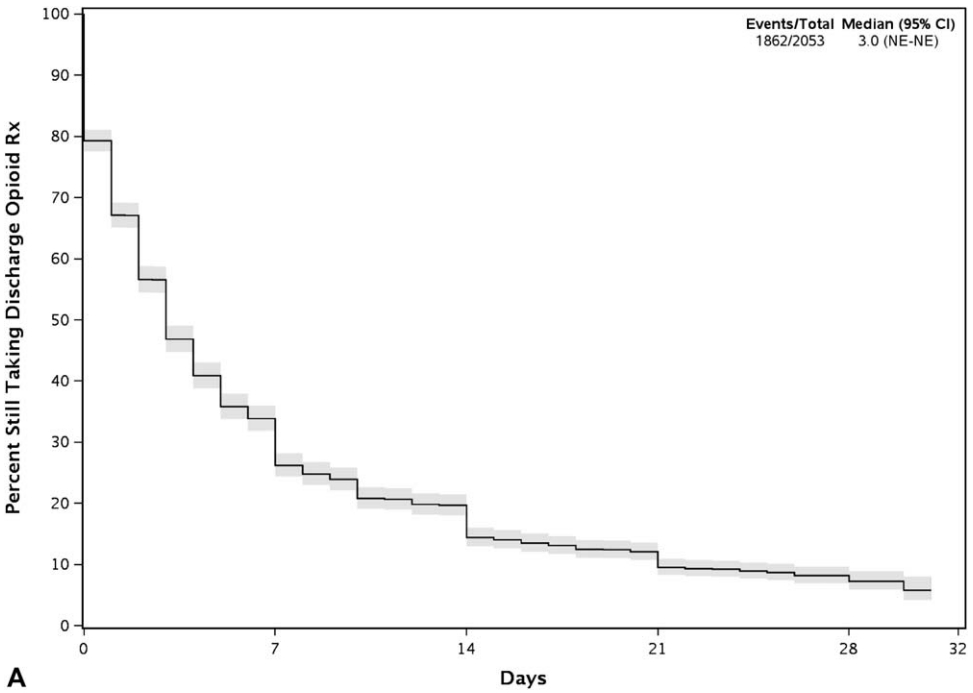


**FIGURE 3.** Kaplan-Meier curve demonstrated days to cessation of opioid usage after surgery in opioid-naive patients across all procedures (A) and stratified by procedure (B). AV Fistula indicates arteriovenous fistula creation; BRST LUMP, breast lumpectomy ± sentinel node; CAROTID, carotid endarterectomy; CTR, carpal tunnel release; IHR, open inguinal hernia repair; KNEE SCOPE, knee arthroscopic meniscectomy; L DECOMP, lumbar laminotomy/laminectomy; L FUSION, lumbar fusion; LOBECTOMY, open lung lobectomy; MASTECT, simple mastectomy ± sentinel node; MIS CHOLE, MIS cholecystectomy; MIS COLON, MIS partial colectomy with anastomosis; MIS IHR, MIS inguinal hernia repair; MIS HYST, MIS hysterectomy; MIS LAR, MIS low anterior resection ± diverting ileostomy; MIS NEPH, MIS nephrectomy; MIS PROSTATE, MIS prostatectomy; OVARIAN, ovarian cancer cytoreduction; PARA, parathyroidectomy; ROTATOR, rotator cuff surgery; THA, total hip; TKA, total knee; TONSIL, tonsillectomy; WEDGE, MIS lung wedge resection; WHIPPLE, open pancreaticoduodenectomy.

endarterectomy, carpal tunnel release, MIS inguinal hernia repair, breast lumpectomy, and parathyroidectomy were the only procedures where at least 75% of patients reported being off opioids at 3 days after surgery. In only 15 of 25 procedures did at least 75% of patients report being off opioid at 7 days after surgery (Fig. 3B).

## Identifying High and Low-opioid Users (Naive and Preoperative Users)

Further analysis was done to identify factors associated with being a bottom quartile user (Q1) as well as a top quartile user (Q4) within each procedure group as summarized in Table 3.

Patients who consumed less opioids (Q1) tended to be older, lower BMI, were more likely to be in the top 75th percentile LOS within each procedure, more likely to have cancer, and less likely to have anxiety and depression. They also tended to have consistently lower pain scores, reported superior pain control after discharge, were more likely to report being very or somewhat satisfied with pain control, and were more likely to report being prescribed too many opioids at discharge. Multivariable logistic regression (Table 4) demonstrated that being opioid naive, older in age, BMI <30, not having a diagnosis of anxiety, PLOS (>75th percentile), and have low discharge pain score was associated with being a lowest quartile opioid user. Age 80+ years was most strongly associated with low opioid consumption [odds ratio (OR) 4.72, 95% confidence interval (95% CI) 2.92–7.62, $P < 0.001$ vs age 18 to 39 years].

Patients who used the most number of opioids after discharge (Q4) tended to be preoperative users, younger, less likely to be non-Hispanic white, higher BMI, and more likely to have anxiety and depression (Table 3). Preoperative users were much more likely to be in the highest consumption group (25.1% vs 13.6% opioid naive, $P < 0.001$). Further, patients in the highest consumption quartile were more likely to report lower satisfaction with their pain control and not receiving enough medications at discharge. However, 85.7% of patients in the highest quartile group still reported being very or somewhat satisfied with pain control after discharge. Multivariable analysis (Table 4) demonstrated that preoperative opioid use, younger age, anxiety diagnosis, and high discharge pain score were independently associated with being in the highest opioid utilization group with age 18 to 39 years (OR 0.19, 95% CI 0.10–0.36, $P < 0.001$ vs age 80+) being most strongly associated with high postdischarge opioid use. Finally, having surgery in either Arizona (OR 1.56, 95% CI 1.22–2.01, $P < 0.001$) or Florida (OR 1.63, 95% CI 1.24–2.14, $P < 0.001$) was associated with higher opioid consumption than Minnesota.

## Opioid-prescribing Recommendations

On the basis of the findings of this work and previous work by our group, we developed the Mayo Clinic Surgical Outcomes Program Recommendations for Adult Discharge Opioid Prescriptions (Supplemental 3, http://links.lww.com/SLA/B477).

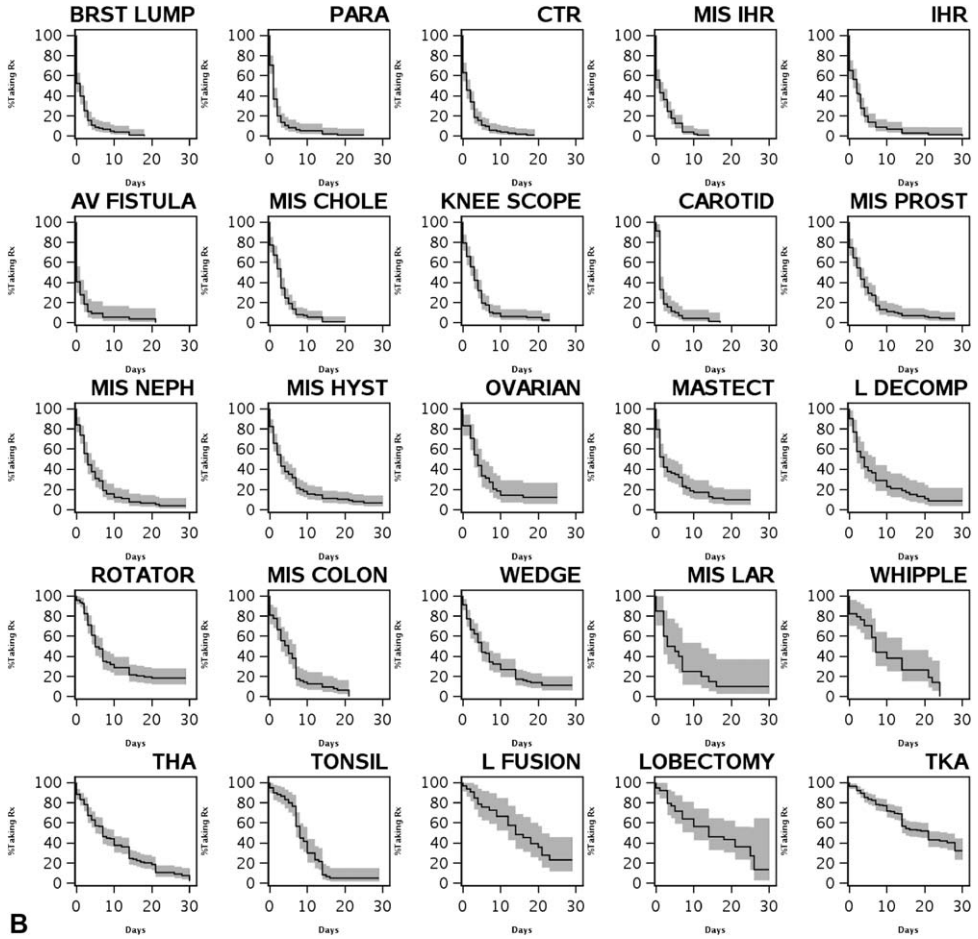


**FIGURE 3.** (*Continued*)

## DISCUSSION

A multicenter survey of 2486 patients undergoing 25 procedures concluded that while 91% of patients received opioids at discharge, 77% of patients had leftover opioids, and 62% of opioids prescribed went unused. Nearly one-third of patients reported using no opioids following discharge. These results and our identification of factors associated with low and high-opioid consumption after discharge demonstrate that a one-size fits all maximum for postdischarge opioid prescribing, currently advocated by many insurers[18–20] and legislators[21] for the treatment of acute pain, is likely not in the patients' best interest. In particular, they are not patient-centered and may inadvertently encourage both over- and underprescribing. In light of the above, we developed procedure-specific, evidence-based discharge opioid-prescribing guidelines.

Neither prescription, nor consumption, was similar across procedures in our study, yet the Centers for Disease Control (CDC) recommends that the treatment of acute pain should be limited to less than 7 days,[22,23] and in 2018, a bill proposed to Congress proposed limiting opioid prescriptions for acute pain, including surgery, to a maximum of 3 days.[21] Although our data suggest that this may be appropriate for some surgical patients, it may also leave a significant proportion of patients with poorly controlled pain. Importantly, our study of opioid cessation showed that while many patients discontinued opioids at 5 to 7 days after surgery, for some operations, patients required opioids for up to 15 days after surgery. Others have also demonstrated a similar variable length of appropriate opioid prescriptions, ranging from 4 to 15 days.[24] Therefore, it is imperative that blanket guidelines such as those being considered by legislators, states, and insurance companies be avoided, as our data clearly show that one-size-fits-all guidelines are inappropriate given the range of surgical pain.

Similar to previous studies that were aimed to develop opioid-prescribing guidelines, we used patient-reported consumption data to identify the number of opioids the majority of patients would need after surgery (Supplemental 3, http://links.lww.com/SLA/B477). Nearly one-third of patients reported using no opioids following discharge and over half used less than 50 MMEs, signaling the importance of including a recommendation for a low/no-opioid dosing option. Other have shown that a similar number of patients take no opioids after surgery, yet most patients still receive an opioid prescription at discharge.[16,25,26] A standard dosing group was developed in a similar fashion to the guidelines proposed by other institutions but recommends slightly fewer opioids be prescribed per procedure.[10,13,17] Given that surgeons can expect to treat a high number of preoperative opioid users,[27,28] we deemed it important to include a high-opioid dosing group that also allowed for the inclusion of preoperative users, as well as opioid naive that may require higher

**TABLE 3.** Comparison of Patients in Lowest Quartile Opioid Used (Quartile 1 vs 2–4) and Highest Quartile Opioid Usage (Quartile 4 vs 1–3)

| | Q1 MME Consumption (n = 860) | Q2–4 MME Consumption (n = 1546) | *P* | Q1–3 MME Consumption (n = 1836) | Q4 MME Consumption (n = 750) | *P* |
|---|---|---|---|---|---|---|
| Demographics | | | | | | |
| Age, median [IQR] (year) | 68 [59–75] | 62 [52–70] | <0.001 | 65 [56–73] | 60 [50–68] | <0.001 |
| Sex, female | 450 (52.3%) | 803 (51.9%) | 0.86 | 950 (51.7%) | 303 (53.2%) | 0.55 |
| Race/ethnicity, non-Hispanic white | 800 (93.0%) | 1430 (92.5%) | 0.87 | 1709 (93.1%) | 521 (91.4%) | 0.006 |
| Black | 16 (1.9%) | 33 (2.1%) | | 28 (1.5%) | 21 (3.7%) | |
| Other | 44 (5.1%) | 83 (5.4%) | | 99 (5.4%) | 28 (4.9%) | |
| BMI, median (IQR) | 28.0 [24.4–32.6] | 29.1 [25.6–33.5] | <0.001 | 28.7 [25.2–32.9] | 29.2 [25.3–33.9] | 0.003 |
| Surgery site, Rochester | 596 (69.3%) | 999 (64.6%) | 0.06 | 1260 (68.6%) | 335 (58.8%) | <0.001 |
| Arizona | 145 (16.9%) | 308 (19.9%) | | 327 (17.8%) | 126 (22.1%) | |
| Florida | 119 (13.8%) | 239 (15.5%) | | 249 (13.6%) | 109 (19.1%) | |
| Patient factors, % Yes | | | | | | |
| Cancer diagnosis | 336 (39.1%) | 527 (34.1%) | 0.02 | 672 (36.6%) | 191 (33.5%) | 0.18 |
| Anxiety diagnosis | 69 (8.0%) | 203 (13.1%) | <0.001 | 123 (6.7%) | 70 (12.3%) | <0.001 |
| Depression diagnosis | 90 (10.5%) | 211 (13.6%) | 0.02 | 155 (8.4%) | 62 (10.9%) | <0.001 |
| Preoperative opioid user | 95 (11.0%) | 298 (19.3%) | <0.001 | 248 (13.5%) | 142 (24.9%) | <0.001 |
| PLOS >75$^{th}$ percentile | 104 (12.1%) | 126 (8.2%) | 0.002 | 169 (9.2%) | 61 (10.7%) | 0.29 |
| Pain scores | | | | | | |
| Preoperative pain score | 1.26 ± 2.21 | 1.89 ± 2.62 | <0.001 | 1.51 ± 2.38 | 2.13 ± 2.77 | <0.001 |
| Max pain score | 4.34 ± 2.86 | 5.82 ± 2.73 | <0.001 | 5.01 ± 2.84 | 6.14 ± 2.77 | <0.001 |
| Discharge pain score | 1.71 ± 1.69 | 2.93 ± 2.04 | <0.001 | 2.22 ± 1.86 | 3.34 ± 2.23 | <0.001 |
| Patient experience | | | | | | |
| Adequacy of pain control after discharge, Mean ± Std. Dev. | 8.22 ± 1.98 | 7.86 ± 2.05 | <0.001 | 8.07 ± 2.00 | 7.68 ± 2.12 | <0.001 |
| % Very or somewhat satisfied with pain control after discharge | 796 (93.%) | 1368 (89.1%) | <0.001 | 1678 (92.2%) | 486 (85.7%) | <0.001 |
| % prescribed too much medication at discharge | 241 (45.1%) | 353 (23.3%) | <0.001 | 529 (35.6%) | 65 (11.5%) | <0.001 |
| % prescribed not enough medication at discharge | 10 (1.9%) | 176 (11.6%) | <0.001 | 86 (5.8%) | 100 (17.7%) | <0.001 |
| Discharge opioid prescriptions | | | | | | |
| Median MME prescribed | 150 [0–225] | 225 [150–450] | <0.001 | 210 [100–375] | 300 [188–625] | <0.001 |
| Median MME consumed | 0 [0,0] | 125 [40–285] | <0.001 | 15 [0–75] | 225 [131–488] | <0.001 |
| Consumed zero MME | 759 (88.3%) | 0 (0.0%) | <0.001 | 759 (41.3%) | 0 (0.0%) | <0.001 |
| Consumed <50 MME | 827 (96.2%) | 438 (28.3%) | <0.001 | 1225 (66.7%) | 40 (7.0%) | <0.001 |
| Refill rate | 39 (4.5%) | 259 (16.8%) | <0.001 | 146 (8.0%) | 152 (26.7%) | <0.001 |

IQR indicates interquartile range; MME, Morphine Milligram Equivalents; PLOS, prolonged length of stay; Q, quartile.

**TABLE 4.** Multivariable Logistic Regression Demonstrating the Odds of Patients Using the Lowest (Quartile 1) and Highest Quartile (Quartile 3) Number of Opioids Within Each Procedure

| | Odds of Lowest Quartile Consumed (vs Quartile 2–4) | | Odds of Highest Quartile Consumed (vs Quartile 1–3) | |
|---|---|---|---|---|
| | **OR [95% CI]** | ***P*** | **OR [95% CI]** | ***P*** |
| Preoperative opioid user, vs naive | 0.63 [0.49–0.83] | <0.001 | 1.63 [1.27–2.10] | <0.001 |
| Age group, 80+ vs 18–39 | 4.72 [2.92–7.62] | <0.001 | 0.19 [0.10–0.36] | <0.001 |
| 60–79 vs 18–39 | 2.72 [1.84–4.03] | 0.002 | 0.60 [0.42–0.84] | 0.003 |
| 40–59 vs 18-39 | 1.92 [1.28–2.89] | 0.001 | 0.86 [0.61–1.23] | 0.42 |
| BMI ≥30, vs >30 | 0.78 [0.65–0.93] | 0.006 | 1.10 [0.90–1.35] | 0.33 |
| Race/ethnicity, black vs non-Hispanic white | | | 1.75 [0.94–3.24] | 0.08 |
| Other vs non-Hispanic white | | | 0.82 [0.52–1.29] | 0.39 |
| Cancer diagnosis, vs no cancer | 1.10 [0.91–1.32] | 0.33 | | |
| Anxiety, vs no anxiety | 0.71 [0.51–0.97] | 0.03 | 1.68 [1.24–2.27] | <0.001 |
| Depression, vs no depression | 0.93 [0.70–1.24] | 0.62 | 1.22 [0.91–1.65] | 0.19 |
| PLOS (>75$^{th}$ percentile), vs No PLOS | 1.56 [1.16–2.09] | 0.003 | | |
| Site, Florida vs Rochester | 0.83 [0.64–1.07] | 0.14 | 1.63 [1.24–2.14] | <0.001 |
| Arizona | 0.76 [0.60–0.96] | 0.02 | 1.56 [1.22–2.01] | <0.001 |
| Discharge pain score ≥5, vs <5 | 0.32 [0.23–0.44] | <0.001 | 2.56 [1.99–3.28] | <0.001 |
| Unknown | 0.88 [0.58–1.34] | 0.56 | 0.96 [0.59–1.57] | 0.88 |

BMI indicates body mass index; PLOS, prolonged length of stay.

doses of opioids at discharge. Lastly, we were able to identify factors to help providers identify which dosing group to use. Our institution adopted these guidelines in the Department of Surgery in February of 2018; implementation was supported by training for prescribers, nursing and pharmacy and patient education.

The 2486 surgical patients included in this study resulted in an excess of 55,199 pills across all responders being at risk of diversion and misuse. Although better education regarding appropriate disposal is crucial, prescribing the correct amount of opioids should reduce the need to improve disposal practices. Similar to the findings from Lee et al,[29] our findings demonstrate that reducing opioid prescribing after surgery may not negatively impact patient experience, and even those who required a refill found it easy to obtain. Therefore, prescribing higher number opioids to avoid the inconvenience of a refill should not be considered as a barrier to limited initial discharge prescriptions.

The primary limitation of this study is that it includes only 3 affiliated academic medical centers. While our response rate was relatively high (75% with only 3% refusing), responder bias may exist. We also expect that there may be cognitive bias present that influenced the amount of opioids patients consumed given the amount available to them. As we prescribe fewer opioids, the number of opioids patients need may also decrease and therefore the prescribing guidelines we developed may need to be further tailored or reduced following ongoing monitoring of prescribing practices, refill rates, and patient utilization. Importantly, although we are able to identify high and low-opioid users, we were unable to determine which patients are at risk of long-term dependence. We also did not account for complications in our data other than through PLOS. Finally, we did not account for multimodal analgesia and regional anesthesia in this study, although these are commonly utilized at our institution.

## CONCLUSION

Following a large multicenter survey of patients, evidence-based, procedure-specific guidelines were developed to guide appropriate prescribing of opioids after surgery so that patients' pain is managed appropriately without exposing communities to the risk of opioid diversion and misuse.

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## DISCUSSANTS

### Dr Justin Dimick (Ann Arbor, MI):

Thank you, Dr Ellison, and to the ASA Program Committee for inviting me to discuss this paper. First, let me congratulate you, Dr Thiels. You have completed an American Surgical ''hat trick.'' This is your third consecutive presentation at the American Surgical. That is something to be very proud of and something that very few people have accomplished, especially as a surgical resident.

Second, let me congratulate you on what is a really wonderfully conducted study. One of my favorite things to do as a methods nerd is to poke holes in a study, and you do not have many at all. This is a superbly conducted survey study.

When I think about survey research, there are many ways to mess it up, and conduct a bad survey. One way to mess up a survey study is to ask an unimportant question. You have asked probably one of the premier questions facing surgery and U.S. health care and public health, so congratulations on that.

Another way to mess up a survey is to ask poorly designed questions. Having had access to your full manuscript, I can see that did many things right. You engaged the survey research group at Mayo, who brings expertise; you did pilot testing, you got feedback, and you did cognitive interviews. You did all the right things to make sure the questions you are asking will provide accurate results.

Finally, another way to mess up a survey is to have a really low response rate. You had a 75% response rate, which is high. So, I believe your results are right.

You confirmed some things that we already know. For example, that we prescribe way too many opioids, and that patients do not dispose of them. Less than 10% of people dispose of their excess opioids. We therefore have a large amount of pills at risk for diversion into our communities and fueling our public health crisis.

Your study also contributes some very new and unique findings. You generated reliable patient reports of actual use as opposed to what is prescribed. You also gave us procedure-specific data to inform guideline development, which is really important.

Perhaps the most important innovative thing you did was to form this multidisciplinary group to develop an implementation plan and procedure-specific prescribing guidelines. So, congratulations on taking your research findings all the way to close the loop to create an implementation plan.

I have a few questions for you. My first question is about the accuracy of patient reports. Do you think there is a cognitive bias at play in using patient reports for ''right-sizing'' opioid prescriptions? We give patients a big bottle of pills and we say, ''Here, take these at 4 to 6 hours PRN for pain.'' Then, they tell us how much they took. There is a framing effect here when we give them generous suggested amounts in our prescribing. How many patients took pills that they did not actually need for their pain because we told them to take them? Maybe the ''right'' amount is even lower than your prescribing guidelines suggest.

Second, what is next? Give us more details on the implementation. Most of us want to understand the details of your implementation plan so we can take them back to our institutions and use them.

My third question is, what are you going to do about advocacy? You have really important data here. There are currently federal and state policies to limit opioid prescribing for acute pain to as low as 3 days. In my own state and sounds like in your state, we are planning to limit acute pain prescribing to 7 days, which may be a problem as you showed from your Kaplan-Meier curve. These ''one–size–fits–all'' limits could create problems for a lot of procedures and could create a lot of unintended consequences. So, what are you going to do to make sure these data end up in the hands of policymakers who are currently pushing that legislation in D.C. and in our own state capitals?

### Response From Dr Cornelius A. Thiels:

Thank you, Dr Dimick. Regarding the first question, prior studies have shown that if you give less, it does not actually result in more refills. I think part of that is the expectation that if you give more opioids to patients they are going to feel they have to take them, just as you suggested. This suggests that if we give out less, people might actually need fewer opioids. While we are unable to assess this cognitive bias in this work, it is an important consideration when applying these data to practice and the guidelines may need to be revised in the future.

Regarding the accuracy of how much patients are using, I think this would be ideal for technology to count how many pills patients used out of a bottle and potentially even limiting how much can be dispensed automatically. While this technology remains pretty expensive, these are certainly areas for improvement.

Regarding the next step, implementation. We developed an online interactive module that was required to be taken by all of our primary prescribers, essentially our residents, NPs and PAs. It was narrated by one of our education leaders, Dr Farley, as we needed a leader who could help facilitate buy in from the prescribers. The guidelines were also endorsed from the Department of Surgery and we got support, most importantly, from pharmacy. Pharmacy has

actually been a major advocate in rolling out these guidelines because they are now starting to get requests from the insurance companies for prior authorization. So, for many scripts we write now for an opioid, we are now getting calls for prior authorization, which is very expensive and time-consuming, so pharmacist have been our number one advocate in reducing opioid prescribing to within the guidelines. Furthermore, educational emails were sent to all staff including attendings as well as pre-op clinic nurses. Patient education was provided to physicians and nurses, and we are developing formalized patient education materials. Having buy in from all these different groups, and especially the department leadership really helped with the roll out.

Lastly, we are continuing to prospectively call patients now that we have rolled out these guidelines across our Department in Rochester. While I suspect there will certainly be more implementation needed, we will be able to monitor this and I look forward to getting back to you about it in the future.

Lastly related to your question on advocacy. I think this is certainly our next step and something we want to look at. We have worked with some work groups in the state of Minnesota who are developing their own guidelines to try to adjust their guidelines because they are often more of a one-size-fits-all approach. I think this is something we need to act on quickly because guidelines are being written across the country and legislative bills are already being proposed that may place patients at risk.

### Dr John Daly (Philadelphia, PA):

I would compliment you as well for everything that you have done over these past several years to help us. Currently, in the House of Representatives, there is little north of 50 bills in various stages regarding opioids, prescribing education for surgeons and other physicians. So, your information is really important.

I have 2 questions. One is, did you survey what was done intraoperatively and perioperatively? For many of these procedures are outpatient procedures. How did you handle that in looking at what patients took postoperatively? How was their pain handled intraoperatively and perioperatively?

Second, did you have any questions at all about patient education, about how they should handle their pain management?

### Response From Dr Cornelius A. Thiels:

We did not look at the actual opioid prescribed during the hospitalization. Intraoperatively, we still use essentially 100% opioid-based anesthesia, although there are some groups around the country that are going to nonopioid-based anesthesia. In the perioperative period, we do have a lot of enhanced recovery processes, and about one-third of our patients get some type of regional anesthetics as well. So, it is something we commonly use. Our next step would be to look at that and see how that actually impacts perioperative and postdischarge pain control. As you suggested, while many of the procedure are outpatient procedures, we did have some very major operations included as well, but for the outpatient procedures, there are limited perioperative data from their hospitalization.

Regarding the patient education question, we did ask patients about their use of multimodal analgesia, other alternative pain control strategies, as well as additional patient-reported outcomes questions about their pain control and more detailed analysis of this is one of our next steps.

### Dr Feza Remzi (New York, NY):

Quickly, did you adjust for the diagnosis of these patients?

Let me follow up. On these complex patients with inflammatory bowel disease or reoperative surgery because it is a different beast, and every time I hear a guideline, my blood pressure goes up a little bit more. So, how are we going to award the guideline not to override the common sense of these patients who legitimately have a major issue not to get dragged into the system, that the pharmacy is going to block your insurance and everything? Because this is a very critical point that I am very passionate about for these patients. Thank you for a great job.

### Response From Dr Cornelius A. Thiels:

Thank you. Those are great questions. Regarding the diagnosis, we did look at patients who had a cancer versus noncancer diagnosis particularly. And while cancer diagnosis was associated with how much patients used on an unadjusted univariate analysis, it turned out that was not significant on the multivariable analysis.

We also looked at history of anxiety and depression, and actually that was strongly associated with opioid consumption. We included that in the results of our study but did not include that in the guidelines because we do not yet really understand if these patients need more pain medication and/or at risk of increased of long-term dependency. I think a more thorough understanding of this is certainly needed.

And your question about guidelines is certainly appropriate and important. We try to roll these out as more of a recommendation and tried to emphasize to providers' that judgment does take priority over these recommendations. However, most prescribers are actually very desperate to have some type of recommendation, because for the prescribers have historically given an arbitrary number, and they were actually very interested in using guidelines to help them give the right amount. Lastly, in order to avoid leaving patients in pain, we included a 3-tiered approach that included a higher dose group, instead of just 1 number for each procedure, so we hope that that helps prevent this problem.

### Dr Richard C. Thirlby (Seattle, WA):

This is a spectacular study. I do not know who made 2500 phone calls, but they are to be commended. I think you said that you did not quantify non-narcotic analgesic consumption, which is unfortunate. I would strongly suggest that you create a protocol with patient education material facilitates aggressive use of non-narcotic pain meds. At Virginia Mason, our patients receive a written protocol with scheduled NSAIDs, acetaminophen, gabapentin. You will find that patients are very poorly informed about the appropriate use of non-narcotics. You will find that it is possible to improve your results even more.

### Response From Dr Cornelius A. Thiels:

That is a great question. We certainly have our survey research center to thank for contacting all these patients. Regarding the non-narcotic pain medication consumption, we actually did have some questions about it and about 80% of patients reported taking the nonopioid-based pain medications after discharge and all of our discharge recommendations include taking nonopioid-based pain medications as a baseline. However, while we do try to educate patients on this and have it in the discharge paperwork that does not necessarily ensure that the patients understand the importance of it or actually follow the directions, so this is something we certainly need to work on. And while most patients are using them, it is not all, so we have more to do.

### Dr William Richards (Mobile, AL):

Dr Thiels, congratulations on a nicely presented and performed study. I am struck by the low amount of narcotic use in the partial colectomy group compared to nephrectomy. In those 2 groups, I would expect about the same amount of narcotic use. Yet,

the patients undergoing nephrectomy used about twice as many narcotics. Is that because of the ERAS protocols and the use of preoperative non-narcotics and the use of local anesthetic blocks that the colorectal surgeons are doing?

## Response From Dr Cornelius A. Thiels:

Thank you, Dr Richards. We were surprised by the findings that tonsillectomy and nephrectomy required significantly more opioid than we expected, but going back to the specialties, they were actually not as surprised by that. We do heavily use ERAS protocols in colorectal, and the colectomy patients typically stay 3 or 4 days usually, and a lot of times they are able to get off more opioids by then. We also found that some open operations actually do not have significantly more opioid requirement than the minimally invasive ones, which was a very surprising finding and needs to be explored more.