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.

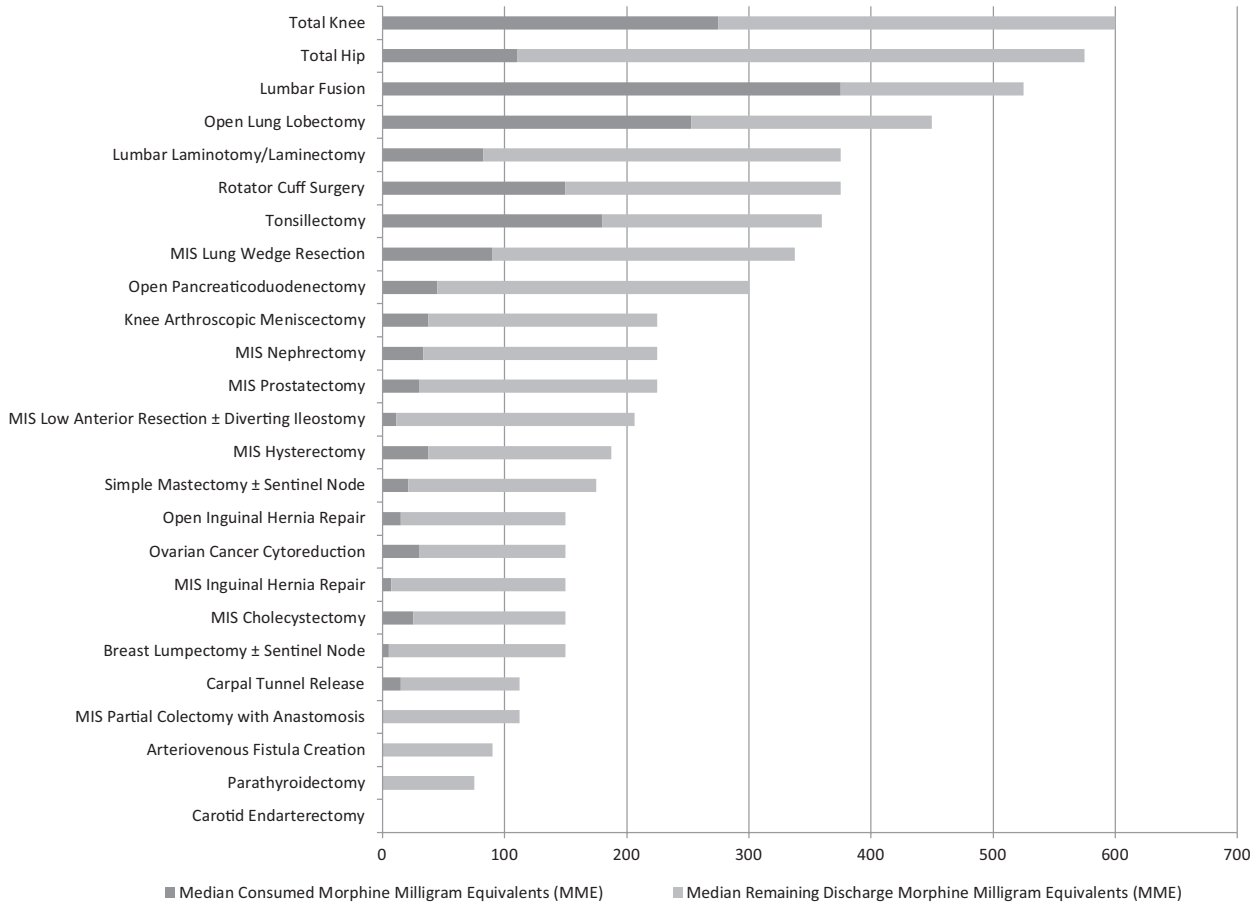

FIGURE 1. Amount of opioids prescribed versus used in opioid-naive patients after discharge for 25 elective procedures.

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 ± 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.

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 >75th 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.