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## Primary Arthroplasty

## Prescribing and Consumption of Opioids After Primary, Unilateral Total Hip and Knee Arthroplasty in Opioid-Naive Patients



Karl C. Roberts, MD <sup>a</sup>, Stephanie E. Moser, PhD <sup>b</sup>, Angela C. Collins, MD, PhD <sup>c</sup>, Brian R. McCardel, MD <sup>d</sup>, Kyle A. Schultz, DO <sup>e</sup>, Nathaniel E. Schaffer, MD, PhD <sup>f</sup>, Joseph S. Tramer, MD <sup>g</sup>, Creg A. Carpenter, MD <sup>h</sup>, Jennifer M. Pierce, PhD <sup>b</sup>, Alan Edwards, MD <sup>a</sup>, Kendall M. Dubois, MS <sup>b</sup>, Chad M. Brummett, MD <sup>b,\*</sup>

<sup>a</sup> Orthopedic Surgery, Spectrum Health, Grand Rapids, MI

<sup>b</sup> Anesthesiology, University of Michigan, Ann Arbor, MI

<sup>c</sup> Orthopedic Surgery, McLaren Flint, Flint, MI

<sup>d</sup> Orthopedic Surgery, Sparrow Hospital, Lansing, MI

<sup>e</sup> Orthopedic Surgery, Ascension Genesys Hospital, Grand Blanc, MI

<sup>f</sup> Orthopedic Surgery, University of Michigan, Ann Arbor, MI

<sup>g</sup> Orthopedic Surgery, Henry Ford Hospital, Detroit, MI

<sup>h</sup> Orthopedic Surgery, St. Joseph Mercy Chelsea Hospital, Chelsea, MI

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## ABSTRACT

**Background:** This cohort study was designed to determine the discrepancy between the quantity of opioid prescribed vs that which was consumed after total knee arthroplasty (TKA) and total hip arthroplasty (THA) in opioid-naive patients.

**Methods:** Seven hundred twenty-three opioid-naive patients (426 TKAs and 297 THAs) from 7 hospitals in Michigan were contacted within 3 months of their surgery. Opioid prescribing and self-reported consumption was calculated in oral morphine equivalents (OMEs). Secondary outcomes included opioid refill in the first 90 days, pain in the first 7 days post-operatively, and satisfaction with pain care. **Results:** For TKA, the mean prescribing was 632 mg OME ( $\pm 229$ ), and the mean consumption was 416 mg ( $\pm 279$ ). For THA, the mean prescribing was 584 mg OME ( $\pm 335$ ), and the mean consumption was 285 mg ( $\pm 301$ ). There were no associations between the amount of opioid prescribed and the likelihood of refill, post-operative pain, or satisfaction with pain control. The amount of opioid prescribed was associated with increased consumption, such that each increase of 1 pill was associated with approximately an additional half pill consumed after adjusting for other covariates. Moreover, 48.2% felt that they received “More” or “Much more” opioid than they needed.

**Conclusion:** We recommend no more than 50 tablets of 5 mg oxycodone or its equivalent after TKA and 30 tablets after THA. Although dose reductions in other surgeries have not resulted in harm, continued assessment is needed to ensure that there are no unintended effects of opioid reduction, including worsened pain, decreased satisfaction, emergency department visits, or hospital readmissions.

**Level of Evidence:** Level III; Retrospective, cohort study;

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\* Reprint requests: Chad M. Brummett, MD, Division of Pain Medicine, Department of Anesthesiology, University of Michigan Medical School, 1500 East Medical Center Drive, 1H247 UH, PO Box 5048, Ann Arbor, MI 48109.

Chronic opioid use and opioid use disorder represent significant public health challenges in the United States currently and are one of the few public health problems that continue to worsen [1–3]. Although pain management and primary care physicians may prescribe the majority of the opioids in the United States [4,5], the most common first exposure to opioids comes from acute care prescriptions (eg, surgery, dentistry, and emergency medicine). Surgery is a common cause of new chronic opioid use with 6%–15% of opioid-naïve patients becoming chronic users after major or minor surgery [6–11], including 4% of total hip arthroplasty (THA) and 8% of total knee arthroplasty (TKA) patients [9]. Opioids are often prescribed in excess, with current estimates suggesting that up to ~75% of the pills prescribed go unused [12,13]. Excess pills become a potential source of diversion and misuse, including abuse in teens and adolescents [14]. Despite this public health crisis, physicians receive a paucity of education on opioid prescribing and post-operative pain management, and as such there remains high variability in post-surgical opioid prescribing among providers and institutions [15,16]. In addition, there exists very little research to guide post-surgical prescribing practices and enable physicians to appropriately align the post-operative pain management needs of patients with the amount of opioids prescribed.

Previous research has shown no association between the amount of pain medication prescribed post-operatively and patient satisfaction [17] or refill requests [18,19]. Rather, patients who are prescribed more opioids tend to consume more [18–20]. This creates increased opportunity for misuse or abuse, and also results in increased medication-related side effects [21].

TKA and THA are 2 of the most commonly performed surgeries in the United States annually for the treatment of chronic pain and disability. Over 1.3 million surgeries were performed in 2015 and these numbers are expected to increase [22,23]. There are currently no data available regarding appropriate opioid prescribing following hospital discharge after TKA and THA. The purpose of this study is to evaluate the potential mismatch between prescribing and patient-reported consumption following TKA and THA at multiple hospitals in the state of Michigan. We further studied the associations among the amount prescribed and opioid refill rates, self-reported pain, and patient satisfaction. From these data we provide the first evidence-based recommendations for opioid prescribing after TKA and THA.

## Materials and Methods

We identified eligible patients by examining local database records from 7 hospitals across the state of Michigan that are members of the Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI): University of Michigan (Ann Arbor, MI), Spectrum Health (Grand Rapids, MI), Hurley Center (Flint, MI), Henry Ford (Detroit, MI), St. Joseph Mercy Chelsea (Chelsea, MI), Sparrow Hospital (Lansing, MI), and Genesys Regional Medical Center (Grand Blanc, MI). This protocol was considered as quality improvement and, therefore, deemed not regulated by the University of Michigan Institutional Review Board. Informed consent was not obtained. Data regarding consumption of opioids and satisfaction with pain management were obtained retrospectively based on patient recall surveyed after 3 months from surgery. Patients were not instructed to count pills prospectively. Study reporting conforms to the Strength in Reporting of Observational Studies (STROBE) guidelines [24].

This retrospective cohort study included opioid-naïve patients aged 18 years and older who underwent elective, primary TKA or THA between September 2017 and December 2017. Any patients with reported pre-operative opioid use in the electronic health record, including tramadol, were excluded. Patients were contacted

by phone 3 months from surgery, with some variability due to challenges in contacting the large number of patients. Patients were surveyed about the number of opioid pills they had used from their first prescription following surgery, refills in the first 90 days, their use of non-opioid analgesics, their pain level in the first week after their surgery, and satisfaction with their pain care (Survey included [Appendix](#)). The amount of opioid prescribed was obtained from the medical record and confirmed with the patient by phone. Local MARCQI data were used to collect gender, age, race, surgical approach, anesthesia type, pre-operative smoking, alcohol, and American Society of Anesthesiologists (ASA) class. A formal power analysis was not done a priori as we were unable to estimate an effect size in this observational study.

## Outcomes

Our primary outcome was the patient-reported total amount of opioids consumed from the initial prescription following TKA or THA. Secondary outcomes were pain in the first week after surgery, overall satisfaction with pain management, and perception of amount of pain medication prescribed following surgery. Pain during the first week after surgery was assessed with a single 4-point item with the following categories: no pain, minimal pain, moderate pain, and severe pain. Satisfaction with pain management was assessed on a 10-point scale ranging from 1 (extremely dissatisfied) to 10 (extremely satisfied). Perception of amount of pain medication prescribed following surgery was assessed with the following categories: much less than I needed, less than I needed, about right, more than I needed, and much more than I needed.

Opioid prescribing and consumption were converted into oral morphine equivalents (OMEs) and number of 5 mg oxycodone pills. Secondary outcomes, or pain in the first week after surgery and overall satisfaction with pain management, were available for 478 respondents (273 TKAs and 205 THAs).

## Statistical Analysis

Descriptive statistics of pre-surgical patient characteristics, amount of opioids prescribed, and amount consumed were computed for the total sample and for TKA and THA patients separately. The association between quantity of prescribed opioid and probability of refill was assessed using logistic regression. The associations between quantity of prescribed opioids and pain following surgery, satisfaction with pain management, and perception of amount of pain medication prescribed following surgery were assessed with univariable linear regression models or 1-way analysis of variance models for TKA and THA separately. Univariable and multivariable linear regression models predicting total opioids consumed from each predictor from the MARCQI dataset were conducted separately for TKA and THA. Clustered standard errors were used to adjust for clustering within hospitals. All analyses were conducted with Stata 14.1.

## Results

Means and standard deviations of pre-surgical patient characteristics are presented in [Table 1](#). Patients had an average age of 67.2 ( $\pm 9.6$ ) and had an average body mass index of 31.2 ( $\pm 5.6$ ). A majority of patients were female (56.7%), white (88.9%), non-tobacco users (55.5%), received neuraxial anesthesia (87.0%), and stayed in the hospital 0–1 days (60.3%). After exclusions the final cohort consisted of 723 (426 TKAs and 297 THAs) opioid-naïve eligible patients ([Fig. 1](#)).

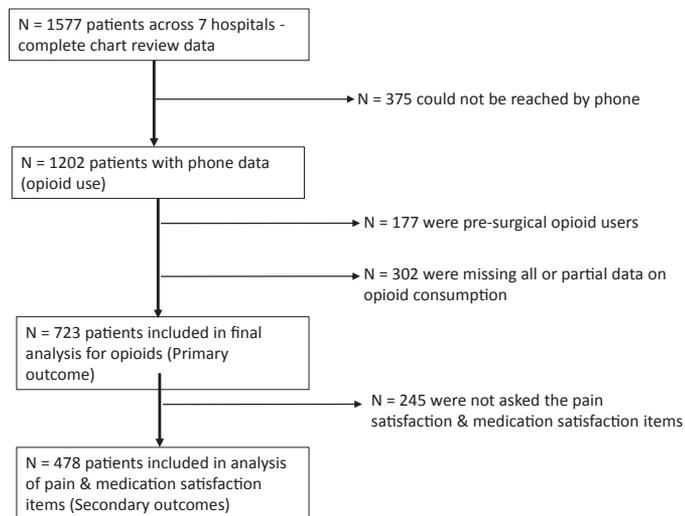
**Table 1**  
Pre-Surgical Patient Characteristics for Full Sample and TKA and THA Surgeries.

	Overall (n = 723), n (%)	Knee (n = 426), n (%)	Hip (n = 297), n (%)
Male	312 (43.3%)	169 (40.0%)	143 (48.2%)
Age	67.2 (9.6)	68.2 (8.6)	65.6 (10.7)
White	638 (88.9%)	373 (88.4%)	265 (89.5%)
BMI	31.2 (5.6)	32.1 (5.5)	30.0 (5.6)
Alcohol use			
None	242 (33.7%)	145 (34.4%)	97 (32.7%)
Yes, amount unknown	130 (18.1%)	76 (18.0%)	54 (18.2%)
Yes, ≤1 drink per week	110 (15.3%)	70 (18.0%)	40 (13.5%)
Yes, 2-7 drinks per week	182 (25.3%)	99 (23.5%)	83 (28.0%)
Yes, ≥8 drinks per week	55 (7.6%)	32 (7.6%)	23 (7.7%)
Tobacco use			
Never	399 (55.5%)	235 (55.6%)	164 (55.4%)
Former	279 (38.8%)	171 (40.4%)	108 (36.5%)
Current	41 (5.7%)	17 (4.0%)	24 (8.1%)
ASA			
1	10 (1.4%)	4 (1.0%)	6 (2.0%)
2	378 (52.5%)	208 (49.2%)	170 (57.2%)
3	322 (44.7%)	203 (48.0%)	119 (40.1%)
4	10 (1.4%)	8 (1.9%)	2 (0.7%)
Anesthesia			
General anesthesia	93 (13.0%)	60 (14.3%)	33 (11.1%)
Neuraxial	625 (87.0%)	361 (85.8%)	264 (88.9%)
Block	231 (32.1%)	214 (50.6%)	17 (5.7%)
Length of stay (d)			
0-1	434 (60.3%)	233 (55.1%)	201 (67.7%)
2	197 (27.4%)	137 (32.4%)	60 (20.2%)
3+	89 (12.4%)	53 (12.5%)	36 (12.1%)
OME prescribed	612.2 (278.1)	631.5 (228.9)	584.2 (334.9)
Approach: knee			
Medial		352 (83.4%)	
Mid-vastus		65 (15.4%)	
Sub-vastus		5 (1.2%)	
Approach: hip			
Anterior			92 (31.3%)
Posterior			204 (68.7%)

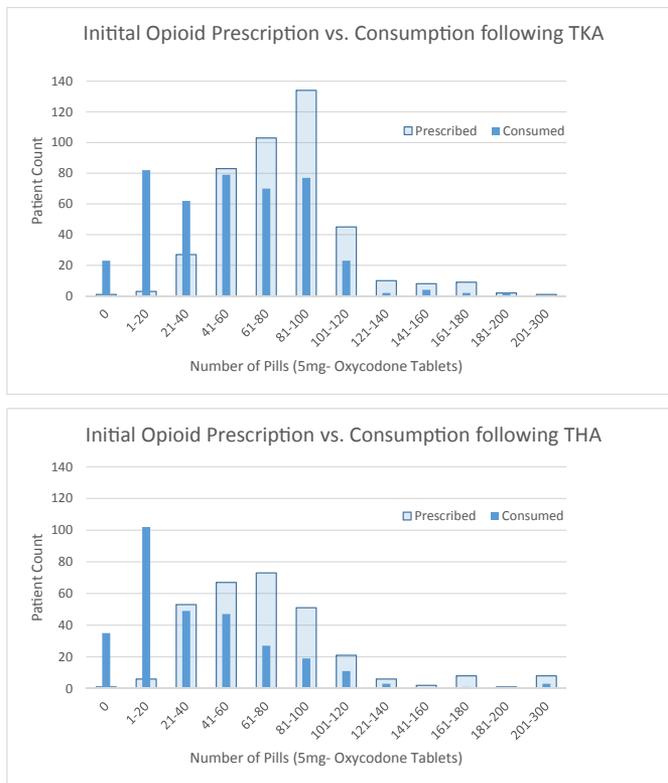
THA, total hip arthroplasty; TKA, total knee arthroplasty; BMI, body mass index; ASA, American Society of Anesthesiologists; OME, oral morphine equivalents. Means and standard deviations reported for continuous variables.

**Opioid Prescribing and Consumption**

For TKA patients, the mean amount of opioid prescribed was 632 mg OME (±229) while the mean consumption was 416 mg (±279), which is equal to 84 pills prescribed and 55 pills consumed of 5 mg oxycodone. For THA patients, the mean prescribing was 584



**Fig. 1.** Participant flow diagram.



**Fig. 2.** Initial opioid prescribed vs consumed following TKA or THA.

mg OME (±335) while the mean consumption was 285 mg (±301), which is equal to 78 pills prescribed and 38 pills consumed of 5 mg oxycodone (Fig. 2). Fifty percent of patients consumed equal to or less than the equivalent of 55 and 29 tablets of 5 mg oxycodone for TKA and THA, respectively.

Less than half of TKA patients (42.6%) and less than one-quarter (22.0%) of THA patients received a refill. The amount of opioids in the initial prescription was not related to the odds of receiving a refill in either TKA (odds ratio 0.99, standard error = 0.0004, P = .891) or THA patients (odds ratio 0.99, standard error = 0.0004, P = .698).

**Pain and Satisfaction**

For TKA, 4 (1.5%) patients reported no pain, 70 (25.7%) reported minimal pain, 138 (50.7%) reported moderate pain, and 60 (22.1%) reported severe pain in the week following surgery. TKA patients had a mean score of 8.6 (±1.9) out of 10 on the pain satisfaction item. Forty-five (16.5%) TKA patients reported having “much more pain medication than needed” and 70 (25.7%) patients reported having “more pain medication than needed.” One hundred seventeen (43.0%) patients indicated that the amount of pain medication was “about right,” 29 (10.7%) indicated they received “less than needed,” and 11 (4.0%) reported “much less than needed.” Interestingly, the amount of opioids prescribed was not related to pain during the week following surgery (P = .293), satisfaction with pain management (P = .895), or perception of amount of pain medication prescribed following surgery (P = .851).

For THA, 10 (4.9%) patients reported no pain, 79 (38.5%) reported minimal pain, 97 (47.3%) reported moderate pain, and 19 (9.3%) reported severe pain in the week following surgery. THA patients had a mean score of 9.0 (±1.5) out of 10 on the pain satisfaction item. Fifty (25.6%) THA patients reported having “much more pain medication than needed” and 60 (30.8%) patients reported having

**Table 2**  
Univariable Linear Regression Models Predicting Total Opioid (OME) of Opioids Consumed of Initial Prescription for TKA and THA Patients.

	Knee (n = 418)			Hip (n = 295)		
	Coefficient	SE	P-Value	Coefficient	SE	P-Value
Male	−38.9	51.1	.476	−17.4	15.5	.306
Age	<b>−10.0</b>	<b>1.6</b>	<b>.001</b>	<b>−8.0</b>	<b>2.9</b>	<b>.035</b>
White	−37.9	40.9	.390	−104.8	121.0	.420
BMI	6.8	3.8	.120	3.1	1.3	.057
Alcohol use						
None (reference)						
Yes, amount unknown	28.1	36.5	.470	−67.7	29.1	.059
Yes, ≤1 drink per week	−1.4	42.0	.974	30.6	27.3	.305
Yes, 2–7 drinks per week	<b>44.0</b>	<b>13.0</b>	<b>.015</b>	−55.9	33.6	.147
Yes, ≥8 drinks per week	126.9	92.8	.220	55.4	77.7	.502
Tobacco use						
Never (reference)						
Former	1.8	22.0	.937	−6.5	22.3	.780
Current	112.6	83.6	.227	<b>391.0</b>	<b>91.5</b>	<b>.005</b>
ASA						
1 (reference)						
2	−62.9	43.3	.196	86.0	79.7	.322
3	−89.5	42.3	.079	84.4	130.5	.542
4	<b>−147.5</b>	<b>49.4</b>	<b>.024</b>	255.0	328.7	.467
Anesthesia						
General anesthesia (reference)						
Neuraxial	−16.5	26.8	.560	−22.2	67.9	.755
Block	−50.7	27.3	.112	64.1	33.8	.107
Length of stay (d)						
0–1 (reference)						
2	−37.7	55.0	.519	134.9	76.1	.126
3+	−76.4	53.5	.204	−11.5	67.5	.870
Opioid (OME) prescribed	<b>0.6</b>	<b>0.1</b>	<b>&lt;.001</b>	<b>0.51</b>	<b>0.04</b>	<b>&lt;.001</b>
Approach						
Medial (reference)						
Mid-vastus	−49.9	28.5	.130			
Sub-vastus	<b>−194.0</b>	<b>61.6</b>	<b>.020</b>			
Approach						
Anterior (reference)						
Posterior				−36.3	48.3	.480

Note: Clustered standard errors were used to account for clustering within hospitals.

Bolded text indicates statistical significance at  $P < .05$  or less.

THA, total hip arthroplasty; TKA, total knee arthroplasty; OME, oral morphine equivalents; SE, standard error; BMI, body mass index; ASA, American Society of Anesthesiologists.

“more pain medication than needed.” Seventy-three (37.4%) indicated that the amount of pain medication was “about right,” 9 (4.6%) indicated they received “less than needed,” and 3 (1.5%) indicated “much less than needed.” The amount of opioid prescribed was related to pain during the week following surgery ( $P = .021$ ), with a post hoc test revealing that those who rated their pain as “severe” were prescribed *more* opioid medication than those who reported no pain (Bonferroni adjusted  $P = .033$ ). The amount of opioid prescribed was not statistically significantly related to satisfaction with pain management ( $P = .096$ ), or perception of amount of pain medication prescribed following surgery ( $P = .314$ ).

#### Predictors of Opioid Use After Discharge

Univariable regression models predicting total OME consumed for TKA and THA respectively are presented in Table 2. Younger age ( $P < .001$ ) and greater amount of opioid prescribed ( $P < .001$ ) were associated with increased opioid consumption following TKA. Patients with an ASA score of 4 used significantly fewer opioids than patients with an ASA score of 1 ( $P = .024$ ). Patients who underwent TKA with the subvastus approach used fewer opioids than those who underwent the medial approach ( $P = .020$ ). For THA, younger age ( $P = .035$ ), current tobacco use ( $P = .005$ ), and greater amount of opioid prescribed ( $P < .001$ ) were associated with increased opioid consumption.

Multivariable models are presented in Table 3. For TKA, younger age ( $P < .001$ ), greater body mass index ( $P = .033$ ), an ASA class of 1

( $P < .001$ ), length of stay (LOS) 3 or more days ( $P = .028$ ), and greater amount of opioid prescribed ( $P < .001$ ) were associated with increased opioid consumption following surgery. After adjustment, patients consumed 0.6 pills more for every additional pill prescribed following TKA. No significant difference was seen among the surgical approaches in the multivariable model. For THA, current smoking was associated with increased opioid consumption compared to non-smokers (reference group) ( $P < .001$ ). Furthermore, LOS of 2 days was associated with greater opioid consumption than those with shorter stays ( $P = .015$ ). Greater amount of opioid prescribed was also associated with an increased opioid use of 0.4 pills following THA for each additional 1 pill prescribed after adjustment ( $P = .002$ ). No significant difference was seen in opioid consumption between the direct anterior and posterior approach for THA. When assessing the raw LOS values (range 0–8), there was no apparent positive correlation between LOS and the initial opioid prescription for TKA ( $r = -0.07$ ,  $P = .125$ ) or THA patients ( $r = -0.03$ ,  $P = .611$ ).

#### Discussion

Our data procured from 7 hospitals in Michigan demonstrate that opiate-naïve patients, on average, consumed far fewer opioid pain pills than were prescribed after primary TKA and THA. We did not find any association between the amount of opioid prescribed and the likelihood of refill, post-operative pain, or satisfaction with pain control. Moreover, 48.2% felt that they received “More” or

**Table 3**  
Multivariable Linear Regression Models Predicting Total Opioid (OME) of Opioids Consumed of Initial Prescription for TKA and THA Patients.

	Knee (n = 418)			Hip (n = 295)		
	Coefficient	SE	P-Value	Coefficient	SE	P-Value
Male	−62.6	29.5	.078	−24.5	27.4	.406
Age	<b>−6.1</b>	<b>0.6</b>	<b>&lt;.001</b>	−3.2	2.2	.199
White	−59.5	28.3	.080	−90.4	102.1	.410
BMI	<b>3.8</b>	<b>1.4</b>	<b>.033</b>	2.5	3.3	.471
Alcohol use						
None (reference)						
Yes, amount unknown	−10.5	17.0	.559	−95.6	43.8	.072
Yes, ≤1 drink per week	23.6	25.9	.397	13.5	43.6	.767
Yes, 2–7 drinks per week	29.8	21.8	.221	−35.7	48.7	.491
Yes, ≥8 drinks per week	111.5	84.1	.233	40.8	105.0	.711
Tobacco use						
Never (reference)						
Former	9.1	17.5	.624	6.2	15.5	.705
Current	62.1	61.6	.352	<b>244.7</b>	<b>39.5</b>	<b>.001</b>
ASA						
1 (reference)						
2	<b>−124.9</b>	<b>15.7</b>	<b>&lt;.001</b>	50.5	58.9	.425
3	<b>−147.4</b>	<b>19.5</b>	<b>&lt;.001</b>	57.5	82.9	.514
4	<b>−107.3</b>	<b>19.4</b>	<b>.001</b>	−47.8	303.1	.880
Anesthesia						
General anesthesia (reference)						
Neuraxial	3.6	30.8	.911	11.3	42.6	.799
Block	−27.1	24.3	.308	16.1	41.4	.711
Length of stay (d)						
0–1 (reference)						
2	12.2	26.7	.663	<b>89.4</b>	<b>26.6</b>	<b>.015</b>
3+	<b>−60.3</b>	<b>20.9</b>	<b>.028</b>	39.3	39.1	.354
OME prescribed	<b>0.6</b>	<b>0.1</b>	<b>&lt;.001</b>	<b>0.4</b>	<b>0.1</b>	<b>.002</b>
Approach						
Medial (reference)						
Mid-vastus	−71.3	32.5	.071			
Sub-vastus	16.8	32.6	.624			
Approach						
Anterior (reference)						
Posterior				−6.5	21.790	.777

Note: Clustered standard errors were used to account for clustering within hospitals.

Bolded text indicates statistical significance at  $P < .05$  or less.

THA, total hip arthroplasty; TKA, total knee arthroplasty; OME, oral morphine equivalents; SE, standard error; BMI, body mass index; ASA, American Society of Anesthesiologists.

“Much more” opioid than they needed. The excess opioids created by overprescribing are at risk of being misused, abused, and diverted into the community [14,25,26].

The results of the present study build on a growing body of literature about opioid overprescribing after surgery [12,13,20]. Our results show that the majority of patients reported high satisfaction with their pain management and received enough or more than enough opioids at discharge. Only a minority of patients (15% TKA, 6% THA) reported that they did not receive enough opioids at discharge. Identifying the differences between these groups warrants further research such that prescribing patterns can be aligned with patient needs following TKA and THA such that all patients have adequate pain management. Our data showed differences in predictors between TKA and THA (Table 3). No significant difference was seen in opioid consumption between the direct anterior and posterior approach for THA. In a recent study of more than 5000 general and gynecologic surgery patients from 33 Michigan hospitals, one of the strongest predictors for the amount of opioid used was the amount prescribed [20]. The effect of increased prescribing between the previous study and our study was remarkably similar with an additional half pill consumed for every additional pill prescribed after adjusting for other covariates.

It is important to note that our data did not show a correlation between the amount of the initial opioid prescription and the need for refills, satisfaction with pain management, or the reported level of pain in the first week. This is in line with previous studies in other

surgical conditions [18,20,27,28]. This further refutes a popular myth that reduced opioid prescribing may lead to either decreased patient satisfaction from increased pain, or inconvenience for patients and physicians having to deal with increased refill requests as neither were found to occur. Longer LOS was predictive of increased opioid consumption after discharge and this could reflect selection of a subset of patients with more severe pain peri-operatively as increased LOS has been shown to correlate with pain [29]. However, the fact that the relationship between opioid prescribed and opioids consumed remains consistent after adjusting for a set of covariates, including LOS, provides evidence that amount of pills prescribed is independently associated with opioid consumption.

Although our findings were consistent between TKA and THA patients with regards to variability in prescribing patterns and the trend toward overprescribing, there were some interesting differences. THA patients had slightly higher overall satisfaction with their pain management following surgery than TKA patients (9.0/10 compared to 8.6/10) despite lower amounts of pain medication prescribed, and also required roughly half as many refills (22% compared to 43%). Fewer THA patients reported receiving not enough pain medication at discharge compared to TKA patients (6% and 15%, respectively). Many physicians prescribe the same amount of opioids following TKA and THA, yet our data suggest that THA patients require less opioid pain medication than TKA patients and therefore prescribing patterns for these procedures should be different.

## Prescribing Recommendations

Based on our data, along with new prescribing limits of 7 days or less in many states and the recommendation to limit the daily opioid dose  $\leq 50$  mg OME, we recommend 50 tablets of oxycodone or its equivalent for TKA and 30 tablets for THA. These recommendations meet the approximately 50th percentile for opioid consumption in this cohort. These recommendations would represent a decrease from currently observed prescribing patterns of 41% for TKA and 61% for THA. In the State of Michigan, where over 56,000 primary THAs and TKAs are done annually with volume increasing (MARCQI data 2017), this would represent over 2.1 million fewer pills prescribed annually (oxycodone 5 mg equivalent) in the State of Michigan alone. If these recommendations were followed nationally, it would represent over 70 million fewer opioid pills prescribed annually based on current trends in utilization of THA and TKA [22,23].

## Strengths and Limitations

Our study captures a large number of patients across the State of Michigan from multiple healthcare institutions including academic and non-academic medical centers of varying size. It is the first such study not only to assess the variability, prescribing patterns, and opioid consumption following THA and TKA but to make recommendations regarding opioid prescribing. This effort leverages the very strong collaborative structure in Michigan (MARCQI), which currently captures 95% of the TKAs and THAs done in Michigan. The MARCQI statewide joint registry not only facilitated the data collection but will also be leveraged to change the described prescribing patterns by adopting these recommendations throughout our state as performance measures.

There are certain limitations of our study that should be noted. The amount of opioids prescribed was able to be abstracted from the clinical record, but we were only able to analyze the amount of the initial prescription consumed. In addition, recall error can be expected 3 months following a procedure and patient satisfaction with post-surgical pain control may be affected by multiple variables when recalled retrospectively, not the least of which is overall satisfaction with the procedure itself. Finally, any study involving pain management is subject to multiple confounding variables including patients' subjective response to pain, complexity of surgery, surgical technique, multimodal pain management strategies, anesthesia techniques, length of hospital stay, and psychosocial factors. All of these factors could account for differences in post-operative pain that would not be identified in this study.

## Conclusion

We recommend no more than 50 tablets of 5 mg oxycodone or its equivalent after TKA and 30 tablets after THA. Although dose reductions in other surgeries have not resulted in harm, continued assessment is needed to ensure that there are no unintended effects of opioid reduction, including worsened pain, decreased satisfaction, emergency department visits, or hospital readmissions.

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Appendix

**Postoperative Patient Survey**

1. Did you take any opioid pain medications daily or most days before your {NAME OF SURGERY} on {DATE OF SURGERY}? *Examples of opioids include hydrocodone (Vicodin, Norco), oxycodone (Percocet), morphine, fentanyl, methadone.*
    - a. No
    - b. Yes
      - i. If Yes:
        1. What was the name of the medication?
        2. What was the dose?
        3. How many pills did you take/day?
        4. Did you continue this medication after your surgery?
          - a. No
          - b. Yes:
            - i. How many pills did you take/day?
            - ii. Are you currently taking this medication?
              - a. No
                - i. When did you stop taking this medication?
              - b. Yes
2. In reviewing data from your medical record, I see that you were discharged with {MEDICATION NAME} after your {NAME OF SURGERY}. Did you fill this prescription? *(If discharge medications are unknown, "Were you discharged with a prescription for opioid pain medications? If so, did you fill this medication?")*
  - a. No *(if no, skip to Question 8)*
  - b. Yes
3. I see that you were given {NUMBER OF PILLS}. Do you remember how many pills you used?
  - a. Allow patient to estimate number of pills:
  - b. If patient unable to remember exact number, provide the following choices:
    - i. None
    - ii. Estimate number within 5 pills (e.g. 1-5, 6-10, 11-15, etc): \_\_\_\_\_ pills
    - iii. All of the pills
  - c. If patient unable to estimate within 5 pills:
    - iv. None
    - v. About a quarter (25%) of the pills
    - vi. About half (50%) of the pills
    - vii. About three quarters (75%) of the pills
    - viii. All of the pills
4. *(Only ask if they used all the pills in question 3)* Did you need to refill the prescription for {NAME OF MEDICATION} you were given after your surgery or a different opioid pain medication prescription after you left the hospital?
  - a. No
  - b. Yes
    - i. If yes, how many times did you refill your opioids?
5. And do you remember the number of days you took {NAME OF MEDICATION}?
  - a. Allow patient to estimate number of days:
  - b. If patient unable to remember exact number, provide the following choices:
    1. 0 days (not used)
    2. 1-3 days
    3. 4-7 days
    4. 1-2 weeks
    5. 2-4 weeks
    6. 4-6 weeks
    7. 6-8 weeks
    8. More than 8 weeks
    9. Still taking today *(ask question 6)*
6. *(Only ask if still taking the medication in question 5)* Since you are still taking {NAME OF MEDICATION}, what are you currently taking it for?
  - a. Surgical pain
  - b. Other pain (please describe)
    - i. Is this new pain after your surgery?
      - a. No
      - b. Yes
7. How would you describe the amount of opioid pain pills that you received after you left the hospital?
  - a. Much less than I needed
  - b. Less than I needed
  - c. About right
  - d. More than I needed
  - e. Much more than I needed
8. Besides the {pre-procedural opioid} and the {post-procedural opioid}, did you take any other opioid pain medication in the 3 months after your {NAME OF SURGERY}? *(If they did not take a pre- or post-procedural opioid "Did you take any other opioid pain medication in the 3 months after your {NAME OF SURGERY}?"*)
  1. Hydrocodone (Norco, Vicodin)
  2. Oxycodone
  3. Oxymorphone (should be rare)
  4. Hydromorphone (Dilaudid)
  5. Tramadol (Ultram)
  6. Morphine
  7. Fentanyl patch
  8. Methadone
  9. Buprenorphine (suboxone, subutex, Butrans)
  - a. No
  - b. Yes
    - i. Can you please estimate the number of pills/day you took of each?
    - ii. Who prescribed this medication?
      - a. Surgeon
      - b. PCP
      - c. ER
      - d. Urgent Care
      - e. Other (please describe)
    - iii. What are you currently taking this opioid pain medication for? (Select all that apply)
9. Did you take medications like ibuprofen, Motrin, Celebrex or naproxen after you left the hospital to treat your pain?
  - a. No
  - b. Yes
10. Did you take Tylenol or acetaminophen after you left the hospital to treat your pain?
  - a. No
  - b. Yes
11. Did you take any other pain medications in the 3 months after your {NAME OF SURGERY}? This can include other prescription medications or medications like gabapentin (Neurontin), Lyrica, duloxetine (Cymbalta), or other medications use for pain.
  - a. No
  - b. Yes
    - i. What was the name of the medication?
12. Thinking back, how would you rate your pain in the week after you left the hospital after your {NAME OF SURGERY}?
  - a. No pain
  - b. Minimal pain
  - c. Moderate pain
  - d. Severe pain
13. Did you have to seek additional care for your pain after you left the hospital?
  - a. No
  - b. Yes
    - i. If yes, where did you seek care:
      - a. Surgeon's office
      - b. Primary care/family physician
      - c. Emergency Department or Urgent Care
      - d. Other (please describe)
14. Did you receive printed discharge paperwork?
  - a. No
  - b. Yes
15. Do you remember receiving specific instructions about pain management?
  - a. No
  - b. Yes
16. Do you remember receiving specific instructions on how to take the {NAME OF MEDICATION} prescription when you were discharged?
  - a. No
  - b. Yes
    - i. If so, were instructions written, verbal or both? \_\_\_\_\_
    - ii. Did they include:
 

1. The risks of operating heavy machinery or driving	Yes/No
2. The risks of addiction to pain medication	Yes/No
3. That you may not need this medication at all?	Yes/No
4. That you should try using other medications (i.e. Tylenol/Motrin) to reduce your opioid pain medication use	Yes/No
5. How to store your medication	Yes/No
6. Risks of leftover medication	Yes/No
7. How to dispose of leftover medication	Yes/No
8. How long most patients need to take opioid medication	Yes/No
17. Overall, how would you rate your satisfaction with your pain management following your {NAME OF SURGERY}? (1 = extremely dissatisfied, 10 = extremely satisfied)
 

1	2	3	4	5	6	7	8	9	10
Extremely Dissatisfied									Extremely Satisfied