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Original Research

Effect of State Legislation on Discharge Opioid Prescriptions After Total Hip and Knee Arthroplasties

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ABSTRACT

Background: Recent literature suggests that state-level legislation is effective in reducing postoperative opioid prescribing after total joint arthroplasty but has not addressed the effect on opioid antagonist coprescribing. This study aims to describe the change in postoperative opioid and opioid antagonist prescribing patterns after total joint arthroplasty following passage of state-level opioid-limiting legislation and to determine the comorbidities associated with increased opioid prescribing in this population.

Methods: Billing data were used to identify all patients who underwent primary total hip or knee arthroplasty admitted between March 2016 and March 2018 at our institution. The data were divided into 2 cohorts comprising the year before (671 subjects) and after (713 subjects) the legislation. Discharge prescriptions were reviewed, and the median morphine milligram equivalents (MME) per day and naloxone prescriptions were recorded. International Classification of Diseases codes were used to identify comorbid conditions of interest present during previous inpatient or outpatient encounters.

Results: There was a significant reduction in both the minimum and maximum median MME per day after introduction of state legislation and a substantial increase in opioid antagonist coprescription. Total knee arthroplasty, younger age, male sex, chronic pain disorders, post-traumatic stress disorder, and prior opioid abuse were correlated with increased opioid prescribing.

Conclusion: Our findings suggest that state-level legislation is effective in decreasing the MME per day prescribed and increasing opioid antagonist coprescription in the postoperative period for patients undergoing total hip and knee arthroplasties at our institution. These changes may lead to a decrease in opioid-related morbidity and mortality in the patient population undergoing total hip and knee arthroplasties.

Introduction

Across all specialties, orthopaedic surgeons are the most likely to prescribe opioids for pain management [1].While the American Academy of Orthopaedic Surgeons has been unable to recommend for or against opioid use for the treatment of symptomatic osteoarthritis of the knee, opioids are still commonly prescribed for treatment of postoperative pain [2]. With rates of total hip arthroplasty (THA) and total knee arthroplasty (TKA) increasing by 174% and 673%, respectively, by 2030, the overprescribing of opioids for postoperative pain may significantly contribute to increased opioid abuse and patient morbidity and poses a risk for diversion [3].

Bates et al showed that of postoperative pain medication prescribed, only 58% was consumed and 67% of patients reported leftover medications [4]. A large proportion of opioid-naïve patients undergoing primary THA and TKA have been shown to still be taking opioid pain medication at 1 month postoperatively with up to 4.4% still taking opioid medication at 6 months postoperatively [5].

In 2016, there were more than 46 fatal overdoses per day attributable to prescription opioids [6]. The state of Virginia

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declared the opioid addiction crisis a public health emergency and enacted Emergency Regulation 18VAC85-21 (VAC85-21) on March 14th, 2017. This state regulation restricts the prescribing of opioids for the treatment of acute pain in nonsurgical and postsurgical settings as well as chronic pain. Specifically, opioid prescriptions are limited to a 7-day supply for acute pain and 14 days for postoperative pain. All opioid prescriptions require documentation of the indication for the opioids and a search on the Virginia Prescription Monitoring Program to identify patients at risk for opioid abuse or overdose. In addition, patients with concomitant benzodiazepine use or those receiving prescriptions amounting to greater than 120 morphine milligram equivalents (MME) per day must be coprescribed naloxone [7]. Naloxone is an opioid receptor antagonist, which is to be administered intranasally in the event of suspected or actual overdoses.

Prior studies have reported sustained decreases in opioid prescribing rates for neck and back pain and chronic pain over an 18-month period after the implementation of an opioid prescribing guideline in 2 separate emergency departments [8]. Similar studies have reported an effective reduction of opioid prescribing of up to 39.6% [9]. Although these studies address changes in prescribing after the implementation of opioid prescribing guidelines, they are only at the institution and departmental level. Both Whale et al and Reid et all showed that state-level legislation was effective in reducing MME in the immediate postoperative period after primary THA and TKA in 2 different states [10,11]. Similarly, Lott et al showed that state-level legislation led to a reduction in discharge opioid prescribing after orthopaedic surgery procedures [12]. Although these prior studies in other states have examined the effect of legislation on opioid prescriptions after hip and knee arthroplasties, they have not included data regarding opioid antagonist coprescribing.

This study aims to evaluate the effect of the recent Virginia opioid legislation on discharge prescriptions in patients undergoing total knee and total hip replacements at our individual institution. In addition, we aim to identify patient factors that are associated with increased opioid prescribing at our institution. We hypothesize that in the wake of VAC85-21, there has been a reduction in opioids prescribed to patients at discharge after THA or TKA, and there has been inconsistent coprescribing of naloxone with prescriptions exceeding 120 MME per day.

Methods

Our institutional review board approved this retrospective cohort study. Our inclusion criterion was any patient undergoing primary THA and TKA for any reason, including fracture, at our institution from March 3, 2016, to March 3, 2018. We chose 1 year before and after the date at which the legislation took effect as we felt this provided enough patients to appropriately power the study. All data were obtained with assistance from the Virginia Commonwealth University Wright Center for Clinical and Translational Research. We identified our population of interest by searching the electronic medical record (EMR) for patient encounters with current procedural terminology (CPT) codes associated with THA and TKA (27130 and 27447, respectively) during the aforementioned time period. Identification or analysis of the surgical approach, instrumentation, or implants used was not performed. We identified the opioid discharge medication orders for the index surgery encounters. From these prescriptions, and using the Centers for Disease Control conversion chart, we calculated the minimum and maximum MME per day for each opioid prescription. Minimum and maximum MME were calculated as providers' prescription diction often gave patients dosing and frequency options for a given opioid formulation. For example, one such prescription was for "oxycodone 5-mg tablet, one-half or 1 tablet every 4 to 6 hours as needed for pain." Such prescriptions required calculating minimum and maximum MME to account for varying dosage patterns. Total opioid pill counts and concomitant naloxone prescriptions were also identified.

In addition to prescription data, other patient-related variables were obtained from the EMR using automated search tools. These variables were selected based on prior literature demonstrating positive correlation with increased postoperative opioid prescribing after THA or TKA [17-19]. These included age, sex, body mass index (BMI), and length of hospital stay after the index surgery. We searched the "problem list" portion of the EMR using both 9th and 10th edition International Classification of Diseases (ICD) codes to identify comorbid conditions of interest present during previous inpatient or outpatient encounters. These included anxiety, depression, post-traumatic stress disorder, fibromyalgia, chronic pain syndrome, multiple codes associated with chronic back pain, tobacco use or nicotine dependence, opioid abuse or dependence, and substance abuse or dependence other than opioid (including alcohol and marijuana).

A post hoc power analysis demonstrated 99% power to detect differences in minimum and maximum MME per day and pills dispensed using the nonparametric Mann-Whitney U-test. Power analysis also demonstrated 99% power to detect differences in naloxone prescription and 75% power to detect a difference in maximum MME per day >120 using a 2-sample chi-squared test.

To assess the impact of additional covariates (procedure type, length of stay, BMI, age, sex, histories of depression, anxiety, post traumatic stress disorder, fibromyalgia, back pain, chronic pain, substance abuse, tobacco use, and opioid abuse), a linear regression model was created using the average of minimum and maximum MME per day. A backward elimination procedure was used, whereby all the predictor variables were entered and then variables were removed one at a time based on their *P*-values, until a final parsimonious model was achieved. Statistical analysis was performed using SAS software, version 9.4 (SAS Institute Inc, Cary, NC). A *P*-value of 0.05 was considered statistically significant.

Results

Although there was a slight increase of 1 kg/m^2 in the BMI among patients undergoing THA or TKA after legislation took effect ($P < .05$), there was no additional significant variation observed in patient demographics (see Table 1).

There was a statistically significant reduction in both the minimum ($\chi^2 = 63.12$, 1 degree of freedom, $P < .0001$) and maximum ($\chi^2 = 67.69$, 1 d.f., $P < .0001$) median MMEs per day after the introduction of VAC85-21 (see Table 2). In addition, there was a significant reduction in the percentage of patients who were prescribed a maximum MME per day >120 from 15.95% before legislation to 11.36% after legislation ($\chi^2 = 6.19$, 1 d.f., $P = .0128$). In the cohort of patients who had a maximum MME per day >120 prescribed, naloxone coprescribing increased from 1.87% to 66.67% ($\chi^2 = 92.55$, 1 d.f., $P < .0001$).

Using the aforementioned linear regression model, we identified 7 significant covariates. These were the study period (after legislation vs before legislation), procedure type (THA vs TKA), age, sex (male vs female), PTSD, chronic pain, and opioid abuse.

Based on the parameter estimates, we determined that the average MME per day was about 15.12 MME per day lower after legislation when all other covariates are held constant. Similarly, patients undergoing THA received about an average of 2.61 MME per day less than a similar patient undergoing TKA. In addition, as patients aged, they received lower doses of opioids; almost 1 (0.95) MME per day for every 10 years of age. Males received on average of

Table 1
Patient demographics.

	Total ($n = 1391$)	Before 03/2017 ($n = 674$)	After 03/2017 ($n = 717$)	*P*-value
Age	60 [18, 93]	60 [23, 92]	60 [18, 93]	.9143
BMI	31 [13, 54]	30 [13, 54]	31 [17, 52]	.0083
Gender—male	44%	47%	42%	.0937
Histories				
Depression	16%	14%	17%	.0725
Anxiety	15%	13%	16%	.0885
PTSD	2%	1%	2%	.3934
Fibromyalgia	7%	7%	8%	.6179
Chronic pain	3%	2%	3%	.6257
Back pain	35%	33%	36%	.1912
Substance abuse	17%	17%	16%	.5107
Tobacco use	33%	34%	31%	.2075
Opioid abuse	3%	4%	3%	.2033
Procedure				.0015
Total hip	52%	56%	47%	
Total knee	48%	44%	53%	
LOS	2 [1, 25]	2 [1, 25]	2 [1, 24]	.0012

LOS, length of stay.
Demographic information for patients undergoing primary total hip and knee arthroplasties at our institution during the study period is given. The only significant difference was an increased BMI in the prelegislation cohort.

5.57 MME per day more than did similar females. Patients with PTSD received an average MME per day of 21.45 more than did similar patients without PTSD. Patients with chronic pain received approximately 30.63 MME per day more than patients without chronic pain. Patients with a history of opioid abuse received 24.88 MME per day more than patients without a history of opioid abuse.

Discussion

As the specialty is most likely to prescribe opioid pain medication for non–cancer-related pain, the current public health focus on reducing community opioid burden is of particular interest to all orthopaedic surgeons [1]. There have been several departmental, institutional, and state-level initiatives to reduce the amount of opioids prescribed for acute and postoperative pain. With the rates of THA and TKA procedures predicted to increase substantially, these patients are at a particularly high risk for opioid-related morbidity and mortality. The present study aims to determine if state-level legislation is successful in both reducing the amount of opioid medication prescribed postoperatively and increasing the rate of opioid antagonist coprescription after THA and TKA at our institution.

This study supports the results of Reid et al in which the mean MME in the immediate postoperative period after THA and TKA was reduced after prescription-limiting state legislation in Rhode Island [11]. The Virginia legislation, in contrast with that of Rhode Island, does not differentiate between opioid-naïve and opioid-tolerant patients. Similarly, Whale et al showed that Ohio opioid-limiting legislation decreased the morphine equivalent doses among patients undergoing THA and TKA [10]. They demonstrated that a large portion of this decrease is attributed to a reduction in the amount of opioids prescribed at discharge, which is the time period assessed in the present study. Lott et al demonstrated a reduction in postoperative MME per day after orthopaedic surgery procedures following New York State legislation limiting opioids to a 7-day supply [12]. This study was not specific to any particular procedure, diagnosis, or patient population. None of these recent studies evaluated the effect of legislation on opioid receptor antagonist coprescription.

The Centers for Disease Control and Prevention guidelines state that opioid doses greater than or equal to 50 MME per day were associated with greater overdose risk without necessarily providing the benefit of improved pain control. In addition, daily opioid use close to or in excess of 100 MME per day is associated with a significant risk of fatal overdose [13]. The state legislation in this study requires the coprescribing of naloxone for patients receiving >120 MME per day. In the period after legislation passage, the percentage of patients receiving >120 MME per day decreased from 15.95% to 11.36%.

Virginia data from the Medicare Part D Program showed that in 2017 naloxone coprescribing with any opioid increased from a rate of 1.2 to 33.0 per 1000 patients demonstrating a 2650% increase [14]. This is the first study to evaluate the effect of state legislation on the coprescription of an opioid receptor antagonist in the postoperative period among patients who underwent THA and TKA. At our institution, coprescribing of naloxone for patients who underwent THA and TKA receiving opioid prescriptions for greater than 120 MME per day increased by more than 64% in the year after passage of legislation. Although this represents a significant increase from the previous year, the coprescribing rate of opioid doses greater than 120 MME per day was not at the mandated 100% rate. This rate could potentially improve by emphasizing provider education on the risks of high opioid doses and the importance of reversal agents in decreasing fatalities associated with opioid overdoses. In addition, improvements to the EMR including automated prompts may help facilitate provider adherence with prescribing guidelines.

Table 2
Opioid and opioid antagonist prescription data before and after legislation.

Measure	Total ($n = 1384$)	Before 03/2017 ($n = 671$)	After 03/2017 ($n = 713$)	*P*-value
Minimum MME per day	45 [10, 360]	48 [15, 360]	45 [15, 360]	<.0001
Maximum MME per day	90 [10, 540]	90 [15, 540]	90 [10, 360]	<.0001
Maximum MME per day > 120	14%	16%	11%	.0128
Pills dispensed	84 [4, 540]	84 [4, 540]	80 [5, 252]	<.0001
Naloxone Rx for maximum MME per day > 120[2]	30%	2%	67%	<.0001

MME per day and pill counts reported as the median, minimum, and maximum. The naloxone coprescription rate is reported as the percentage.

Many studies have shown correlations between common medical comorbidities, patient-related factors, and postoperative pain and opioid utilization after surgery. Patients undergoing primary TKA with at least one comorbid condition were 3.1 times more likely to need opioid refills postoperatively than patients without [15]. Patients with major depressive disorder undergoing THA or TKA demonstrated increased opioid consumption compared with those without [16]. Younger age, anxiety, substance abuse, back pain, fibromyalgia, and nonspecific chronic pain have been associated with prolonged opioid use after TKA [17]. Singh et al demonstrated that BMI >30 was significant predictors of opioid medication use at 2-years post primary THA [18]. Preoperative opioid use, age <60 years, female gender, increasing Charlson Comorbidity Index (used as a surrogate for overall health status), and greater length of stay were all risk factors for increased postoperative opioid use after TKA [19]. We found that at our institution, TKA, younger age, male sex, prior diagnosis of PTSD, chronic pain syndromes, and prior documented opioid abuse are associated with increased postoperative opioid subscribing. Our findings are consistent with those of previous studies.

Although we believe that this study provides an accurate appraisal of the effect of Virginia state legislation on postoperative opioid prescribing patterns among patients who underwent THA and TKA, it is not without limitations. Given that this study is a retrospective chart review, the data may be incomplete or inaccurate. This is especially true regarding the assessment of comorbidities and patient factors associated with increased opioid usage. These were obtained using automated search tools and ICD codes within the EMR. Providers often enter these ICD codes manually into the health record during patient encounters and may not do so accurately or completely. Although the study is powered to detect differences in our variables of interest, prescribers may not have changed their prescribing patterns within 1 year of the legislation taking effect, which is the end time for our population of interest. Changes in preoperative patient education may have also indirectly led to a decrease in postoperative opioid prescriptions. After passage of the legislation, patients were informed that postoperative opioid prescriptions would be limited in accordance with state law. This change in patient education may have altered both patient and surgeon expectations regarding amount and duration of opioids prescribed postoperatively.

This study supports the use of state-level opioid-limiting legislation to reduce the prescription of opioid medications in the immediate postoperative period after THA and TKA. This is the first study to evaluate the effect of state legislation on the coprescribing of an opioid receptor antagonist and demonstrates improved coprescription rates that fell short of the mandated requirement. State-level regulations such as VAC85-21 are effective in reducing the opioid burden among postoperative patients who underwent THA and TKA and may lead to reduced medication diversion and adverse medication-related morbidity and mortality.

Conflict of interests

G.J. Golladay receives royalties from OrthoSensor, Inc, is a member of the speakers' bureau for OrthoSensor, Inc, is a paid consultant for OrthoSensor, Inc, holds stock ownership in OrthoSensor, Inc, receives research support from OrthoSensor, Inc, Cerus, and KCI, receives royalties and financial or material support from the AAHKS—*Arthroplasty Today*, is a member of the editorial or governing board of *Arthroplasty Today* and *Journal of Arthroplasty*, and is a board member of the AAKHS-Publications Committee and Virginia Orthopaedic Society; all other authors declare no potential conflicts of interest.

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