



# Opioid Utilization After Knee Arthroscopy in Adolescents

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## **Opioid Utilization after Knee Arthroscopy in Adolescents**

Jennifer Bido, BA; Frances Tepolt, MD, Mininder Kocher, MD, MPH

## **Abstract:**

**Background:** The purpose of this study was to compare the amount of opioids prescribed to the amount of pain medication required following knee arthroscopy in adolescent and young adult patients in order to determine the effectiveness of current pain control practices at a single institution.

**Methods:** Patients 12-35 years of age who underwent knee arthroscopy between May-August 2016 were provided pain control log books in which they were asked to maintain a record of daily pain medication intake. The outcome of the study was defined as the total number of opioids consumed per patient.

**Results:** One hundred patients returned completed logbooks, 56% female and of average (SD) age 17.54 (3.51). The majority of patients underwent a ligament reconstruction or tibial tubercle osteotomy (57%), had a nerve block placed (51%) and had local anesthesia injected (90%). Use of both IV acetaminophen and ketorolac during the perioperative period was also common (41%). Patients were prescribed an average (SD) of 50.98 (12.50) oxycodone pills and 27.10 (11.94) diazepam pills. They reported consuming an average (SD) of 16.52 (13.94) oxycodone pills and 3.64 (5.52) diazepam pills, approximately 32.4% and 13.4% of those prescribed, respectively. Eleven percent never consumed opioids, and only one patient requested a refill during the 21-day postoperative period. Multivariate analysis revealed that increased weight, longer surgery time, and diazepam use were most closely associated with increased opioid consumption.

**Conclusion:** Following knee arthroscopy, adolescent and young adult patients are commonly over-prescribed opioids, consuming on average only approximately one-third of those prescribed.

## **Student role**

I completed this project for the fulfillment of my MPH practicum requirement in 2017. My concentration at the public health school was Quantitative Methods and I spent the year taking classes in statistics and epidemiology. Therefore, my goal was to find a project for which I could run all the analyses myself. I met with Dr. Kocher early in the academic year and identified the database used in this project as something that would be interesting to work on. I had previously published a paper on opioid use and thought this project would be a perfect follow-up.

Before I joined the effort the data had already been collected. I was then responsible for organizing and analyzing the data, as well as writing up the paper. My collaborators initiated the project, collected the data, provided feedback on the manuscript, and then submitted it for publication. We are still awaiting an acceptance.

## **Appendix 1: MPH report**

### **Opioid Utilization after Knee Arthroscopy in Adolescents**

Jennifer Bido, BA; Frances Tepolt, MD, Mininder Kocher, MD, MPH

#### **Background:**

The current opioid epidemic in the United States is characterized by both an increase in the prevalence of the disorder and an increase in deaths due to opioid overdose. There are an estimated 12.5 million people in the US who use prescription pain relievers for nonmedical purposes [1]. This increase in opioid use has led to a quadrupling in the rate of opioid overdose since 1999, with nearly 30,000 deaths in 2014 due to overdose from prescription pain relievers or heroin [2,3].

Research has shown that adolescents have been particularly affected by the opioid epidemic. It is estimated that 22.3% of US high school students have used prescription opioids, with 12.9% using it for nonmedical purposes. The authors of this study concluded that extreme caution in the practice of prescribing opioids to adolescents is needed, as their cohort showed that 80% of students who used opioids for nonmedical reasons admitted to using their leftovers from prior prescriptions [4].

The reasons for the observed increase in opioid prescription rates has been investigated, with particular attention paid to the rate of prescription written for low-risk surgical procedures. An analysis by Wunsch et al. investigated opioid prescription trends for low-risk surgeries such as carpal tunnel release, laparoscopic cholecystectomy, inguinal hernia repair, or knee arthroscopy. The authors found that 80% of patients filled an opioid prescription within 7 days of their procedure. Additionally, over the study period the mean dose of opioids prescribed increased by 18% although the duration of the prescription remained the same. The increase in mean dose was highest for knee arthroscopy [5].

Opioids are currently commonly prescribed to adolescents post knee arthroscopy although there is currently a paucity of research on appropriate pediatric pain management guidelines for this procedure. Additionally, there are no consensus statements on appropriate dosing of opioids. In light of the US opioid epidemic and the growing literature on the increased prevalence of opioid use and misuse by adolescents, it is imperative to monitor the prescription rates in this group and develop appropriate treatment guidelines.

This investigation uses data from adolescent patients who underwent knee arthroscopy to compare the number of prescribed narcotics to the amount taken by the patients in order to determine the effectiveness of current analgesic practices. Additionally, we aim to determine what demographic or surgical factors are associated with increased opioid intake.

## **Methods:**

### Data collection:

This is a retrospective cohort study on opioid use post knee arthroscopy in adolescents. Patients between the ages of 12-35 who underwent knee arthroscopy by two surgeons at Boston Children's Hospital from May – August 2016 were eligible for enrollment. Patients with a diagnosed pain syndrome or history of chronic pain were excluded from this study. All patients were prescribed opioids (oxycodone or hydromorphone), diazepam, and acetaminophen. All oxycodone and diazepam prescriptions stated that one dose was 5mg/ml. The hydromorphone prescription was converted to the equivalent oxycodone dose (2mg hydromorphone = 5mg oxycodone).

Patients were given pain control log books in which they were directed to write in their daily medication intake for 21 days post-surgery. 104 patients were able to complete and return their logbooks and four were excluded based on age or chronic pain history. Patients were also asked if they felt their pain was well controlled, whether they felt they needed more or fewer pills for pain control, as well as what they had done with their leftover pills. The information from these logbooks were transferred to an online database.

The following variables were abstracted from the medical records: demographics (age, sex, weight, history of prior psychiatric illnesses, whether the patient had been prescribed opioids in the past), surgical information (type of arthroscopic procedure, total surgical time, total time of tourniquet use, whether a nerve block was used and what kind, whether local anesthesia was used, agents used for either nerve block or local anesthesia, pain medications used in the perioperative period, and whether the patient stayed overnight), and prescription information (what medications were prescribed for post-operative recovery, as well as amount of oxycodone and diazepam prescribed). Type of procedure was categorized into three groups based on the invasiveness of the procedure (ligament reconstructions and tibial tubercle osteotomies, meniscal repairs and/or meniscectomy, and other).

#### Statistical analysis:

The outcome of the study was the total number of opioids consumed per patient. Given that this is not a continuous variable and is instead count data (non-negative integer values), we used nonparametric testing for univariate testing and then used a negative binomial multivariate regression to account for overdispersion. We used the method of purposeful selection to build our multivariate model<sup>6</sup>. To identify which variables to include in the model we first conducted univariate tests examining the association between each factor and the outcome. We then advanced those variables that had a p-value less than 0.25 to multivariate linear regression models. We kept predictors with a p-value of less than 0.1 in the model, but did not remove confounders. Next, we added in the covariates that had not passed univariate testing to see if they became significant in the model. If not, they were removed from the model.

We calculated the power to detect effects of binary covariates on the negative binomial distribution of the opioid consumption outcome in 100 patients with complete data. We assume a type I error of 0.05 and an equal distribution of patients with and without a covariate of interest (eg with regional block vs. without regional block). Under these circumstances, we have power of 0.8 to detect differences in outcome of 0.15 standard deviations and power of 1 to detect differences in outcome of 0.5 standard

deviations. Power is generally increased in multivariate analyses, which reduce error variance. Thus, the analysis has adequate power to detect moderately strong effects.

## **Results:**

### *Patient pre-operative demographics:*

Characteristics of the participants are shown in Table 1. Of the 100 patients enrolled in this study 56% were female. The average(SD) age of the population was 17.54 (3.51), whereas the average(SD) weight was 68.42kg (13.93). 10% had a history of prior psychiatric illness, while 28% had a prior opioid prescription in their records. The majority of patients underwent a ligament reconstruction or tibial tubercle osteotomy (57%), had a nerve block placed (51%) and had local anesthesia injected (90%). Additionally, most patients received both acetaminophen and toradol through their IV during the perioperative period (41%). Furthermore, 13% of patients had a planned overnight stay. Of note, two patients were diagnosed with DVTs during the 21-day postoperative period.

### *Medication consumption:*

Patients were prescribed an average(SD) of 50.98 (12.50) oxycodone pills and 27.10 (11.94) diazepam pills (Table 1). They reported consuming an average(SD) of 16.52 (13.94) oxycodone pills and 3.64 (5.52) diazepam pills (Table 2). Therefore, patients consumed approximately 32.4% of their prescribed opioids and 13.4% of their prescribed diazepam. 11% of the patients never consumed opioids, and only one patient requested a refill during the 21-day postoperative period. Additionally, patients reported consuming an average(SD) of 17.87 (15.72) over the counter (OTC) painkillers, defined as either ibuprofen or acetaminophen.

83% of patients consumed opioids on post-operative day one. However, less than half (32%) of patients were still using opioids by post-operative day four (Fig. 1). Patients consumed the most opioids on post-operative day one, an average of 6.1 pills, and by post-operative day four they had reduced consumption to an average of 2.84 pills. 75% of patients consumed  $\leq 25$  opioid pills, whereas 90% of patients consumed  $\leq 38$  opioid pills and 95% of patients consumed  $\leq 42$  opioid pills.

### *Factors associated with increased opioid consumption:*

Univariate analysis (Table 3) identified the following associations with increased opioid consumption per patient: age, weight, prior use of opioids, type of procedure, total surgery time, total time of tourniquet use, use of a nerve block, amount of diazepam consumed, and the amount of OTC painkillers consumed. Given that total surgery time and total time of tourniquet use are collinear variables, we choose to only advance total surgery time into the model. The remaining factors were included in the multivariate analysis (Table 4). Of these eight variables, only weight (p-value= 0.07), total surgery time (p-value = 0.02), and amount of diazepam consumed (p-value = 0.0005) remained in the model. Specifically, an increase in weight or surgery time was associated with increased opioid consumption. Additionally, increased diazepam consumption was associated with increased opioid consumption (one pill of diazepam was associated with an additional opioid pill consumed).

### **Discussion:**

To our knowledge this is the first published study on opioid consumption post arthroscopy in adolescents. Using patient reported medication consumption data, we investigated how opioid prescription amounts compared to use post arthroscopy, as well as the variables that were associated with increased consumption. We found that patients consumed approximately 32.4% of their prescribed opioids. Additionally, longer surgery time, as well as increased weight and diazepam consumption were associated with increased opioid consumption.

Much of the literature on adolescent opioid use has focused on prescription trends throughout the years, with studies showing increased prescription rates. Additionally, musculoskeletal injuries have been found to be one of the most common reasons why opioids are prescribed to adolescents. Our study adds to this literature by providing data on what a cohort of patients actually consumed, as opposed to just the amount that they were prescribed. The large disparity between prescription and consumption totals highlights an opportunity for physicians to decrease prescription amounts so that patients are left with fewer leftover pills. Given the danger of recreational use of leftover opioids it is imperative for physicians to consider ways to

reduce opioid availability in patients' homes. Given that in our study 90% of patients consumed less than forty pills, this may represent a reasonable maximum prescription amount. Furthermore, given that 68% of patients stopped taking opioids by postoperative day 4, physicians may consider only prescribing enough opioids to last for a week and then checking on patients to see why they are still consuming them.

It is important to identify which variables are associated with increased opioid consumption in order for physicians to consider each patient's individual need. Increased weight was associated with increased opioid consumption in our cohort, which is expected as a heavier patient may need a larger dose to ameliorate their pain. In our cohort increased surgery time was associated with increased opioid consumption, which is understandable given that longer surgeries are likely more invasive and may result in greater postoperative pain. Although not in the final model, opioid consumption by type of procedure highlights this point as patients who underwent ligament reconstructions had increased opioid consumption relative to less invasive procedures such as meniscal repairs. Finally, in our cohort increased diazepam consumption was associated with increased opioid consumption. There was a positive correlation between diazepam and opioid consumption, as well as between OTC painkiller and opioid consumption. In our study, it seems that patients did not substitute one type of medication for another and instead consumed all types of medications when in pain. As physicians consider new prescription protocols it is important to note that increased prescription of OTC painkillers may not decrease opioid consumption. Instead, they may consider emphasizing other practices, such as recommending that patients only fill half of their prescription at a time.

There are several limitations to this study. While using patient reported data allowed us to ascertain medication consumption totals, this introduces uncertainty into the study as patients may not have logged all their medications. This could lead to an underestimation of opioid use if patients did not accurately log their consumption. However, given the large disparity between usage and prescription amounts, even if patients misreported 50% of their usage there would still be large gap. Additionally, our sample size of 100 adolescents being seen at a large pediatric medical center may not be a representative sample of adolescents who undergo knee arthroscopy.

Furthermore, as our study focused on opioid usage post knee arthroscopy the results may not be generalizable to other orthopedic procedures in this population.

**Conclusion:**

There is a large disparity between the number of opioids that are prescribed to adolescents after knee arthroscopy and the amount they required. Specifically, patients only consumed 32.4% of their prescribed opioids. Additionally, increased weight, longer surgery time, and increased diazepam were associated with increased opioid consumption. Prescription practices should be reconsidered in order to leave patients with fewer leftover pills, thus decreasing the risk of recreational use. Physicians should consider significantly decreasing the number of pills prescribed, possibly down to a maximum of forty doses, as well as checking in during the first week to see if more medications are needed. Further research is needed to elucidate medication use patterns after different orthopedic procedures in order to determine if the disparity between prescription and consumption persists across procedures.

Table 1. Demographics

<b>Patient Demographics</b>	
Age	Mean: 17.54 (3.51) Range = 12-28
Sex	Female = 56 Male = 44
Weight	Mean: 68.42kg (13.93) Range = 35-104
History of psychiatric illness	Y= 10 N= 90
Prior opioid prescription	Y= 28 N=72
<b>Surgical Information</b>	
Procedure	Ligament reconstruction or TTO: 57 Meniscal repair: 18

	Other: 25
Total surgery time	Mean: 66.74 (25.60) minutes Range: 16-130
Total time of tourniquet use	Mean: 47.53 (22.23) minutes Range: 13-155
Nerve Block	Y= 51 N= 49
Type of Nerve Block	Femoral = 46 Sciatic = 5
Agent used for nerve block	Ropivacaine = 46 Bupivacaine = 3 Lidocaine = 2
Local Anesthesia	Y = 91 N = 9
Perioperative IV pain medication	Acetaminophen = 20 Toradol = 26 Both = 41
Overnight Stay	Y = 13 N = 87
<b>Prescription Information</b>	
Opioid Prescription Type	Oxycodone: 99 Hydromorphone: 1
Opioid Prescription Amount	Average: 50.98 (12.50) Range: 12-60
Diazepam Prescription Amount	Average: 27.10 (11.94) Range: 5-60

Table 2. Medication consumption per patient.

Average number of opioids taken per patient	16.52 (13.94)
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	Range: 0-69
# of patients who took > 40 opioid pills	7
# of patients who did not take opioids	11
Average number of Diazepam taken per patient	3.64 (5.52) Range: 0-26
Average number of OTC painkillers taken per patient	17.87 (15.72) Range: 0-81

Figure 1.

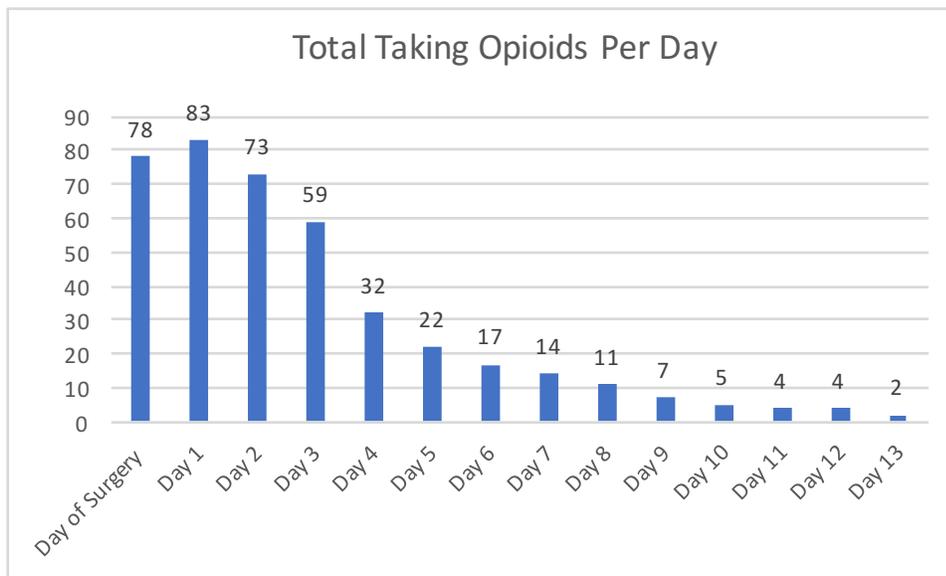


Table 3. Univariate analysis

Predictor	Univariate Test (p-value)
Age	0.12
Sex	0.91
Weight	0.24
History of psychiatric illness	0.29
Prior use of opioids	0.09

Procedure	0.007
Total surgery time	<.0001
Total time of tourniquet use	<.0001
Use of nerve block	0.0002
Type of nerve block	0.37
Use of local anesthesia	0.30
Perioperative IV pain medication	0.28
Overnight stay	0.46
Amount of Diazepam taken	<.001
Amount of OTC killers taken	0.006

Table 4. Multivariate regression results.

Predictor	Estimate	95% CI	p-value
Intercept	1.011	(0.0159, 2.0061)	0.0464
Weight	0.0123	(-0.0010, 0.0257)	0.0699
Total surgery time	0.0093	(0.0018, 0.0169)	0.0156
Total diazepam pills	0.0632	(0.0279, 0.0986)	0.0005

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- 1) Birnbaum HG, White AG, Schiller M, Waldman T, Cleveland JM, Roland CL. Societal costs of prescription opioid abuse, dependence, and misuse in the United States. *Pain Med.* Apr 2011;12(4):657-667.
- 2) "The Opioid Epidemic by the Numbers." Department of Health and Human Services. <http://www.hhs.gov/sites/default/files/Factsheet-opioids-061516.pdf>
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- 5) [Wunsch H](#)<sup>1</sup>, [Wijeysundera DN](#)<sup>2</sup>, [Passarella MA](#)<sup>3</sup>, [Neuman MD](#)<sup>4</sup>. Opioids Prescribed After Low-Risk Surgical Procedures in the United States, 2004-2012. *JAMA.* 2016 Apr 19;315(15):1654-7
- 6) Z Bursac, CH Gauss et al. "Purposeful selection of variables in logistic regression." *Source Code for Biology and Medicine.* 2008

# Appendix 1: MPH poster presentation



## Opioid Utilization after Knee Arthroscopy in Adolescents

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### Introduction

- An estimated 12.5 million people in the US use prescription pain relievers for nonmedical purposes [1].
- An estimated 22.3% of US high school students have used prescription opioids, with 12.9% using it for nonmedical purposes [2].
- In one study 80% of students who used opioids for nonmedical reasons admitted to using their leftovers from prior prescriptions [2].
- Over the last ten years there has been an increase in opioid prescription rates for low-risk surgical procedures, such as knee arthroscopy [3].
- Opioids are currently commonly prescribed to adolescents post knee arthroscopy although there is currently a paucity of research on appropriate pediatric pain management guidelines for this procedure.

### Objectives

Objective 1: To compare the number of prescribed narcotics given to adolescent patients post knee arthroscopy to the amount taken by the patients in order to determine the effectiveness of current analgesic practices.

Objective 2: To determine what factors are associated with increased opioid intake.

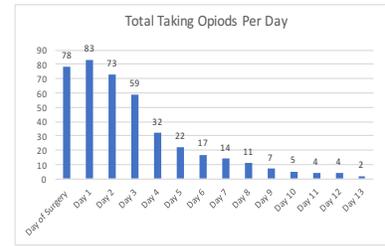
### Methods

- Cohort: 100 patients aged 12-35 who underwent knee arthroscopy from May – August 2016
- Excluded patients with chronic pain syndromes
- Demographics, surgical, and prescription information were abstracted from the medical record
- Patients logged their daily medication intake for 21 days post-surgery
- Outcome: total number of opioids consumed per patient
- Nonparametric testing was used for univariate testing
- Used purposeful selection to build the model
- Used negative binomial multivariate regression to account for overdispersion.

### Results

- Patients were prescribed an average(SD) of 50.98 (12.50) oxycodone pills and 27.10 (11.94) diazepam pills.
- They reported consuming an average(SD) of 16.52 (13.94) oxycodone pills and 3.64 (5.52) diazepam pills.
- 11% of the patients never consumed opioids, and only one patient requested a refill during the 21-day postoperative period.
- 75% of patients consumed  $\leq 25$  opioid pills, whereas 90% of patients consumed  $\leq 38$  opioid pills and 95% of patients consumed  $\leq 42$  opioid pills.
- Univariate analysis identified the following associations with increased opioid consumption per patient: age, weight, prior use of opioids, type of procedure, total surgery time, total time of tourniquet use, use of a nerve block, amount of diazepam consumed, and the amount of OTC painkillers consumed.
- Our multivariate model demonstrated that increased weight, longer surgery time, and increased diazepam were associated with increased opioid consumption.

Average number of opioids taken per patient	16.52 (13.94) Range: 0-69
# of patients who took > 40 opioid pills	7
# of patients who did not take opioids	11
Average number of Diazepam taken per patient	3.64 (5.52) Range: 0-26
Average number of OTC painkillers taken per patient	17.87 (15.72) Range: 0-81



Predictor	Univariate Test (p-value)
Age	0.12
Sex	0.91
Weight	0.24
History of psychiatric illness	0.29
Prior use of opioids	0.09
Procedure	0.007
Total surgery time	<.0001
Total time of tourniquet use	<.0001
Use of nerve block	0.0002
Type of nerve block	0.37
Use of local anesthesia	0.30
Perioperative IV pain medication	0.28
Overnight stay	0.46
Amount of Diazepam taken	<.001
Amount of OTC killers taken	0.006

### Conclusion

- Patients consumed approximately 32.4% of their prescribed opioids and 13.4% of their prescribed diazepam.
- Prescription practices should be reconsidered in order to leave patients with fewer leftover pills, thus decreasing the risk of recreational use.
- Possible solutions include prescribing fewer pills or encouraging patients to only fill half of their prescriptions at a time.

### References

- Birnbaum HG, White AG, Schiller M, Waldman T, Cleveland JM, Roland CL. Societal costs of prescription opioid abuse, dependence, and misuse in the United States. *Pain Med.* Apr 2011;12(4):657-667.
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