

## Opioid Prescription Trends After Arthroscopic Knee Surgery, 2009 - 2014

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### Abstract

**Background:** Opioid prescription (OP) patterns among orthopaedic surgeons are often guided by multiple factors that are not well understood and can result in patients being prescribed an excessive number of opioids.

**Purpose:** The purpose of this study was threefold: to assess the perioperative OP trends, from 2005 to 2014, in patients undergoing five ambulatory knee procedures, to determine whether trend differences existed among procedures and to evaluate the risk factors associated with a higher OP.

**Methods:** Data was collected from the Market Scan® database. Search was performed using current procedural terminology codes (CPT-4) for patients with isolated anterior cruciate ligament reconstruction (IACLR), ACLR with any other intervention (ACLR+), isolated meniscectomy (IM), isolated meniscal repair (IMR) and isolated chondroplasty (IC), of age from 18 or older with and without peripheral nerve block (PNB). Patients who filled an opioid prescription in the range of four weeks before to four weeks after the intervention were included. Drugs included were Hydrocodone/Acetaminophen, Oxycodone/Acetaminophen, Tramadol and Hydro-morphone/Hydrochloride.

**Results:** OP trends displayed similar patterns for all opioids and procedures evaluated with no significant differences in prescription patterns among procedures ( $p > 0.05$ ). Variables associated with a higher OP were the US West and South regions ( $p < 0.001$ ), female sex ( $p < 0.001$ ), year beyond 2004 ( $p < 0.001$ ), younger age ( $p < 0.001$ ) and presence of PNB ( $p < 0.001$ ).

**Conclusion:** Over the past decade there has been an escalation in the perioperative OP trends in patients undergoing ambulatory knee surgery in the US with no significant differences in OP trends among procedures.

**Keywords:** Knee; Arthroscopy; Opioids; Prescription; Perioperative

### Introduction

There is a growing epidemic in the United States (US) concerning the misuse of prescription opioids. In 2016, 91.8 million people in the US used pain relievers, of these, 11.5 million reported misuses [1]. Several studies have shown that opioids are overprescribed to patients postoperatively among all specialties, but notably in orthopaedic surgical procedures [2-9]. Multiple factors have been identified as responsible contributors to the current opioid crisis including unsubstantiated claims [3,10], patient pain advocacy [11], aggressive promotion by the opioid pharmaceutical manufacturing and supply chain industry [12,13], rogue pharmacies and unethical physician prescribing [14], pain as the fifth vital sign [15,16] and others [1,5,17,18].

Additionally, the rate of ambulatory orthopedic procedures performed in the US has increased steadily over the last decade [19-21] with over 130,000 anterior cruciate ligament reconstructions (ACLR) being performed annually [22]. It has been reported that more than

40% of these patients experience moderate to severe pain postoperatively [23]. Opioid prescription (OP) patterns are often guided by multiple factors that are not well understood and can result in patients being prescribed an excessive number of opioids. Anthony, *et al.* [8] found that 35% of patients undergoing ACLR were prescribed preoperative opioid medication. Few data exist, however, regarding patterns of perioperative prescription trends over time in patients undergoing arthroscopic ambulatory surgery of the knee. In addition, there is a need to improve access to evidence-based pain management and to decrease excessive prescribing that may leave unused opioids available for potential misuse [2]. Hence, we decided to study the perioperative opioid prescription patterns and their progression over time in patients undergoing five common ambulatory knee procedures. Based on the stated limitations of the current literature, the purpose of our study was threefold: to assess the perioperative opioid prescription (OP) trends, from 2005 to 2014, in patients undergoing five common ambulatory knee procedures (isolated ACLR, ACLR plus any other procedure, isolated meniscectomy, isolated meniscal repair, isolated chondroplasty); to assess whether differences existed in OP trends among procedures; and to evaluate the risk factors associated with a higher OP. We hypothesized that OP trends would progressively increase throughout years and no differences would exist among groups.

### Materials and Methods

This study was exempt from institutional review board approval by the author's institution.

#### Data source

Data was collected from the Market Scan® Commercial Claims and Encounters database (Truven Health Analytics, 2016) [24]. Market Scan® consists of reimbursed healthcare claims that include information of patients covered by diverse private insurance plans across all the 50 U.S. states. Information provided through Market Scan® includes healthcare claims from more than 130 payers reporting healthcare utilization and expenditures, with claims from in-patient, out-patient encounters and prescribed drugs, for an estimate of 50 million employees and family members per year. The database contains over 170 million de-identified patients who have been sampled since 1995. Patients ages range from birth to 64 years old.

#### Study populations

The Market Scan [24] database was searched, from 2005 to 2014, using Current Procedural Terminology (4<sup>th</sup> Edition (CPT-4)) codes for patients with isolated ACLR (iACLR) (29888), ACLR with any other intervention (ACLR+) (29888 + 29877, 29880, 29881, 29882, 29883), isolated meniscectomy (iM) (29880, 29881), isolated meniscus repair (iMR) (29882, 29883), and isolated chondroplasty (iC) (29877), of age from 18 or older with and without peripheral nerve block (CPT codes 64450, 64450/77003). Patients who filled an opioid prescription in the range of four weeks before to four weeks after the intervention were included. Drugs included were Hydrocodone/Acetaminophen, Oxycodone/Acetaminophen, Tramadol and Hydromorphone/Hydrochloride.

#### Data analysis

In order to reduce the effect of outliers, we applied winsorization to the data by replacing negative number by zero and the largest values by the 99<sup>th</sup> percentiles. OP trends (mean number of pills prescribed per drug) were assessed using linear regression, adjusting for all procedures and year. OP trends (morphine equivalents of hydrocodone/acetaminophen and oxycodone/acetaminophen were calculated utilizing a standard conversion table [25] were assessed using linear regression, adjusting for each procedure and year. Univariate analysis was conducted to assess statistical significance of differences in proportions using a Chi-Square test for categorical variables and a t-test for continuous variables. The statistical tests were reported as significant if the level of significance (p-value) was less than 0.05 (two-sided). Multivariable analysis was conducted to examine the relationship between OP and various potential predictors, such as: age, sex, year, US region and peripheral nerve block (PNB). This analysis was performed using generalized estimating equations (GEE) to account for possible clustering by individuals who had more than one procedure during the study time period. All analyses were performed using SAS version 9.4 software (SAS Institute, Cary, NC).

**Results**

Demographic data is represented in table 1. OP trends displayed similar patterns for all opioids and all procedures evaluated (Table 2 and figure 1). Significant peaks were observed in 2007 and 2008 followed by plateaus in 2009 and 2010. Significant increases were observed again in 2011 with peaks in 2013 followed by a drop off in 2014 for all drugs except for Hydrocodone/A. All opioids presented an increase in the mean number of pills prescribed perioperatively from 2005 to 2014. Hydrocodone/Acetaminophen presented the highest adjusted increase (95.32, absolute change (AC);  $p < 0.001$ ), followed by Oxycodone/Acetaminophen (47.64 AC;  $p < 0.001$ ), Tramadol (37.21 AC;  $p < 0.001$ ) and Hydromorphone/A (4.81 AC;  $p < 0.001$ ). No significant differences were observed in OP trends among different procedures (Table 3 and figure 2). Chondroplasty presented the highest adjusted increase (358.8 AC;  $p < 0.001$ ), followed by ACLR+ (338.66 AC;  $p < 0.001$ ), meniscectomy (281.58 AC;  $p < 0.001$ ), iACL (270.96 AC;  $p < 0.001$ ) and meniscal repair (191.19 AC;  $p < 0.001$ ). All procedures presented similar OP trend patterns as well (Figure 2). Table 4 summarizes the analysis results of the multivariable regression analysis. Variables associated with a higher OP were the US West and South regions ( $p < 0.001$ ), female sex ( $p < 0.001$ ), year beyond 2004 ( $p < 0.001$ ), younger age ( $p < 0.001$ ) and presence of peripheral nerve block ( $p < 0.001$ ).

	N° Cases	Male (%)	Female (%)	Mean Age	Standard Deviation
iACL	50886	55.59	44.41	32.11	10.68
ACLR +	805714	54.44	45.56	46.18	12.33
M	564109	56.34	43.66	47.92	11.54
MR	23758	61.47	38.53	32.07	11.89
C	171711	46.83	53.17	46.60	11.40

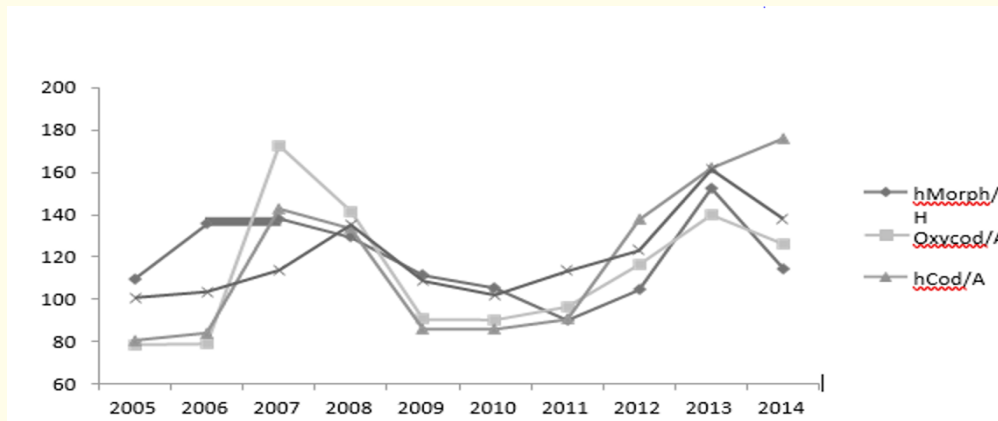
**Table 1:** Demographic data.

*iACL*: Isolated Anterior Cruciate Ligament Reconstruction; *ACLR+*: ACLR Plus Additional Procedure; *M*: Meniscectomy; *MR*: Meniscal Repair; *C*: Chondroplasty.

	hMorph/H	Oxycod/A	hCod/A	Tramadol
2005	109,83 (132.77)	78,66 (76.27)	80.73 (96.36)	100.88 (117.90)
2006	135.52 (130.40)	79.01 (90.26)	84.14 (100.06)	103.69 (117.49)
2007	138.11 (142.58)	172.79 (32.37)	142.76 (124.97)	113.90(158.03)
2008	129.42 (84.63)	141.61 (70.01)	133.55 (95.43)	135.34 (52.90)
2009	111.42 (99.05)	90.62 (132.12)	86.05 (187.54)	108.72 (199.04)
2010	105.32 (72.87)	90.42 (285.49)	86.00 (212.42)	102.06 (196.39)
2011	90.13 (207.91)	96.55 (289.55)	90.51 (214.74)	113.50 (203.71)
2012	104.50 (177.23)	116.4 (246.45)	137.69 (373.69)	123.16 (246.47)
2013	152.54 (318.01)	139.89(368.43)	162.07 (462.21)	161.33 (359.49)
2014	114.64 (327.96)	126.30 (162.43)	176.05 (159.72)	138.09 (177.85)
A.C.	4.81 ( $p < 0.001$ )	47.64 ( $p < 0.001$ )	95.32 ( $p < 0.001$ )	37.21 ( $p < 0.001$ )

**Table 2.** Perioperative mean number of pills prescribed and standard deviations including all procedures.

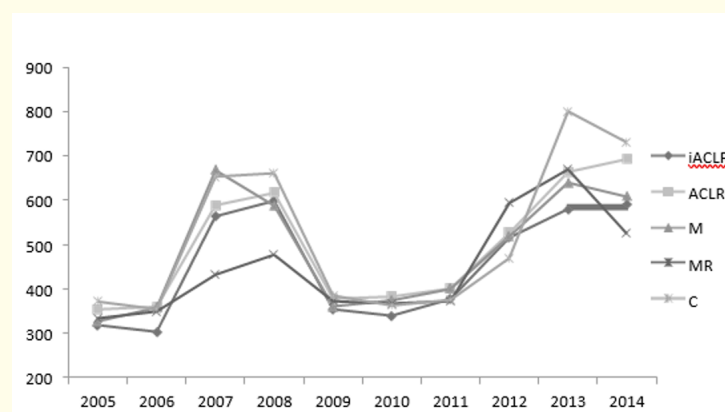
*hMorph/H*: Hydromorphone/Hydrochloride; *Oxycod/A*: Oxycodone/Acetaminophen; *hCod/A*: Hydrocodone/Acetaminophen; *A.C.*: Absolute Change.



**Figure 1:** Perioperative opioid prescriptions trends per opioid including all procedures (mean number of pills prescribed). hMorph/H: Hydromorphone Hydrochloride; Oxycod/A: Oxycodone Acetaminophen; hCod/A: Hydrocodone Acetaminophen.

	iACLR	ACLR+	M	MR	C
2005	317.88 (65.00)	353,74 (106.21)	326,89 (99.87)	333,13 (74.19)	371,05 (87.64)
2006	302,93 (60.68)	359,25 (111.08)	357,48 (111.41)	348,53 (97.48)	353,97 (85.12)
2007	563,33 (39.17)	588,93 (150.64)	667,88 (104.95)	431,83 (144.79)	652,85 (157.46)
2008	598,53 (52.36)	616,63 (108.34)	587,64 (93.81)	476,80 (82.63)	660,98 (161.73)
2009	353,42 (119.00)	377,97 (259.72)	360,99 (159.41)	372,27 (119.88)	384,89 (91.99)
2010	339,16 (182.40)	382,61 (301.23)	373,71 (242.69)	367,31 (269.49)	362,33 (87.13)
2011	376,57 (297.22)	400,95 (283.60)	399,52 (306.10)	371,77 (123.46)	375,32 (89.72)
2012	515,92 (302.26)	525,75 (340.57)	518,13 (333.99)	593,53 (286.44)	469,37 (110.14)
2013	580,45 (333.90)	663,66 (509.15)	639,86 (393.88)	669,26 (425.11)	800,20 (199.35)
2014	588,84 (167.05)	692,40 (443.80)	608,47 (120.69)	524,32 (328.72)	729,85 (171.04)
A.C.	270.96 (p < 0.001)	338.66 (p < 0.001)	281.58 (p < 0.001)	191.19 (p < 0.001)	358.8 (p < 0.00)

**Table 3:** Perioperative opioid prescription (morphine equivalents) and standard deviations of the five procedures evaluated. A.C.: Absolute Change; iACLR: Isolated Anterior Cruciate Ligament Reconstruction; ACLR+: ACLR Plus Additional Procedure; M: Meniscectomy; MR: Meniscal Repair; C: Chondroplasty.



**Figure 2:** Perioperative opioid prescription trends (morphine equivalents) per procedure. iACLR: Isolated anterior cruciate ligament repair; ACLR+: Anterior cruciate ligament repair plus any other procedure; M: Meniscectomy; MR: Meniscal repair; C: Chondroplasty.

Region	Estimate	95% Confidence Limits		P
Northeast	-0.1134	-0.1233	-0.1034	<0.0001
South	0.0443	0.0370	0.0515	<0.0001
West	0.1562	0.1475	0.1648	<0.0001
Unknown	0.0477	-0.0027	0.0981	0.0636
Midwest (Ref.)	0.0000	0.0000	0.0000	-
Female	0.0695	0.0640	0.0751	<0.0001
Male (Ref.)	0.0000	0.0000	0.0000	-
Year >2004	0.0368	0.0354	0.0381	<0.0001
Age	-0.0013	-0.0015	-0.0011	<0.0001
P. Nerve Block (+)	0.1259	0.0973	0.1545	<0.0001
P. Nerve Block (-) (Ref.)	0.0000	0.0000	0.0000	-

**Table 4:** Results of the multivariable regression analysis.

*P. Nerve Block (+): Presence of Peripheral nerve block; P. Nerve Block (-): Absence of Peripheral Nerve Block; Ref: Reference.*

## Discussion

In this study of a national representative sample, we were able to identify significant perioperative OP trends surrounding five common ambulatory knee procedures. Among the noteworthy trends we observed a significant increase in the mean number of opioids prescribed perioperatively from 2005 to 2014 with no significant differences among procedures and opioids. US west and south regions, female sex, year, younger age and presence of peripheral nerve block were predictors of a higher OP. Ambulatory surgery is on the rise with more than a 100% increase in the number of ambulatory surgery centers since 1990 in the US [26]. Severe postoperative pain is the most common cause of unanticipated admission to the hospital after ambulatory surgery and postponed discharged [27,28]. With the continuing increase in the number of ambulatory procedures, attention to the perioperative pain management of patients in this setting is critical. ACLR is nowadays almost solely performed on an outpatient basis [27]. While this has benefited patient satisfaction scores [29] and costs [27], it has also complicated postoperative pain management. Adequate postoperative pain control in this setting is essential as pain levels are closely related to both functional recovery [30] and quality of life assessments [28]. Current treatment modalities to control and manage postoperative pain with different levels of efficiency are available, including peripheral nerve blocks (PNB), local anaesthetics, opioids, nonsteroidal anti-inflammatory drugs, corticosteroids, clonidine, psychological therapy and cryotherapy [31]. Nevertheless, opioids such as Oxycodone, Hydrocodone, Tramadol and Hydromorphone continue to play a major role in the treatment of postoperative pain in patients following orthopedic ambulatory surgery [8,9]. This had led to an excessive postsurgical prescription of opioids and the subsequent contribution to their availability for diversion, abuse and accidental harm. The US Center for Disease Control and Prevention has reported a growing epidemic of prescription painkiller abuse [1].

Prior authors [4] evaluated trends in the amount of hydrocodone/acetaminophen and oxycodone/acetaminophen prescribed after low-risk surgical procedures, including knee arthroscopy, in the US, from 2004 to 2012. They reported an increase in the mean morphine equivalents dispensed over time for all procedures with an adjusted increase of 45.16 morphine equivalents for knee arthroscopy. No previous studies were found to evaluate perioperative OP trends surrounding different procedures in patients undergoing ambulatory knee surgery. Our results are, however, consistent with those previously reported. Significant increases were observed in the amount of OP for all procedures and all opioids. Hydrocodone/Acetaminophen showed the highest adjusted increase followed by Oxycodone/Acetaminophen, Tramadol and Hydromorphone/Hydrochloride. All procedures presented similar trends of OP from 2005 to 2014 with

no significant differences between them. Chondroplasty showed the highest adjusted increase followed by ACLR+, meniscectomy and meniscal repair. Previous authors have evaluated opioid demand before and after ACLR. Anthony, *et al.* [8] observed that 35% of patients undergoing ACLR were using preoperative opioid medication. They identified preoperative opioid use as a strong predictor of postoperative opioid demand, as well as the addition of microfractures to ACLR and age younger than 25 years. Our data suggest that younger age is a strong predictor of a higher perioperative OP. We also observed other predictors, not previously reported in the setting of ambulatory knee surgery and included the US West and South regions, female sex, presence of PNB and year beyond 2004. We were not able to observe significant differences in the perioperative OP among the different procedures evaluated, which seems to indicate, that the amount of perioperative OP is independent from the procedure performed. Orthopedic surgeons should recognize these factors when prescribing opioids in the perioperative setting of patients undergoing outpatient arthroscopic knee surgery.

Besides, as we can extract from our data, Peripheral Nerve Block (PNB) does not seem to influence the amount of OP trends among groups. Both orthopedic surgeons and anesthesiologists should take our data and further analysis into consideration as minor but significant differences were found in OP trends between patients who had undergone PNB and those who did not. Further research should focus on investigating this particular issue. The complexities of assessment and optimum treatment of pain within a short period of time in the setting of ambulatory knee surgery of a variety of conditions make optimal pain control truly challenging. Patients undergoing orthopedic surgical procedures have shown to have higher postoperative pain compared to those from other specialties [23,31]. Moreover, it has been shown that orthopedic surgeons have the highest patient readmission rate due to persistent postoperative pain [33]. The most common reasons given for prescribing large number of opioids were to avoid undermanaging postoperative pain, to minimize patients' calls and to limit hospital readmissions [1,3,10-12]. Other possible explanations include an increased focus on pain treatment or an increasing reliance on opioids for pain control relief versus alternative therapies [13-18]. The approach of an ambulatory pain management specialist [34] overseeing care for subjects with a history pain issues, substance abuse, chronic pain, as well as supervising pain control perioperatively in the surgery center could be critical in order to reduce postoperative OP. Ambulatory pain control can be really complicated and is most likely best accomplished through risk stratification, multidisciplinary communication, the use of multimodal analgesia and other procedures when strategies fall short preoperatively [35]. One of the main goals of this paper is to make orthopedic surgeons aware of the increasing OP trends that take place all along the US and specifically in their own regions. Hopefully, this would aid doctors to play a role in reversing those very trend as they approach pain control from a more consistent and judicious way. Improving the way opioids are prescribed perioperatively through clinical practice guidelines can ensure patients have access to safer, more effective postoperative pain treatment while reducing the risk of opioid use disorder, overdose and death [35].

### Limitation and Conclusion

Limitations of this study include restriction to five surgical procedures and four opioids, lack of data after 2014, since further changes in prescribing practices could have occurred; use of data that may not be generalizable, and the inability to determine which patients filled the prescriptions they received. Additionally, other patient factors associated with perioperative opioid demand, such as, previous surgery, complications during or after the procedure, type of anesthesia, use of supplemental local anesthesia, psychiatric diagnoses and or other musculoskeletal conditions were not evaluated. All of these factors could affect perioperative opioid consumption. What emerges from the available data utilized in this study is the conclusion that over the past decade there has been an escalation in the perioperative OP trends in patients undergoing ambulatory knee surgery in the US. The pattern of prescribing high volumes of opioids is a common practice among orthopedic surgeons. To avoid overprescribing, surgeons should establish prescribing standards on a case-by-case basis depending on the nature of the procedure and patient characteristics. Sizing OP properly may lead to fewer cases of patient overmedication, death, and drug diversion in the community.

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