Opioid Use in Pediatric Patients After Common Orthopaedic Surgeries

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Background: The use and misuse of opioid medications is an epidemic and public health emergency. There are currently no standard guidelines for treating perioperative pain in the pediatric population. The purpose of this study is to describe opioid use among pediatric patients after common orthopaedic surgeries.

Methods: Patients between 5 and 20 years of age undergoing one of 7 common orthopaedic surgeries between the years 2018 to 2020 were prospectively studied. Patients and their families completed a medication logbook to track all doses of pain medication and associated pain scores.

Results: Three hundred forty-two patients completed the study, including 174 females and 168 males with a mean age of 14.0 years (range, 5 to 20 y). A total of 4351 tablets or liquid doses of the narcotic medication, 44% of the total prescribed, were consumed. Of the prescribed medication,56% remained unused. Nonsteroidal anti-inflammatory drug use was identified to be the only independent predictor of less narcotic use, with a mean of 5.1 tablets ($P = 0.003$) and 1.7 days ($P < 0.01$) less opioid consumed among these patients. Thirty-two (9.4%) patients consumed 100% of their prescriptions. Nonmedicinal methods of pain control, most commonly ice, were used by 77% of patients, and this was highly variable between procedures. Physicians were cited as a source of medication information by only 50% of patients, with high variability between procedures.

Conclusions: Opioid medication use in children and adolescents after orthopaedic surgery is significantly less than the number of tablets prescribed, with 56% of the medication prescribed remaining unused in the postoperative period. Duration of narcotic use was longer than anticipated with a wide SD (4.7 d +/−3 d). We recommend orthopaedic surgeons responsibly prescribe pain medications using evidence-based data or the results of their own experience monitoring medication consumption. In addition, and important in the setting of the "opioid epidemic," physicians must counsel patients and families on postoperative pain expectations and appropriate medication use.

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The United States is in the midst of a public health crisis, plagued by the use and misuse of opioid medications. Although the United States is composed of 4% to 5% of the world's population, it is responsible for 80% of global opioid use.[1] This is of particular concern in the pediatric population, as it has been shown that prescribed opioid use in this age group is associated with a 33% increased risk of future opioid misuse.[2] Prescription pain medications were the second most commonly abused drug among adolescents, just behind marijuana, and adolescent fatalities due to opioids more than doubled from 1980 to 2008.[3–5]

Although the rise in opioid medication use and misuse is multifactorial, the opioid epidemic may be exacerbated by the tendency for prescribers to overprescribe pain medication.[6,7] Pain control is an important component of postoperative care after surgery and opioid medications are commonly prescribed. However, with 38% of nonmedical opioid users reporting that they received their opioids from a friend or family member at no cost,[8,9] decreasing excessive opioid prescribing is essential. As the third most common prescriber of opioids, orthopaedic surgeons are presented with a significant opportunity to lead the efforts to minimize opioid use and misuse.[10,11]

There are currently no standard guidelines for treating acute or perioperative pain in the pediatric population.[12,13] Recommendations for opioid prescribing in adolescents are based on adult guidelines and are inadequate in accounting for the variable size of the pediatric patient.[4,12,14–16] Prescribers must, therefore, navigate between undertreating pain in children, which often have difficulty verbally expressing and quantifying pain, and overprescribing, which could be harmful.[3] Therefore, there is a pressing need to provide quantitative evidence-based guidelines for the treatment of postoperative pain in pediatric patients. The purpose of this study is to describe opioid use among pediatric patients after common orthopaedic surgeries. We hypothesize that average opioid use will be significantly lower than the quantity prescribed.

METHODS

Consecutive pediatric patients ages 5 to 20 years undergoing orthopaedic surgeries at a single pediatric hospital by a fellowship-trained pediatric orthopaedic surgeon between the years 2018 and 2020 were enrolled in this IRB-approved prospective study. Surgeries included posterior spinal fusion for adolescent idiopathic scoliosis (PSF AIS), distal femur epiphysiodesis, closed reduction and percutaneous pinning of supracondylar humerus fracture (CRPP SCH), anterior cruciate ligament reconstruction with autograft, simple knee arthroscopy for partial meniscectomy or partial synovectomy, shoulder arthroscopy for Bankart repair, and hip arthroscopy for the treatment of femoroacetabular impingement. There was a total of 12 surgeons whose patients were enrolled. Regional anesthesia blocks were routinely performed intraoperatively for anterior cruciate ligament reconstruction (adductor canal block) and Bankart repair (interscalene block). For other surgeries, local infiltrate of anesthetic was at the discretion of each individual surgeon.

Postoperatively all patients have been prescribed medications based on individual surgeon preferences. Opioid prescriptions included hydrocodone-acetaminophen 5 to 325 mg tablets or hydrocodone-acetaminophen 7.5 to 325 mg/15 mL elixir based on the patient's preference. Nonsteroidal anti-inflammatory drugs (NSAIDs), specifically ibuprofen, when recommended, were either obtained as an over-the-counter medication or prescribed. Recommendations for pain management, including medicinal and nonmedicinal methods were at the discretion of each surgeon.

Patients and their families were provided a medication log at the time of enrollment and asked to complete an entry for each dose of opioids or NSAIDs. The medication log included the medication dose, date and time of use, and a corresponding numeric pain score at the time of dosing. For patients younger than 8 years of age, the Wong-Baker FACES pain rating scale was used, and for patients 8 years of age and older, the numeric pain rating scale was used. Patients and their families were asked to log all medications from the time they arrived home from the hospital to the last dose of opioid medication and the last regularly scheduled NSAID dose. Patients and families were also asked to complete a series of questions after their last dose of medication, including satisfaction with pain control, a description of why they stopped taking the opioid medication, use of nonmedicinal pain relief (ice, heat, distraction techniques, etc), side effects attributed to the medication (drowsiness, nausea/vomiting, dizziness, and constipation), disposal of the opioid medication, and details regarding instructions they received for use of the pain medication. Upon completion of the medication log, families were asked to return it through the mail in a prepaid envelope or at their scheduled postoperative clinic visit. Once successful completion of the medication log was confirmed, patients were provided a $25 prepaid gift card.

To enhance the completion of the medication log, enrolled patient families were contacted the day after the outpatient procedure or the day after discharge to remind them to document medication consumption. They were also contacted a second time 1 week after surgery and asked to either return the completed log in the prepaid envelope or bring it with them to their scheduled clinical follow-up visit.

The primary outcome, opioid medication use was measured in the total amount taken, duration of use in days, and as a percentage of the total prescribed amount. The total quantity consumed was recorded by the patient and/or family member as a number of doses, where 1 dose equals 1 tablet or 1 weight-based liquid aliquot. Patient demographics, including age, sex, and race were recorded. Opioid medication use was analyzed as an entire cohort as well as within each of the 7 individual surgeries.

Statistical Analyses

Data were analyzed with *R* software (ver. 4.0.2, R for Statistical Computing). χ^2 analyses were used for categorical variables. Student *t* tests and 1-way analysis of variance tests were used for continuous variables with normal distributions. Post hoc Tukey tests were performed for analysis of variance tests with significant findings. Mann-Whitney *U* tests and Kruskal-Wallis tests were used for analyses with non-normal sample distributions. Multivariable linear or logistic regressions were performed to determine predictive factors for prescription size, patient narcotic use, pain control satisfaction, presence of side effects, and disposal of any leftover medication. For all analyses, $P < 0.05$ was considered statistically significant.

RESULTS

Six hundred eighty-six patients were enrolled and 342 patients (50%) completed the study, including 174 females and 168 males with a mean age of 14.0 years (range, 5 to

TABLE 1. Narcotic Prescriptions and Consumption by Procedure

Procedure	Patients	Prescribed mean, median (range)	Consumedmean, SD (range)	Mean % Unused	VAS pain; mean, SD
PSF AIS	48	62, 50 (30–150)	33, 21 (4–113)	42	5.3, 1.5
Epiphysiodesis	53	20, 20 (6–40)	7, 6 (0–28)	62	5.3, 2.2
CRPP SCH	42	18, 18 (6–40)	8, 5 (0–26)	52	5.7, 1.8
ACL reconstruction	52	29, 30 (20–60)	14, 14 (2–54)	49	6.0, 1.9
Simple knee arthroscopy	57	21, 20 (10–30)	8, 6 (0–24)	61	5.6, 1.9
Hip arthroscopy	53	28, 30 (15–30)	7, 5 (0–20)	74	6.3, 1.5
Shoulder arthroscopy	37	25, 20 (15–50)	12, 12 (0–37)	47	5.1, 1.7

ACL indicates anterior cruciate ligament; AIS, adolescent idiopathic scoliosis; CRPP, closed reduction and percutaneous pinning; PSF, posterior spinal fusion; SCH, supracondylar humerus; VAS, visual analog scale.

20 y). The number of patients who completed the study for each of the 7 surgeries is listed in Table 1. A total of 9867 doses of the opioid medication were prescribed, with an average of 29 doses per patient. Of the patients, 98% reported that they filled the opioid prescription.

The mean number and range of doses consumed, doses remaining at the end of treatment, and pain scores at the time the patient consumed each medication dose are listed in Table 1. A total of 4351 doses of the opioid medication, 44% of the total prescribed, were consumed. Of the prescribed medication, 56% remained unused. The mean number of remaining doses varied by procedure, ranging from 10 for patients after CRPP SCH to 29 after PSF AIS.

Overall mean duration of opioid use was 5.4 days +/–4.7 days. Duration of narcotic use by procedure ranged from 3.6 days +/–2.9 days after CRPP SCH to 11.3 days +/–5.5 days after PSF AIS (Table 2). Multivariable linear regression analysis identified NSAID use to be the only independent predictor of less opioid use, with a mean of 5.1 doses ($P = 0.003$) and 1.7 days ($P < 0.01$) less opioid medication consumed among patients who took NSAIDs. There were no significant differences in duration of use among any procedure except for PSF AIS, where patients used their opioid medication for significantly longer than all other procedures ($P < 0.001$).

Thirty-two patients (9.4%) consumed 100% of their opioid prescriptions. No variables were identified among the entire cohort as significantly different among 100% users and <100% users, including age, sex, ethnicity, prescription size, NSAID use, and nonmedicinal methods of pain control. PSF AIS and shoulder arthroscopy were the most frequent procedures to use 100% of the prescribed opioid medication (17% and 12%, respectively). In these subgroups, prescription size was significantly different between 100% and <100% users (PSF AIS 66 vs 40, $P = 0.027$; shoulder arthroscopy 26 vs 19, $P = 0.008$).

Nonmedicinal methods of pain control, most commonly ice, were used by 77% of patients. This was highly variable between procedures, with 91% to 97% of patients undergoing arthroscopic knee and shoulder surgeries using nonmedicinal methods of pain control, whereas patients who had epiphysiodesis (62%), PSF AIS (56%), and CRPP SCH (48%) used these techniques much less frequently. Nonmedicinal methods of pain control were associated with a nonsignificant mean reduction of 2.8 opioid doses ($P = 0.10$).

Most patients (95%) reported receiving instruction from a medical professional regarding how and when to take opioid medication. Of the patients, 58% cited only a single source of instruction, most commonly a nurse (74%). Physicians were cited as a source of information by 50% of patients, with high variability between procedures. Among patients after PSF AIS, who had the highest narcotic consumption, only 38% of patients reported receiving instructions on pain medication from their physician. Linear regression analysis identified a decreased duration of narcotic use by 2.6 days ($P = 0.07$) associated with receiving medication instructions.

The majority of patients (91%) reported being "very satisfied" or "satisfied" with their pain control. Mean satisfaction was not statistically different by surgery type. Female sex ($P < 0.01$) and users of 100% of the prescribed opioid doses ($P < 0.01$) were associated with decreased overall satisfaction as compared with the entire cohort. Of the patients, 61% reported a side effect that they attributed to the narcotic, most commonly drowsiness, constipation, and nausea. Increased reporting of side effects was identified in females versus males (70% vs 53%, $P < 0.02$) and older patients (14.3 y vs 13.6 y, $P < 0.001$).

TABLE 2. Duration of Opioid Use

Procedure	Mean of *D* (SD)
PSF AIS	11.3 (5.5)
Epiphysiodesis	4.7 (5.2)
CRPP SCH	4.1 (4.5)
ACL reconstruction	4.8 (3.4)
Simple knee arthroscopy	4.3 (3.6)
Hip arthroscopy	4.7 (4.3)
Shoulder arthroscopy	4.2 (2.7)

AIS indicates adolescent idiopathic scoliosis; ACL, anterior cruciate ligament; CRPP, closed reduction and percutaneous pinning; PSF, posterior spinal fusion; SCH, supracondylar humerus.

DISCUSSION

Opioid medication consumption in this study of pediatric patients after orthopaedic surgery was significantly less than the number of doses prescribed, with 56% of the doses prescribed remaining unused. The mean duration of narcotic use was longer than anticipated with a wide SD (5.4 d +/–4.7 d). Patient education decreased the duration of narcotic use, highlighting the importance of educating patients and families regarding the appropriate indications for these strong medications. Furthermore, the use of NSAIDs decreased the total number of doses and the number of days of opioid use, emphasizing the importance of a multimodal pain strategy.

The overuse and misuse of opioid medications in the pediatric patient population is a significant public health concern. Recent studies emphasized that there are no clear guidelines or standards for prescribing medications for postoperative pain management in children and adolescents.[12–14,17,18] Furthermore, patient and family expectations of postsurgical pain and strategies for outpatient pain management in the pediatric population have been minimally studied.[19,20] Considering that orthopaedic patients are one of the populations most at risk for opioid misuse,[21] this study attempts to fill the gaps in the pediatric population by investigating prescribing patterns, prescription fulfillment and utilization, patient satisfaction, and level of provider education following common orthopaedic procedures.

In our study, the duration of narcotic use was longer than anticipated with an average length of use of 5.4 days. This duration of use is much greater than typical expectations for acute postoperative pain after these

orthopaedic procedures and may be due to families inappropriately using opioid medications when traditional nonopioid medications would be sufficient. Although the majority of patients and families reported receiving some education regarding pain medications, only 50% reported that they received this information from a physician. This is most especially concerning among our highest users of opioid medication, patients undergoing PSF AIS, among whom only 38% of patients and families reported receiving education and instructions from their physician on opioid medication use. The finding that physician education decreased opioid duration use in these highest-use patients by 2.6 days emphasizes the importance of patient and family education by physicians to curb excessive opioid medication use.

In addition to education, the use of NSAIDs also decreased the total number of opioid doses and duration of use in the study. These findings correlate with prior literature supporting the positive effects of nonopioid medications and multimodal pain management on decreasing opioid requirements, minimizing opioid-induced adverse events, and increasing patient satisfaction.[22–25] Results from a randomized controlled trial by the Canadian Medical Association of pediatric patients having minor outpatient orthopaedic surgery found equal improvements in pain scores with no difference in efficacy between oral morphine and ibuprofen for at-home pain control.[26] This study also reported significant decreases in medication-related adverse events with the use of ibuprofen rather than morphine, again supporting the potential benefits of nonopioid medications in the 61% of patients in this study who reported opioid-associated side effects.

One fear that physicians have in prescribing opioids is of prescribing too few doses and patients requiring a refill and/or being dissatisfied with pain control. Although changes in controlled substance prescribing now allow e-prescribing of opioid medications, at the time of this study, the inability to provide an opioid medication refill by any means other than a paper prescription was frequently cited by physicians as a reason for larger initial prescription sizes. Nearly 10% of patients in this study consumed 100% of their opioid prescription, indicating that we were more frequently overprescribing than underprescribing. Similarly, Meza et al[27] identified just 2% of 1413 pediatric patients undergoing orthopaedic surgery at a single center obtained a secondary opioid prescription within 6 months after surgery. By improving physician education on postoperative pain management and typical medication usage, standardized guidelines for prescribing postoperative pain medications can be developed, and providers can play a more active role by minimizing unused opioid medication. Furthermore, changes in the ability to e-prescribe controlled substances, allow providers to more easily provide additional medication when occasionally needed, rather than uniformly overprescribing to potentially account for 100% of users.

This study demonstrates that the majority of pediatric patients undergoing common orthopaedic procedures in our practice are receiving postoperative opioid medication in amounts greater than those used for acute pain management. Evidence-based prescribing guidelines are a natural application of these study findings and are critically needed. One single-institution pediatric opioid prescribing guideline implemented by Jones et al[20] for orthopaedic patients achieved a 54% reduction in prescribed opioids. Likewise, Baker et al[28] demonstrated decreased opioid prescribing variability associated with a 4-tier discharge opioid prescribing guideline. We recommend orthopaedic surgeons utilize evidence-based data such as these, or the results of their own experience monitoring medication consumption to achieve similar reductions in opioid prescribing. Accounting for the variability in opioid consumption by individual patients, too narrow of a prescribing range may result in inadequate medication and patient and family dissatisfaction, yet too large risks potential misuse. Preoperative education of patients and families of postoperative pain expectations and multimodal pain treatment strategies should be considered as equally important as the informed consent process. We hypothesize that proper education on anticipated postoperative pain and multimodal pain management strategies would further decrease the opioid doses identified in this study.

Our study is not without limitations. First, this was a single-center study and the results reflect only those patients seen at our institution. However, our institution is a large tertiary referral pediatric hospital located in a metropolitan area and provides care to a diverse population of patients, which may improve generalizability. Second, the pain scores and medication logs reported are subject to potential recall and/or response bias. The logs were taken home with the patient and family and they were instructed to log each individual dose of medication as it was taken, but as this was completed without oversight by study personnel, there is potential that it was completed in batches in retrospective nature. Lastly, the study included 12 pediatric orthopaedic surgeons and no prestudy guidelines for prescribing or education were provided. Although this results in wide variability in prescribing and educational practices, we believe it also accurately reflects the significant variability among pediatric orthopaedists as a whole.

CONCLUSIONS

This study reveals that pediatric orthopaedic patients are often overprescribed postoperative opioid medications for pain management. This further contributes to the opioid excess and potential misuse amidst the opioid epidemic that our country is currently facing. This study emphasizes the importance of patient and family education regarding pain management, medication use, and the role of multimodal pathways as strategies to decrease opioid consumption. With that being said, future studies should attempt to further provide evidence-based, quantifiable data on a national scale, and then monitor opioid use among patients after common orthopaedic surgeries in a vast number of hospital systems so as to establish a national guideline for opioid prescribing patterns.

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