

# Variation in Prescribing Patterns and Use of Opioids in Pediatric Orthopaedic Surgery Patients

Marguerite Anne Mullen, BA; Michaela Procaccini, NP; Aristides I. Cruz Jr., MD, MBA

Alpert Medical School of Brown University, Providence, RI

## Abstract:

Pediatric patients receiving opioid prescriptions after orthopaedic surgery are an at-risk population amidst the ongoing opioid epidemic in the United States. While there is significant literature about opioid prescribing patterns and consumption among the adult population, there is limited data in the pediatric population. As a result of this limited knowledge, there remains substantial variation in practice patterns surrounding opioid use. This review evaluates the current literature regarding variation in opioid prescribing patterns in pediatric orthopaedic surgery patients with the aim of increasing awareness of risks and potential interventions.

## Key Concepts:

- As rates of surgical treatment of pediatric orthopaedic ailments increase, there is a growing pediatric patient population receiving opioid medication for analgesia.
- Variation in opioid prescription volume correlates with provider type and years of clinical experience.
- Opioid utilization after many orthopaedic procedures appears to be low, increasing potential risk of misuse and diversion.
- Orthopaedic surgeons must balance the pain needs of their patients with the practices of opioid stewardship.

## Introduction

The United States accounts for a disproportionate amount of the world's opioid consumption, utilizing about 80% of the global supply for less than 5% of the global population.<sup>1</sup> There are a myriad of potential factors behind this disproportionate use including cost, drug access, and cultural perceptions around pain. Yet, in the context of the opioid epidemic, it is important to recognize that the United States is an outlier.

Orthopaedic surgeons rank third highest of opioid prescribing physicians in the United States.<sup>1</sup> Although many orthopaedic procedures are inherently painful, consideration must be paid to opioid stewardship and limiting the potential for harm to the patient and the community.

Pediatric patients comprise a small but substantial proportion of orthopaedic surgeries and it is valuable to review their unique position as this group is especially vulnerable given their ongoing development. While some analgesic control is often necessary after surgery, amid a national opioid crisis it is imperative for physicians, surgeons, and advanced practice providers to review their prescriptive practices with the intent of limiting the potential for opioid misuse and diversion. The purpose of this article is to review opioid prescription patterns in pediatric orthopaedic surgery patients, specifically assessing variation in prescription volume by provider type, opioid utilization, and the efficacy of opioid reduction interventions.

## Pediatric Opioid Use

Coinciding with the opioid epidemic in the United States, there is also a trend of increasing surgical treatment for pediatric orthopaedic injuries. Between 2007 and 2011, the incidence of ACL tear in 10–14 year olds increased by 18.9%, whereas surgical reconstruction increased by 27.6%.<sup>2</sup> One study of femoral shaft fractures in 4–5 year olds identified an increase in surgical fixation of femoral shaft fractures to be 13.8% and 7.6% per year, respectively, between 1997 and 2012.<sup>3</sup> The rate of surgical treatment of forearm fractures, one of the most common pediatric injuries, increased 10.7% from 2000 to 2012.<sup>4</sup> Increasing surgical management may contribute to better clinical outcomes, but it also likely means a higher chance of receiving an opioid prescription.

There is limited data regarding the exact amount of opioid prescriptions to pediatric patients.<sup>5</sup> However, in a large study of a nationally representative claims database, 21.5% of pediatric patients undergoing surgical fracture treatment filled one or more opioid prescriptions.<sup>6</sup> Since fractures are one of the most common injuries in children and adolescents<sup>7</sup> and fracture surgery is becoming increasingly common, more research is needed to determine trends of pediatric opioid prescriptions as well as the trend specifically in orthopaedic patients.

While pain control after surgery is vital, research has demonstrated that non-medical use of prescription opioids (NMUPO) is both dangerous and common. As children and their families are given medication for legitimate health reasons (e.g., postoperative pain control) and high numbers of these pills are not consumed, they may remain in the household and carry the risk of potential diversion. Thus, understanding the appropriate amount of opioids needed after an orthopaedic injury or surgery is important in order to minimize the potential for diversion and/or misuse.

## Variation in Prescriptions by Provider

Several studies have reviewed the variation in opioid prescription volume by provider type. Overall, it appears

that both the role and clinical experience of the provider have an important effect on prescribed opioid doses. In a study of medication prescribed to pediatric orthopaedic surgery fracture patients, Iobst et al. found that residents and physician assistants prescribed significantly higher opioid doses to pediatric patients than nurse practitioners and attending surgeons.<sup>8</sup> On average, attending surgeons prescribed 25 doses per patient, and nurse practitioners prescribed 26.7 doses. However, physician assistants and residents prescribed an average of 31.4 doses and 31.7 doses, respectively. In other studies, those with more clinical experience have been found to prescribe fewer medication doses across a variety of roles.<sup>9</sup> Similarly, analysis of prescriptive patterns at one institution showed that prescription volume distinctly varied with each year of training among plastic and orthopaedic surgery residents.<sup>10</sup> Attending surgeons prescribed lower morphine milligram equivalents (MME) per patient compared to residents as a whole and were more likely to believe that patients were disposing of unused opioids appropriately.

While studies consistently demonstrate variation in opioid prescriptions by provider type, they do not account for injury type. This co-variable will obviously have confounding effects as differing levels of trauma are seen and managed by different providers with different non-opioid pain strategies. Additionally, the role of patient race should be considered. One can review the paper by McCarthy et al. in the current edition of *JPOSNA*; they review their experience on pain management in cerebral palsy patients in reference to race.

## Variation in Prescription Types

The variation in opioid prescription by type of medication is still under investigation. In a study from the Advocacy Committee of the Pediatric Orthopaedic Society of North America (POSNA), the three most prescribed opioid medications overall were hydrocodone, oxycodone, and acetaminophen with codeine.<sup>11</sup> Similarly, Iobst et al. found that 95% of opioid prescriptions to pediatric orthopaedic surgery patients with fractures were a hydrocodone-acetaminophen combination

**Table 1. Prescribed Number of Opioid Doses in Reviewed Studies**

	Fractures							Spine	Procedure	Weight	POSNA Category*
	Wrist	Forearm	Elbow	Humerus	Femur	Tibia	Ankle				
<i>Iobst</i> <sup>8</sup>	24.4	28.8	27.3	28.8	24.4	29.4	37.1	-	-	<25kg: 27.6 ± 10.4 25-50: 27.0 ± 10.4 50-75: 31.9 ± 13.8 75+: 36.2 ± 16.9 54.4% under 25kg	n/a
<i>Nelson</i> <sup>15</sup>	-	-	-	19.8	-	-	-	-	Closed reduction	23.1 ± 7.1	Minor
<i>Stillwagon (14-16)</i> <sup>13</sup>	-	-	-	45	-	-	-	-	Closed reduction	23.2 ± 10.5	Minor
<i>Stillwagon (17-18)</i> <sup>13</sup>	-	-	-	17.2	-	-	-	-	Closed reduction	20.5 ± 5.2	Minor
<i>Meyer</i> <sup>16</sup>	-	-	30.1	-	31.9	-	-	-	Closed reduction	-	Minor
<i>Grant</i> <sup>17</sup>	-	-	-	-	-	-	-	43.6	Fusion	57.6 ± 17.2	Spinal Fusion
<i>Monitto</i> <sup>14</sup>	Non-Spine Orthopaedic Surgery – 76 doses							113	-	-	n/a

\*Additional Link 1

(commonly branded as Vicodin, Lortab, or Norco).<sup>8</sup> Oxycodone and oxycodone-acetaminophen were 2% and 1%, respectively. Furthermore, hydrocodone is the highest single cause of opioid exposure as reported by the National Poison Data System.<sup>12</sup>

On the other hand, oxycodone was chosen for 120/126 pediatric patients with supracondylar humerus fracture at a single Level 1 trauma center in a study by Stillwagon et al.<sup>13</sup> A report by Monitto et al. also found oxycodone to be prescribed most frequently to pediatric surgery patients.<sup>14</sup> These discrepancies demonstrate probable institution-specific prescribing patterns that are necessary to recognize when considering institutional policy changes around opioid medications. Iobst et al. also observed upon adjusted analysis that patients with tablet prescriptions were prescribed 7.6 times larger doses than patients with liquid medications.<sup>8</sup> While the route of administration sensibly varies by age, and the mean patient age in this study was less than 9 years old, there is yet to be a clear explanation regarding the reason behind the difference. In the study, Iobst et al. posit that

the liquid doses are more patient specific as more weight and age specific calculations are required for prescription. This difference in dosage between formulations without any other intervention could be a starting point for future work to identify if this difference holds true across other institutions.

## Variation in Prescription Volume

A large number of pediatric orthopaedic patients receive opioid prescriptions for analgesia.<sup>6,8,13,14,15,16</sup> Several studies have investigated prescription volume by procedure type (Table 1), and while the data is still limited, the current results show little correlation between fracture type, sex, and opioid doses.

Iobst et al. found that the average opioid dose for patients undergoing ankle surgery was significantly higher than any other fracture type besides tibia.<sup>8</sup> Patients with wrist and forearm fractures received 5.0- and 4.6-times smaller doses than patients with elbow fractures ( $p = 0.0003$ ). Only prescriptions for wrist fractures varied significantly by sex, with males receiving more doses

**Table 2. Opioid Utilization (% used)**

	Fractures						Spine	Other orthopaedic surgeries	Mean age
	Wrist	Forearm	Elbow	Humerus	Femur	Tibia			
<i>Nelson</i> <sup>15</sup>	-	-	-	24.10%	-	-	-	-	6.1 ± 2.1 years
<i>Stillwagon</i> <sup>13</sup>	-	-	-	23%	-	-	-	-	4.8 ± 1.9 years
<i>Grant</i> <sup>17</sup>	-	-	-	-	-	-	90.16%	-	14.9 ± 2.4 years
<i>Monitto</i> <sup>14</sup>	-	-	-	-	-	-	65.49%	60.52%%	n/a

than females. Beyond these findings, the study identified no significant distinctions in opioid prescription volume by fracture type or sex. Patients that were older and heavier received more doses. The difference between fracture type groups in the Meyer et al. study likewise did not reach significance.<sup>16</sup> Pediatric patients undergoing spinal fusion were prescribed significantly more opioids than non-spine orthopaedic procedures in another study by Monitto et al.<sup>14</sup>

Given the similarities among doses for distinct diagnoses, Iobst et al. express a concern that prescriptions are not diagnosis-specific and that it is likely that not every fracture requires the same amount of medication.<sup>8</sup> Fractures were treated in a universal manner rather than patient-specific, possibly a function of programmed computer orders, habit, or other factors. Consequently, the authors propose that it is reasonable to believe that different fracture types may have different pain control needs and that prescriptions should vary by diagnosis. More research is needed to determine whether procedures have distinct prescribing requirements.

A limitation of many of these studies is the inability to convert doses to morphine milligram equivalents (MME) as much of the required data is unavailable. Thus, prescription doses per fracture type cannot be compared across studies for the purpose of this review. Given this shortcoming, it is still possible to see trends in each study and consider this for future work.

Notably, POSNA released a quality, safety, and value initiative in 2020 promoting evidence-based postoperative opioid prescription guidelines (see Additional Links). Other organizations, such as the American

Academy of Pediatrics also have a wide variety of educational tools regarding opioid use for patients and their guardians.

### Variation in Prescription Use

While it is important to help families control postoperative pain, it is essential to minimize excess medication doses to limit risks of medication diversion and non-medical use (NMPO). Multiple researchers have studied opioid utilization rates particularly focusing on common pediatric fractures and spinal fusions/scoliosis (Table 2).

Outside of patients undergoing spinal fusion, opioid utilization rates demonstrate that as much as 40–77% of prescribed medication may remain unused. Spinal fusion patients are typically considered outliers in this field due to acknowledged high levels of postoperative pain.<sup>11,18</sup> These trends of low utilization rates similarly hold true to the field of pediatric surgery. Ray et al. found that 79.3% of pediatric surgery patients did not use all prescribed opioids.<sup>19</sup> When parents were asked in one study about why they stopped providing opioids to their children before the prescription was finished, 76.4% reported that pain was well-controlled and 18% reported stopping due to gastrointestinal and neurologic side effects.<sup>14</sup> Given this information, it is reasonable to conclude that non-spine patients require much less medication to treat postoperative pain than they are currently prescribed.

### Prescription Misuse and Diversion

The non-medical use of diverted prescription opioid medication has been well-documented in the adolescent population. In a study of 2,964 adolescents, 393 received

legitimate prescriptions in the past year, and 18% of the 393 reported misuse.<sup>20</sup> A different study found that 80% of high school seniors with NMUPO used leftover medication from their own legitimate prescriptions.<sup>21</sup> Given these statistics, there is a significant risk of misuse of legitimate prescriptions by the child to which they are prescribed.

Hudgins et al. found that 25.4% of adolescents and young adults misusing opioids obtained the medications from the healthcare system (55.7% were from family and friends).<sup>22</sup> Thus, opioids that originate as valid prescriptions may have a broad reach. Even if a child is too young to purposefully misuse opioids, there is a risk for prescription diversion via family and friends.

In addition to misuse and diversion, acute opioid poisoning is another significant risk of opioid overprescribing. From 2005 to 2018, there were 207,543 reported opioid poisonings in children according to the United States National Poison Data System.<sup>23</sup> The rate of poisonings has decreased since 2010; however, the topic remains of concern as the proportion of suspected suicides among this group has increased. There is additional concern that increasing opioid prescriptions to adults may contribute to this crisis as there is a correlation between the prescription of opioids to an adult and the overdose of a family member without an opioid prescription. Given this information, it is essential to consider both the risks of misuse and diversion of opioids and the risks of purposeful self-harm or accidental poisoning. A wide array of literature has demonstrated that many parents and guardians do not know how to, or plan to, properly dispose of unused opioid medication prescribed to their child.<sup>11,14,17,24</sup> In a review of postoperative opioid use across specialties, between 9% and 90.8% intended to keep unused opioids.<sup>18</sup>

To date, limiting excess prescriptions is a challenge. Feinberg et al. cite a reluctance among healthcare providers to require patients to refill their prescriptions for adequate pain control.<sup>18</sup> Rather, providers may write

more generous prescriptions with the intention of helping patients. They make the argument that this behavior should change given the heightened risks during the opioid epidemic.

## Interventions

Over the past several years, significant literature has emerged regarding single institution interventions aimed at reducing over prescription of opioids. Interventions typically fall into three categories: provider education, institutional change, and patient involvement.

Winslow et al. combined provider and patient education during a study of pediatric orthopaedic surgery patients with supracondylar humerus fractures.<sup>25</sup> After requesting self-appraisal for a theoretical supracondylar humerus fractures case, hypothetical prescription volumes were shared with the department. Outlier prescribing providers were identified monthly and re-educated via email. Order sets were also modified to encourage prescription of acetaminophen and ibuprofen and an educational consent form was introduced for patient caregivers regarding opioid side effects, storage, and risks. After one year, the institution increased the percent of patients receiving five or fewer doses of opioid after surgical management of SCH fracture from 30.4% to 72.6%.

Caruso et al. likewise joined provider training with changes to order sets.<sup>26</sup> Specifically, they focused on reducing the use of acetaminophen-opioid combination products and encouraging the use of liquid oxycodone. The focus on acetaminophen containing medications is unique and the authors recognized resistance from staff amid concerns that this could lead to more abuse. However, they discuss that the combination analgesics are not titrated for individuals, unlike liquid formularies, which can not only increase misuse but also hepatotoxicity from the acetaminophen. There was a significant decrease in the use of opioid-acetaminophen products during the intervention and sustainment period, though there was no significant change in average MME. While utili-

zation was not reviewed in this study, divorcing acetaminophen from the opioid could theoretically lead to increased postoperative acetaminophen use, allowing for decreased opioid consumption.

While many interventions relevant to this field focused on prescribers, several studies focus on interaction with other healthcare team members. In a study of pediatric orthopaedic and plastic surgery patients, parents and guardians were given an at-home disposal product and instructions on safe opioid disposal from anesthesiologists.<sup>24</sup> Anesthesiologists additionally met with families at postoperative visits and followed up with families who reported unused opioids. Weiner et al. examined the correlation of interaction with Certified Child Life Specialists (CCLS) and outcomes of pediatric patients admitted for lower extremity surgery.<sup>27</sup> Citing studies examining the association of anxiety and increased response to pain, they studied whether a specialist meant to help with the hospital experience could translate into other clinical outcomes. While there was no significant effect, this is a constructive reminder about working across departments and the potential for engaging others in the hospital on these projects.

## Prescription Trends in Adults

There exists even more research into the above outlined topics in adult orthopaedic surgery patients with similar conclusions.<sup>28,29,30,31,32,33,34</sup> Additionally, studies of adults consider factors such as state guidelines on maximum opioid prescriptions.<sup>35,36</sup> Overall, it would be worthy to investigate further how trends in the adult population may carry over to pediatric orthopaedics.

## Limitations

Because this was not a systematic review, relevant articles to the topic may not have been included. One limitation of comparing prescription volume and utilization is state-to-state differences in maximum prescription to opioid-naïve patients. Some studies do not correlate opioid use with reported pain or previous use. Most of these interventions are institution-specific, taking place at academic institu-

tions. This may limit the replication of results in other settings. Many studies in this area are retrospective, and as such there is a delay from prescription to publication year. Changes made to prescribing patterns in the past years may not be reflected in this review.

## Summary

Given the repeated demonstration that pediatric orthopaedic surgery patients do not utilize a large percentage of their postoperative opioid prescriptions, it is essential that the field pursue both further research to create evidence-based guidelines for prescription volume as well as interventions to reduce over prescription and educate patients and parents about opioid safety.<sup>13,14,15</sup> During the COVID-19 pandemic, opioid deaths increased across every state in America.<sup>37</sup> While this data is new and its causes are still being investigated, this review serves to highlight how variation in prescription and utilization patterns may lead to opioid misuse and diversion.

The efficacy of the above-mentioned interventions to reduce excess opioid prescribing is promising. Comparison among peers looks to serve as an effective tool to encourage change. The intention of discussing variation in provider groups is not to blame but rather to take this as an opportunity for education. It is essential to understand how we can help new providers across all roles succeed and reduce any unintentional harm. With education and institutional policies, it is very possible to make sizable change, affecting not only patients but also our communities at large.

## Additional Links

- POSNA PostOp Pain Management Prescription Guidelines: <https://posna.org/Physician-Education/QSVI/PostOp-Pain-Management-Prescription-Guidelines>
- FDA Safe Disposal Video: <https://www.fda.gov/drugs/safe-disposal-medicines/disposal-unused-medicines-what-you-should-know>

## References

1. Morris BJ, Mir HR. The opioid epidemic: impact on orthopaedic surgery. *J Am Acad Orthop Surg*. 2015 May;23(5):267-71.
2. Werner BC, Yang S, Looney AM, Gwathmey FW Jr. Trends in Pediatric and Adolescent Anterior Cruciate Ligament Injury and Reconstruction. *J Pediatr Orthop*. 2016;36(5):447-452.
3. Alluri RK, Sabour A, Heckmann N, Hatch GF, Vandenberg C. Increasing Rate of Surgical Fixation in Four- and Five-year-old Children With Femoral Shaft Fractures. *J Am Acad Orthop Surg*. 2019;27(1):e24-e32.
4. Cruz AI Jr, Kleiner JE, DeFroda SF, Gil JA, Daniels AH, Eberson CP. Increasing rates of surgical treatment for paediatric diaphyseal forearm fractures: a National Database Study from 2000 to 2012. *J Child Orthop*. 2017;11(3):201-209.
5. Groenewald CB, Rabbitts JA, Gebert JT, Palermo TM. Trends in opioid prescriptions among children and adolescents in the United States: a nationally representative study from 1996 to 2012. *Pain*. 2016;157(5):1021-1027.
6. Zhong H, Ladenhauf HN, Wilson LA, et al. Persistent opioid use after surgical treatment of paediatric fracture. *Br J Anaesth*. 2021;126(6):1192-1199.
7. Naranje SM, Erali RA, Warner WC Jr, Sawyer JR, Kelly DM. Epidemiology of Pediatric Fractures Presenting to Emergency Departments in the United States. *J Pediatr Orthop*. 2016;36(4):e45-e48.
8. Iobst CA, Singh S, Yang JZ. Opioid prescription patterns for pediatric orthopaedic fracture patients. *J Clin Orthop Trauma*. 2020;11(2):286-290.
9. Kattail D, Hsu A, Yaster M, et al. Attitudes and self-reported practices of orthopaedic providers regarding prescription opioid use. *J Opioid Manag*. 2019;15(3):213-228.
10. Gaspar MP, Pflug EM, Adams AJ, et al. Self-Reported Postoperative Opioid-Prescribing Practices Following Commonly Performed Orthopaedic Hand and Wrist Surgical Procedures: A Nationwide Survey Comparing Attending Surgeons and Trainees. *J Bone Joint Surg Am*. 2018;100(19):e127.
11. Raney EM, van Bosse HJP, Shea KG, Abzug JM, Schwend RM. Current State of the Opioid Epidemic as it Pertains to Pediatric Orthopaedics From the Advocacy Committee of the Pediatric Orthopaedic Society of North America. *J Pediatr Orthop*. 2018;38(5):e238-e244.
12. Allen JD, Casavant MJ, Spiller HA, et al. Prescription opioid exposures among children and adolescents in the United States: 2000-2015. *Pediatrics*. 2017;139:e20163382.
13. Stillwagon MR, Feinstein S, Nichols B, Andrews PN, Vergun AD. Pain Control and Medication Use in Children Following Closed Reduction and Percutaneous Pinning of Supracondylar Humerus Fractures: Are We Still Overprescribing Opioids?. *J Pediatr Orthop*. 2020;40(10):543-548.
14. Monitto CL, Hsu A, Gao S, et al. Opioid Prescribing for the Treatment of Acute Pain in Children on Hospital Discharge. *Anesth Analg*. 2017;125(6):2113-2122.
15. Nelson SE, Adams AJ, Buczek MJ, Anthony CA, Shah AS. Postoperative Pain and Opioid Use in Children with Supracondylar Humeral Fractures: Balancing Analgesia and Opioid Stewardship. *J Bone Joint Surg Am*. 2019;101(2):119-126.
16. Meyer ZI, Krucylak P, Mo M, Miller ML, Wall LB. Opioid Use Following Operatively Treated Pediatric Elbow and Femur Fractures. *J Pediatr Orthop*. 2019;39(4):e253-e257.
17. Grant DR, Schoenleber SJ, McCarthy AM, et al. Are We Prescribing Our Patients Too Much Pain Medication? Best Predictors of Narcotic Usage After Spinal Surgery for Scoliosis. *J Bone Joint Surg Am*. 2016;98(18):1555-1562.
18. Feinberg AE, Chesney TR, Srikandarajah S, Acuna SA, McLeod RS; Best Practice in Surgery Group. Opioid Use After Discharge in Postoperative Patients: A Systematic Review. *Ann Surg*. 2018;267(6):1056-1062.
19. Ray JJ, Shackelford TL, Bronikowski D, Lubicky JP, Lancaster J, Grant DR. Pain Medication Disposal Rates After Pediatric Surgery. *Hosp Pediatr*. 2021;11(5):521-524.
20. McCabe SE, West BT, Boyd CJ. Motives for medical misuse of prescription opioids among adolescents. *J Pain*. 2013;14(10):1208-1216.



21. McCabe SE, West BT, Teter CJ, Boyd CJ. Medical and nonmedical use of prescription opioids among high school seniors in the United States. *Arch Pediatr Adolesc Med*. 2012;166(9):797-802.
22. Hudgins JD, Porter JJ, Monuteaux MC, Bourgeois FT. Prescription opioid use and misuse among adolescents and young adults in the United States: A national survey study. *PLoS Med* [online]. 2019;16(11):e1002922. Accessed June 3, 2021.
23. Megan E. Land, Martha Wetzel, Robert J. Geller, Pradip P. Kamat & Jocelyn R. Grunwell. Analysis of 207,543 children with acute opioid poisonings from the United States National Poison Data System. *Clinical Toxicology*. 2020;58:8, 829-836.
24. Zhang, De-An, Marilan Luong, Emmanuel Barragan, Frederic Bushnell, Robert Cho, and Selina Poon. Disposal of Unused Opioids Using an At-Home Disposal Method. *JPOSNA* [online]. February 2021;3(1). Available at: <https://www.jposna.org/ojs/index.php/jposna/article/view/150>. Accessed June 30, 2021.
25. Winslow L, Holstine J, Samora JB. Reducing the Use of Opioids for Pediatric Patients with Supracondylar Humerus Fractures. *Jt Comm J Qual Patient Saf*. 2020;46(10):581-587.
26. Caruso TJ, Trivedi S, Chadwick W, et al. A Quality Improvement Project to Reduce Combination Acetaminophen-opioid Prescriptions to Pediatric Orthopedic Patients. *Pediatr Qual Saf*. 2020;5(3):e291.
27. Weiner J, Zeno R, Thrane SE, Browning KK. Decreasing Opioid Use in Pediatric Lower Extremity Trauma: A Quality Improvement Project. *J Pediatr Health Care*. 2020;34(5):446-452.
28. Bhashyam AR, Young J, Qudsi RA, Parisien RL, Dyer GSM. Opioid Prescribing Patterns of Orthopedic Surgery Residents After Open Reduction Internal Fixation of Distal Radius Fractures. *J Hand Surg Am*. 2019;44(3):201-207.e2.
29. Kvarda P, Hagemeijer NC, Waryasz G, Guss D, DiGiovanni CW, Johnson AH. Opioid Consumption Rate Following Foot and Ankle Surgery. *Foot Ankle Int*. 2019;40(8):905-913.
30. Choo KJ, Grace TR, Khanna K, Barry J, Hansen EN. A Goal-directed Quality Improvement Initiative to Reduce Opioid Prescriptions After Orthopaedic Procedures. *J Am Acad Orthop Surg Glob Res Rev*. 2019;3(9):e109.
31. King C, Curran J, Devanagondi S, Balach T, Conti Mica M. Targeted Intervention to Increase Awareness of Opioid Overprescribing Significantly Reduces Narcotic Prescribing Within an Academic Orthopaedic Practice. *J Surg Educ*. 2020;77(2):413-421.
32. Kahlenberg CA, Stepan JG, Premkumar A, Lovecchio FD, Cross MB. Institutional Guidelines Can Decrease the Amount of Opioids Prescribed After Total Joint Replacement. *HSS J*. 2019;15(1):27-30.
33. Wyles CC, Hevesi M, Ubl DS, et al. Implementation of Procedure-Specific Opioid Guidelines: A Readily Employable Strategy to Improve Consistency and Decrease Excessive Prescribing Following Orthopaedic Surgery. *JB JS Open Access*. 2020;5(1):e0050
34. Smith DH, Kuntz JL, DeBar LL, et al. A randomized, pragmatic, pharmacist-led intervention reduced opioids following orthopedic surgery. *Am J Manag Care*. 2018;24(11):515-521.
35. Ukert B, Huang Y, Sennett B, et al. State-level variation in opioid prescribing after knee arthroscopy among the opioid-naïve in the USA: 2015–2019. *BMJ Open*. 2020;10:e035126.
36. Chalmers BP, Mayman DJ, Jerabek SA, Sculco PK, Haas SB, Ast MP. Reduction of Opioids Prescribed Upon Discharge After Total Knee Arthroplasty Significantly Reduces Consumption: A Prospective Study Comparing Two States. *J Arthroplasty*. 2021;36(1):160-163.
37. American Medical Association. Issue brief: Drug overdose epidemic worsened during COVID pandemic [AMA Assn Web site]. June 1, 2021. Available at: <https://www.ama-assn.org/system/files/2020-12/issue-brief-increases-in-opioid-related-overdose.pdf>. Accessed June 25, 2020.