

Association of Preoperative Opioid Use With Postoperative Opioid Use and Patient-Reported Outcomes in Ankle Fracture Fixation Patients

Nicholas Reiners, MD¹ , Sandy Vang, BA^{1,2}, Rachael Rivard, MPH¹, Nicholas Bostrom, BA¹, and Mai P. Nguyen, MD^{1,2}

Abstract

Background: Ankle fracture surgery is a common procedure with many patients receiving opioid medications for postoperative pain control. Whether there are factors associated with higher medication quantities or patient-reported outcomes, however, remains largely unknown.

Methods: Patients with isolated, rotational ankle fractures who underwent surgical fixation between January 2018 and March 2020 were retrospectively reviewed. Patient demographics, injury characteristics, and preoperative and postoperative opioid prescription information were recorded. Clinical follow-up and Foot and Ankle Ability Measure (FAAM) questionnaires were collected at 6 weeks and 3 months postoperatively. Multiple linear regression was used to examine the influences of age, sex, body mass index (BMI), fracture characteristics, medical comorbidities, and preoperative opioid use (OU) on postoperative opioid morphine milligram equivalent (MME) amount and FAAM scores.

Results: A total of 294 patients were included with an average age of 52.11 ± 17.13 years (range, 18–97). Fracture types were proportional to one another. Chronic pain (mean = 145.89, 95% CI = 36.72, 255.05, $P = .0009$), preoperative OU (mean = 178.22, 95% CI = 47.46, 308.99, $P = .0077$), psychiatric diagnoses (mean = 143.81, 95% CI = 58.37, 229.26, $P = .001$), tobacco use (mean = 137.37, 95% CI = 33.35, 229.26, $P = .0098$), and trimalleolar fractures (mean = 184.83, 95% CI = 86.82, 282.84, $P = .0002$) were associated with higher postoperative opioid MME amounts. Older age (mean = -0.05 , 95% CI = $-0.08, -0.02$, $P = .0014$) and higher BMI (mean = -0.06 , 95% CI = $-0.12, 0.00$, $P = .048$) were both independently associated with lower FAAM scores at 6 weeks. At 3 months, higher BMI (mean = -0.09 , 95% CI = $-0.13, -0.04$, $P = .0002$), bimalleolar fractures (mean = -1.17 , 95% CI = $-2.17, -0.18$, $P = .021$), and higher postoperative MME amounts (mean = -0.10 , 95% CI = $-0.19, -0.01$, $P = .0256$) were each independently associated with lower FAAM scores.

Conclusion: In this study, we found that patients with chronic pain, preoperative OU, psychiatric diagnoses, tobacco use, and trimalleolar fractures were more likely to have higher amounts of opioid prescribed following ankle fracture surgery. However, only age, BMI, bimalleolar fractures, and postoperative MME amount were associated with lower FAAM scores postoperatively.

Level of Evidence: Level III, retrospective cohort study.

Keywords: ankle fracture, trauma, opioid, patient-reported outcomes

Introduction

Ankle fractures are common orthopaedic injuries that account for 9% of all fractures.¹⁰ Excellent outcomes can be achieved following surgery, but they are among the most painful ambulatory procedures and necessitate the use of opioid medications.¹⁹ Orthopaedic surgeons remain the highest surgical prescriber of these medications and

¹Department of Orthopedic Surgery, University of Minnesota, Minneapolis, MN, USA

²Department of Orthopedic Surgery, Regions Hospital, St Paul, MN, USA

Corresponding Author:

Nicholas Reiners, MD, Department of Orthopedic Surgery, University of Minnesota, 2512 South 7th St, Ste R200, Minneapolis, MN 55455, USA.
 Email: reiner189@umn.edu



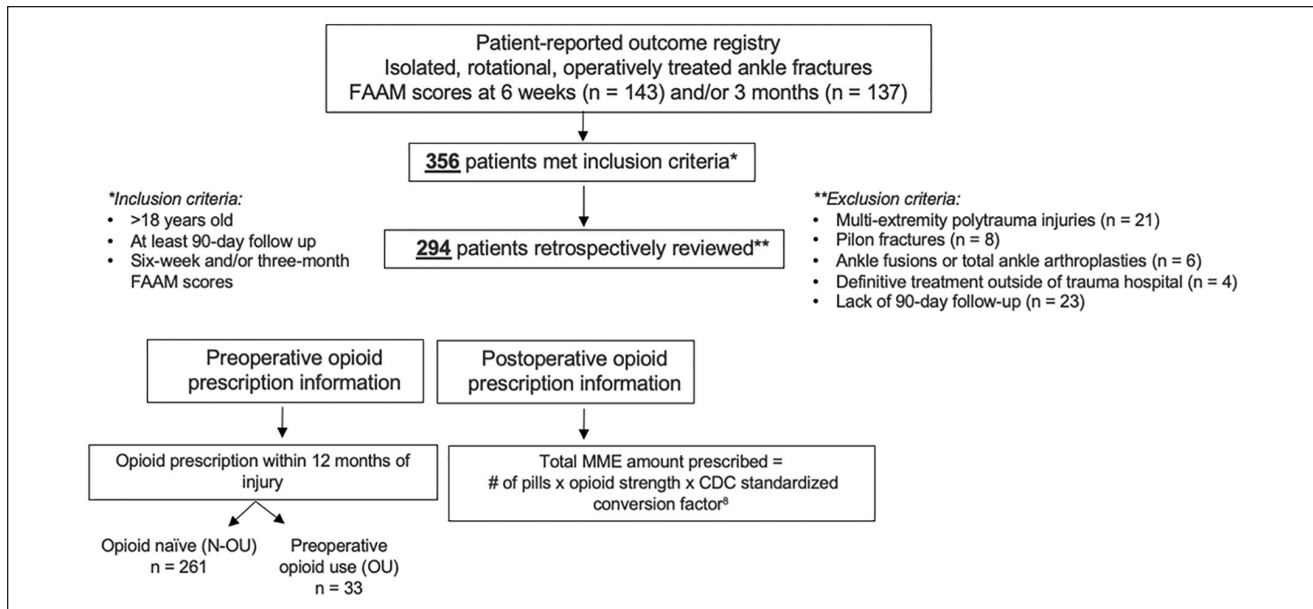


Figure 1. STROBE diagram demonstrating patient selection and stratification.

thirdmost among all physicians.^{7,11} Historically, however, orthopaedic surgeons admitted to not knowing how many opioid pills to prescribe, which has led to variability in postoperative pain protocols.^{2,27}

Two million Americans are documented as having an opioid use (OU) disorder, and opioid overdose is among one of the leading causes of accidental death in the country.³ In 2016, more than half of all drug overdoses were related to opioids with legally prescribed prescription drugs thirdmost responsible after fentanyl and heroin.¹³ Therefore, the importance of adequately controlling pain while minimizing OU cannot be understated, as prescription OU remains a significant problem in the United States. Although the literature is evolving, postoperative pain recommendations do vary between subspecialties and is especially sparse in the foot and ankle community.^{7,24,26} It is currently not well understood whether there are factors associated with higher postoperative opioid requirements or postoperative functional outcomes in patients undergoing operative fixation of ankle fractures. Our hypothesis, based on known data from arthroplasty and spine literature, was that preoperative OU would be associated with higher postoperative opioid amounts and lower patient-reported outcomes (PROs).

Materials and Methods

Institutional review board approval was obtained for the study. A prospective PRO registry of trauma patients at our level 1 trauma center was queried for operative ankle fractures from 2018 to 2020. We utilized the Foot and Ankle Ability Measure (FAAM) activities of daily living (ADL)

subscale as a surrogate for patient functional outcome postoperatively, as it is a well-validated and reliable 21-item, scaled questionnaire for lower extremity injuries.^{12,16} After applying inclusion and exclusion criteria (Figure 1), 294 patients were retrospectively reviewed in the electronic medical record. These patients were further divided into preoperative opioid use (OU) and opioid naïve (N-OU) groups based on whether an opioid prescription was documented in their chart 12 months prior to their date of surgery. In some situations, patients were prescribed opioids for pain management in between their date of injury and date of surgery, and these patients were still considered N-OU because previous to their fracture they were not exposed to opioids.

At our institution, rotational ankle fractures (when indicated) are operated on within 2 weeks of injury by trauma fellowship-trained orthopaedic surgeons. On presentation, the fractures are reduced and immobilized in a short-leg splint or external fixator depending on soft tissue status. Patients are instructed to remain nonweightbearing and to elevate the injured limb. Postoperatively, patients are seen at 2 weeks, 6 weeks, and 3 months where clinical and radiographic evaluations are performed. Outpatient physical therapy is provided, and weightbearing is advanced at the discretion of the orthopaedic surgeon.

Medical records were reviewed for patient demographics, medical comorbidities, injury characteristics, and opioid information (Table 1). Alcohol, tobacco, and illicit drug use were self-reported at the time of presentation and recorded as binary variables. Postoperative OU was standardized by calculating the total MME amount prescribed

Table 1. Patient Demographics.

Demographic	N-OU (n = 261; 89%)	Preoperative OU (n = 33; 11%)	P
Age, y, mean \pm SD	50.7 \pm 17.0	63.0 \pm 14.4	.003*
Sex, male, n (%)	109 (41.8)	7 (21.2)	.09
BMI, mean \pm SD	32.1 \pm 8.3	33.2 \pm 9.9	.89
Chronic pain diagnosis, n (%)	40 (15.3)	14 (42.4)	.01*
Diabetes, n (%)	38 (14.6)	12 (36.4)	.01*
Psychiatric diagnoses, n (%)	85 (32.6)	21 (63.6)	.01*
Tobacco use, n (%)	41 (15.7)	7 (21.2)	.90
Alcohol use, n (%)	166 (63.6)	19 (57.6)	.80
Illicit drug use, n (%)	18 (6.9)	3 (9.1)	.22
Postoperative MME, mean \pm SD	309.7 \pm 18.2	565.6 \pm 116.2	.04*

Abbreviations: BMI, body mass index; MME, morphine milligram equivalent; OU, opioid use.

*Significant at the .05 level.

(beginning with their first outpatient opioid prescription after surgery) equal to the number of pills prescribed times strength of the opioid prescribed times Centers for Disease Control and Prevention (CDC) standardized conversion factors.⁵ Higher FAAM scores correlate with better functional outcomes and vis versa.¹⁷

Descriptive statistics were calculated. Data were evaluated with Levene test for equality of variance, 2-tailed Student *t* tests, or Pearson χ^2 tests where appropriate. Mann-Whitney *U* test was used for nonparametric data. Multiple linear regression was used to examine the influences of age, patient demographics, medical comorbidities, injury characteristics, and preoperative OU on both postoperative MME amount and FAAM scores at 6 weeks and 3 months postoperatively. Statistical significance was set at $\alpha < 0.05$. All statistical analyses were performed using SPSS, version 25.0 (SPSS, Inc).

Results

Patient Demographics, Injury Characteristics, and Opioid Exposure

Two hundred ninety-four patients with isolated, operative ankle fractures and minimum 90-day follow-ups were included for the final analysis. The mean age was 52.11 (range, 18-97) years, and 39.5% were men. Ninety-five patients had isolated lateral malleolar fractures (32.3%), 96 patients had bimalleolar fractures (32.7%), and 95 patients had trimalleolar fractures (32.3%). There were 10 open fractures (3.4%).

The subdivided preoperative OU and N-OU cohorts consisted of 33 and 261 patients, respectively. Patients with preoperative OU were on average older (63.0 vs 50.7 years; $P = .003$) and had a higher prevalence of chronic pain (42.4% vs 15.3%; $P = .01$), diabetes (36.4% vs 14.6%; $P = .01$), and psychiatric (63.6% vs 32.6%; $P = .01$) diagnoses

(Table 2). The preoperative OU group also had a significantly higher mean MME amount over the 3-month postoperative period compared to the N-OU group (565.6 vs 309.7; $P = .03$).

Postoperative Opioid Use

Median postoperative MME amount for the entire patient population was 225 (interquartile range, 147-375). Multiple linear regression demonstrated that chronic pain and psychiatric diagnoses, tobacco use, trimalleolar fractures, and preoperative OU were independently associated with higher postoperative MME amounts (Table 2). Seventy-five percent of patients were prescribed less than 375 MME (50 tablets of 5-mg oxycodone) during their entire postoperative course.

Patient-Reported Outcomes

Multiple linear regression demonstrated that higher age and higher BMI were associated with lower FAAM scores at 6 weeks (Table 3). At 3 months, multiple linear regression demonstrated that patient age, higher BMI, bimalleolar fractures, and higher postoperative MME amount were each independently associated with lower FAAM scores (Table 3). However, preoperative opioid use was not associated with lower FAAM scores at either 6 weeks or 3 months postoperatively.

Discussion

The association between preoperative OU, postoperative opioid prescriptions, and PROs has been well established in arthroplasty^{3,19,25,30} and spine surgery.¹⁴ Although our study found an association between preoperative OU and postoperative opioid prescriptions among ankle fracture patients, we found that preoperative OU was not associated

Table 2. Multiple Linear Regression Data for Postoperative MME.

Factor	Estimate (Mean)	SE	95% CI	P
Age	-0.42	1.30	-2.99, 2.14	.745
Sex	27.38	43.03	-57.32, 112.08	.525
BMI	2.60	2.51	-2.34, 7.54	.183
Open fracture	56.70	113.05	-165.80, 279.24	.616
Lateral malleolar fracture	37.00	111.61	-182.70, 256.71	.741
Bimalleolar fracture	64.16	50.50	-35.26, 163.57	.205
Trimalleolar fracture	184.83	49.79	86.82, 282.84	.0002*
Chronic pain diagnosis	145.89	55.46	36.72, 255.05	.009*
Diabetes	-11.03	58.42	-126.00, 103.97	.850
Psychiatric diagnosis	143.81	43.41	58.37, 229.26	.001*
Tobacco use	137.37	52.84	33.35, 241.40	.0098*
Alcohol use	13.69	41.94	-69.87, 96.25	.744
Illicit drug use	49.80	80.18	-108.00, 207.65	.531
Preoperative OU	178.22	66.43	47.46, 308.99	.0077*

Abbreviations: BMI, body mass index; MME, morphine milligram equivalent; OU, opioid use.

*Significant at the .05 level.

Table 3. Multiple Linear Regression Data for Patient-Reported Outcomes.

Factor	6-wk				3-mo			
	Estimate	SE	95% CI	P	Estimate (mean)	SE	95% CI	P
Age	-0.05	0.02	-0.08, -0.02	.0014*	-0.02	0.01	-0.04, 0.00	.101
Sex	0.46	0.60	-0.74, 1.65	.449	0.82	0.41	0.02, 1.63	.0548
BMI	-0.06	0.03	-0.12, 0.00	.048*	-0.09	0.02	-0.13, -0.04	.0002*
Open fracture	-3.31	1.81	-6.92, 0.29	.071	-0.63	1.14	-2.91, 1.64	.581
Lateral malleolar fracture	-0.93	1.22	-3.36, 1.49	.446	-1.66	0.89	-3.42, 0.10	.065
Bimalleolar fracture	-0.48	0.66	-1.79, 0.84	.474	-1.17	0.50	-2.17, -0.18	.021*
Trimalleolar fracture	-0.38	0.67	-1.71, 0.95	.570	-0.86	0.46	-1.77, 0.05	.0642
Chronic pain diagnosis	0.97	0.76	-0.55, 2.49	.206	0.17	0.54	-0.91, 1.24	.759
Diabetes	0.47	0.82	-1.15, 2.10	.564	-1.00	0.59	-2.18, 0.17	.094
Psychiatric diagnosis	-0.02	0.57	-1.17, 1.12	.970	-0.58	0.42	-1.41, 0.24	.166
Tobacco use	0.97	0.72	-0.47, 2.41	.183	0.15	0.53	-0.90, 1.20	.774
Alcohol use	-0.53	0.55	-1.62, 0.56	.333	-0.20	0.39	-0.98, 0.57	.605
Illicit drug use	0.32	1.16	-2.00, 2.63	.786	-0.16	0.99	-2.12, 1.79	.868
Preoperative OU	-0.44	0.93	-2.30, 1.41	.633	-0.99	0.72	-2.42, 0.44	.172
Postoperative MME	-0.09	0.05	-0.19, 0.00	.057	-0.10	0.05	-0.19, -0.01	.0256*

Abbreviations: BMI, body mass index; MME, morphine milligram equivalent; OU, opioid use.

*Significant at the .05 level.

with lower patient-reported outcomes. This interesting finding suggests that pain measures may not always correlate with physical function. This is an area for further research. Similar to other studies,²⁴ we found that older age, higher BMI, and higher postoperative opioid amounts were associated with lower functional outcomes. Older patients may be slower to heal and thus more disabled in the acute postoperative period compared with younger patients, which may explain the inverse association with

PROs only at 6 weeks and not at 3 months. Higher BMI was associated with lower PROs at both 6 weeks and 3 months; this makes theoretical sense as an increased load on the ankle joint could be expected to negatively impact a patient until the fracture fully heals.²⁸ Although trimalleolar fractures were not associated with lower PRO scores at either time point, these patients did have higher associated postoperative opioid requirements perhaps secondary to the higher severity of the fracture type.

Our results suggest that patients with known chronic pain or psychiatric diagnoses, preoperative OU or tobacco use, and trimalleolar fractures have higher associated postoperative opioid requirements. This is consistent with prior data that have shown that orthopaedic trauma patients at baseline have a higher incidence of the above comorbidities compared with an elective outpatient population, along with prolonged opioid use after surgery, higher rates of emergency department visits, hospital readmissions, reoperations, and complications.^{4,6,8,11,22} Furthermore, the risks have been shown to have an opioid dose-dependent association.²⁰ Our data could be useful to the orthopaedic trauma surgeon who often does not have the luxury of time to preoperatively counsel these patients as in an elective setting, but instead must set appropriate expectations almost exclusively postoperatively.

Our data show that, for isolated ankle fractures, the majority of patients were prescribed 50 tablets or fewer of 5-mg oxycodone over their entire postoperative course, regardless of whether or not they were previously exposed to opioids. Prior studies have recommended higher amounts for different injuries, such as 47 tablets of 20-mg oxycodone in up to 3 prescriptions for femoral shaft fractures whereas upper extremity injuries have been treated with 15 to 20 tablets with 1 refill.^{1,14,21,23} Gupta et al⁹ recommended 30 tablets of 5-mg oxycodone following foot and ankle surgeries; however, importantly their population was composed of opioid-naïve patients undergoing elective procedures; our data instead suggest that nonelective trauma patients have higher associated postoperative opioid needs. Although it is beyond the scope of this study, it is important to be mindful of the differences between opioid prescribed and opioid consumed.^{15,25} Further research in the foot and ankle subspecialty would do well to prospectively determine how much opioid medication patients actually consume from their prescription.

Our study has several limitations. This is a retrospective chart review with only 3-month follow-up. The study was performed based on a single institution's patient population, yet our patient demographics were consistent with those of other trauma populations and are likely generalizable.⁶ We defined preoperative OU as exposure within a one-year window of surgery. Although the washout period of opioid is only 7-10 days, this interval has been commonly used by other studies that found a correlation between pre- and postoperative OU, suggesting that the relationship is more lasting and is beyond the physiologic effects of the medication on the human body.³ In this study design, we cannot specifically know how much opioid patients were taking before surgery or how far before surgery they were taking them, and we recognize that we are inferring usage based on the information available to us in the electronic medical record. Another limitation of the study is the self-reported nature of alcohol, tobacco, and illicit drug use without the amount of

use or the degree of overuse; future research may instead wish to further classify these categories into different severity-of-use groups or else use only a physician diagnosis of an actual substance use disorder. We only captured narcotics prescribed within our health system and care everywhere. However, we are a large health care system providing the majority care for patients in the area. It is unlikely that the patients who followed up with us postoperatively would have successfully sought narcotics elsewhere. We recognize that the studied PRO measure has the potential for response bias and may not completely capture the importance of a particular outcome.¹⁸ Furthermore, although the FAAM used in this study has been clinically validated, it is not a true measurement of satisfaction with pain control.^{12,16} Future direction for this topic would include an investigation and discussion on the impact of alternative or multimodal pain management strategies, which has already shown promise in other surgical specialties.^{27,29}

Conclusion

There is little indication that the opioid crisis in the United States is slowing down.¹³ Orthopaedic surgeons must balance providing adequate postoperative pain control with minimizing the potential for known opioid complications. In our study, we found that although preoperative OU was associated with higher postoperative opioid requirement after ankle fracture fixation, it was not associated with lower functional outcomes.

Ethical Approval

IRB approval was received from the HealthPartners Institute, A21-063.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Nicholas Reiners, MD,  <https://orcid.org/0000-0001-6090-2282>

References

1. Attum B, Rodriguez-Buitrago A, Harrison N, et al. Opioid prescribing practices by orthopaedic trauma surgeons after isolated femur fractures. *J Orthop Trauma*. 2018;32(3):e106-e111.
2. Blendon RJ, Benson JM. The public and the opioid-abuse epidemic. *N Engl J Med*. 2018;378(5):407-411.

3. Bonner BE, Castillo TN, Fitz DW, et al. Preoperative opioid use negatively affects patient-reported outcomes after primary total hip arthroplasty. *J Am Acad Orthop Surg*. 2019;27:1016-1020.
4. Broggi MS, Oladeji PO, Spenser C, Kadakia RJ, Bariteau JT. Risk factors for prolonged opioid use after ankle fracture surgery. *Foot Ankle Spec*. Published online August 8, 2021. doi:19386400211029123.
5. Centers for Disease Control and Prevention. *2018 annual surveillance report of drug-related risks and outcomes - United States. Surveillance Special Report*. Centers for Disease Control and Prevention, US Department of Health and Human Services; August 31, 2018.
6. Comadoll SM, Liu B, Abbenhaus E, et al. The synergistic effect of preoperative opioid use and many associated preoperative predictors of poor outcome in the trauma patient population. *Injury*. 2020;51(4):919-923.
7. Donahue GS, Hagemeyer NC, Johnson AH. How will the foot and ankle orthopaedic community respond to the growing opioid epidemic? *Foot Ankle Orthop*. 2018;3(3):1-7.
8. Forlenza EM, Lavoie-Gagne O, Lu Y, et al. Preoperative opioid use predicts prolonged postoperative opioid use and inferior patient outcomes following anterior cruciate ligament reconstruction. *Arthroscopy*. 2020;36(10):2681-2688.
9. Gupta A, Kumar K, Roberts MM, et al. Pain management after outpatient foot and ankle surgery. *Foot Ankle Int*. 2018;39(2):149-154.
10. Han SM, Wu TH, Wen JX, et al. Radiographic analysis of adult ankle fractures using combined Danis-Weber and Lauge-Hansen classification systems. *Sci Rep*. 2020;10(1):7655.
11. Holman JE, Stoddard GJ, Higgins TF. Rates of prescription opiate use before and after injury in patients with orthopaedic trauma and the risk factors for prolonged opiate use. *J Bone Joint Surg Am*. 2013;95(12):1075-1080.
12. Hung M, Baumhauer JF, Licari FW, Voss MW, Bounsanga J, Saltzman CL. PROMIS and FAAM minimal clinically important differences in foot and ankle orthopaedics. *Foot Ankle Int*. 2019;40(1):65-73.
13. Jones MR, Viswanath O, Peck J, et al. A brief history of the opioid epidemic and strategies for pain medicine. *Pain Ther*. 2018;7(1):13-21.
14. Kim N, Matzon JL, Abboudi J, et al. A prospective evaluation of opioid utilization after upper-extremity surgical procedures: identifying consumption patterns and determining prescribing guidelines. *J Bone Joint Surg Am*. 2016;98(20):e89.
15. Kvarda P, Hagemeyer 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.
16. Lee D, Armaghani S, Archer KR, et al. Preoperative opioid use as a predictor of adverse postoperative self-reported outcomes in patients undergoing spine surgery. *J Bone Joint Surg Am*. 2014;96(11):e89.
17. Martin RL, Irrgang JJ, Burdett RG, Conti SF, Van Swearingen JM. Evidence of validity for the Foot and Ankle Ability Measure (FAAM). *Foot Ankle Int*. 2005;26(11):968-983.
18. McCreary DL, Sandberg BC, Bohn DC, Parikh HR, Cunningham BP. Interpreting patient-reported outcome results: is one minimum clinically important difference really enough? *Hand*. 2020;15(3):360-364.
19. McGrath B, Elgendy H, Chung F, Kamming D, Curti B, King S. Thirty percent of patients have moderate to severe pain 24 hr after ambulatory surgery: a survey of 5,703 patients. *Can J Anaesth*. 2004;51:886-891.
20. Morris BJ, Mir HR. The opioid epidemic: impact on orthopaedic surgery. *J Am Acad Orthop Surg*. 2015;23(5):267-271.
21. Morris BJ, Sheth MM, Laughlin MS, Elkousy HA, Edwards TB. Risk factors for preoperative opioid use in patients undergoing primary anatomic total shoulder arthroplasty. *Orthopaedics*. 2020;43(6):356-360.
22. Oladeji PO, Broggi MS, Spenser C, Hurt J, Hernandez-Irizarry R. The impact of preoperative opioid use on complications, readmission, and cost following ankle fracture surgery. *Injury*. 2021;52(8):2469-2474.
23. Rodgers J, Cunningham K, Fitzgerald K, Finnerty E. Opioid consumption following outpatient upper extremity surgery. *J Hand Surg Am*. 2012;37(4):645-650.
24. Rothrock NE, Kaat AJ, Vrahas MS, et al. Validation of PROMIS physical function instruments in patients with an orthopaedic trauma to a lower extremity. *J Orthop Trauma*. 2019;33(8):377-383.
25. Ruder J, Wally MK, Oliverio M, et al. Patterns of opioid prescribing for an orthopaedic trauma population. *J Orthop Trauma*. 2017;31(6):179-185.
26. Saini S, McDonald EL, Shakked R, et al. Prospective evaluation of utilization patterns and prescribing guidelines of opioid consumption following orthopedic foot and ankle surgery. *Foot Ankle Int*. 2018;39(11):1257-1265.
27. Stanton T. Symposium addresses pain management in the opioid epidemic. *AAOS Now*. April 1, 2014.
28. Vincent HK, Seay AN, Vincent KR, Atchison JW, Sadasivan K. Effects of obesity on rehabilitation outcomes after orthopaedic trauma. *Am J Phys Med Rehabil*. 2012;91(12):1051-1059.
29. Wick EC, Grant MC, Wu CL. Postoperative multimodal analgesia pain management with nonopioid analgesics and techniques: a review. *JAMA Surg*. 2017;152(7):691-697.
30. Zywielski MG, Stroth DA, Lee SY, Bonutti PM, Mont MA. Chronic opioid use prior to total knee arthroplasty. *J Bone Joint Surg Am*. 2011;93(21):1988-1993.