

Guidelines

Evidence-Based Orthopaedic Post-Operative Opioid Prescribing Recommendations Following Orthopaedic Trauma Surgery

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Effective opioid prescribing following orthopedic trauma surgery is a complex task, requiring consideration of diverse injury patterns and patient variables. Given the likelihood of postoperative hospitalization, it is crucial to implement inpatient strategies that can mitigate opioid consumption before and after discharge. By comprehensively exploring evidence-based approaches for minimizing opioid use in orthopedic trauma surgery, prescribing practices can be enhanced to avoid excessive prescriptions while ensuring adequate postoperative pain management. Literature supports multimodal anesthesia, cautious opioids, scheduled acetaminophen, NSAIDs, nerve blocks, and personalized prescribing for orthopedic trauma procedures.

INTRODUCTION

The scope of the United States' opioid epidemic is staggering. Between 1999 and 2019, nearly half a million individuals died due to overdoses related to opioids.¹ According to data from 2019, drug overdose deaths in the United States rose to 70,630 individuals. Of these deaths, over 70% were attributed to opioids, resulting in an average of 136 opioid-related deaths per day.² Despite comprising less than 5% of the world's population, Americans account for 80% of the global consumption of oral opioids.³ In economic terms, the abuse, dependence, and overdose of prescription opioids impose a hefty financial burden of around \$78.5 billion on the U.S. economy each year. It includes costs related to healthcare, lost productivity, criminal justice, and social welfare and has far-reaching impacts on individuals, families, communities, and society.⁴ In 2019, prescription opioids were responsible for more than 28% of all opioid overdose deaths, resulting in over 14,000 fatalities, equivalent to 38 deaths per day.⁴

Multiple effective measures have been enacted to curb prescription opioid abuse, including Prescription Drug Monitoring Programs (PDMP),⁴⁻⁷ provider education on opioid prescribing,⁸ and multimodal analgesia strategies.^{9,10} These have resulted in an overall 19% decrease in annual U.S. opioid prescribing rates from 2006 to 2017 and

a 7% decrease in prescription opioid-involved U.S. death rates from 2018 to 2019.⁴ Despite these advances, total opioid amounts prescribed per person in morphine milligram equivalents (MME) is still over three times higher than it was in 1999.⁴ In 2019, 10.1 million people misused prescription opioids and 1.6 million people had an opioid use disorder and misused prescription pain relievers for the first time.¹¹ In 2017, over 17% of Americans had at least one opioid prescription filled, with a mean of 3.4 opioid prescriptions dispensed per patient, with an average dose of 45.3 MME per day over 18 days.¹² Further, recent studies report an increase in opioid-related overdoses since the rise of the recent coronavirus (COVID-19) pandemic. This increase has been attributed to strains on social and healthcare safety nets, and greater social and economic stressors.¹³⁻¹⁵

Appropriate opioid prescribing after orthopedic trauma surgery is a unique challenge that must address various injury patterns and patient factors surrounding a traumatic injury. As most of these patients will require postoperative hospitalization, it is crucial to consider inpatient strategies that may reduce opioid consumption before and after discharge. Through a detailed understanding of the available evidenced-based strategies to limit opioid use after orthopedic trauma surgery, prescribing habits may improve to prevent over-prescription while still effectively managing postoperative pain.

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PROBLEM STATEMENT

After orthopedic trauma surgeries, there exists the potential for inadvertent postoperative opioid over-prescribing that can lead to dependency, abuse, diversion, and death. Yet, guidelines for appropriate opioid dosing and analgesic strategies are lacking.

PROPOSED SOLUTION

Comprehensive evidence-based guidelines for postoperative analgesic regimens for routine orthopedic trauma procedures, based on published evidence in the orthopedic trauma and overall medical/surgical literature.

STRATEGIES

Pain management can vary based on individual circumstances. Analgesic principles are typically divided into acute pain, post-operative pain, chronic pain, and palliative pain management. For this review, pain management principles refer to acute and post-operative pain and will be presented using the current best evidence and defining principles.¹⁶ Defining principles for postoperative analgesia regimens are outlined in this section; detailed, evidence-based recommendations are presented later.

Non-pharmacologic treatment strategies should be incorporated whenever possible. These strategies include but are not limited to rest, ice, elevation, and compressive surgical dressings that are secure but not constrictive.¹⁷

Non-opioid analgesics should be considered a first-line pharmacologic treatment for pain and the foundational agent in a multi-modal pain management strategy of pain. Moreover, non-opioid analgesics are best utilized on standing rather than on an as-needed (PRN) basis. Specifically, acetaminophen and non-steroidal anti-inflammatory drugs (NSAIDs) have shown remarkable effectiveness in multi-modal analgesia studies.^{9,10} Regimens are further detailed below. However, opioid-acetaminophen combination medications (i.e., Percocet, Roxicet, Vicodin, etc.) should be avoided to prevent accidental acetaminophen overdosing.

Risk factors for opioid abuse and dependence should be considered before providing opioid prescriptions. These include substance abuse history, psychiatric conditions, and low educational levels.^{18,19} Providers should utilize their state's PDMP to review the patient's prescription drug history before prescribing opioids and periodically throughout their therapy beyond the acute period.

Before prescribing an opioid, counseling on safe opioid use should be performed with the patient. Counseling has been shown to decrease voluntary opioid use while maintaining high pain management satisfaction.²⁰⁻²² Counseling should establish the duration of therapy and goals of opioid use (2 weeks postoperative is recommended, with a maximum of 6 weeks). It may include the use of a physician-patient opioid agreement. Lastly, patients should be advised on safely storing prescribed opioids to avoid diversion and abuse.²³

If an opioid is prescribed, the lowest dose and shortest duration possible should be prescribed.²⁴ The CDC recommends a maximum of 50 morphine milligram equivalents (approximately six doses of 5mg of Oxycodone) for no more than 3-7 days in most acute musculoskeletal injuries. Tramadol may be considered a first-line opioid agent as it may be equally efficacious as other more potent opioids with a lower risk of dependency.²⁵ Medication interactions with tramadol must be regarded on an individual basis, as should the potential for resultant postoperative delirium in older patients.²⁶

Surgeon prescribers should engage other providers in the patient's healthcare delivery team during the perioperative period (i.e., primary care provider or pain management specialist). This communication can avoid double-prescribing and discrepancies in prescribing assumptions.²⁷ Specifically, in geriatric proximal femur fractures, implementing dedicated hip fracture services with cooperating orthopedic and medical providers has reduced postoperative opioid consumption.²⁸ If patients with prior opioid use history proceed to surgery, baseline opioid prescription doses should be continued. They may require dose increases by 1.5 to 2 times in the acute postoperative period (2 weeks).^{21,23} For these patients, postoperative analgesia is best managed by their pain management provider preferentially, if applicable.

MEDICATIONS

1. NON-STEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDS)

Non-steroidal Anti-Inflammatory Drugs (NSAIDs) have a two-pronged effect after fracture surgery to both limit pain and postoperative edema.⁹ However, concern may arise regarding these agents' impact on bone healing after surgery. Clinical studies have identified a higher risk of nonunion with NSAID use after a long bone fracture fixation.⁵⁻⁸ However, the beneficial effects of NSAID use in the immediate postoperative period have been realized without deleterious effects on union rates.¹⁰ The type of NSAID utilized also appears to impact the overall effect on bone healing. A recent database study identified an increased risk of nonunion after long bone fractures with selective COX-2 inhibitor use (i.e., celecoxib) but not with the more commonly utilized nonselective NSAIDs (i.e., ibuprofen, naproxen, or ketorolac).¹¹ Similarly, two studies by McDonald et al. in 2018 and 2020 found that using ketorolac following ankle fractures did not significantly impact clinical nor radiographic healing while decreasing opioid consumption by 25%.^{12,13} Given the available data, it is likely safe to use nonselective NSAIDs for their analgesic and anti-inflammatory effects within the early postoperative course without increased concern for nonunion risk. Standard precautions and contraindications of NSAIDs should be considered, and pharmacy or medical specialists should be consulted for assistance in unclear cases. NSAIDs should be used cautiously in patients with renal insufficiency, cardiovascular disease, GI bleeding, and anticoagulation/antiplatelet therapy. A concomitant proton pump inhibitor,

such as omeprazole 20 mg BID or pantoprazole 40 mg daily, can be used in patients over 50 years old and/or with gastric ulcer risk factors while taking NSAIDs. Daily ibuprofen dose should not exceed 2400 mg, and daily naproxen dose should not exceed 1100 mg (initial day can be up to 1375 mg).²³

2. ACETAMINOPHEN

Strong evidence supports the use of scheduled acetaminophen for analgesia after surgery.^{14,15} The FDA recommendation remains a maximum of 4000 mg daily for less than ten days in healthy adults with normal liver function, no other acetaminophen sources, and less than two alcoholic drinks daily. Recently, specific manufacturers such as McNeil's "Tylenol®" recommend 3000-3250 mg daily due to reports of an overdose in patients taking standard doses up to 4000 mg daily.²³ However, these reports have been due to patients unintentionally ingesting acetaminophen through other sources (sleep medications, cough medications, etc.). Patients with abnormal liver function tests, active hepatitis, cirrhosis, or other active hepatic diseases should consider a maximum of 2000 mg daily or less. Standard precautions and contraindications should be regarded, and pharmacy or medical specialists should be consulted for assistance in unclear cases.

3. NEURALGIA-RELATED DRUGS

Adjuvant analgesics have been less commonly reported in the orthopedic trauma surgery literature, but have been reported advantageous as part of a multimodal strategy.¹⁶ Similar to selective COX-2 inhibitors, gabapentin carries a concern for harmful effects on bone healing. However, the literature regarding this potential effect is minimal.¹⁷ The potential for delayed bone healing must be weighed against the proven efficacy of gabapentin in reducing postoperative pain following numerous surgical procedures, as great as 35% within the first 24 hours.^{18,19}

4. REGIONAL / LOCAL ANESTHESIA

Nerve blocks have been well studied with purported benefits in controlling pain, decreasing time to ambulation, and limiting opioid use.²⁰⁻²³ However, the effect of restricting opioid use after surgery appears short-lived,²⁰ and some studies have failed to identify any significant differences in comparative opioid consumption.²⁴ Additionally, nerve blocks in the upper extremity, particularly brachial plexus blocks, while effective, carry the risk of pneumothorax and significant vessel injury.²⁵ Overall, nerve blockade appears most reliably evidenced in the perioperative management of hip fracture-associated pain.

Surgical site infiltration and interfascial blocks provide a less invasive alternative to the peripheral nerve blocks. While studies specifically analyzing the impact of surgical site infiltration for orthopedic trauma are not available, the benefit of this technique has been well described in orthopedics and surgery in general. These injections directly infiltrate the area surrounding the surgical procedure with an anesthetic, significantly reducing opioid use following vari-

ous surgical procedures.²⁷ While there exists some concern over the potential for wound complication following surgical site injection, studies have found no increase in wound complication rates.

5. CURRENT EVIDENCE FOR POSTOPERATIVE OPIOID REQUIREMENTS

There is a relative lack of data to develop specific opioid prescribing guidelines after orthopedic trauma surgeries, as many studies have more broadly assessed generalized prescribing patterns.²⁹⁻³² Bhashyam et al. specified fracture types in proposing maximum opioid prescribing guidelines for various orthopedic trauma injuries,³³ similar investigations are sparse. A broad synthesis of the available literature surrounding orthopedic trauma opioid prescribing can be summarized accordingly:

- Opioids are a mainstay of analgesia strategies after orthopedic trauma, are frequently over-prescribed, and American surgeons prescribe more opioids compared to other countries.^{29,30,34}
- Increased opioid use is associated with more outstanding pain scores and decreased satisfaction with pain control.³⁵
- Prior opioid use is perhaps the most significant risk of increased opioid use after orthopedic trauma injuries.^{29,36}
- Evidenced alternative strategies to limit opioid use and control pain include scheduled acetaminophen, NSAIDs in the immediate postoperative period, and perioperative nerve blockade.^{10,14,15,20,21,23,37}

6. DEXAMETHASONE

Single-dose dexamethasone has been shown to reduce perioperative and postoperative pain following surgical procedures significantly. Szucs et al. found a significant reduction in postoperative pain in patients who underwent operative fixation of femoral neck fractures using a 0.1mg/kg dose administered before induction of anesthesia.³⁸ Additionally, similar results have been seen following the use of dexamethasone following total knee arthroplasty. There may be a benefit to the routine use of dexamethasone in patients without contraindications or concern for blood glucose control. However, the impact of dexamethasone in orthopedic trauma patients has not been investigated.³⁹⁻⁴⁴

7. ENHANCED RECOVERY AFTER SURGERY PROTOCOL

The "Enhanced Recovery After Surgery" (ERAS) Protocol is a multidisciplinary, multimodal, evidence-based pathway developed to optimize patient care and decrease the length of stay and postoperative pain. The protocol involves five distinct phases – pre-hospital, preoperative, intraoperative, postoperative, and post-discharge – to standardize protocols for patients following their surgery. While not applied broadly in the field of orthopedics, Zarina et al. compared ERAS to non-ERAS protocol patients following spine surgery, finding greater rates of postop mobilization on day 1, significantly less opioid use at one month, and 0.5%

Table 1. Summary of Analgesia Inpatient Medication Recommendations

| Surgical Fracture | Recommended Inpatient Regimen | | |
|---|--|---|--|
| | Preoperative | Intraoperative | Postoperative |
| Clavicle Proximal Humerus Humeral Shaft Distal Humerus Elbow Forearm Shaft Radius/Hand Pelvic Ring Acetabulum Proximal Femur (Hip) Femoral Shaft Distal Femur Tibia Ankle/ Hindfoot | <ul style="list-style-type: none"> Acetaminophen 1g given 2 hours preoperatively Celecoxib 400mg given 2 hours preoperatively Gabapentin 300-600mg given 2 hours preoperatively Dexamethasone 0.1mg per kg is given prior to induction of anesthesia | <ul style="list-style-type: none"> Surgical Site Infiltration IV acetaminophen 1g (if not given preoperatively) IV ketorolac 15-30mg at end of procedure IV morphine 0.05 to 0.1mg per kg of ideal body weight approximately 20 minutes prior to extubation | <ul style="list-style-type: none"> Acetaminophen 1g every 6 hours Gabapentin 300mg every 8 hours Oxycodone 5mg every 4 hours as needed for moderate pain Oxycodone 10mg every 4 hours as needed for severe pain Ketorolac 15-30mg every 6 hours as needed, up to 7 doses IV hydromorphone 0.25-0.5mg every 2-3 hours for breakthrough pain |

*IV opioid medications should be avoided whenever there is a concern for evolving compartment syndrome present

patient-controlled analgesia utilization rate compared to 54.1% in the control group postoperatively. Based on these findings, orthopedic trauma patients may benefit from the implantation of the ERAS protocol.

RECOMMENDATIONS

The existing literature on non-opioid multimodal anesthesia strategies and opioid use after routine orthopedic trauma procedures have been presented thus far. For all trauma surgeries, regardless of type, we recommend a multimodal anesthesia strategy before and after hospital discharge (Tables 1 and 2) and peripheral nerve blocks before surgery, when indicated. This includes using scheduled acetaminophen postoperatively (unless medically contraindicated) and adjuvant incorporation of early NSAID use and perioperative nerve blockade when appropriate. For acetaminophen, we recommend a standing dose of 3000-3900 mg daily (500-650 mg q4 hours standing) for up to 10 days postoperatively. For NSAIDs, we recommend perioperative use of ketorolac 15-30 mg PRN for up to seven doses. It is likely safe to prescribe nonselective NSAIDs in cases where acetaminophen is contraindicated, or additional analgesia is required. In such instances, we recommend a dose of naproxen 440 mg or 500 mg BID standing for ten days, or alternatively 800 mg ibuprofen q8 hours standing for ten days. A concomitant proton pump inhibitor, such as omeprazole 20 mg BID or pantoprazole 40 mg daily, should be used in patients over 50 years old or with gastric ulcer risk factors while taking NSAIDs.

Preoperative nerve blocks and catheters should be considered on a case-by-case basis and are likely most beneficial in treating hip fractures. However, their use does not substantially change the prescribing guidelines being presented. Adjuvant pharmacologic agents such as gabapentin, pregabalin, cyclobenzaprine, etc., lack the necessary evi-

dence to be included within a standard multimodal strategy. Still, they may be considered on a case-by-case basis.

Fracture location should be considered when considering appropriate opioid prescriptions after surgery. Femoral shaft, acetabulum, pelvic ring, proximal and distal femur, tibial shaft, and proximal and distal tibia fractures often require higher amounts of opioid analgesia compared to upper extremity fracture surgeries.³³ In these cases, PRN doses of IV hydromorphone .25-.5 mg may be considered in the immediate postoperative period. Though proximal femur fractures fall into the category of increased analgesia requirements, it should be considered that these injuries are most commonly occurring in geriatric patients. It is therefore recommended that standard practices include initiating opioid prescriptions at smaller doses and, more often, incorporating adjuvant strategies to limit opioid requirements.

CONCLUSIONS

Current literature highlights non-opioid multimodal anesthesia strategies and opioid use after orthopedic trauma surgeries. A multimodal anesthesia approach is recommended for all trauma procedures, along with pre- and post-discharge measures to reduce opioid consumption. Peripheral nerve blocks and scheduled acetaminophen are suggested, while NSAIDs can be used if acetaminophen is contraindicated. Specific opioid prescriptions should consider fracture location, and adjuvant strategies are encouraged to minimize opioid requirements.

DECLARATION OF CONFLICT OF INTEREST

The authors do not have any potential conflicts of interest in the information and production of this manuscript.

Table 2. Summary of Oral Analgesia Following Discharge

| Fracture | Representative Procedures | Recommended Postoperative Prescription on Discharge* |
|--------------------------------|---|--|
| Clavicle | ORIF, ExFix, & Intramedullary Nailing Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Proximal Humerus | ORIF & Intramedullary Nailing Arthroplasty Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Humeral Shaft | ORIF, ExFix, & Intramedullary Nailing Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Distal humerus | ORIF, ExFix, & Intramedullary Nailing Arthroplasty Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Elbow | ORIF, ExFix, & Intramedullary Nailing Arthroplasty Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Forearm shaft | ORIF, ExFix, & Intramedullary Nailing Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Radius/Hand | ORIF, ExFix, & Intramedullary Nailing Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #60 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Pelvic Ring | ORIF, ExFix, & Intramedullary Nailing Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Acetabulum | ORIF Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Proximal Femur (Hip) | ORIF & Intramedullary Nailing Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Femoral Shaft and Distal Femur | ORIF, ExFix, & Intramedullary Nailing Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |

| Fracture | Representative Procedures | Recommended Postoperative Prescription on Discharge* |
|-----------------|---|--|
| Tibia | ORIF, ExFix, & Intramedullary Nailing Nonoperative Treatment | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #20 |
| Ankle/Hindfoot | ORIF, ExFix, & Fusion | <ul style="list-style-type: none"> • Naproxen 500mg BID with food, standing for 10 days (if not contraindicated), dispense #20 • Acetaminophen 500mg q4, standing for 5 days, then PRN mild to moderate pain, dispense #50 • Oxycodone 5mg q4 PRN for severe pain, dispense #30 |

*Recommended prescription durations (ten-day course) are to include inpatient stay. For example, if a patient is discharged on postoperative day three, they should be prescribed seven days of acetaminophen and oxycodone.

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DECLARATION OF ETHICAL APPROVAL FOR STUDY

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