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Analgesics for Acute Pain in Adults: Practice Pearls

Updated February 2025

This chart reviews analgesics for acute pain. See **footnote a** for general information on acute pain and its treatment.
Interactive note: Roll over **blue text** to view additional information.

Preferred Analgesics for Acute Pain in Adults	
Simple Analgesics (i.e., acetaminophen, NSAIDs)	**Consider first-line for**: osteoarthritis,[7*] dental pain (including surgery),[2,8*] renal colic,[9,18] low back pain (NSAIDs),[10] fractures,[11,19] musculoskeletal pain,[2,12] tension headache,[13,20] migraine headache,[14,15] biliary colic (NSAIDs),[16] abdominal surgery,[2] orthopedic surgery,[2] episiotomy,[17] opioid-sparing effect.[6] (*Asterisk denotes indications where NSAID may be more effective than APAP). **Efficacy considerations**: • One in 2 to 3 patients (**ibuprofen**) or one in 3 to 4 patients (**APAP** 1,000 mg) has a 50% decrease in moderate-to-severe musculoskeletal pain over 4 to 6 hours.[21] • Oral **ibuprofen** at doses of 400, 600, and 800 mg provide similar pain relief.[22] **APAP** 1,000 mg may not relieve pain much more than 500 mg.[21,31] • Ibuprofen 400 mg plus APAP 1,000 mg reduces moderate-to-severe musculoskeletal pain as well as many opioid/APAP combinations.[12] • Oral **ketorolac** has similar efficacy to other NSAIDs, but the risks associated with its use outweigh the possible benefits.[2,23] • **Injectable NSAIDs** may not be more effective than oral. • **Topical NSAIDs** may work as well as oral NSAIDs for acute musculoskeletal pain (e.g., sprain).[29] See our chart, *Topicals for Pain Relief* **Safety considerations**: • Limit use to <15 days/months to reduce the risk of medication overuse headache.[30] APAP may post a higher risk than NSAIDs.[33] • In US labeling, NSAIDs are contraindicated for perioperative pain due to CABG. • In chronic liver impairment, limit the **APAP** total daily dose to 2 to 3 grams (instead of the usual 4 gram max adult daily dose).[32] • For information on the use of NSAIDs in patients with kidney or CV disease, and mitigation of gastrointestinal risk, see our FAQ, *Managing NSAID Risks*.
Strong oral opioids (e.g., hydrocodone, oxycodone)	**Consider for**: pain not relieved by nonopioids:[1,6] or pain not expected to be relieved by non-opioids (e.g., invasive surgery [open abdominal surgery], major trauma [crush injuries, burns], assuming patient can take oral medications.[1,3,6] **Efficacy considerations:** • Not proven more effective than ibuprofen 400 mg at achieving 50% reduction in moderate to severe pain.[21] • May be as effective as IV opioids, even after significant surgeries (e.g., cardiac surgery).[34] • Consider combining with nonopioids to provide better analgesia and minimize side effects (e.g., opioid-sparing effect).[5,6] **Safety considerations** (Also see our toolbox, Appropriate Opioid Use): • Do NOT use extended-release opioids for acute pain.[1] • Meperidine is poorly effective orally and is neurotoxic; not preferred.[76] See **footnote c** regarding neurotoxicity and other safety concerns. • Use the lowest necessary dose for the shortest duration possible to prevent transition of acute use to chronic use.[35] • Advise patients to taper the opioid as pain resolves, being mindful of the APAP daily dose if weaning from an opioid/APAP combo to APAP.[1]
Parenteral opioids (IV, epidural, or spinal [intrathecal])	**Consider for**: pain not expected to be relieved by non-opioids (e.g., invasive surgery [open abdominal surgery], major trauma [e.g., crush injuries, burns]) in patients who cannot take oral medications;[1,3,6] moderate to severe pain in patients with suspected malabsorption;[6] moderate to severe pain requiring immediate relief or rapid dose titration;[6] painful procedures (consider fentanyl),[3,5,28] pain due to MI despite nitroglycerin and beta-blocker (IV morphine; may cause bradycardia or hypotension, or reduce preload in right ventricular MI).[36,84,85] **Efficacy considerations**: • IV opioids have a quicker onset of action than oral opioids, allowing for faster titration, but have more risks and shorter duration of action.[6] • PCA improves patient satisfaction and perhaps analgesia, with side effects comparable to non-PCA opioid-based regimens.[37] **Safety considerations**: • Consider combining with nonopioids to provide better analgesia and minimize side effects (e.g., opioid-sparing effect).[5,6] • Meperidine is neurotoxic; not preferred.[76] See **footnote c** regarding neurotoxicity and other safety concerns. • Follow policies to get pain service approval before adding a systemic opioid to a regional (e.g., epidural, spinal) opioid. • Kidney impairment: avoid morphine; fentanyl (with cautious dosing) or hydromorphone are preferred.[3,28,38] Reduce hydromorphone starting dose for CrCl <60 mL/min.[38] • Fentanyl accumulates in fat with repeat dosing and may not be a good choice in obesity.[3,37] Instead, consider intermittent IV morphine doses or PCA without the continuous infusion, with especially close monitoring if the patient has OSA.[37]

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Local anesthetics (e.g., bupivacaine, ropivacaine, lidocaine, mepivacaine). For information on lidocaine patches, see our chart, *Topicals for Pain Relief*.	**Consider for:** Opioid-sparing effect for patients at high risk from opioids (e.g., patients with lung disease, obstructive sleep apnea, morbid obesity, opioid tolerance, opioid misuse);[39,40] intrathoracic, abdominal, or spinal surgery (e.g., epidural anesthesia);[41] upper extremity/hand surgery (e.g., peripheral nerve block);[42] lower extremity surgery (e.g., spinal or epidural anesthesia, peripheral nerve block),[42] carotid endarterectomy (e.g., peripheral nerve block);[43] laceration repair (e.g., local infiltration, peripheral nerve block);[44] post-op pain (e.g., local anesthetics for surgical site pain; intravenous lidocaine).[45,46] **Efficacy considerations**: • Liposomal bupivacaine (***Exparel*** [US]) can be used for local infiltration or for regional anesthesia (interscalene brachial plexus, sciatic nerve [popliteal fossa], or adductor canal block).[47] » Data do not demonstrate consistent, clinically important advantages of liposomal bupivacaine over other local anesthetics.[49,50] • Bupivacaine/meloxicam extended-release (***Zynrelef*** [US]) is applied to the surgical site prior to suturing.[48] » Compared to standard bupivacaine, bupivacaine/meloxicam extended-release reduces opioid use by ~5 to 10 mg of morphine in the first 24 hours, and pain score differences don't seem clinically significant after about 24 hours.[48] • Elastomeric pumps (e.g., ***On-Q***) can provide continuous infusion of local anesthetics to the surgical site for ~4 days.[55] • Continuous IV lidocaine infusion may be an option when local or regional anesthesia is not possible.51 IV lidocaine may be most beneficial for patients undergoing abdominal surgeries, to reduce early post-op pain and opioid use.[52] **Safety considerations** (Also see our clinical resource, *Safe Use of Local Anesthetics*, for tips to minimize risks): • For epidural administration, local anesthetics are often combined with an opioid to reduce the amount of local anesthetic needed.[3] • Ensure safe antithrombotic management in patients receiving regional anesthesia. • Avoid repeat bupivacaine doses, or other local anesthetics, for at least 96 hours after administration of Exparel (liposomal bupivacaine [US]) or *Zynrelef* (bupivacaine/meloxicam [US]) due to persistence of bupivacaine in the systemic circulation and potential for overdose.[47,48] • Lidocaine may not be appropriate for patients with heart disease, electrolyte disturbances, seizure disorders, or kidney or liver impairment.[38] Dose based on ideal body weight (unless actual body weight is less) and stop within 24 hours.[38] Monitor for signs of toxicity (e.g., ringing in the ears, lightheadedness, tingling around the mouth), and treat serious toxicity with 20% lipid infusion.[38] For details, see https://anaesthetists.org/Home/Resources-publications/Guidelines/Management-of-severe-local-anaesthetic-toxicity-2023.
Ketamine (For information on use of ketamine in the ICU, see our chart, *Meds for ICU Analgesia and Sedation*.)	**Consider for**: surgery in which severe post-op pain is expected (e.g., abdominal, thoracic, orthopedic)(best evidence);[56] surgical patients who are opioid-tolerant;[56] surgical patients at high risk of respiratory depression caused by opioids (e.g., patients with sleep apnea);[56] as an opioid adjunct for sickle cell crisis;[56] acute pain in patients presenting to the ED in whom an opioid is undesirable (e.g., opioid-tolerant, history of opioid misuse, opioid-naïve, elderly, taking medication-assisted treatment for opioid use disorder).[57] **Efficacy considerations**: • Consider doses of ≤0.35 mg/kg bolus (e.g., 0.15 to 0.3 mg/kg), or an infusion of 0.1 to 0.3 mg/kg/hour (max 1 mg/kg/hour).[56,65] • There is less evidence for nasal administration. Consider a dose of 0.7 to 1 mg/kg, with a maximum of 1 mL per nostril.[63] • Perioperative ketamine does not seem to benefit patients undergoing surgery not associated with moderate to severe pain.[56] **Safety considerations**: • Avoid ketamine in patients with psychosis, uncontrolled cardiovascular disease or hypertension, pregnancy, moderate to severe liver impairment, or increased intraocular or intracranial pressure.[56] • Ketamine at doses ≥0.3 mg/kg may be associated with more neuropsychiatric side effects compared to standard care (e.g., dizziness, drowsiness, emergence phenomena, dissociation, dysphoria, hallucinations, nightmares).[57,58] • Examples of monitoring in the ED include continuous pulse oximetry, telemetry (or vitals every 10 minutes), and immediate availability of the ED physician for at least 30 min post-dose.[62,64]

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NOT Preferred for Acute Pain	
Mixed agonist/ antagonists (buprenorphine, butorphanol, nalbuphine)	• Buprenorphine is a partial agonist (mu)/antagonist (kappa and delta), while butorphanol and nalbuphine are kappa agonists with poor mu activity.[66,67] • Analgesic effects of partial agonist/antagonists are limited by a dose ceiling.[67] • Avoid in opioid-tolerant patients, as use may lead to withdrawal symptoms.[28] • Agent-specific considerations » Buprenorphine: see our FAQ, *Buprenorphine for Chronic Pain*, for more on buprenorphine, including why sublingual, buccal, and transdermal buprenorphine products should NOT be used for **acute** pain, and drawbacks of parenteral buprenorphine. » Butorphanol use is often reserved for pain when other options are not effective, tolerated, or inadequate.[68] • Use may be limited by adverse effects (e.g., psychotomimetic effects) and prolonged respiratory depression at higher doses.68 » Nalbuphine may be associated with less itching and less respiratory depression compared to morphine.[69] • Avoid doses greater than 20 mg/dose, especially in opiate-naive patients.[28]
Codeine	Codeine is metabolized to morphine via CYP2D6.[71] Efficacy and toxicity are affected by genetics and CYP2D6 drug interactions. See **footnote b** for details.
Fentanyl transdermal (patch)	Do NOT use fentanyl patch for acute pain.[1]
Gabapentinoids (gabapentin or pregabalin)	• Mounting evidence suggests any benefit of pre-op gabapentin or pregabalin are marginal and likely don't outweigh risks, such as delirium, dizziness, respiratory depression, or visual disturbances.[78,79] • Avoid gabapentinoids in the elderly, patients with kidney impairment, and patients with sleep apnea.[78,80] • See our chart, *Enhanced Recovery After Surgery: Developing an ERAS Protocol* for dosing.
Muscle relaxants	See our chart, *Muscle Relaxants*.
Suzetrigine (*Journavx*)	• Well-tolerated non-opioid (sodium channel blocker). As effective as hydrocodone 5 mg/acetaminophen 325 mg for post-op (bunionectomy, abdominoplasty) pain.[83] • May not be more effective than ibuprofen/acetaminophen (no data).[83] • Contraindicated with strong CYP3A4 inhibitors. Suzetrigine is a CYP3A4 inducer. Backup contraception is required during and for 28 days afterward in patients using hormonal contraception containing progestins other than levonorgestrel and norethindrone.[83]
Tramadol	• Less effective than NSAIDs or acetaminophen (1 in 8 patients with moderate to severe pain has 50% pain reduction over 4 to 6 hours with tramadol).[21] • Tramadol is an opioid with additional "baggage" (e.g., atypical adverse effects and withdrawal, genetic influence on efficacy and toxicity). • Maximum adult daily dose is 300 mg or 400 mg, depending on product.[28] See product labeling for dosing in elderly patients, or in patients with renal or hepatic dysfunction. » In elderly patients with CrCl <30 mL/min., avoid extended-release tramadol products due to central nervous system adverse effects.[76]

Abbreviations: APAP = acetaminophen; CABG = coronary artery bypass graft; CV = cardiovascular; ED = emergency department; IV = intravenous; MI = myocardial infarction; NSAID = nonsteroidal anti-inflammatory drug; OSA = obstructive sleep apnea; PCA = patient-controlled analgesia

Footnotes:

a. Acute pain can result from acute illness (e.g., renal colic, sickle cell crisis), injury, or surgery.[1,2] As opposed to chronic pain, its etiology and location is usually clear.[3] Acute pain is self-limited, improving over hours to weeks as the injury heals.[3] Treatment minimizes detrimental physiologic responses (e.g., tachycardia, shallow breathing, immobility, muscle spasms, ileus, impaired immune response), adverse psychological effects (e.g., anxiety, fear), and progression to chronic pain.[4] Set realistic goals for pain relief and function (e.g., 33% to 50% decrease in pain).[5] Some hospitals are developing ALternatives To Opioid (ALTO) or Enhanced Recovery After Surgery (ERAS) protocols. Perioperatively, different medications and routes are combined (i.e., a multimodal or balanced approach) to increase efficacy and decrease side effects.[5,6]

b. CYP2D6 is responsible for metabolism of codeine to morphine, and tramadol to its active metabolite.[71] Therefore, genetic polymorphisms may result in poor response (in poor metabolizers) or toxicity (in ultrarapid metabolizers) with codeine or tramadol.[71] In extensive metabolizers (i.e., most patients), efficacy is reduced by strong CYP2D6 inhibitors (e.g., bupropion, fluoxetine).[71] Avoid codeine and tramadol in children and breastfeeding women.[70,72,73] See our chart, *Keeping Pediatric Patients Safe* for information on codeine and tramadol in children.

c. Meperidine safety concerns: Meperidine has a neurotoxic metabolite, normeperidine, that can cause anxiety, tremors, myoclonus, hallucinations, and seizures.81 Normeperidine can accumulate with repeated meperidine dosing, especially in patients with kidney or liver impairment and in the elderly.[28,76,81] Meperidine poses a higher risk of postoperative delirium than other opioids.[28] Other side effects include confusion and dysphoria.[28] Naloxone is not effective for treating normeperidine toxicity, and in fact may worsen it.[82] Meperidine's vagolytic activity can cause increased ventricular response in patients with supraventricular tachyarrhythmias.[28] Poses risk of serotonin syndrome with other serotonergic medications.[28]

References:

1. Dowell D, Ragan KR, Jones CM, et al. CDC Clinical Practice Guideline for Prescribing Opioids for Pain - United States, 2022. MMWR Recomm Rep. 2022 Nov 4;71(3):1-95.
2. Chou R, Wagner J, Ahmed AY, Blazina I, Brodt E, Buckley DI, Cheney TP, Choo E, Dana T, Gordon D, Khandelwal S, Kantner S, McDonagh MS, Sedgley C, Skelly AC. Treatments for Acute Pain: A Systematic Review [Internet]. Rockville (MD): Agency for Healthcare Research and Quality (US); 2020 Dec. Report No.: 20(21)-EHC006.
3. Ghafoor V, Kral LA, Atkinson TJ. Pain and its management. In: Zeind CS, Carvalho MG, Cheng JWM, et al., editors. Applied Therapeutics: the Clinical Use of Drugs. 12th ed. Philadelphia, PA: Wolters Kluwer Health, 2024:1207-1236.
4. Baratta JL, Schwenk ES, Viscusi ER. Clinical consequences of inadequate pain relief: barriers to optimal pain management. Plast Reconstr Surg. 2014 Oct;134(4 Suppl 2):15S-21S.
5. Anderson WG, Liao S. Improving pain management for hospitalized medical patients: a Society of Hospital Medicine implementation guide. https://www.hospitalmedicine.org/globalassets/clinical-topics/clinical-pdf/shm_painmanagement_guide.pdf. (Accessed February 4, 2025).
6. Herzig SJ, Mosher HJ, Calcaterra SL, et al. Improving the Safety of Opioid Use for Acute Noncancer Pain in Hospitalized Adults: A Consensus Statement From the Society of Hospital Medicine. J Hosp Med. 2018 Apr;13(4):263-271.
7. Katz JN, Arant KR, Loeser RF. Diagnosis and Treatment of Hip and Knee Osteoarthritis: A Review. JAMA. 2021 Feb 9;325(6):568-578.
8. Moore RA, Derry S, Aldington D, Wiffen PJ. Single dose oral analgesics for acute postoperative pain in adults - an overview of Cochrane reviews. Cochrane Database Syst Rev. 2015 Sep 28;2015(9):CD008659.
9. Afshar K, Jafari S, Marks AJ, Eftekhari A, MacNeily AE. Nonsteroidal anti-inflammatory drugs (NSAIDs) and non-opioids for acute renal colic. Cochrane Database Syst Rev. 2015 Jun 29;2015(6):CD006027.
10. Cashin AG, Wand BM, O'Connell NE, et al. Pharmacological treatments for low back pain in adults: an overview of Cochrane Reviews. Cochrane Database Syst Rev. 2023 Apr 4;4(4):CD013815.
11. Murphy PB, Kasotakis G, Haut ER, et al. Efficacy and safety of non-steroidal anti-inflammatory drugs (NSAIDs) for the treatment of acute pain after orthopedic trauma: a practice management guideline from the Eastern Association for the Surgery of Trauma and the Orthopedic Trauma Association. Trauma Surg Acute Care Open. 2023 Feb 21;8(1):e001056.
12. Chang AK, Bijur PE, Esses D, Barnaby DP, Baer J. Effect of a Single Dose of Oral Opioid and Nonopioid Analgesics on Acute Extremity Pain in the Emergency Department: A Randomized Clinical Trial. JAMA. 2017 Nov 7;318(17):1661-1667.
13. Derry S, Wiffen PJ, Moore RA, Bendtsen L. Ibuprofen for acute treatment of episodic tension-type headache in adults. Cochrane Database Syst Rev. 2015 Jul 31;2015(7):CD011474.
14. Ailani J, Burch RC, Robbins MS; Board of Directors of the American Headache Society. The American Headache Society Consensus Statement: Update on integrating new migraine treatments into clinical practice. Headache. 2021 Jul;61(7):1021-1039.
15. Rabbie R, Derry S, Moore RA. Ibuprofen with or without an antiemetic for acute migraine headaches in adults. Cochrane Database Syst Rev. 2013 Apr 30;2013(4):CD008039.
16. Long B, April MD. Are Nonsteroidal Anti-inflammatory Drugs Efficacious in Relieving Biliary Colic Pain? Ann Emerg Med. 2017 Dec;70(6):822-824.
17. Luxey X, Lemoine A, Dewinter G, et al. Acute pain management after vaginal delivery with perineal tears or episiotomy. Reg Anesth Pain Med. 2024 Jun 14:rapm-2024-105478.
18. Alghamdi YA, Morya RE, Bahathiq DM, et al. Comparison of acetaminophen, ketamine, or ketorolac versus morphine in the treatment of acute renal colic: A network meta-analysis. Am J Emerg Med. 2023 Nov;73:187-196 [abstract].
19. Nasr Isfahani M, Etesami H, Ahmadi O, Masoumi B. Comparing the efficacy of intravenous morphine versus ibuprofen or the combination of ibuprofen and acetaminophen in patients with closed limb fractures: a randomized clinical trial. BMC Emerg Med. 2024 Jan 25;24(1):15. doi: 10.1186/s12873-024-00933-y. PMID: 38273252; PMCID: PMC10809472.
20. Stephens G, Derry S, Moore RA. Paracetamol (acetaminophen) for acute treatment of episodic tension-type headache in adults. Cochrane Database Syst Rev. 2016 Jun 16;2016(6):CD011889.
21. Richards, D. The Oxford Pain Group League table of analgesic efficacy. Evid Based Dent 5, 22–23 (2004).
22. Motov S, Masoudi A, Drapkin J, et al. Comparison of Oral Ibuprofen at Three Single-Dose Regimens for Treating Acute Pain in the Emergency Department: A Randomized Controlled Trial. Ann Emerg Med. 2019 Oct;74(4):530-537.
23. Irizarry E, Restivo A, Salama M, et al. A randomized controlled trial of ibuprofen versus ketorolac versus diclofenac for acute, nonradicular low back pain. Acad Emerg Med. 2021 Nov;28(11):1228-1235.
24. Bookstaver PB, Miller AD, Rudisill CN, Norris LB. Intravenous ibuprofen: the first injectable product for the treatment of pain and fever. J Pain Res. 2010 May 25;3:67-79.
25. Zhou P, Chen L, Wang E, et al. Intravenous ibuprofen in postoperative pain and fever management in adults: A systematic review and meta-analysis of randomized controlled trials. Pharmacol Res Perspect. 2023 Aug;11(4):e01123.
26. Neighbor ML, Puntillo KA. Intramuscular ketorolac vs oral ibuprofen in emergency department patients with acute pain. Acad Emerg Med. 1998 Feb;5(2):118-22.
27. Gu HY, Luo J, Wu JY, et al. Increasing Nonsteroidal Anti-inflammatory Drugs and Reducing Opioids or Paracetamol in the Management of Acute Renal Colic: Based on Three-Stage Study Design of Network Meta-Analysis of Randomized Controlled Trials. Front Pharmacol. 2019 Feb 22;10:96.
28. Clinical Pharmacology powered by ClinicalKey. Tampa (FL): Elsevier. 2025. http://www.clinicalkey.com. (Accessed February 4, 2025).
29. Derry S, Wiffen PJ, Kalso EA, et al. Topical analgesics for acute and chronic pain in adults - an overview of Cochrane Reviews. Cochrane Database Syst Rev. 2017 May 12;5(5):CD008609.
30. Alstadhaug KB, Ofte HK, Kristoffersen ES. Preventing and treating medication overuse headache. Pain Rep. 2017 Jul 26;2(4):e612.
31. McQuay HJ, Moore RA. Dose-response in direct comparisons of different doses of aspdcirin, ibuprofen and paracetamol (acetaminophen) in analgesic studies. Br J Clin Pharmacol. 2007 Mar;63(3):271-8.
32. Imani F, Motavaf M, Safari S, Alavian SM. The therapeutic use of analgesics in patients with liver cirrhosis: a literature review and evidence-based recommendations. Hepat Mon. 2014 Oct 11;14(10):e23539.
33. McNeil M. Headaches in Adults in Primary Care: Evaluation, Diagnosis, and Treatment. Med Clin North Am. 2021 Jan;105(1):39-53.
34. Ruetzler K, Blome CJ, Nabecker S, et al. A randomised trial of oral versus intravenous opioids for treatment of pain after cardiac surgery. J Anesth. 2014 Aug;28(4):580-6.
35. Shah A, Hayes CJ, Martin BC. Characteristics of Initial Prescription Episodes and Likelihood of Long-Term Opioid Use - United States, 2006-2015. MMWR Morb Mortal Wkly Rep. 2017 Mar 17;66(10):265-269.
36. Dunn B, Page R. Acute coronary syndrome. In: Zeind CS, Carvalho MG, Cheng JWM, et al., editors. Applied Therapeutics: the Clinical Use of Drugs. 12th ed. Philadelphia, PA: Wolters Kluwer Health, 2024:240-273.

References:

37. Motamed C. Clinical Update on Patient-Controlled Analgesia for Acute Postoperative Pain. Pharmacy (Basel). 2022 Jan 27;10(1):22.
38. Roy PJ, Weltman M, Dember LM, et al. Pain management in patients with chronic kidney disease and end-stage kidney disease. Curr Opin Nephrol Hypertens. 2020 Nov;29(6):671-680.
39. Siu EY, Moon TS. Opioid-free and opioid-sparing anesthesia. Int Anesthesiol Clin. 2020 Spring;58(2):34-41.
40. Gupta L, Agarwal J, Saxena KN. Opioid-free anaesthesia: The conundrum and the solutions. Indian J Anaesth. 2022 Mar;66(Suppl 2):S91-S94.
41. Novak-Jankovič V, Markovič-Božič J. REGIONAL ANAESTHESIA IN THORACIC AND ABDOMINAL SURGERY. Acta Clin Croat. 2019 Jun;58(Suppl 1):96-100.
42. Kamel I, Ahmed MF, Sethi A. Regional anesthesia for orthopedic procedures: What orthopedic surgeons need to know. World J Orthop. 2022 Jan 18;13(1):11-35.
43. Rerkasem A, Orrapin S, Howard DP, et al. Local versus general anaesthesia for carotid endarterectomy. Cochrane Database Syst Rev. 2021 Oct 13;10(10):CD000126.
44. deLemos DM. Skin laceration repair with sutures. (Last updated March 6, 2024). In UpToDate, Post TW (ed), UpToDate, Waltham, MA 02013.
45. Stamenkovic DM, Bezmarevic M, Bojic S, et al. Updates on Wound Infiltration Use for Postoperative Pain Management: A Narrative Review. J Clin Med. 2021 Oct 11;10(20):4659.
46. Foo I, Macfarlane AJR, Srivastava D, et al. The use of intravenous lidocaine for postoperative pain and recovery: international consensus statement on efficacy and safety. Anaesthesia. 2021 Feb;76(2):238-250.
47. Product information for Exparel. Pacira Pharmaceuticals. San Diego, CA 92121. March 2023.
48. Product information for Zynrelef. Heron Therapeutics. San Diego, CA 92121.November 2024.
49. Gong R, Tan G, Huang Y. The Efficacy of Liposomal Bupivacaine in Thoracic Surgery: A Systematic Review and Meta-Analysis. J Pain Res. 2024 Nov 28;17:4039-4051.
50. Nguyen A, Grape S, Gobbetti M, Albrecht E. The postoperative analgesic efficacy of liposomal bupivacaine versus long-acting local anaesthetics for peripheral nerve and field blocks: A systematic review and meta-analysis, with trial sequential analysis. Eur J Anaesthesiol. 2023 Sep 1;40(9):624-635.
51. McEvoy MD, Raymond BL, Krige A. Opioid-Sparing Perioperative Analgesia Within Enhanced Recovery Programs. Anesthesiol Clin. 2022 Mar;40(1):35-58.
52. Chu R, Umukoro N, Greer T, et al. Intravenous Lidocaine Infusion for the Management of Early Postoperative Pain: A Comprehensive Review of Controlled Trials. Psychopharmacol Bull. 2020 Oct 15;50(4 Suppl 1):216-259.
53. Foo I, Macfarlane AJR, Srivastava D, et al. The use of intravenous lidocaine for postoperative pain and recovery: international consensus statement on efficacy and safety. Anaesthesia. 2021 Feb;76(2):238-250.
54. Teames R, Joyce A, Scranton R, Vick C, Nagaraj N. Characterization of Device-Related Malfunction, Injury, and Death Associated with Using Elastomeric Pumps for Delivery of Local Anesthetics in the US Food and Drug Administration MAUDE Database. Drug Healthc Patient Saf. 2020 Dec 23;12:293-299.
55. Faraoni TJ, Kruisselbrink R. Implementation and Postoperative Management of Continuous Adductor Canal Catheters for Total Knee Arthroplasty to Reduce Surgical Backlog Related to the COVID-19 Pandemic: An Acute Pain Service Nursing Perspective and Educational Resource. J Perianesth Nurs. 2023 Apr;38(2):186-192.
56. Schwenk ES, Viscusi ER, Buvanendran A, et al. Consensus Guidelines on the Use of Intravenous Ketamine Infusions for Acute Pain Management From the American Society of Regional Anesthesia and Pain Medicine, the American Academy of Pain Medicine, and the American Society of Anesthesiologists. Reg Anesth Pain Med. 2018 Jul;43(5):456-466.
57. Ying M, Zuo Y. Efficacy of Low-dose Ketamine for Control of Acute Pain in the Emergency Setting: A Systematic Review and Meta-analysis of Randomized Controlled Trials. West J Emerg Med. 2023 May 9;24(3):644-653.
58. Avidan MS, Maybrier HR, Abdallah AB, et al. Intraoperative ketamine for prevention of postoperative delirium or pain after major surgery in older adults: an international, multicentre, double-blind, randomised clinical trial. Lancet. 2017 Jul 15;390(10091):267-275. Erratum in: Lancet. 2017 Jul 15;390(10091):230.
59. Motov S, Drapkin J, Likourezos A, et al. Continuous Intravenous Sub-Dissociative Dose Ketamine Infusion for Managing Pain in the Emergency Department. West J Emerg Med. 2018 May;19(3):559-566.
60. Siu EY, Moon TS. Opioid-free and opioid-sparing anesthesia. Int Anesthesiol Clin. 2020 Spring;58(2):34-41.
61. Brinck EC, Tiippana E, Heesen M, et al. Perioperative intravenous ketamine for acute postoperative pain in adults. Cochrane Database Syst Rev. 2018 Dec 20;12(12):CD012033.
62. Mo H, Campbell MJ, Fertel BS, et al. Ketamine Safety and Use in the Emergency Department for Pain and Agitation/Delirium: A Health System Experience. West J Emerg Med. 2020 Jan 27;21(2):272-281.
63. Motov SM, Vlasica K, Middlebrook I, LaPietra A. Pain management in the emergency department: a clinical review. Clin Exp Emerg Med. 2021 Dec;8(4):268-278.
64. UNC Healthcare guideline. Low-dose ketamine for analgesia in the ED. Last updated June 2015. https://www.med.unc.edu/emergmed/wp-content/uploads/sites/649/2018/04/low-dose-ketamine-for-analgesia-in-the-ed.pdf. (Accessed February 6, 2025).
65. Riccardi A, Guarino M, Serra S, et al. Narrative Review: Low-Dose Ketamine for Pain Management. J Clin Med. 2023 May 2;12(9):3256.
66. Webster L, Gudin J, Raffa RB, et al. Understanding Buprenorphine for Use in Chronic Pain: Expert Opinion. Pain Med. 2020 Apr 1;21(4):714-723.
67. Helm S, Trescot AM, Colson J, et al. Opioid antagonists, partial agonists, and agonists/antagonists: the role of office-based detoxification. Pain Physician. 2008 Mar-Apr;11(2):225-35.
68. Pharmacy Times. Opioid agonists, partial agonists, antagonists: oh my! January 2018. http://www.pharmacytimes.com/contributor/jeffrey-fudin/2018/01/opioid-agonists-partial-agonists-antagonists-oh-my. (Accessed February 7, 2025).
69. Zeng Z, Lu J, Shu C, et al. A comparison of nalbuphine with morphine for analgesic effects and safety : meta-analysis of randomized controlled trials. Sci Rep. 2015 Jun 3;5:10927.
70. FDA drug safety communication: safety review update of codeine use in children; new boxed warning and contraindication on use after tonsillectomy and/or adenoidectomy. February 20, 2013. https://www.fda.gov/media/85072/download. (Accessed February 7, 2025).
71. Crews KR, Monte AA, Huddart R, et al. Clinical Pharmacogenetics Implementation Consortium Guideline for CYP2D6, OPRM1, and COMT Genotypes and Select Opioid Therapy. Clin Pharmacol Ther. 2021 Oct;110(4):888-896.
72. Food and Drug Administration. FDA drug safety communication: FDA restricts use of prescription codeine pain and cough medicines and tramadol pain medicines in children; recommends against use in breastfeeding women. April 20, 2017. https://www.fda.gov/media/104268/download. (Accessed November 1, 2023).

References:

73. Government of Canada. Summary safety review -tramadol-containing products – assessing the potential risks of serious breathing problems (respiratory depression) in children and adolescents. February 22, 2017. https://www.canada.ca/en/health-canada/services/drugs-health-products/medeffect-canada/safety-reviews/summary-safety-review-tramadol-potential-risk-serious-breathing-problems-children-adolescents.html. (Accessed February 7, 2025).
74. Roulet L, Rollason V, Desmeules J, Piguet V. Tapentadol Versus Tramadol: A Narrative and Comparative Review of Their Pharmacological, Efficacy and Safety Profiles in Adult Patients. Drugs. 2021 Jul;81(11):1257-1272.
75. Health Canada. Summary safety review-tramadol-containing products-assessing the potential risk of hallucinations. December 28, 2020. https://hpr-rps.hres.ca/reg-content/summary-safety-review-detail.php?lang=en&linkID=SSR00253. (Accessed November 2, 2023).
76. By the 2023 American Geriatrics Society Beers Criteria® Update Expert Panel. American Geriatrics Society 2023 updated AGS Beers Criteria® for potentially inappropriate medication use in older adults. J Am Geriatr Soc. 2023 Jul;71(7):2052-2081.
77. DEA. Tramadol (trade names: Ultram, Ultracet). February 2024. https://www.deadiversion.usdoj.gov/drug_chem_info/tramadol.pdf#search=tramadol. (Accessed November 2, 2023).
78. Park CM, Inouye SK, Marcantonio ER, et al. Perioperative Gabapentin Use and In-Hospital Adverse Clinical Events Among Older Adults After Major Surgery. JAMA Intern Med. 2022 Nov 1;182(11):1117-1127.
79. Kharasch ED, Clark JD, Kheterpal S. Perioperative Gabapentinoids: Deflating the Bubble. Anesthesiology. 2020 Aug;133(2):251-254.
80. Deljou A, Hedrick SJ, Portner ER, et al. Pattern of perioperative gabapentinoid use and risk for postoperative naloxone administration. Br J Anaesth. 2018 Apr;120(4):798-806.
81. Buck ML. Is Meperidine the Drug That Just Won't Die? J Pediatr Pharmacol Ther. 2011 Jul;16(3):167-9.
82. Hassan H, Bastani B, Gellens M. Successful treatment of normeperidine neurotoxicity by hemodialysis. Am J Kidney Dis. 2000 Jan;35(1):146-9 [abstract].
83. Product information for Journavx. Vertex Pharmaceuticals. Boston, MA 02210. January 2025.
84. Jeffers JL, Boyd KL, Parks LJ. Right Ventricular Myocardial Infarction. [Updated 2023 Jul 31]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK431048/. (Accessed February 13, 2025).
85. Duarte GS, Nunes-Ferreira A, Rodrigues FB, et al. Morphine in acute coronary syndrome: systematic review and meta-analysis. BMJ Open. 2019 Mar 15;9(3):e025232.