REVIEW

Postoperative Pain Management in Enhanced Recovery Pathways

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Abstract: Postoperative pain is a common but often inadequately treated condition. Enhanced recovery pathways (ERPs) are increasingly being utilized to standardize perioperative care and improve outcomes. ERPs employ multimodal postoperative pain management strategies that minimize opioid use and promote recovery. While traditional opioid medications continue to play an important role in the treatment of postoperative pain, ERPs also rely on a wide range of non-opioid pharmacologic therapies as well as regional anesthesia techniques to manage pain in the postoperative setting. The evidence for the use of these interventions continues to evolve rapidly given the increasing focus on enhanced postoperative recovery. This article reviews the current evidence and knowledge gaps pertaining to commonly utilized modalities for postoperative pain management in ERPs.

Keywords: enhanced recovery after surgery, ERAS, multimodal analgesia, opioid-sparing analgesia, postsurgical pain, pain management

Introduction

Postoperative pain is a common but often inadequately treated condition, with 80% of surgical patients experiencing postoperative pain but less than 50% of these patients reporting sufficient pain control according to a US Institute of Medicine report.[1] In addition, a national survey suggests that 39% of patients with postoperative pain experience severe to extreme levels of pain.[2] The consequences of suboptimal postoperative pain control include elevated risk for morbidity and persistent postsurgical pain as well as increased length of hospital stay and healthcare costs.[3] Pain management in the postoperative setting presents a challenge as the development and severity of pain after surgery is dependent on various patient and procedural factors.[4–6] Furthermore, opioid medications, the traditional mainstay of postoperative pain treatment, are associated with significant short- and long-term adverse effects.[7,8] Over the past two decades, structured perioperative programs known as enhanced recovery pathways (ERPs) have been developed in order to standardize care and improve outcomes.[9] These pathways, which are often built around procedure-specific, evidence-based guidelines from organizations such as the Enhanced Recovery After Surgery (ERAS) Society, Procedure-Specific Postoperative Pain Management (PROSPECT) group, and the American Society for Enhanced Recovery (ASER), are increasingly considered standard of care for patients undergoing a variety of surgical procedures.[10–12] With regard to postoperative pain management, ERPs apply a multimodal, opioid-sparing approach.[13] In particular, non-opioid medications and regional anesthesia techniques are

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commonly employed to minimize use of opioid medications.[14] As strategies for postoperative pain treatment continue to evolve rapidly in the context of an increasing focus on enhanced postoperative recovery,[15] we review the current evidence as well as knowledge gaps and controversies pertaining to commonly utilized postoperative pain management modalities in ERPs.

Methods

This article is a narrative review of the literature on the management of postoperative pain in the context of ERPs. The primary objective of this review is to provide an overview of salient pain management modalities employed by ERPs in the postoperative setting as well as the current evidence and recommendations for their use. We identified pertinent treatment modalities by reviewing current postoperative pain management guidelines published by the Enhanced Recovery After Surgery (ERAS) Society, Procedure-Specific Postoperative Pain Management (PROSPECT) group, and the American Society for Enhanced Recovery (ASER), including its Perioperative Quality Initiative (POQI). In addition, we reviewed articles obtained via searches of the PubMed database and Google Scholar for the following terms: "enhanced recovery pain management", "enhanced recovery analgesia", "multimodal analgesia", and "opioid-sparing analgesia". We only included treatment modalities employed in the postoperative setting and excluded preemptive analgesia and intraoperative management techniques. After identifying commonly utilized treatment modalities, we then reviewed articles pertaining to each individual treatment modality obtained by searching the PubMed database, Cochrane Library database, and Google Scholar using the term "postoperative pain" plus the name of the specific treatment modality (eg "acetaminophen", "epidural", etc.). We excluded studies performed solely in the pediatric population.

Opioid Medications

Opioid medications such as fentanyl, morphine, hydromorphone, oxycodone, and hydrocodone exert their analgesic action through the mu opioid receptor. Opioids are traditionally considered integral to postoperative pain management, but their use is associated with a number of adverse effects including urinary retention, ileus, nausea, vomiting, pruritus, respiratory depression, and central nervous system depression.[7] These adverse effects are associated with increased mortality, length of stay, risk for readmission,

and healthcare costs in surgical patients.[16,17] Opioid use can also lead to tolerance and opioid-induced hyperalgesia, which may in turn contribute to the development of persistent postsurgical pain.[18] Furthermore, opioid use in the postoperative setting is associated with increased risk of chronic opioid use, which is particularly concerning in the context of the current national opioid epidemic.[19] Therefore, ERPs generally utilize opioid medications sparingly, only for moderate-to-severe pain not responsive to other treatments, and always in conjunction with non-opioid analgesic interventions (Table 1). The use of non-opioid analgesic modalities is especially important in patients with chronic pain who take opioids preoperatively as these patients are at increased risk for severe postoperative pain, poor postoperative pain control, and opioid-related adverse effects in the postoperative setting.[5,6,20,21]

Implementation of ERPs has been shown to significantly reduce inpatient opioid consumption after a wide range of surgical procedures.[22–31] Zhao et al demonstrated a dose-response relationship between postoperative opioid consumption and opioid-related adverse effects.[32] Accordingly, several studies suggest opioid-sparing strategies may be associated with lower rates of opioid-related adverse effects, including nausea, vomiting, sedation, urinary retention, and constipation.[24,30–36] Reduced consumption of opioids does not appear to negatively impact patient-reported pain or satisfaction levels and, in some studies, is associated with improved patient-reported pain scores.[25–31,34–38] The effect of opioid-sparing strategies during the acute postoperative period on chronic opioid use remains unclear, with some studies demonstrating a reduction of longer term opioid use while others showing no difference.[30,38–43] Although opioid-sparing postoperative analgesic interventions have clear advantages with respect to reduced adverse effects and some studies even suggest that opioid medications may provide superior analgesia for acute pain compared to non-opioid therapies, the feasibility of opioid-free postoperative analgesia remains controversial and additional research in this area is needed.[44–46]

If opioids are required during the postoperative period, ERPs generally recommend that they be administered orally for patients who are tolerating oral intake. Short-acting rather than long-acting opioids should be used in patients who are not taking opioids chronically as short-acting opioids are more easily titratable and associated with a lower risk of unintentional overdose.[47] In patients with renal failure, morphine and codeine are generally

Table 1 Common Non-Opioid Modalities for Treatment of Postoperative Pain in Enhanced Recovery Pathways

Modality	Advantages	Disadvantages
Acetaminophen	• Reduced opioid requirements • Improved pain control • Generally well-tolerated • Synergistic analgesic effect when combined with NSAIDs	• Hepatotoxicity with higher doses • Caution in patients with liver dysfunction
Nonsteroidal anti-inflammatory drugs (NSAIDs)	• Reduced opioid requirements • Improved pain control • Synergistic analgesic effect when combined with acetaminophen	• Risk of gastrointestinal ulceration, bleeding, renal impairment, and cardiovascular adverse events • Possible association with bone nonunion after spinal fusion • Possible association with anastomotic leak after colorectal surgery
Gabapentinoids	• Reduced opioid requirements • Improved pain control	• Benefits of questionable clinical significance • Risk of sedation, visual disturbances, and respiratory depression • Caution in patients with renal dysfunction • Only available in oral formulations • Optimal dosing regimen unclear
Alpha-2 agonists	• Reduced opioid requirements • Improved pain control • Can be used as adjuncts in regional anesthetic techniques	• Risk of sedation, hypotension, and bradycardia • Limited evidence supporting use in postoperative setting • Optimal dosing regimen unclear
Ketamine	• Reduced opioid requirements • Improved pain control • May reduce risk of opioid-induced hyperalgesia and opioid tolerance	• Risk of neuropsychiatric symptoms • Caution in patients with cardiovascular disease, hepatic dysfunction, elevated intracranial and intraocular pressure, active psychosis, and pregnancy • Optimal dosing regimen unclear
Intravenous lidocaine	• Reduced opioid requirements • Improved pain control • Decreased risk of ileus and shorter length of stay • May be particularly beneficial after abdominal surgery	• Risk of toxicity requiring monitoring of plasma lidocaine levels • Optimal dosing regimen unclear
Peripheral nerve blocks	• Reduced opioid requirements • Improved pain control • Faster postoperative recovery and decreased length of stay	• Risk of bleeding, nerve injury, infection, local anesthetic systemic toxicity, and various site-specific complications • Risk of motor blockade and impaired postoperative mobilization after lower extremity surgery
Epidural analgesia	• Reduced opioid requirements • Improved pain control • Decreased risk of postoperative morbidity, particularly ileus and cardiopulmonary complications	• Risk of hypotension, urinary retention, motor blockade, backache, inadvertent dural puncture, neurological injury, infection, epidural hematoma, and local anesthetic systemic toxicity • Usually avoided in patients with coagulopathy

avoided due to reduced clearance of drug metabolites and other opioids should be used with caution.[48] If frequent parenteral opioid administration is required, ERPs often favor the use of patient-controlled analgesia as this delivery method individualizes opioid dosing and is associated with increased patient satisfaction and pain control.[49] Prior to employing traditional opioids, some ERPs may

recommend the use of tramadol, which produces analgesia via weak mu opioid receptor agonism as well as serotonin-norepinephrine reuptake inhibition.[50] Tramadol is associated with lower rates of certain opioid-related adverse events including constipation, respiratory depression, and abuse.[51] However, tramadol should be utilized carefully in patients with a seizure history as seizures are a known rare

side effect. In addition, concomitant use of tramadol and other serotonergic medications may precipitate serotonin syndrome.

Non-Opioid Medications

Acetaminophen

Acetaminophen is a cornerstone of multimodal postoperative pain treatment in ERPs. Its analgesic effect is thought to be primarily mediated through inhibition of the cyclooxygenase pathway, though the exact mechanism of action remains incompletely understood.[52] A single dose of acetaminophen has been shown to provide 50% pain relief for four hours in about half of patients experiencing moderate-to-severe acute postoperative pain.[53,54] Use of acetaminophen in conjunction with nonsteroidal anti-inflammatory drugs can have an additive or even synergistic analgesic effect.[55] In addition, acetaminophen use has been associated with reduced opioid requirements during the postoperative period.[56–60] ERPs generally recommend that acetaminophen be given on a scheduled basis as this leads to more consistent dosing and is associated with decreased opioid use.[61] While intravenous acetaminophen is associated with more favorable pharmacokinetics including faster onset and higher plasma and cerebrospinal fluid levels compared to oral and rectal acetaminophen, it does not provide a clear benefit with regard to analgesic efficacy and patient outcomes.[62,63] Therefore, use of oral acetaminophen is generally preferred in patients that are able to tolerate oral intake while intravenous acetaminophen is useful in patients who are unable to tolerate oral intake or have impaired gastrointestinal tract function.[63] Overall, acetaminophen is well-tolerated with its most concerning adverse effect being hepatotoxicity at higher doses and in patients with liver insufficiency. Given its favorable safety profile and the strong evidence supporting its use for postoperative pain treatment, almost all ERPs will recommend the routine use of acetaminophen in postoperative analgesia regimens.

Nonsteroidal Anti-Inflammatory Drugs

Nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen, ketorolac, and celecoxib, produce analgesia by inhibiting the cyclooxygenase enzyme and disrupting prostaglandin synthesis. NSAIDs are effective treatments for postoperative pain and important adjuncts in a multimodal analgesia regimen for the treatment of postoperative pain.[64–66] When used in conjunction with opioids in the postoperative period, NSAIDs are associated with reduced opioid consumption and improved pain control.[54,58,59,67,68] Combining NSAIDs with acetaminophen produces an additive or potentially synergistic analgesic effect.[55,67] In addition, NSAID use may be associated with a reduced risk of opioid-related side effects, including nausea, vomiting, and sedation.[33,35,36,59] Although NSAIDs are generally well-tolerated, they are associated with an increased risk of gastrointestinal ulceration, bleeding, and renal impairment.[59,69,70] The use of NSAIDs that selectively inhibit the cyclooxygenase-2 (COX-2) enzyme, such as celecoxib, may reduce the risk of gastrointestinal events and bleeding. However, COX-2 inhibitors can increase the risk of cardiovascular adverse events and are typically avoided after cardiac surgery.[71] Some studies suggest that NSAIDs may result in bone nonunion after spinal fusions, although the overall body of evidence remains inconclusive.[72–74] Due to the lack of strong evidence that short term use of NSAIDs in the perioperative setting affects bone fusion, the ERAS Society continues to recommend NSAID use after spinal surgery.[75] Similarly, there is ongoing debate regarding the association between NSAID use and increased risk of anastomotic leaks after colorectal surgery.[76–80] Despite these potential risks, many ERPs will recommend the use of NSAIDs unless contraindicated given the strong evidence supporting their efficacy in the treatment of postoperative pain.

Gabapentinoids

Gabapentinoids, such as gabapentin and pregabalin, are antiepileptic medications that produce analgesia through inhibition of voltage-gated calcium channels. These medications were traditionally used in the management of chronic neuropathic pain. However, some studies suggest that perioperative use of gabapentinoids may reduce acute postoperative pain, opioid consumption, and postoperative nausea and vomiting.[75–87] In addition, perioperative gabapentinoid use may also reduce the risk of developing persistent postsurgical pain although the evidence for this effect remains insufficient.[88,89] Based on these findings, gabapentinoids have been included as part of a multimodal analgesia regimen in some ERPs. However, other studies have called into question the benefit of gabapentinoid use in the perioperative setting as they are associated with adverse effects, and their analgesic and opioid-sparing effects may in fact be clinically insignificant.[90–93] In particular, use of gabapentinoids has been linked to sedation, visual disturbances, and dizziness that can hinder early

postoperative mobilization and delay recovery.[81–87,90–92] In addition, perioperative gabapentin use has been associated with risk of respiratory depression, especially in older patients and those receiving higher doses of opioids.[94] Overall, the quality of evidence supporting the perioperative use of gabapentinoids remains low, and optimal dosing has not been clearly established. Furthermore, gabapentinoids are currently only available in oral formulations, which may limit their use in the acute postoperative setting. Therefore, while gabapentinoids are a potential opioid-sparing adjunct for management of postoperative pain, the risks and benefits of their use should be carefully considered for each individual patient. In particular, given their side effect profile, gabapentinoids should be used with caution in elderly patients as well as patients with renal dysfunction, which often necessitates dose reduction.

Alpha-2 Agonists

Alpha-2 agonists, such as clonidine and dexmedetomidine, produce analgesia by stimulating alpha-2 receptors in the dorsal horn of the spinal cord and reducing transmission of nociceptive signals. While these medications can be administered via multiple routes, for postoperative pain management, clonidine is often given intravenously or orally while dexmedetomidine is typically administered intravenously. Clonidine and dexmedetomidine can also be used as adjuvants in epidurals and peripheral nerve blocks to potentially improve and prolong analgesia, although data supporting these benefits is limited.[95–99] Some ERPs may utilize clonidine or dexmedetomidine as an analgesic adjust for postoperative pain management as some evidence suggests that alpha-2 agonists have opioid-sparing properties.[100,101] In particular, recent studies suggest postoperative dexmedetomidine infusions may reduce opioid consumption and opioid-related adverse effects.[102,103] While the benefits of intraoperative use of alpha-2 agonists, particularly dexmedetomidine, are well-studied, the evidence supporting the use of alpha-2 agonists in the postoperative setting remains scarce and optimal dosing regimens have not been identified. Common adverse effects of alpha-2 agonists include sedation, hypotension, and bradycardia. These risks should be considered when including alpha-2 agonists in a postoperative analgesia regimen given the limited evidence supporting their use in the postoperative setting.

Ketamine

Ketamine is a dissociative anesthetic that antagonizes N-methyl-D-aspartate (NMDA) receptors in the brain and spinal cord to reduce transmission of pain signals.[104] Intravenous ketamine infusions at subanesthetic doses have been shown to reduce opioid consumption and improve pain control without causing major adverse effects.[105–110] The addition of ketamine to an opioid regimen has also been shown to reduce the incidence of postoperative nausea and vomiting.[107–109,111] Furthermore, ketamine may prevent the development of opioid-induced hyperalgesia and opioid tolerance.[112] However, it remains unclear whether perioperative ketamine use reduces the risk of developing persistent postsurgical pain.[89,113] The most common adverse effects associated with use of subanesthetic doses of ketamine in the postoperative setting are neuropsychiatric symptoms, such as hallucinations and nightmares.[105] Poorly controlled cardiovascular disease, hepatic dysfunction, elevated intracranial and intraocular pressure, active psychosis, and pregnancy are considered relative contraindications to ketamine use.[114] As part of an ERP, ketamine infusions can be used as an analgesic adjunct for those with moderate-to-severe pain who have failed initial treatment options. Because ketamine at subanesthetic doses does not suppress airway reflexes and preserves spontaneous respirations, it can be used to reduce opioid intake in patients at risk for respiratory depression, such as those with obstructive sleep apnea. Ketamine may also be a particularly useful analgesic adjunct in patients who are opioid tolerant.[115,116]

Intravenous Lidocaine

Lidocaine is an amide local anesthetic that has analgesic, anti-inflammatory, and anti-hyperalgesic properties when administered intravenously.[117] Some studies suggest that lidocaine infusions can reduce postoperative pain and opioid intake, especially after abdominal surgeries.[118–122] In addition, lidocaine infusions may be associated with decreased risk for postoperative nausea, vomiting, and ileus as well as shorter duration of hospital stay.[118–122] Based on these data, some ERPs may utilize lidocaine infusions as part of a multimodal analgesia regimen for moderate-to-severe pain, particularly after abdominal surgeries. However, a Cochrane review found insufficient evidence to confirm the benefit of lidocaine infusions for postoperative pain control and recovery.[123] In addition,

optimal dosing and infusion duration have not been established. Therefore, some uncertainty remains regarding the routine use of lidocaine infusions for postoperative pain management. Although lidocaine has a narrow therapeutic index, toxicity appears to be very rare with infusions.[119–122] The risk of lidocaine toxicity is directly related to plasma lidocaine levels, which should be monitored during infusions.

Regional Anesthesia Techniques
Peripheral Nerve Blocks

Peripheral nerve blocks (PNBs) target local anesthetic medications directly to peripheral nerves to provide analgesia. Commonly used PNBs include brachial plexus blocks for upper extremity surgeries, paravertebral blocks for thoracic surgeries, transversus abdominis plane (TAP) blocks for abdominal surgeries, and femoral and sciatic nerve blocks for lower extremity surgeries. Both single-shot PNBs and continuous PNBs can be utilized to manage postoperative pain. Single-shot PNBs are primarily limited by a short duration of action that is typically less than twenty-four hours. The addition of adjuvants, such as dexamethasone, dexmedetomidine, clonidine, and buprenorphine, may prolong the analgesia provided by single-shot PNBs, although further studies are warranted.[97] There is an increasing number of studies examining the use of liposomal bupivacaine in PNBs and its effect on prolonging analgesia or improves outcomes compared to other local anesthetics.[124,125] Continuous PNBs allow for a longer duration of analgesia compared to single-shot PNBs by delivering a constant local anesthetic infusion via a perineural catheter. Continuous PNBs are associated with improved pain control, decreased opioid consumption, and higher patient satisfaction compared to single-shot PNBs.[126] Patients who receive continuous PNBs may even be discharged home with ambulatory infusion pumps for continued pain control.

PNBs are associated with a number of benefits in the perioperative setting including improved postoperative pain control, reduced opioid consumption, quicker postoperative recovery, decreased duration of hospital stay, lower risk of opioid-related adverse effects, and increased patient satisfaction.[127–131] In some instances, PNBs may be associated with lower rate of complications, such as hypotension, compared to epidural analgesia.[132,133] PNBs may also reduce the risk of developing persistent postoperative pain.[134] However, PNBs do not appear to reduce

the risk of long-term opioid use after surgery.[41,42,135] Given their clear benefits in the perioperative setting, ERPs may recommend the use of PNBs as part of a multimodal analgesia regimen. However, a potential complication of PNBs is motor blockade, which may lead to delayed postoperative mobilization, increased risk of falls, and prolonged hospital course.[136–138] Therefore, the use of PNBs for postoperative pain control after certain lower extremity surgeries is controversial. Although the use of PNBs in total knee and hip arthroplasties is somewhat controversial due to the risk of motor blockade,[139] the International Consensus on Anesthesia-Related Outcomes after Surgery (ICAROS) group recommends the use of PNBs in total knee and hip arthroplasties based on their meta-analysis demonstrating that use of PNBs in these surgeries was associated with lower risk for a variety of complications including cognitive dysfunction, cardiopulmonary complications, surgical site infections, thromboembolic events, and blood transfusions.[140] Similarly, the Agency for Healthcare Research and Quality (AHRQ) recommends the use of PNBs in total knee and hip arthroplasties given their numerous demonstrated benefits.[141] Some evidence suggests that motor-sparing PNBs may preserve lower extremity muscle strength and reduce the risk of complications associated with motor blockade, although further research is needed to elucidate the optimal strategy for their use.[142–143] Other complications associated with PNBs include bleeding, nerve injury, infection, and local anesthetic systemic toxicity. Individual PNBs may also be associated with site-specific complications, such as pneumothorax with brachial plexus blocks and intraperitoneal organ injury with TAP blocks. Ultrasound guidance for PNB placement reduces the risk of complications as well as improves block quality and performance time.[144,145] Overall, PNBs can be effective interventions for the management of postoperative pain in ERPs but the risks, benefits, and suitability of specific PNBs should be considered in the context of the individual patient and procedure.

Epidural Analgesia

Epidural analgesia involves injection of local anesthetics with or without adjuvants into the epidural space and can be used to manage postoperative pain after a variety of thoracic, abdominal, pelvic, and lower extremity surgeries. Compared to opioid-based treatment regimens, epidural analgesia is associated with more effective postoperative pain control as well as decreased postoperative morbidity

and mortality.[146–152] In particular, epidural analgesia may lead to quicker return of bowel function and reduce the risk of cardiac and respiratory complications after surgery.[148–151] However, the effect of epidural analgesia on duration of hospitalization remains unclear.[147,149] Epidural analgesia may also reduce the risk of developing persistent postoperative pain.[134] Given its demonstrated benefits in the postoperative period, epidural analgesia can be a valuable part of an opioid-sparing, multimodal analgesia regimen. However, the use of epidurals must be weighed against their potential adverse effects. Risks of epidural catheter placement include backache, inadvertent dural puncture, nerve or spinal cord injury, infection, epidural hematoma, and local anesthetic systemic toxicity. Epidural analgesia may also lead to hypotension, urinary retention, and motor blockade—all of which can delay return to functionality and hospital discharge. In addition, the administration of epidural opioid medications can lead to systemic absorption and opioid-related adverse effects such as nausea, vomiting, pruritus, and respiratory depression. As a result, recommendations for the use of epidural analgesia in ERPs are often procedure specific. For example, the ERAS Society generally recommends the use of epidural analgesia in open gastrointestinal surgeries, open radical cystectomies, and open gynecologic surgeries but not necessarily in hip and knee replacement surgeries due to the risk of motor blockade impairing postoperative mobilization or open liver surgeries due in part to concern for postoperative coagulopathy delaying epidural catheter removal.[139,153–159] In addition, the benefits of epidural analgesia in laparoscopic surgery are less clear compared to open surgeries.[153,154,160] When utilizing epidural analgesia, individual risk-benefit analyses must be performed. Epidural analgesia can be particularly advantageous in patients at high risk of ileus, cardiac complications, or pulmonary complications. However, in other patients, the risk of hypotension and subsequent need for intravenous fluid or vasopressor support may necessitate the use of alternative analgesic modalities such as TAP or paravertebral peripheral nerve blocks.[132,133]

Limitations and Directions for Future Research

This article is a narrative review of the literature rather than a systematic review. We focus only on analgesic interventions commonly utilized by ERPs in the perioperative setting. There are numerous other pharmacologic and non-pharmacologic interventions not discussed in this article currently being investigated for the treatment of postoperative pain that may ultimately be useful in ERPs, ranging from serotonin-norepinephrine reuptake inhibitors to novel peripheral nerve blocks to music therapy. These emerging interventions represent important areas for future research. In addition, there are preemptive analgesic techniques, such as preoperative acetaminophen dosing, and intraoperative interventions, such as esmolol infusions and local anesthetic wound infiltration, that have important implications for postoperative pain control but are beyond the scope of this review. This article demonstrates that there are a variety of evidence-based interventions routinely used for postoperative pain management in ERPs, and an important direction for future research is identifying the ideal combination of these various modalities for specific procedures and patient populations. Additional research is also needed to assess the feasibility and outcomes associated with opioid-free postoperative analgesia as well as the optimal strategies to achieve this goal.

Conclusions

Postoperative pain is often suboptimally treated and remains a challenge to manage. ERPs generally utilize a multimodal, opioid-sparing approach in the treatment of postoperative pain. While opioids remain an important treatment option for postoperative pain, ERPs employ a variety of non-opioid systemic medications and regional anesthetic techniques with the goal of minimizing opioid consumption, reducing risk of opioid-related adverse effects, and improving postoperative outcomes. While strong evidence supports this multimodal, opioid-sparing strategy, the data supporting specific modalities commonly utilized in ERPs to manage postoperative pain continues to evolve rapidly and knowledge gaps and controversies remain. As a result, there are numerous opportunities for future research, and the risks and benefits of specific treatment options should always be considered in the context of the individual patient and procedure.

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Disclosure

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