VER
Vascular & Endovascular Review

Evidence-Based Pain Management Strategies in Post-Operative Patients: Advancing SDG 3

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ABSTRACT

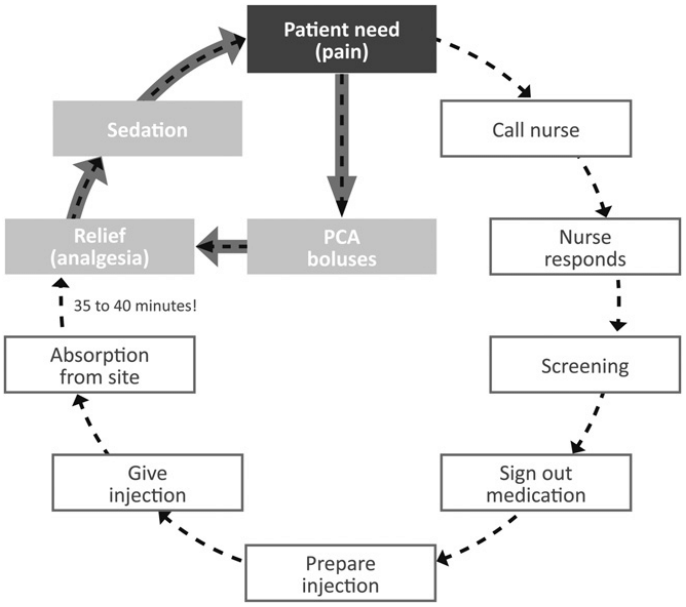
Pain management in post-operative patients is a critical determinant of surgical recovery and overall patient well-being. Despite significant advances in anesthesia and analgesia, a considerable proportion of patients continue to experience inadequate pain relief, leading to prolonged hospital stays, increased risk of complications, and reduced quality of life. This paper reviews pharmacological, non-pharmacological, and multimodal strategies for post-operative pain management, highlighting their effectiveness, limitations, and clinical implications. Pharmacological approaches such as opioids, non-opioid analgesics, adjuvants, and regional anesthesia remain fundamental but are increasingly supplemented by non-pharmacological interventions including physiotherapy, cognitive-behavioral therapy, and complementary therapies. The adoption of multimodal analgesia and Enhanced Recovery After Surgery (ERAS) protocols emerges as the most effective model, offering superior pain control, faster recovery, and reduced opioid dependency. However, challenges such as resource constraints, inconsistent implementation, and limited training persist. The findings underscore the need for a holistic, multidisciplinary, and patient-centered framework that integrates diverse strategies to optimize outcomes in post-operative care.

KEYWORDS: Post-operative pain, Pain management strategies, Pharmacological interventions, Non-pharmacological interventions, Multimodal analgesia, Enhanced Recovery After Surgery (ERAS), Sustainable Development Goals (SDGs), SDG 3 (Good Health and Well-being).

How to Cite: Amit Kumar Goel, Pol. Col. Ubol Chumjinda, Ian Pranandi, SENTHUR N S, (2025) Evidence-Based Pain Management Strategies in Post-Operative Patients: Advancing SDG 3, Vascular and Endovascular Review, Vol.8, No.3s, 298-305.

INTRODUCTION

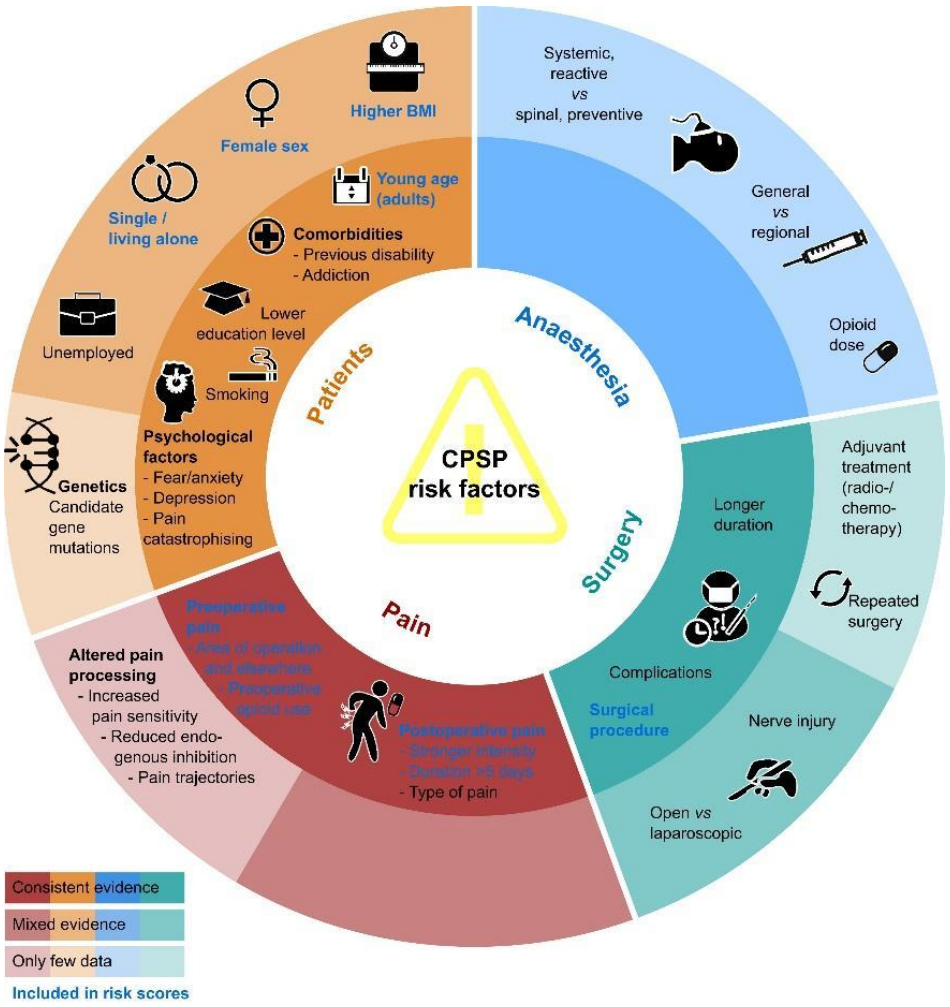
Pain is one of the most common and distressing experiences reported by patients following surgery. Despite significant advances in surgical techniques and anesthesia, inadequate post-operative pain management continues to remain a global health challenge. Uncontrolled pain not only causes physical discomfort but also contributes to psychological distress, delayed recovery, prolonged hospital stays, and in some cases, the development of chronic pain syndromes. Effective pain management is therefore recognized as a cornerstone of quality patient care and a key determinant of clinical outcomes. Post-operative pain is a complex, multifactorial experience influenced by surgical procedures, individual pain thresholds, pre-existing health conditions, and psychosocial factors. Traditionally, opioids were considered the mainstay for post-surgical pain control; however, concerns about adverse effects, dependence, and the global opioid crisis have necessitated the adoption of multimodal and evidence-based strategies (Meissner et al. 2015). Multimodal analgesia-a combination of treatments has become the standard in recent years that combine pharmacological and non-pharmacological processes. The innovative practices of local anesthesia, PCA, other non-opioid analgesia, and disease- and patient-specific approaches, including relaxation, physiotherapy, and cognitive-behavioral management techniques all have demonstrated beneficial outcomes of improving postoperative recovery and decreasing opioid exposure. With the focus on patient-centered care further supporting the importance of adapting approaches to pain management to particular patient requirements, it is critical to find solutions that lend themselves to adaptation. ERAS protocols, as well as interdisciplinary approaches, are referring to the fact that it is paramount to incorporate anesthesiologists, surgeons, nurses, and pain specialists in comprehensive pain management. Nevertheless, even against these developments, there remains a gap in implementation, education of the patient, and access to effective modalities at various healthcare settings.



Pain, as a byproduct of the procedure, cannot be ignored with most surgical operations and therefore, pain management after surgical operations is proving to be one of the main concerns of any given medical care. Millions of patients annually at the global level have surgical operations and post-surgery pain is affecting a noteworthy percentage during the immediate post-surgery period. Poor management of pain not only causes suffering, but also initiates physiological stress responses that effect hypertension, tachycardia, impaired immune system, and wound delay healing. Moreover, uncontrolled pain is closely related to limited mobility, a higher likelihood of occurrence of thromboembolic events, longer in-hospital stays, as well as a lower quality of life (Mitra et al. 2018). It is based on these factors that management of post-operative pain is considered to be clinical and ethical requirement of the healthcare professionals. Post-surgical pain itself is a complex phenomenon that can be conditioned by the kind and length of surgery, the place of an incision, age, and pre-existing illness, as well as mental aspects including anxiety or depression. It is related to complicated neurophysiological processes when nociceptive, inflammatory, and, in some cases, neuropathic circuits interact, which complicates therapy. Traditional literature suggests that the use of opioids represented the mainstay of post-operative pain management because of its significant analgesic properties. However, side effects like nausea, respiratory depression, vomiting, constipation and, more importantly, the risk of tolerance and dependence prompted the need to find safer analgesics and novel approaches (Meissner et al. 2015). The aim of the research paper is to explain and examine various parameters in detail on pain management techniques in post-operative individuals and their effectiveness, safety, and their implications on clinical practice. The study will review the pharmacological, non-pharmacological, and multimodal protocols to illuminate the best practices to improve patient outcomes and surgical care quality.

RATIONALE OF THE STUDY

Pain management after the surgery is one of the burning issues in the scope of surgical care regardless of the fact that there is a range of advanced anesthetic and pain relieving methods that can be carried out. Numerous studies indicate that several of the patients still have negative reports on pain management after surgery, which may cause physical, emotional, and social sequels. Ineffectively treated pain impedes the healing process not to mentionsan complications like delayed ambulation, the risk of deep vein thrombosis, pulmonary complications, and in some instances, it leads to the development of chronic pain in others. These adverse effects impose a significant burden on patients and health systems, and thus there is a critical need to ensure better pain management after the surgery. The use of opioids to manage post-surgery pain has been a widespread approach to the issue, but as the concerns about the adverse effects of opioids and their abuse rise, medical professionals cannot afford ignoring those and change the common practices. Such change of vision has led to the necessity of developing a better and safer strategy, most especially multimodal approaches that involve the use of pharmacological and non-pharmacological approaches. It is of utmost importance to learn which combinations have the best outcomes when it comes to patient groups of this or that population. This will help professionals make significant improvements in clinical outcomes, as well as contribute to the reduction of opioid use and increased patient satisfaction.



The reasoning behind this work is in the possibility, to fill in the gaps between the currently available evidence-based recommendations and clinical practice. In most healthcare institutions, there is a disparity in regard to the implementation of the standard pain management plans with the inconsistencies being caused by inadequate resources, to make the plans more resourceful, inadequate training, and the ignorance of the alternative non-traditional treatment of pain. Through strategic and comprehensive evaluation methodology, this research strives to bring a better explanation of best practices to healthcare practitioners that can help them in the treatment of the patients and promote quick recovery. The rapidly increasing use of ERAS protocols Acknowledges pain management as the key aspect of perioperative management. Nevertheless, application of these protocols between institutions and geographical areas is highly inconsistent (Afshan et al. 2021). A special emphasis study into pain management approaches can thus act as an informative addition to the standardization of care, reduced post-operative complications and improvement in patient quality of life post surgery. The present study is supported by its possible contribution to the life of the patients as well as the healthcare system in general. By focusing on evidence-based, patient-centered, and multidisciplinary approaches, the research will work to improve the perception of effective pain management approaches and contribute to the global agenda of better outcomes in the surgical setting.

LITERATURE REVIEW

3.1 Post-Operative Pain

The clinical entity of post-operative pain is multidimensional phenomena which due to surgery and tissue injury appear directly in response. It is characterized as an acute ache condition arising directly after surgery and generally reaching maximum levels at between 24 and 72 hours, and, then, it starts to abate as the therapy starts to succeed. In contrast to chronic pain, which cannot be resolved after the usual time of healing, post-operative pain is mostly of a nociceptive nature, i.e. caused by stimulation of peripheral nociceptors by tissue destruction and inflammation processes. Nevertheless, there are instances when neuropathic mechanisms can play an additional role, especially when nerves are damaged surgery (Thomazeau et al. 2016). Pain perception is not simply physiological, because it varies according to pain anatomical thresholds, psychological conditions, culture and past experience with disease or surgical treatment. In clinical terms, the severity of post-operative pain can range to be mild, moderate, and severe and the severity can change to fluctuate with the type of surgery and extent of surgery, the site of surgery, demographics, and comorbidities. An improper evaluation or understanding of the post-operative pain results in under-treatment, which may act as a barrier to recovery, as well as lower patient satisfaction. In addition to physical pain, uncontrolled pain leads to physiological stress response via stimulation of the sympathetic nervous system that manifests in the form of tachycardia, hypertension, reduced pulmonary function, and gastrointestinal recovery. Such complications point to the need to think of post-operative pain as more than a passing symptom; rather, it becomes a major determinant of the overall outcome of the surgery.

3.2 Evolution of Pain Management in Surgery

The control of post-surgery pain has been radically changing throughout the centuries, indicating the progress of the medical, pharmacological, and surgical practices. During the ancient civilizations, the treatment of pain depended more on natural drug, alcohol, and primitive techniques that offered minimal effectiveness. The turning point happened in the 19 th century when ether and chloroform were discovered as anesthetic substances, which transformed the surgical practice, as the procedures could now be performed longer and more complicated with a higher patient tolerance (Gorsky, 2019). Morphine was introduced in the early 1800s further improving pain management, and opioids became the totem of post-surgical analgesia in the following decades. Raising the level of surgery in the 20 th century, there had been an increase in the modes of managing pain. Regional anesthesia techniques, the spinal block, epicur block, etc., had been developed during the mid-20th century, offering the promises of local efficacy with reduced systemic side effects. The end of the 20th and the beginning of the 21 st centuries saw a paradigm shift entailing the idea of a multimodal analgesia where the effective response to pain is based on the combined administration of opioids, non-opioid analgesics, and local anesthetics aiming at obtaining greater control over the pain with a reduced number of complications. The rise of patient-controlled analgesia (PCA) devices gave patients more control of their pain management as per their own circumstances and needs, leading to a higher satisfaction and self-sufficiency with recovery (Hwang, 2025). Over the past decades, there has been an ongoing shift towards the patient centered, holistic treatment of pain. The development of non-pharmacological interventions, evidence-based practices including cognitive-behavioral therapy, physiotherapy, and complementary medicine have enabled a wider scope of interventions to replace pharmacology. Further, implementation of Enhanced Recovery After Surgery (ERAS) protocols has incorporated pain management into a multidisciplinary approach that focuses on early mobilization, decreased length of stay and better surgical results. This transformation is indicative of an increasing understanding that an effective post-operative pain management strategy is not solely the symptom control process but that it is a key aspect of surgical safety, recovery and quality of care.

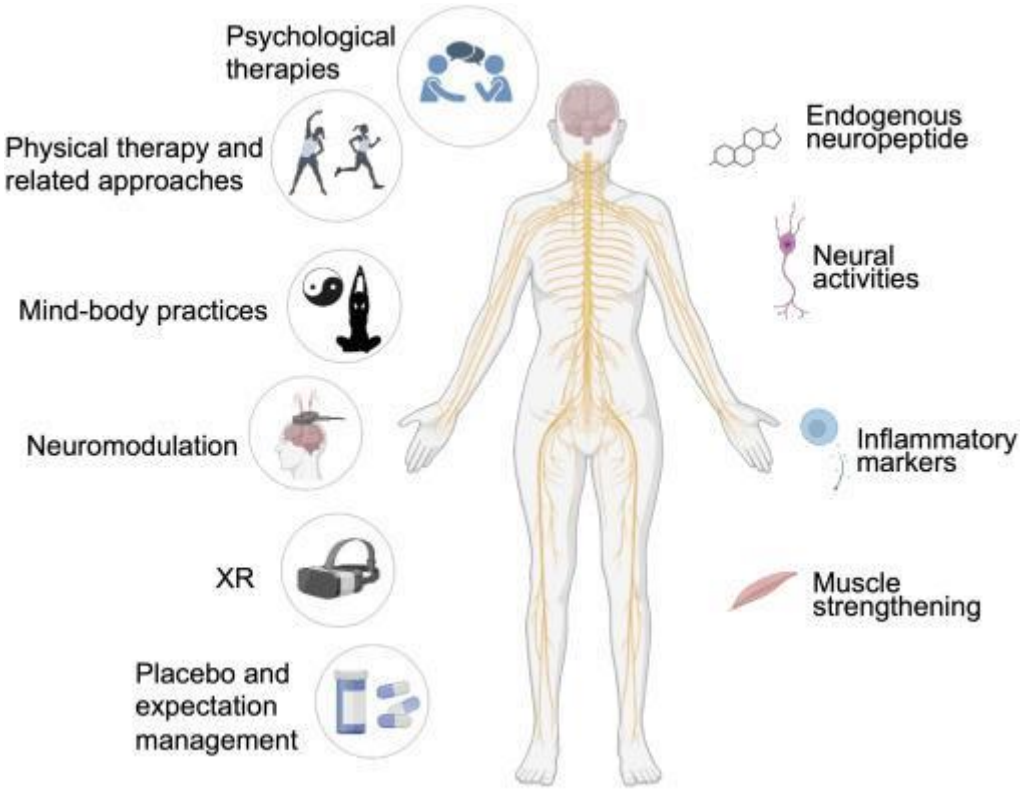
The history of pain management pain management in the surgery is a reflection of all these wider developments of medical science, from cultural practice of medicine, pharmacology as well as advances in technology. In societies like Egypt, Greece and India, herbal extracts are used by the surgeons of the time to cut pain in surgery and opiates that they derived out of poppy were taken as an alternate to curb pain. Methods were primitive and generally inefficient, based on a lack of knowledge of pain physics. There was also lack of reliable pain alleviation which saw surgeries avoided or those that were done at extreme conditions often associated with high mortality and morbidity complications (Hwang, 2025). Modern age of pain management had its beginning during the 19th century with the introduction of general anesthesia. Advances in anesthesia reduced the pain of surgery through the discovery of ether (1846) and chloroform, which allowed surgeons to carry out complicated surgeries on patients who were insensible to pain, a radical change to surgical practice. The discovery that morphine could be isolated out of opium in the early eighteen hundreds solidified opioids as one of the most used drugs in the post- thrown operations. Morphine and its analogs, administered parenterally, were long used because of their powerful analgesical effects, but suspicions of tolerance and dependence soon clouded their use. In the mid-20th century, more specific and effective pain relief techniques like spinal, epidural and peripheral nerve blocks developed. These developments helped healthcare professionals reduce side effects of opioids on the whole organism and make post-surgery recoveries. Local anesthetics such as lidocaine also added to surgical possibilities and made ambulatory surgery a greater possibility. The post-operative setting also saw an emergence of patient-controlled analgesia (PCA), a method through which patients may directly control their pain medication within limits of their prescribed amount thus autonomy and satisfaction improve.

3.3 Pharmacological Pain Management Strategies

Pharmacological treatment has historically been considered the first method of addressing post-operative pain because of the swift onset of controlling pain and efficacy as they have been well studied. Leaders out of these have been the opioids namely morphine, fentanyl, hydromorphone and oxycodone which have always acted as the gold standard for moderate to severe pain. They affect the central nervous system by binding to μ-opioid receptors where they are efficient in prevention of nociceptive transmission and pain perception. Nevertheless, even though potent, opioids are also linked to a wide range of side effects such as a decrease in the depth of breathing, constipation, nausea, drowsiness, and the likelihood of developing tolerance or dependence (Yoong and Poon, 2018). The emerging understanding of these negative factors especially during the opioid epidemic has led to the rebalancing of the focus on opioid-based regimens to a more balanced approach. Alternatives to opioids, including non-steroidal anti-inflammatory drugs (NSAIDs), and acetaminophen, or as adjuncts to opioids, are becoming increasingly common. The mechanism of action of the NSAIDs such as ibuprofen, ketorolac, and and diclofenac creates an analgesic effect by blocking the enzyme cyclooxygenase which leads to a decrease in inflammation caused by prostaglandins, and pain. Acetaminophen, although not efficacious as anti-inflammatory drug, has high level of safety and its effectiveness in alleviating post-operative mild-moderate pain. It has been shown that the joint application of NSAIDs and acetaminophen in the combination with multimodal analgesia regimes not only allows enhancing pain management but also decreating general opioid consumption and its consequences (Alorfi, 2023). However, special attention should be paid in patients with renal, gastrointestinal or bleeding risks because these agents have possible side effects that are systemic in nature.

In addition to conventional analgesics, the pharmacological arsenal encompassing the post-operative pain has extended to include the adjuvant drugs. Gabapentinoids (gabapentin, pregabalin) are frequently applied to affect neuropathic pain pathways and were found to lessen opioid use, but the constraints are caused by sedation and dizziness. Equally, a well-known N-methyl-D-aspartate (NMDA) receptor antagonist, low-dose ketamine, has also been used due to its opioid-sparing properties and general utility in opioid-tolerant patients. Other drugs that contribute to supplement analgesic effect and sedative and anxiolytic effect perioperative are alpha-2 agonist agents such as clonidine and dexmedetomidine. Regional anesthesia methods have also revolutionized surgical

pain management because they provide a regionally limited and prolonged pain relief (Bucsea and Riddell, 2019).



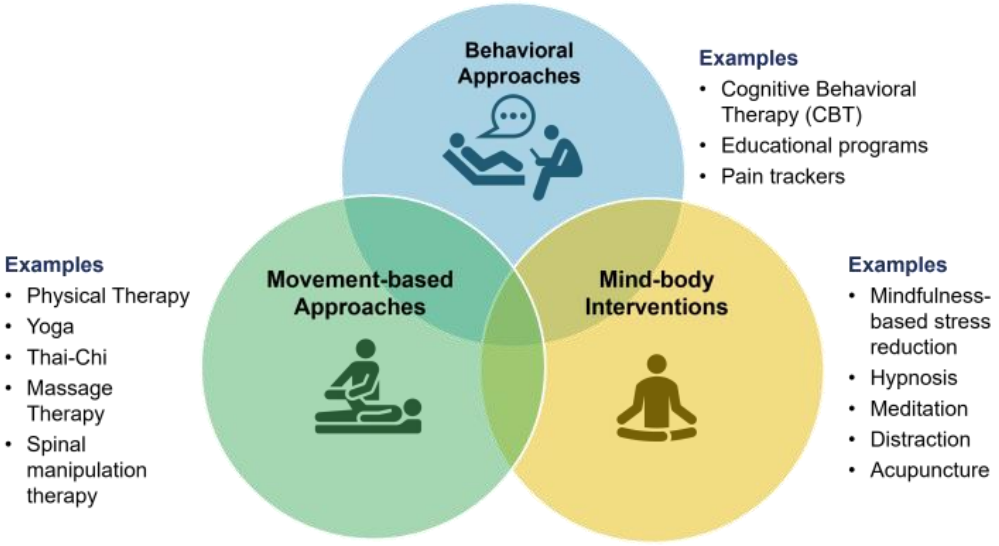
Pain control techniques that include the use of spinal anesthesia, epidural blocks and peripheral nerve blocks would cut short the transmission of nociceptive signals to a surgical site hence exert precise pain control. Miscellaneous Local anesthetics These techniques are very effective yet they take expertise to be applied and may be risky and they can include hypotension, motor impairment, or nerve injury. The next development in the pharmacological approach has been the emergence of patient-controlled analgesia (PCA) systems that allows patients to self-administer fixed doses of analgesics (usually opioids), either by intravenous or epidural administration. The approach shortens the time delay that patients suffer before getting pain medication, increases patient control, and has been linked to a greater degree of satisfaction than nurse administration of dose. Nevertheless, the use of PCA needs to be monitored properly and educated to avoid complications (including overdose or misuse of the device).

3.4 Non-Pharmacological Pain Management Approaches

Although pharmacological measures are understood to be the primary goals of post-operative pain management, non-pharmacological solutions have come to be perceived as valuable parts of individual-centered care and comprehensive treatment. All of these strategies consider the multidimensional aspects of pain that is not purely a physiological phenomenon but one which is also affected by the psychological, emotional, and social aspects. The objective of non-pharmacological technique is to ensure that it supplements the medication program, helps reduce the reliance on opioids and engage the patient in becoming a participant in his or her treatment journey. Nonpharmacologic and rehabilitative approaches include physiotherapy, an early mobility program, breathing exercises, which are used to help mitigate discomfort after surgery and stimulate functional recovery (Nori et al. 2023). These techniques can help mitigate such complications as deep vein thrombosis and pulmonary infections, which may be aggravated by immobilization caused by pain due to their effect in promoting circulation, reducing stiffness and encouraging normal respiratory patterns. In a like manner, another form of treatment is cryotherapy (application of cold-packs) and thermotherapy (application of heat), which have proved to be locally anesthetic in reducing inflammation, swelling and tension of muscles around the area of incision.

From the psychological and cognitive-behavior intervention, the perception of pain in the patient is an important factor that is influenced. Mindfulness training as well as relaxation, guided imagery, distraction and mindfulness-based techniques aid patients in retaining a positive view of their pain experience, minimize anxiety as well as develop coping strategies. It has been indicated that patients experiencing some psychological support during the perioperative period tend to rate a lower pain score, a reduced range of analgesics taken and report, in general, high levels of satisfaction with perioperative care. In particular, cognitive-behavioral therapy (CBT) has been incorporated into multidisciplinary pain management programs due to its demonstrated potential to reduce the pain level and enhance emotional health (Kia et al. 2023). Complementary and alternative treatment is another therapist that has come to the fore in post operation pain treatment. Acupuncture and acupressure are traditional Chinese medicine that has proven their effectiveness in terms of pain relief by stimulating the body to produce endogenous endorphin and altering the mechanism of pain. Likewise, massage therapy, (aromatherapy), music therapy are being employed in clinical practice to decrease pain sensation, induce relaxation and to improve patient comfort. There is inconsistent evidence with regards to the effectiveness of these interventions, though most studies have indicated positive results upon use as an adjunct to conventional

pharmacological treatment.



Another important dimension of non-pharmacological pain management is patient education and empowerment. Providing patients with information about expected post-operative pain, available management strategies, and safe use of analgesics improves adherence to treatment plans and fosters active participation in recovery. Educated patients are more likely to communicate their pain effectively, engage in self-management techniques, and achieve better overall outcomes. Non-pharmacological strategies highlight the importance of a holistic and multidisciplinary approach to pain management. When integrated with pharmacological methods as part of multimodal analgesia or Enhanced Recovery After Surgery (ERAS) protocols, they contribute significantly to improved patient outcomes, reduced opioid consumption, and enhanced quality of care. By addressing the psychological, physical, and social dimensions of post-operative pain, these approaches ensure a more comprehensive and patient-centered management framework.

METHODOLOGY

This study employed a qualitative research design based on a comprehensive literature review to examine pain management strategies in post-operative patients. Inclusion criteria focused on peer-reviewed articles, clinical trials, systematic reviews, and practice guidelines that addressed pain management in adult post-operative patients. Studies that focused exclusively on pediatric populations, chronic pain conditions, or non-surgical pain were excluded to maintain the relevance and specificity of the review. The selected literature was critically appraised for methodological quality, clinical significance, and applicability to contemporary surgical practice. Data were extracted to identify the types of pain management strategies discussed, their reported effectiveness, limitations, and associated outcomes such as patient satisfaction, recovery time, opioid consumption, and complication rates. The findings were then organized into thematic categories, including pharmacological interventions, non-pharmacological approaches, and multimodal pain management within ERAS protocols. A narrative synthesis was applied to compare and contrast the outcomes of different strategies, highlight common patterns, and identify research gaps.

RESULTS AND DISCUSSION

The literature review showed that the management of pain in post-operative patients should be multidimensional combining the pharmacological and the non-pharmacological management strategies. The consistent findings have shown that no quality stands alone, and that multimodal and patient-centered model offers better results in terms of analgesia, recovery and patient satisfaction. Pharmacological pills form the foundation of acute post-surgery pain management and opioids will still be an important part of severe pain management (Hwang, 2025). Nevertheless, the evidence showed also serious disadvantages, such as unpleasant side effects and the chance of addiction. The advantages of using non-opioid analgesics combined with opioids were repeatedly stressed as an effective way of reaching effective analgesia with minimal opioid dosages. The analgesic spectrum especially in neuropathic pain/component patients was further improved by the presence of the adjuvant agents like gabapentinoids, ketamine, along with alpha-2 agonists. The regional anesthesia methods, such as the nerve blocks or epidurals, turned out to be quite effective in terms of tight and prolonged pain relief, but their implementation entails the professional competence and proper supervision (Alorfi, 2023).

Simultaneously, non-drug approaches were proved to be of high importance in enhancing outcomes based on pain. Physiotherapies including early mobilization and cryotherapy relieved pain, as well as fastened healing processes. There is a proven tendency to seek psychological interventions which in their turn are especially effective in the reduction of anxiety-related pain perception: cognitive-behavioral therapy and relaxation techniques. Evidence indicates complementary therapies, including acupuncture, massage, and music therapy may present informative outcomes when provided together with pharmacological treatment, although their evidence base is less likely to be solid (Kia et al. 2023). Education and empowerment of patients was cited as a crucial element consistently with informed patients experiencing better-controlled pain, better coping mechanisms, and

satisfaction with their care. One of the queries that remained common throughout the studies was the efficacy of multimodal analgesia and the incorporation of the same into ERAS regimens. The evidence suggested that multimodal strategies led to better pain relief as well as led to reduced hospital stays, earlier mobility and fewer complications. The multidisciplinary and holistic ethos of RAS pathways strengthened the focus on individualized care and collaborative practice across professions and with patients. Although non-pharmacological methods have several positive effects, some studies have cited impediments to utilization, including a lack of common guidelines, constraint of resources, and a shortage of training of personnel in the non-pharmacological solutions.

Table: Summary of Pharmacological Pain Management Strategies

Strategy	Examples	Key Benefits	Limitations/Concerns
Opioids	Morphine, Fentanyl, Oxycodone	Effective for moderate–severe pain; rapid onset	Respiratory depression, constipation, nausea, dependence risk
Non-Opioid Analgesics	NSAIDs (Ibuprofen, Ketorolac), Acetaminophen	Reduce inflammation and pain; opioid-sparing	GI bleeding, renal impairment, hepatotoxicity (acetaminophen)
Adjuvants	Gabapentin, Pregabalin, Ketamine, Clonidine	Target neuropathic pain, reduce opioid need	Sedation, dizziness, limited use in some patients
Regional Anesthesia	Epidural, Spinal block, Nerve block	Site-specific relief, reduces systemic drug use	Requires expertise, potential motor block, risk of hypotension
Patient-Controlled Analgesia (PCA)	IV or epidural opioids	Patient autonomy, reduced delays in analgesia	Risk of overdose, requires monitoring, device complications

The discussion of results underscores the importance of shifting from an opioid-centric model toward a balanced, evidence-based, and multidisciplinary strategy. While pharmacological interventions remain essential, they should be complemented with psychological support, physical rehabilitation, and patient education. The literature further suggests that widespread adoption of multimodal analgesia and ERAS protocols has the potential to significantly improve post-operative outcomes. However, addressing systemic barriers and ensuring consistent implementation across healthcare settings remain key challenges for future practice and research.

CONCLUSION

One of the most active aspects of surgical care is effective pain management, which is connected with post-operative patients leading to their direct impact on recovery-related factors, patient satisfaction, and further outcomes. As exhibited in the literature, although the pharmacological interventions are essential, especially, opioids, non-opioid analgesics, and regional anesthesia, use of opioids singlehandedly is no longer viable because of their side effects and the risk of developing dependency. The combination of the non-pharmacological methods including physiotherapy, cognitive-behavioral therapy, relaxation interventions, complementary therapies offer more advantages to the patients since it covers the psychological and physical aspects of the pain. In the evidence, there is a special emphasis on multimodal analgesia and Enhanced Recovery After Surgery (ERAS) protocols as the most effective approaches that encompass a combination of pharmacological and non-pharmacological strategies in a patient-centered approach. All of these strategies cut opioid demands, expedite cures and minimise complications. Difficulties with poor application, undermeasurement and training remain a barrier to the best practice. Overcoming these obstacles by creating universal guidelines, interdisciplinary cooperation, and better patient education will play a significant role in further post-operative pain management. Pain management pre- and post-operative is an individual and evidence-based procedure that involves a balance between the goods. In the future, the emphasis should be made on developing multimodal and ERAS-based treatment and guaranteeing accessibility and fairness in care delivery. By closing current gaps, it is possible to provide an improved quality of healthcare delivery and subsequent surgical results.

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