Review Article

DOI: https://doi.org/10.64573/torgj2602001

The Operating Room Global Journal (TORGJ)

https://torgjournal.org/

ISSN: 3105-3262

Pain Management Strategies in Cancer Surgery: Anaesthetic and Technological Innovations

Shaistha Banu[1,3]*, Jocelin Harriate D. Almeida[2]

[1] Department of Anaesthesia and Operation Theatre Technology, KIMS College of Allied Health Sciences, Bengaluru, Karnataka, India.
[2]Acharya Institute of Allied Health Sciences, Bengaluru, Karnataka, India.
[3]The Operating Room Global (TORG).

***Corresponding Author:**
Shaistha Banu
shaistharafeeq@gmail.com

Declaration:
Authors' Contribution: Equal contributions
Conflict of Interest: No conflict of interest.
Funding: No funding received by the authors.

Article History:
Received: 05-02-2026
Accepted: 18-02-2026
Available Online: 20-02-2026

QR access this Article

ABSTRACT

Background: Pain is one of the most common and distressing symptoms experienced by patients following cancer surgery, significantly affecting recovery, functional outcomes, and quality of life. Although surgical techniques have advanced, many patients continue to experience moderate to severe postoperative pain. Growing concerns regarding opioid-related side effects and long-term dependence have driven the development of multimodal and opioid-sparing pain management strategies.

Objective: This review summarizes the epidemiology, causes, and management of pain in cancer surgery patients, with emphasis on anaesthetic and technological advancements, interdisciplinary collaborations, and future directions focusing on perioperative pain outcomes.

Methodology: This study was conducted as a structured narrative review of literature published between 2000 and 2025, focusing on anaesthetic and technological innovations in perioperative pain management for cancer surgery. Following a comprehensive database search (PubMed, Scopus, and Google Scholar), 27 articles were selected through independent screening and consensus-based inclusion according to predefined eligibility criteria.

Conclusion: Current evidence supports multimodal opioid-sparing strategies for improved recovery; however, no anaesthetic technique has demonstrated a consistent long-term oncological benefit.

Keywords: *Cancer Surgery; Perioperative Pain Management; Anaesthetic Innovations; Multimodal Analgesia; Regional Anaesthesia; Opioid-Sparing; ERAS; Multidisciplinary Care*

INTRODUCTION

Pain is a prevalent and distressing symptom for cancer patients, particularly in the perioperative context. The burden of pain in surgical oncology is multifaceted: it not only causes immediate suffering but can also delay recovery, prolong hospitalization, induce psychological distress, and contribute to the transition to chronic pain syndromes (1,2). Traditionally, systemic opioids have been the mainstay of pain management; however, this approach is increasingly challenged by concerns regarding opioid-related adverse events, opioid-induced hyperalgesia, and the potential for immunosuppression, which may even influence cancer recurrence (3).

The landscape of perioperative pain management in cancer surgery is evolving, driven by advances in pharmacology, regional anaesthesia, and technological innovation. The introduction of multimodal analgesia, opioid-sparing protocols, and minimally invasive anaesthetic techniques has contributed to advances in perioperative care. The adoption of technologies such as ultrasound-guided nerve blocks, patient-controlled analgesia (PCA), wearable pain monitoring devices, and digital health platforms is enabling more precise, individualized, and safe pain control(2,4,5). Enhanced recovery after surgery (ERAS) protocols, underpinned by multidisciplinary collaboration, are now central to perioperative care in cancer patients, improving outcomes and patient satisfaction(6).

This review explores the epidemiology, pathophysiology, and principles of pain management in cancer surgery. It provides a comprehensive review of anaesthetic and technological innovations, highlights the importance of multidisciplinary and patient centered approaches, and discusses ongoing challenges and future directions.

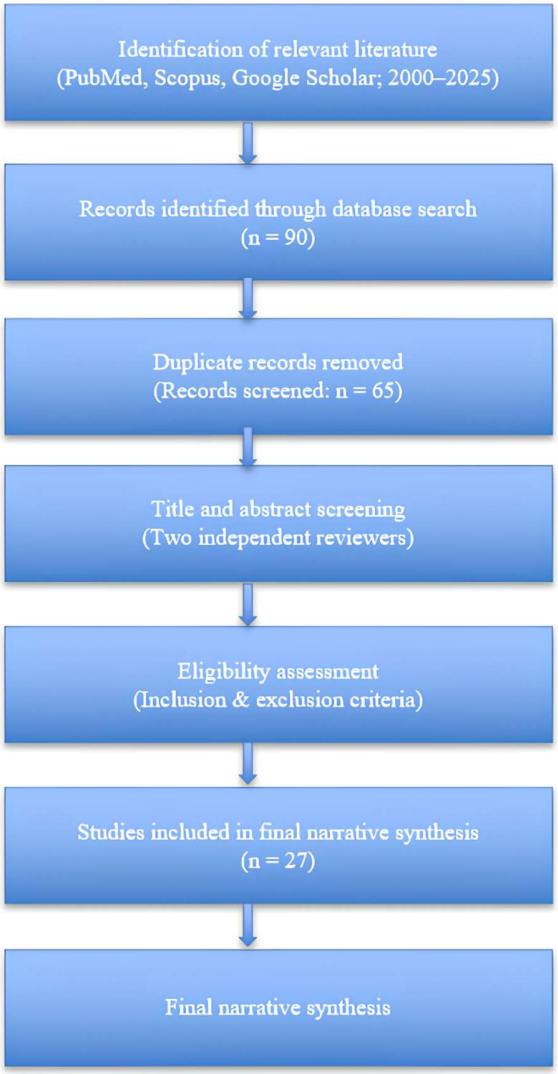
METHODOLOGY OF THE REVIEW

This study was conducted as a structured narrative review of current literature on pain management strategies in cancer surgery, focusing on anaesthetic and technological innovations. A comprehensive literature search was performed using electronic databases including PubMed, Scopus, and Google Scholar. The articles published between 2000 and 2025 were considered.

The search terms used were “cancer surgery,” “perioperative pain management,” “anaesthetic innovations,” “multimodal analgesia,” “regional anaesthesia”, “opioid-sparing,” “ERAS,” and “multidisciplinary care.”
The two reviewers independently screened titles and abstracts form the initial 90 identified articles. Disagreements regarding inclusion were resolved by consensus. After removing 25 duplicates, articles screened for relevance to surgical oncology pain management, 65 articles were filtered for full text review. Finally, 27 articles were selected for final review based on scientific merit and clinical applicability.

Inclusion criteria included peer reviewed original research articles, systematic reviews, meta-analyses and clinical guidelines involving adult patients undergoing cancer surgery, published in the English language. Exclusion criteria included conference abstracts and studies involving nonsurgical cancer pain and noncancer surgical pain.
This study was conducted as a structured narrative review without formal risk of bias scoring because the aim was conceptual synthesis rather than quantitative comparison.
The article selection process is illustrated in Figure 1.

Figure 1:



Epidemiology and Burden of Pain in Cancer Surgery

The reported incidence of Chronic Postsurgical Pain (CPSP) ranges widely among the studies and the variability, reflecting heterogeneity in cancer type, surgical approach, perioperative analgesic techniques, and duration of follow up. (6, 7).

Table 1. Prevalence of Moderate-to-Severe Acute Postoperative Pain across Common Cancer Surgeries (7–10)

Surgery Type	Moderate-Severe Pain (%)
Breast (mastectomy)	40–60
Thoracic (lung)	50–70
Abdominal (colorectal)	35–55

Surgery Type	Moderate-Severe Pain (%)
Head and Neck	45–65
Pelvic (prostate, bladder)	30–50

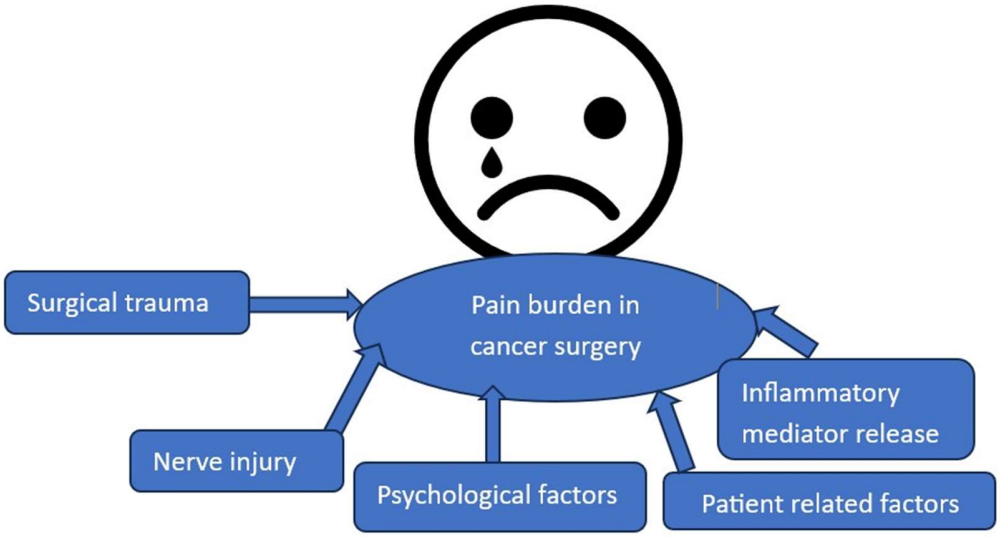
Chronic pain develops in 10–50% of cancer surgery patients, depending on the extent of surgery, nerve involvement, and perioperative management (11).

Uncontrolled pain is associated with:

- Delayed mobilization and rehabilitation
- Increased risk of complications (e.g., pneumonia, deep vein thrombosis)
- Prolonged hospitalization and higher healthcare costs
- Psychological sequelae (anxiety, depression, catastrophizing)
- Transition to chronic pain syndromes
- Reduced quality of life and patient satisfaction

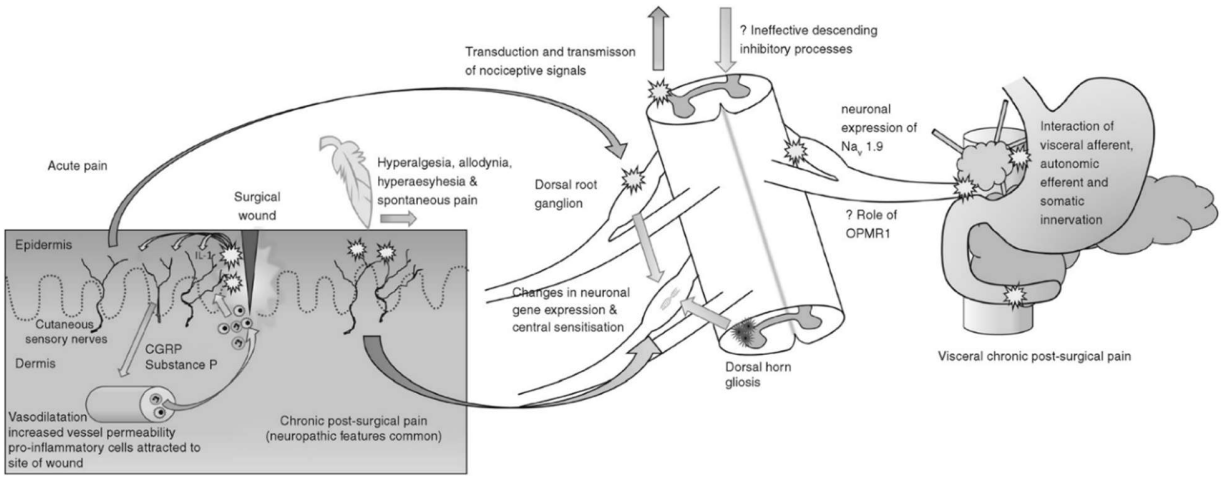
Pain is often undertreated in certain populations, including the elderly, minorities, and those in resource-limited settings. Barriers include limited access to pain specialists, cultural attitudes, and disparities in resource allocation (7).

Figure 2. Factors Contributing to Pain Burden in Cancer Surgery



Original figure created by the authors

Figure 3. An overview of the pain syndromes (acute and chronic) occurring after cancer surgery, with potential mechanisms. (12)



Adapted from Brown and Farquhar-Smith et al., 2017

Pathophysiology of Cancer Pain

Cancer pain is complex, involving multiple mechanisms:

- Nociceptive pain: Results from tissue injury, surgical trauma, or tumour infiltration.
- Neuropathic pain: Arises from nerve damage due to surgical resection, tumour growth, or radiotherapy.
- Inflammatory pain: Mediated by cytokines, prostaglandins, and other inflammatory mediators released during tissue injury (13).
- Mixed pain: Common in cancer patients, involving both nociceptive and neuropathic elements.

Surgical trauma can cause:

- Release of inflammatory mediators
- Direct nerve injury or traction
- Central sensitization (increased responsiveness of spinal and supraspinal neurons)
- Risk of chronic pain syndromes, particularly with inadequate acute pain management (14)
- Table 2. Risk Factors for Severe Postoperative Pain and Chronic Postsurgical Pain

Risk Factor	Rationale
Pre-existing pain	Sensitization, opioid tolerance
High-intensity surgery	Greater tissue/nerve injury
Psychological distress	Increased pain perception, catastrophizing
Younger age	Higher risk of chronic pain
Genetic predisposition	Variability in pain sensitivity and opioid metabolism
History of substance use	Increased analgesic requirements

PRINCIPLES OF PAIN MANAGEMENT IN CANCER SURGERY

Preemptive Analgesia

Preemptive analgesia involves administering analgesics before the onset of noxious stimuli (i.e., before surgical incision) to prevent central sensitization and reduce postoperative pain. Techniques include preoperative regional blocks, NSAIDs, or gabapentinoids (13).

Multimodal Analgesia

Multimodal analgesia is the concurrent use of different classes of analgesics and techniques to maximize pain relief while minimizing side effects. It is now the standard of care in cancer surgery (2, 15).

Table 3. Components of a Typical Multimodal Analgesia Used in Cancer Surgery

Agent/Class	Example Drugs	Mechanism	Benefits
NSAIDs/COX-2 inhibitors	Ibuprofen, celecoxib	Inhibit prostaglandin synthesis.	Reduce inflammation, opioid-sparing
Acetaminophen	Paracetamol	Central action	Few side effects
Gabapentinoids	Gabapentin, pregabalin	Inhibit calcium channels.	Neuropathic pain
NMDA antagonists	Ketamine	Block central sensitization.	Opioid-sparing, chronic pain prevention
Local anaesthetics	Lidocaine, bupivacaine	Nerve blockade	Regional/local analgesia
Alpha-2 agonists	Clonidine, dexmedetomidine	Inhibit sympathetic outflow.	Prolong block duration.
Glucocorticoids	Dexamethasone	Anti-inflammatory	Reduce swelling, pain

NSAIDS: NON-STEROIDAL ANTI-INFLAMMATORY DRUGS

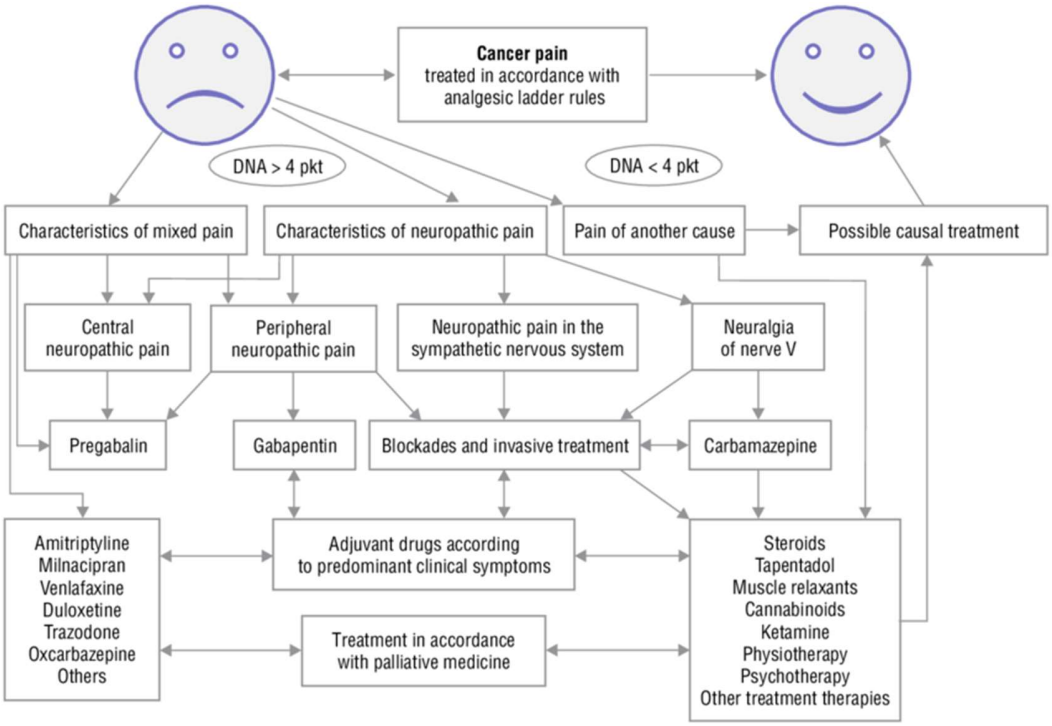
NMDA: N-Methyl-D Aspartate

Individualized, Patient-Centered Care

Pain management must be tailored according to:

- Patient comorbidities (renal/hepatic impairment, cardiovascular risk)
- Cancer type and surgical complexity
- Patient preferences, psychosocial status, and prior analgesic exposure
- Risk of opioid misuse

Figure 4. Algorithm for the diagnosis and treatment of neuropathic pain in cancer patients (16)



Adapted from Jakubow et al., 2020

ANAESTHETIC INNOVATIONS

As mentioned earlier, multimodal analgesia is a foundation of modern cancer therapy, which is reinforced by developments in regional anaesthetic techniques. It reduces opioid consumption and opioid-related adverse effects, improves pain scores, and decreases the incidence of chronic postsurgical pain. (17)
Clinical trials have demonstrated that combinations such as NSAIDs + acetaminophen + regional anaesthesia provide superior outcomes compared to opioids alone (17).

Regional Anaesthetic Techniques
Regional anaesthesia has changed the focus of pain management in cancer surgeries by reducing the systemic effects.
Common Techniques:

- Epidural analgesia: Especially beneficial for thoracic, upper abdominal, and pelvic surgeries; provides superior pain relief and reduces pulmonary complications (15).
- Paravertebral block: Used in breast and thoracic surgery; fewer side effects than epidural (8).
- Peripheral nerve blocks: For extremity and some pelvic procedures; now more accurate and safer with ultrasound guidance (16).
- Continuous catheter techniques: Allow prolonged analgesia, supporting early mobilization.

Opioid-Sparing Approaches
Opioid-sparing protocols are increasingly adopted to mitigate risks of opioid-induced hyperalgesia, immunosuppression, and potential for addiction .

Strategies:
The use of multimodal and opioid-sparing techniques in onco anaesthesia proved safe, practical, and successful, resulting in improved pain relief, hemodynamic stability, and quick postoperative recovery compared to opioid based anaesthesia.(17)

Recent meta-analyses suggest that opioid-sparing approaches improve recovery and reduce opioid-related complications in cancer surgery (18).

TECHNOLOGICAL ADVANCES IN PAIN MANAGEMENT

Ultrasound-Guided Nerve Blocks
Ultrasound guidance has become the gold standard for nerve blocks, enhancing efficacy and safety.

Advantages:
- Real-time visualization of nerves, vessels, and spread of local anaesthetic
- Increased success rates and duration of blocks
- Reduced risk of vascular puncture or nerve injury (19)

Neuromonitoring
Intraoperative neuromonitoring (IONM) is critical in surgeries with a high risk of nerve injury (head/neck, pelvic, spine), helping to preserve nerve function and reduce the risk of neuropathic pain (10, 23).

Techniques:
- Somatosensory evoked potentials (SSEPs)
- Motor evoked potentials (MEPs)
- Electromyography (EMG)

Digital and Remote Pain Assessment
Wearable devices and digital platforms are emerging as tools for perioperative pain assessment:
- Wearable sensors: Monitor pain-related physiological parameters (heart rate variability, activity).(20)
- Mobile apps: Enable patient-reported outcomes (ePROs), medication reminders, and remote monitoring (16)
- Telemedicine: Supports virtual follow-up and titration of analgesia, especially valuable in ERAS pathways.(21)

Patient-Controlled Analgesia (PCA)
PCA empowers patients to self-administer analgesics within prescribed safety parameters.
Benefits:
- Improved pain control and patient autonomy
- Lower total opioid consumption
- Reduced nursing workload

Innovations include smart PCA pumps with wireless connectivity, integrated monitoring, and data analytics (5).

ENHANCED RECOVERY AFTER SURGERY (ERAS) PROTOCOL FOR A TYPICAL CANCER SURGERY

Enhanced Recovery After Surgery (ERAS) protocols in cancer surgery emphasize a multimodal, evidence-based approach across the preoperative, intraoperative, and postoperative phases of care. Preoperatively, patient optimization includes nutritional assessment, minimization of fasting, carbohydrate loading, and comprehensive patient education. Intraoperative strategies focus on minimally invasive surgical techniques, goal-directed fluid therapy, multimodal opioid-sparing analgesia, maintenance of normothermia, and attenuation of the surgical stress response. Postoperatively, ERAS

pathways prioritize early mobilization, early enteral nutrition, effective pain control using regional and non-opioid analgesic techniques, prevention of nausea and vomiting, and early removal of drains and catheters. Collectively, these coordinated interventions aim to reduce postoperative complications, enhance functional recovery, shorten hospital stay, and improve overall patient outcomes in oncologic surgery. (22–25)

Critical Analysis

Strategy	Benefit	Strength	Gaps
Multimodal analgesia	Improved pain relief with reduced opioid consumption	Supported by several RCTs and meta-analyses	Data for long-term outcomes are limited.
Epidural analgesia	Less pulmonary complication with pain relief in thoracic and abdominal surgeries	Supported by several RCTs	Data for Long term oncological outcomes are limited.
Paravertebral block	Good pain relief with lesser systemic effect	Evidence in breast and thoracic surgeries	Further study is required for cancer surgeries.
Ultrasound guided peripheral nerve block	Impeccable procedure, early mobilization	Increased safety and accuracy	Data for Long term oncological outcomes are limited.
Patient controlled analgesia	Reliable pain management with increased patient independency	Well established technology	The role of non-opioid PCA systems should be explored.
Digital tools	Real time pain tracking	Promising early results	Clinical integration is not yet established.
ERAS Protocol	Improved recovery due to reduced hospital stays	Strong evidence from systematic reviews	Adaptation is difficult in places with fewer resources.

While advancements in anaesthetic techniques have markedly improved perioperative pain control, a critical synthesis of the evidence reveals a significant gap between short term clinical success and long-term oncologic certainty. A primary area of debate is the theoretical impact of regional anaesthesia on cancer recurrence; it is hypothesized that by attenuating the surgical stress response and preserving Natural Killer (NK) cell activity, these techniques may limit the perioperative immunosuppression that facilitates micrometastatic seeding. However, clinical evidence remains inconsistent due to significant heterogeneity in tumour types, follow up durations, and retrospective study designs, leading to a current consensus that no anaesthetic technique has yet demonstrated a definitive or consistent long-term oncologic benefit.

When comparing analgesic strategies, the literature indicates that while epidural analgesia remains the gold standard for major abdominal and thoracic surgeries, paravertebral blocks are increasingly favored for breast and thoracic procedures because they provide comparable analgesia with fewer systemic side effects, such as hypotension. Furthermore, while Patient-Controlled Analgesia (PCA) improves patient autonomy, it often relies on systemic opioids; in contrast, ultrasound guided peripheral nerve blocks offer site specific relief that facilitates earlier mobilization and reduces opioid-related complications.

The frequently cited limitation of insufficient long-term data is not merely a lack of research, but a result of methodological challenges, including the difficulty of isolating anaesthesia as a single variable within complex multidisciplinary cancer treatments and a lack of standardized outcome measures across trials. Finally, the routine implementation of these innovations remains restricted by systemic and practical barriers, particularly in Low- and Middle-Income Countries (LMICs), where the high cost of technology, limited availability of resources, and a lack of trained experts create significant disparities in the standard of care.

Multidisciplinary Approaches

Effective pain management in cancer surgeries requires teamwork across disciplines:

- Anaesthesiologists: Lead perioperative pain management, regional anaesthesia
- Surgeons: Minimize tissue trauma, collaborate on ERAS pathways
- Pain specialists: Manage complex and chronic pain cases
- Nurses: Assess pain, administer medication, and provide patient education.
- Physiotherapists: Promote early mobilization and functional recovery
- Psychologists: Address anxiety, depression, and pain catastrophizing.

Table 6. Roles of Multidisciplinary Team Members in Cancer Pain Management

Team Member	Key Contributions
Anaesthesiologist	Acute pain control, regional anaesthesia
Surgeon	Surgical planning, minimizing trauma
Pain specialist	Chronic/complex pain, opioid stewardship
Nurse	Assessment, medication administration
Physiotherapist	Rehabilitation, early mobilization
Psychologist	Psychological support, coping strategies

Regular multidisciplinary rounds, individualized care planning, and patient engagement are essential for optimal outcomes (22).

CHALLENGES AND FUTURE DIRECTIONS

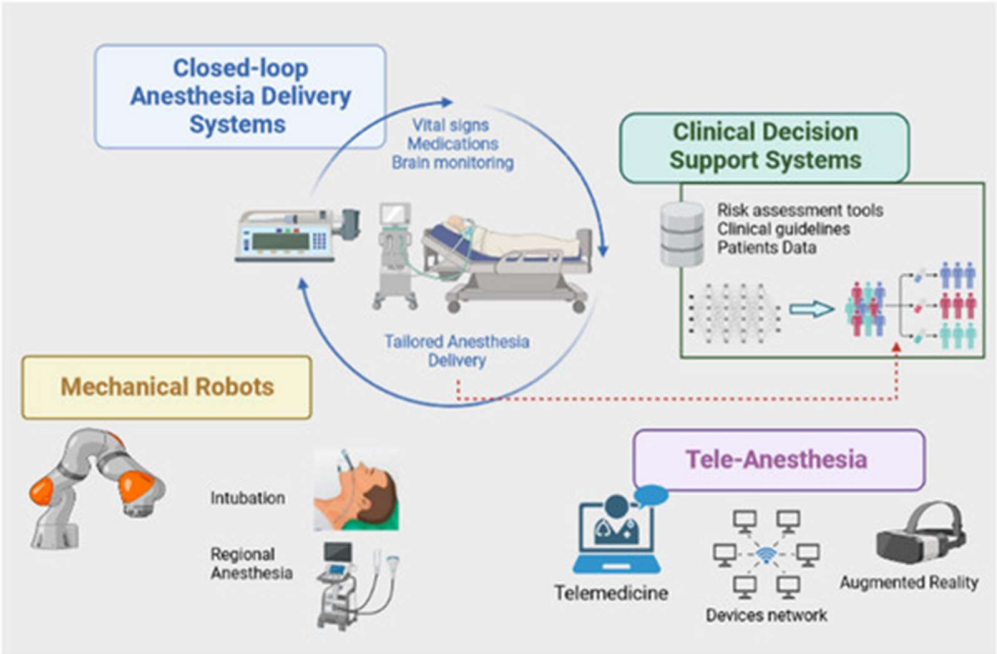
Current Challenges

- Resource limitations: Advanced regional and digital technologies may not be universally accessible.
- Variability in practice: Differences in pain management protocols and guideline implementation.
- Opioid stewardship: Balancing effective analgesia with avoidance of misuse or diversion.
- Equity and access: Addressing disparities in pain care for vulnerable populations.

Future Directions

- Artificial intelligence (AI): Predictive analytics for pain risk, personalized analgesic plans.
- Telemedicine expansion: Broader use in perioperative pain assessment and intervention.
- Novel analgesics and delivery systems: Development of long-acting local anaesthetics and, non-opioid agents.
- Patient engagement: Enhanced use of ePROs, shared decision-making, and education. (26)

Figure 6. Future Trends in Perioperative Pain Management (27)



Adapted from Cascella et al., 2023

AUTHOR CONTRIBUTIONS

Shaistha Banu: Conceptualization, literature search, writing draft, review, and editing
Jocelin Harriate D Almeida: Literature search, critical review, review, and editing

CONCLUSION

A paradigm shift in pain management after the cancer surgery has resulted from the advancements in technology, pharmacology, and anaesthetic techniques. Better results are seen when multimodal, opioid-sparing, and individualized approaches are added with multidisciplinary ERAS protocols. Future developments appear promising due to the continuous development of artificial intelligence, digital health, and minimally invasive anaesthetic techniques. Future progress will depend on high quality, cancer specific research, workforce training, and equitable access to advanced pain management strategies. Since the review was narrative in nature

ETHICAL CONSIDERATIONS

No animal subjects or human participants are involved in this review. Therefore, ethical approval or informed consent was not required.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

FUNDING STATEMENT

All authors have declared that no financial support was received from any organization for the submitted work.

REFERENCES

1. Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: risk factors and prevention. Lancet Lond Engl. 2006 May 13;367(9522):1618–25.
2. Mestdagh F, Steyaert A, Lavand'homme P. Cancer Pain Management: A Narrative Review of Current Concepts, Strategies, and Techniques. Curr Oncol. 2023 Jul;30(7):6838–58.
3. Brogi E, Forfori F. Anesthesia and cancer recurrence: an overview. J Anesth Analg Crit Care. 2022 Jul 20;2(1):33.
4. Yeh CY, Chang WK, Wu HL, Chau GY, Tai YH, Chang KY. Associations of Multimodal Analgesia With Postoperative Pain Trajectories and Morphine Consumption After Hepatic Cancer Surgery. Front Med [Internet]. 2022 Jan 28 [cited 2025 Jun 15];8. Available from: https://www.frontiersin.org/journals/medicine/articles/10.3389/fmed.2021.777369/full
5. Grass JA. Patient-controlled analgesia. Anesth Analg. 2005 Nov;101(5 Suppl):S44–61.
6. Ramirez M, Strang A, Roland G, Lasala J, Owusu-Agyemang P. Perioperative Pain Management and Cancer Outcomes: A Narrative Review. J Pain Res. 2023 Dec;Volume 16:4181–9.
7. Nguyen LH, Dawson JE, Brooks M, Khan JS, Telusca N. Disparities in Pain Management. Anesthesiol Clin. 2023 Jun;41(2):471–88.
8. Villa G, Mandarano R, Scirè-Calabrisotto C, Rizzelli V, Del Duca M, Montin DP, et al. Chronic pain after breast surgery: incidence, associated factors, and impact on quality of life, an observational prospective study. Perioper Med. 2021 Feb 24;10:6.
9. Li S, Zhou K, Che G, Yang M, Su J, Shen C, et al. Enhanced recovery programs in lung cancer surgery: systematic review and meta-analysis of randomized controlled trials. Cancer Manag Res. 2017 Nov 16;9:657–70.
10. Leblanc F, Delaney CP, Neary PC, Rose J, Augestad KM, Senagore AJ, et al. Assessment of Comparative Skills Between Hand-Assisted and Straight Laparoscopic Colorectal Training on an Augmented Reality Simulator. Dis Colon Rectum. 2010 Sep;53(9):1323–7.
11. Macrae WA. Chronic pain after surgery. Br J Anaesth. 2001 Jul;87(1):88–98.
12. Brown M, Farquhar-Smith P. Pain in cancer survivors; filling in the gaps. Br J Anaesth. 2017 Oct 1;119(4):723–36.
13. Haroun R, Wood JN, Sikandar S. Mechanisms of cancer pain. Front Pain Res. 2023 Jan 4;3:1030899.
14. Holthusen H, Backhaus P, Boeminghaus F, Breulmann M, Lipfert P. Preemptive analgesia: no relevant advantage of preoperative compared with postoperative intravenous administration of morphine, ketamine, and clonidine in patients undergoing transperitoneal tumor nephrectomy. Reg Anesth Pain Med. 2002;27(3):249–53.
15. Zhang N, Wang T, Wei P, Zhou J, Li J. Ultrasound-Guided Regional Anesthesia Under Sedation for Radical Mastectomy in an SAS Patient: A Case Report. Front Oncol. 2021 Jun 30;11:631003.
16. Onoda N, Noda S, Tauchi Y, Asano Y, Kusunoki Y, Ishihara S, et al. Continuous intraoperative neuromonitoring for thyroid cancer surgery: A prospective study. Laryngoscope Investig Otolaryngol. 2019 Jul 18;4(4):455–9.
17. Ramesh DP, S DA, Govindasamy DJ. IMPLEMENTATION OF AN ONCO-ANESTHESIA PROTOCOL USING MULTIMODAL, OPIOID-SPARING TECHNIQUES FOR PATIENTS UNDERGOING MAJOR CANCER SURGERY. TPM – Test Psychom Methodol Appl Psychol. 2025 Dec 15;32(S9 (2025): Posted 15 December):2816–23.
18. Ghai B, Jafra A, Bhatia N, Chanana N, Bansal D, Mehta V. Opioid-sparing strategies for perioperative pain management other than regional anaesthesia: A narrative review. J Anaesthesiol Clin Pharmacol. 2022;38(1):3–10.
19. Kettyle G. Multidisciplinary Approach to Cancer Pain Management. Ulster Med J. 2023 Jan;92(1):55–8.
20. Avila FR, McLeod CJ, Huayllani MT, Boczar D, Giardi D, Bruce CJ, et al. Wearable electronic devices for chronic pain intensity assessment: A systematic review. Pain Pract Off J World Inst Pain. 2021 Nov;21(8):955–65.
21. Park HY, Nam KE, Lim JY, Yeo SM, Lee JI, Hwang JH. Real-Time Interactive Digital Health Care System for Postoperative Breast Cancer Patients: A Randomized Controlled Trial. Telemed J E-Health Off J Am Telemed Assoc. 2023 Jul;29(7):1057–67.
22. Bisch SP, Nelson G. Outcomes of Enhanced Recovery after Surgery (ERAS) in Gynecologic Oncology: A Review. Curr Oncol Tor Ont. 2022 Jan 28;29(2):631–40.
23. Ripollés-Melchor J, Abad-Motos A, Zorrilla-Vaca A. Enhanced Recovery After Surgery (ERAS) in Surgical Oncology. Curr Oncol Rep. 2022 Sep;24(9):1177–87.
24. Vaidya H, Rathod J, Parmar H, Vaidya A. The Role of Enhanced Recovery after Surgery (ERAS) Protocols in Reducing Postoperative Complications in Colorectal Surgery. Eur J Cardiovasc Med. 2025 Mar 27;15:737–40.

25. Jain SN, Lamture Y, Krishna M. Enhanced Recovery After Surgery: Exploring the Advances and Strategies. Cureus. 2023 Oct;15(10):e47237.
26. Yoon HK, Yang HL, Jung CW, Lee HC. Artificial intelligence in perioperative medicine: a narrative review. Korean J Anesthesiol. 2022 Jun;75(3):202–15.
27. Cascella M, Tracey MC, Petrucci E, Bignami EG. Exploring Artificial Intelligence in Anesthesia: A Primer on Ethics, and Clinical Applications. Surgeries. 2023 Jun;4(2):264–74.

FIGURE LEGENDS

Figure 1: Factors Contributing to Pain Burden in Cancer Surgery original figure created by authors
Surgical trauma, inflammatory mediator release, nerve injury, psychological stress, and patient related factors are the contributors to pain burden in patients undergoing cancer surgery.
Figure 2: An overview of the pain syndromes (acute and chronic) occurring after cancer surgery, with potential mechanisms- adapted from Brown and Farquhar-Smith et al., 2017
Description of post cancer surgery pain syndromes showing underlying mechanisms like central sensitization, neuropathic damage, nociceptive injury, and inflammatory processes
Figure 3: Algorithm for the diagnosis and treatment of neuropathic pain in cancer patients- adapted from Jakubow et al., 2020
An algorithm for diagnosis and management of neuropathic pain in cancer patients that focuses on early detection and multimodal pharmacological treatment.
Figure 4: ERAS Timeline for a Typical Cancer Surgery -adapted from Jain et al., 2023
For patients undergoing cancer surgery, ERAS protocol encourages perioperative multimodal analgesia, early movement, nutritional optimization, and pain evaluation.
Figure 5: Future Trends in Perioperative Pain Management- adapted from Cascella et al., 2023
Artificial intelligence, digital pain monitoring tools, and personalized analgesic approaches are the emerging technologies in controlling perioperative pain in patients undergoing cancer surgery.

CITE THIS MANUSCRIPT:

- **APA (7th edition):** Banu, S., & Almeida, J. H. D. (2026, February 20). *Pain management strategies in cancer surgery: Anaesthetic and technological innovations*. *The Operating Room Global Journal (TORGJ)*, 2(2). https://doi.org/10.64573/torgj2602001
- **Harvard**: Banu, S. and Almeida, J.H.D., 2026. *Pain management strategies in cancer surgery: Anaesthetic and technological innovations*. *The Operating Room Global Journal (TORGJ)*, 2(2). Published 20 February. Available at: https://doi.org/10.64573/torgj2602001
- **Vancouver**: Banu S, Almeida JHD. Pain management strategies in cancer surgery: Anaesthetic and technological innovations. *The Operating Room Global Journal (TORGJ).* 2026 Feb 20;2(2). https://doi.org/10.64573/torgj2602001
- **MLA (9th edition)**: Banu, Shaistha, and Jocelin Harriate D. Almeida. "Pain Management Strategies in Cancer Surgery: Anaesthetic and Technological Innovations." *The Operating Room Global Journal (TORGJ)*, vol. 2, no. 2, 20 Feb. 2026, https://doi.org/10.64573/torgj2602001
- **Chicago (Author-Date)**: Banu, Shaistha, and Jocelin Harriate D. Almeida. 2026. "Pain Management Strategies in Cancer Surgery: Anaesthetic and Technological Innovations." *The Operating Room Global Journal (TORGJ)* 2 (2), February 20. https://doi.org/10.64573/torgj2602001