E-ISSN 2250-0944

ISSN 2250-1150
doi: 10.48047/ijprt/14.02.23

**Research Article**

# Opioid-Free General Anesthesia: Advancing Safer and More Sustainable Anesthetic Practices

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***Received Date: 21 April 2024*** ***Revised Date: 18 May 2024*** ***Accepted Date: 08 June 2024***

## Abstract

**Background:** Opioid-based anesthesia has been fundamental in perioperative pain management but is associated with significant adverse effects and contributes to the opioid epidemic and environmental pollution. Opioid-free anesthesia (OFA) has emerged as an innovative, multimodal approach aimed at providing effective pain relief while mitigating these issues. **Objective:** To evaluate the effectiveness, safety, and sustainability of opioid-free general anesthesia as an alternative to opioid-based anesthesia in enhancing perioperative care. **Methods:** A systematic review of current literature was conducted, analyzing clinical trials, meta-analyses, and observational studies from key medical databases. Outcomes assessed included analgesic efficacy, opioid-related side effects, recovery parameters, environmental impact, and public health implications. **Results:** OFA demonstrated comparable or superior analgesic efficacy with significant reductions in opioid consumption and opioid-related adverse effects such as postoperative nausea, respiratory depression, and hyperalgesia. Patients receiving OFA experienced faster recovery, shortened hospital stays, and higher satisfaction. OFA also contributed to decreased pharmaceutical waste and reduced carbon footprint, supporting sustainable healthcare. Importantly, OFA reduced perioperative opioid exposure, addressing critical public health concerns related to opioid misuse and dependence. **Conclusion:** OFA is a safe, effective, and environmentally sustainable anesthetic approach that improves perioperative outcomes, enhances patient safety, and aligns with public health goals, representing a progressive shift in anesthesia practice.

**Keywords:** Opioid-Free Anesthesia. Multimodal Analgesia. Sustainable Perioperative Care.

## Introduction

Opioid-free anesthesia (OFA) represents a paradigm shift in perioperative care, aiming to maintain effective analgesia while eliminating the reliance on opioids that have traditionally been cornerstone agents in general anesthesia. The evolution of anesthetic practice over centuries has moved from rudimentary pain control methods such as medicinal sponges and herbal concoctions to the sophisticated use of inhalational agents and intravenous medications. Within this context, opioids emerged as highly potent analgesics with rapid onset and effectiveness, becoming integral to managing surgical pain. However, their use is accompanied by a spectrum of well-documented adverse effects including respiratory depression, postoperative nausea and vomiting (PONV),

ileus, sedation, pruritus, opioid-induced hyperalgesia, and a risk of tolerance and dependence. The growing opioid crisis worldwide has highlighted the urgent need to revisit opioid utilization protocols in anesthesia to mitigate these risks.[1]

The negative sequelae of opioids used perioperatively extend beyond immediate postoperative complications. The prolonged use or misuse of opioids can lead to chronic opioid dependence, substance abuse disorders, and contribute to the broader societal burden of opioid addiction. Recognizing this, anesthesiology has increasingly embraced multimodal analgesic approaches, combining different classes of non-opioid agents and regional anesthesia techniques to achieve effective pain control without the opioid-related side effects. OFA approaches integrate local anesthetics, NMDA receptor antagonists such as ketamine, alpha-2 adrenergic agonists including dexmedetomidine, magnesium sulfate, and NSAIDs, among other agents, to reduce or completely eliminate opioids during the perioperative period.[2]

Clinical evidence accumulated over recent years from diverse surgical specialties including bariatric, thoracic, gynecological, and breast surgeries demonstrates that OFA protocols confer equivalent or superior analgesic efficacy compared to traditional opioid-based regimens. Moreover, OFA has been associated with accelerated postoperative recovery, decreased intensity and duration of pain, reduced opioid rescue requirements, and fewer opioid-related side effects, thus enhancing patient safety and satisfaction. These benefits align well with Enhanced Recovery After Surgery (ERAS) protocols, which emphasize opioid minimization to improve perioperative outcomes.[3]

Beyond individual patient benefits, OFA addresses significant public health concerns by reducing perioperative opioid exposure and the subsequent risk of long-term opioid dependence. This is a crucial step towards combating the opioid epidemic, which has created a major health crisis through increased morbidity, mortality, and healthcare costs worldwide. Furthermore, the shift to opioid-sparing and opioid-free anesthesia contributes to environmental sustainability in healthcare by decreasing pharmaceutical waste, reducing the utilization of volatile anesthetics, and promoting energy-efficient clinical practices.[4]

## Aim

To evaluate the effectiveness, safety, and sustainability of opioid-free general anesthesia as an alternative to opioid-based methods in enhancing perioperative care.

## Objectives

- To assess the analgesic efficacy of opioid-free anesthesia protocols compared to conventional opioid-based anesthesia in various surgical procedures.
- To evaluate the reduction in opioid-related side effects and postoperative complications associated with opioid-free anesthesia.
- To analyze the environmental and public health benefits of implementing opioid-free anesthesia in perioperative management.

## Material and Methodology

**Source of Data:** The study utilized secondary data collected from a comprehensive review of current literature available in academic databases such as PubMed, Medline, Embase, Scopus, Google Scholar, and specialized journals in anesthesiology and pain management. Additional

sources included governmental health policy documents, environmental health reports, and official guidelines relevant to anesthesia practices.

**Study Design:** This research was conducted as a systematic literature review and secondary data analysis aimed at synthesizing evidence on the clinical outcomes, safety profiles, and environmental impacts of opioid-free anesthesia protocols.

**Study Location:** The data were derived from studies conducted worldwide, spanning multiple healthcare settings including tertiary care hospitals, surgical centers, and academic medical institutions noted in the referenced literature.

**Study Duration:** The review encompassed publications from the past decade, with particular emphasis on research published between 2015 and 2025 to capture the most recent advancements and evaluations in opioid-free anesthesia practices.

**Inclusion Criteria:**

- Original research articles, meta-analyses, systematic reviews, and clinical trials evaluating opioid-free anesthesia in adult surgical patients.
- Studies reporting on analgesic efficacy, safety outcomes, side effect profiles, and environmental impacts associated with OFA.
- Publications in English indexed in the selected biomedical databases.

**Exclusion Criteria:**

- Studies involving pediatric populations exclusively.
- Case reports or series with sample sizes less than 10.
- Articles without full-text availability or insufficient methodological detail.

**Procedure and Methodology:**

A systematic search strategy was developed using key terms such as “opioid-free anesthesia,” “multimodal analgesia,” “perioperative pain management,” and “sustainable anesthesia.” Articles were screened based on title and abstract for relevance, followed by full-text assessment to determine eligibility. Data extraction focused on study design, interventions, comparator groups, outcome measures including pain scores, opioid consumption, adverse effects, and recovery parameters. Additionally, environmental assessment data and policy implications related to anesthetic practices were collated.

**Sample Processing:** Although no primary samples were collected, data from selected studies were collated and organized. Comparative analyses were performed on reported outcomes to synthesize a comprehensive understanding of OFA efficacy and safety.

**Statistical Methods:** Descriptive statistics were used to summarize the characteristics of included studies. Where applicable, meta-analytic methods from original sources were referenced. Comparative outcomes were discussed in terms of statistical significance reported in primary studies (e.g., reductions in pain scores, opioid consumption, and adverse effect rates). The narrative synthesis approach was adopted for integrating diverse data types including qualitative assessments of environmental benefits.

**Data Collection:** Data extraction was performed independently by two researchers using a standardized form, with discrepancies resolved through consensus. Extracted data included patient demographics, surgical types, anesthesia protocols, analgesic outcomes, complications, hospital stay duration, and sustainability metrics. The data collection process ensured comprehensiveness and minimized bias by cross-checking data sources and appraising study quality.

**Observation and Results:**

**Table 1: Evaluation of Effectiveness, Safety, and Sustainability of Opioid-Free General Anesthesia (OFA) Compared to Opioid-Based Methods in Perioperative Care**

| Parameter | Opioid-Free Anesthesia (OFA) | Opioid-Based Anesthesia | Comments/Findings |
|---|---|---|---|
| Effectiveness | Comparable or superior multimodal analgesia | Traditional opioid analgesia | OFA provides effective pain control with reduced opioid use, facilitating better acute pain management |
| Safety | Reduced opioid-related side effects and complications | Higher incidence of PONV, respiratory depression, ileus | OFA lowers risks of sedation, nausea, respiratory issues, and opioid-induced hyperalgesia |
| Recovery | Faster mobilization, shorter hospital stay | Delayed recovery due to opioid side effects | Enhanced Recovery After Surgery (ERAS) protocols favor OFA for improved functional outcomes |
| Sustainability | Supports eco-friendly practices by reducing anesthetic waste | Higher carbon footprint from volatile and opioid agents | OFA promotes sustainable healthcare by minimizing pharmaceutical and volatile agent pollution |
| Patient Satisfaction | Higher due to less nausea, sedation, and pain | Moderate due to opioid side effects | Less opioid-related discomfort improves overall patient experience |

Table 1, Opioid-Free Anesthesia (OFA) has been evaluated against traditional opioid-based methods across various parameters, revealing substantial benefits. In terms of effectiveness, OFA offers comparable or even superior multimodal analgesia, delivering effective pain control with lower opioid consumption, which enhances acute pain management. Safety profiles favor OFA significantly, as it reduces the incidence of opioid-related side effects such as postoperative nausea and vomiting (PONV), respiratory depression, ileus, and hyperalgesia, thereby lowering associated complications. Concerning recovery, patients receiving OFA tend to experience faster mobilization and shorter hospital stays, with ERAS protocols further supporting improved functional outcomes; in contrast, opioid-based anesthesia often results in delayed recovery due to side effects. From a sustainability perspective, OFA advocates environmental-friendly practices by minimizing pharmaceutical waste and reducing volatile anesthetic emissions, whereas opioid-based approaches have a higher carbon footprint. Patient satisfaction is generally higher with OFA, owing to decreased nausea, sedation, and pain, leading to a more comfortable postoperative experience, whereas opioid-associated side effects moderate patient satisfaction with conventional methods.

**Table 2: Analgesic Efficacy of Opioid-Free Anesthesia Versus Conventional Opioid-Based Anesthesia in Surgical Procedures**

| Surgical Procedure | Analgesic Approach | Pain Control Outcome | Opioid Rescue Required |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Bariatric Surgery | OFA with multimodal analgesia | Significantly lower pain scores postoperatively | Significantly reduced |
| Thoracic Surgery | OFA with regional blocks + non-opioids | Comparable or superior analgesia versus opioids | Lower opioid rescue doses |
| Breast Surgery | OFA using alpha-2 agonists and ketamine | Pain relief equivalent or superior | Reduced requirement |
| Gynecological Surgery | OFA multimodal approach | Effective analgesia with early ambulation | Less opioid consumption |
| Laparoscopic Procedures | OFA plus local anesthetics | Adequate pain control with multimodal regimen | Minimal opioid rescue |

Table 2, When examining analgesic efficacy across different surgical procedures, OFA demonstrates significant advantages. In bariatric surgeries, OFA with multimodal analgesia results in notably lower postoperative pain scores and reduced opioid rescue doses. During thoracic surgeries, OFA combined with regional blocks yields analgesia comparable or superior to opioid-based techniques, with lower opioid rescue requirements. In breast and gynecological surgeries, OFA utilizing alpha-2 agonists and ketamine has shown to provide pain relief on par or better than traditional methods, with less opioid consumption. Similarly, in laparoscopic procedures, adding local anesthetics to OFA protocols ensures adequate pain control with minimal need for opioid rescue, underscoring its efficacy.

**Table 3: Reduction in Opioid-Related Side Effects and Postoperative Complications with Opioid-Free Anesthesia**

| **Side Effect/Complication** | **Incidence with OFA** | **Incidence with Opioid-Based Anesthesia** | **Clinical Impact** |
|---|---|---|---|
| Postoperative Nausea and Vomiting | Significantly reduced | High incidence in opioid group | Improved patient comfort and shorter stays |
| Ileus and Delayed Bowel Function | Accelerated bowel recovery | Prolonged ileus and delayed recovery | Faster nutritional intake and mobilization |
| Respiratory Depression | Minimal to none | Notable risk, potential need for respiratory support | Enhanced safety, reduced sedation |
| Sedation and Pruritus | Minimal in OFA | Common with opioids | Reduction in opioid-induced sedation |
| Opioid-Induced Hyperalgesia | Avoided | Present in patients with prolonged opioid use | Reduced chronic pain and persistent pain risk |

Table 3, OFA's impact on postoperative complications is profound. It significantly reduces nausea and vomiting, enhancing patient comfort and enabling shorter hospital stays. It also accelerates bowel recovery, decreasing ileus and promoting early nutritional intake. Safety profiles are improved further by minimizing respiratory depression and opioid-induced sedation or pruritus,

thereby reducing risks of respiratory support needs. Importantly, OFA effectively prevents opioid-induced hyperalgesia, decreasing the likelihood of persistent pain and chronic dependence.

**Table 4: Environmental and Public Health Benefits of Implementing Opioid-Free Anesthesia in Perioperative Management**

| Benefit Category | Description | Impact of OFA |
|---|---|---|
| Reduction in Opioid Use | Minimizes perioperative opioid exposure | Decreases risk of long-term opioid dependence |
| Mitigation of Opioid Epidemic | Limits new cases of opioid misuse and addiction | Supports public health efforts in opioid crisis |
| Safer Pain Management | Uses multimodal analgesia without opioids | Lowers side effect burden and respiratory risks |
| Environmental Sustainability | Reduces pharmaceutical waste and volatile anesthetic emissions | Decreases healthcare carbon footprint |
| Healthcare Resource Utilization | Shorter hospital stays and fewer complications | Optimizes healthcare costs and resource use |

Table 4, broader societal and environmental benefits of OFA are substantial. It significantly diminishes perioperative opioid exposure, thus lowering the risk of long-term dependence and opioid misuse. This aligns with public health efforts to curb the opioid epidemic by limiting new cases of misuse and addiction. OFA also supports environmental sustainability by reducing pharmaceutical waste and volatile anesthetic emissions, consequently decreasing the healthcare carbon footprint. Moreover, shorter hospital stays and fewer complications translate into better resource utilization, overall reducing healthcare costs and optimizing resource allocation.

**Discussion:**

The evaluation of opioid-free general anesthesia (OFA) compared to traditional opioid-based anesthesia spans multiple critical aspects, including effectiveness, safety, recovery, sustainability, and patient satisfaction. OFA has demonstrated comparable or superior multimodal analgesia relative to opioid-based anesthesia, effectively managing acute perioperative pain with reduced opioid consumption. This finding aligns with studies by Oliver C et al.(2024)[5] and Torsher L et al.(2024)[6], which highlight OFA's capacity to provide equivalent or better analgesia while limiting opioid-related risks. The safety profile of OFA is markedly improved, with a significant reduction in opioid-induced side effects such as postoperative nausea and vomiting (PONV), respiratory depression, and ileus, corroborated by Siu EY et al.(2020)[7]. These benefits translate into enhanced patient recovery, with faster mobilization and shorter hospital stays reported, consistent with Enhanced Recovery After Surgery (ERAS) protocol outcomes demonstrated by Ibrahim et al. (2022). Importantly, OFA supports sustainability through reduced anesthetic waste and lower carbon emissions compared to the higher ecological footprint of volatile agents and opioid use, as documented by Lauretta MP et al.(2025)[8]. Greater patient satisfaction with OFA, due to fewer side effects like nausea and sedation, further contributes to its clinical appeal.

Regarding analgesic efficacy across various surgical procedures, OFA has shown considerable promise. In bariatric surgeries, multimodal OFA methods significantly reduce postoperative pain scores and opioid rescue requirements, affirming findings from Hyland SJ et al.(2021)[9]. Similarly, thoracic surgeries benefit from OFA protocols combining regional blocks and non-

opioid agents, achieving analgesia equal or superior to opioid-based techniques with fewer opioid rescue doses, as reported by Goff J et al.(2023)[10]. Breast surgery analgesia with alpha-2 agonists and ketamine within OFA yields comparable or improved pain relief while reducing opioid needs, in harmony with Lengston V et al.(2025)[11] observations. Gynecological and laparoscopic surgeries also demonstrate effective analgesia with OFA, facilitating early ambulation and minimal opioid use, underscoring the broad applicability of OFA regimens.

The reduction in opioid-related side effects and postoperative complications is a pivotal advantage of OFA over conventional anesthesia. Postoperative nausea and vomiting, pervasive in opioid-based anesthesia, are significantly diminished with OFA, improving patient comfort and shortening hospital stay duration. Faster bowel recovery and reduced ileus incidence with OFA facilitate accelerated nutritional intake and mobilization, as supported by Bugada D et al.(2022)[12]. Minimal respiratory depression and sedation enhance overall safety, reducing the need for respiratory support, while pruritus and other opioid-associated discomforts are drastically lower in OFA. Crucially, OFA avoids opioid-induced hyperalgesia, cutting the risk of chronic and persistent postoperative pain, which is well-documented by Harfaoui W et al.(2024)[13].

From an environmental and public health perspective, OFA offers significant benefits. By minimizing perioperative opioid exposure, OFA contributes to lowering the risk of long-term opioid dependence, which is a key driver of the opioid epidemic. This aligns with global public health initiatives aimed at reducing opioid misuse and addiction as described by Xing Y. (2025)[14]. The multimodal analgesic strategies employed in OFA provide safer pain management alternatives, mitigating respiratory risks and opioid-related adverse events. Environmentally, OFA reduces pharmaceutical waste and volatile anesthetic emissions, thereby lowering the carbon footprint of perioperative care-an important consideration highlighted by Kuo FH et al.(2014)[15]. Further, OFA's association with shorter hospital stays and fewer complications optimizes healthcare resource utilization, ultimately resulting in reduced healthcare costs and improved systemic efficiency.

## Conclusion

Opioid-free general anesthesia (OFA) represents a transformative advance in perioperative care, offering a safer, more effective, and environmentally sustainable alternative to traditional opioid-based anesthesia. By integrating multimodal analgesics and regional anesthesia techniques, OFA delivers effective pain control while significantly reducing opioid-related adverse effects such as respiratory depression, postoperative nausea, and opioid-induced hyperalgesia. This approach facilitates faster patient recovery, shorter hospital stays, and improved overall patient satisfaction. Furthermore, OFA plays a critical role in addressing the ongoing opioid epidemic by minimizing perioperative opioid exposure and reducing the risk of long-term opioid dependence. Environmentally, OFA supports sustainable healthcare practices by lowering pharmaceutical waste and anesthetic gas emissions. Collectively, these benefits position OFA as a patient-centered, evidence-based anesthetic strategy that enhances clinical outcomes, promotes public health, and fosters ecological responsibility, making it a vital innovation in modern anesthetic management.

## Limitations of the Study

This study is based solely on secondary data obtained from existing literature, which may introduce variability due to heterogeneity in study designs, anesthesia protocols, patient populations, and

outcome measurements across included sources. The reliance on published data limits the ability to control for confounding variables or perform individual patient-level analyses. Additionally, some studies lack long-term follow-up data on chronic pain and opioid dependence outcomes, restricting comprehensive evaluation. The generalizability of results may be affected by differences in healthcare settings, surgical types, and regional practices not fully captured in the literature. Finally, the environmental impact assessments included are often indirect and may require more robust, prospective ecological studies to quantify the true sustainability benefits of OFA practices.

**References:**


1. McLott J, Stahel PF. Opioid-free anesthesia: the next frontier in surgical patient safety. Patient Safety in Surgery. 2022 Dec 2;16(1):38.
2. Kharasch ED, Clark JD. Opioid-free anesthesia: time to regain our balance. Anesthesiology. 2021 Apr 1;134(4):509.
3. Olausson A, Svensson CJ, Andréll P, Jildenstål P, Thörn SE, Wolf A. Total opioid-free general anaesthesia can improve postoperative outcomes after surgery, without evidence of adverse effects on patient safety and pain management: a systematic review and meta-analysis. Acta Anaesthesiologica Scandinavica. 2022 Feb;66(2):170-85.
4. Gricourt Y, Cuvillon P, Forget P. Opioid-free anaesthesia as a valuable alternative to opioid-based practices: evidence and future challenges. Pain Management. 2025 Aug 9:1-1.
5. Oliver C, Charlesworth M, Pratt O, Sutton R, Metodiev Y. Anaesthetic subspecialties and sustainable healthcare: a narrative review. Anaesthesia. 2024 Mar;79(3):301-8.
6. Torsher L, Dutton R, Banerjee A, Pivalizza EG, editors. Advances in Anesthesia, 2024: Advances in Anesthesia, 2024, E-Book. Elsevier Health Sciences; 2024 Oct 25.
7. Siu EY, Moon TS. Opioid-free and opioid-sparing anesthesia. International anesthesiology clinics. 2020 Apr 1;58(2):34-41.
8. Lauretta MP, Marino L, Bilotta F. Safety and efficacy of opioid-sparing anesthesia compared with traditional opioid anesthesia: a scoping review. The Clinical Journal of Pain. 2025 Feb 1;41(2):e1261.
9. Hyland SJ, Brockhaus KK, Vincent WR, Spence NZ, Lucki MM, Howkins MJ, Cleary RK. Perioperative pain management and opioid stewardship: a practical guide. InHealthcare 2021 Mar 16 (Vol. 9, No. 3, p. 333). MDPI.
10. Goff J, Hina M, Malik N, McLardy H, Reilly F, Robertson M, Ruddy L, Willox F, Forget P. Can opioid-free anaesthesia be personalised? A narrative review. Journal of Personalized Medicine. 2023 Mar 10;13(3):500.
11. Lengston V, Falkner S. The World of Surgery and Anesthesia. Journal of Surgery & Anesthesia Research. SRC/JSAR-280. DOI: doi. org/10.47363/JSAR/2025 (6). 2025;238:2-5.
12. Bugada D, Drotar M, Finazzi S, Real G, Lorini LF, Forget P. Opioid-free anesthesia and postoperative outcomes in cancer surgery: a systematic review. Cancers. 2022 Dec 22;15(1):64.
13. Harfaoui W, Alilou M, El Adib AR, Zidouh S, Zentar A, Lekehal B, Belyamani L, Obtel M, HARFAOUI W, Zentar Jr A, Lahcen B. Patient safety in anesthesiology: progress, challenges, and prospects. Cureus. 2024 Sep 16;16(9).

14. Xing Y. Research Progress on the Clinical Application of Opioid-Free Anesthesia. Advances in Precision Medicine. 2025 Jun 28;10(2):264-7.
15. Kuo FH, Tudor BH, Gray GM, Ahumada LM, Rehman MA, Watkins SC. Precision anesthesia in 2050. Anesthesia & Analgesia. 2024 Feb 1;138(2):326-36.