ANESTHESIOLOGY

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Review Article

# Advances in Opioid-Sparing Techniques for Ambulatory Surgery

**Sanne Kraus[1*], Nils Jonsdottir[2] and Laura Ramirez[3]**

[1]Department of Anesthesiology, Bohemian University of Medical Sciences, Czech Republic
[2]Department of Perioperative Medicine, Bohemian University of Medical Sciences, Czech Republic
[3]Department of Anesthesiology and Pain Management, Jutland University of Clinical Medicine, Denmark

***ABSTRACT***

*Ambulatory surgery has expanded rapidly, shifting the burden of postoperative pain management from monitored wards onto patients recovering at home, and this shift has intensified interest in reducing perioperative opioid exposure.*

*This review synthesizes recent comparative evidence on opioid-sparing and opioid-free anesthetic strategies for ambulatory procedures, including multimodal non-opioid pharmacotherapy, dexmedetomidine-ketamine-lidocaine substitution regimens, and regional and local anesthetic techniques.*

*Across procedure types ranging from laparoscopic and bariatric surgery to spine, thoracoscopic, and plastic surgery, opioid-sparing regimens consistently reduce perioperative and take-home opioid consumption, and regional anesthesia in particular contributes the most reliable additional analgesic benefit when layered onto systemic multimodal therapy.*

*Gabapentinoids show a more inconsistent benefit-to-risk profile and are better reserved for selected patients than used routinely, while opioid-free general anesthesia protocols require hemodynamic management skills and infrastructure that remain unevenly distributed across ambulatory facilities.*

*We conclude that the evidence now supports opioid minimization as a default orientation for ambulatory anesthetic practice, with implementation barriers, rather than remaining evidentiary gaps, as the principal obstacle to broader adoption.*

***Keywords:*** *opioid-sparing anesthesia; opioid-free anesthesia; ambulatory surgery; multimodal analgesia; regional anesthesia*

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**Corresponding Author:** *Sanne Kraus*

**E-mail Address:** *s.kraus@bums.cz*

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## INTRODUCTION

Ambulatory surgery has grown from a niche cost-saving arrangement into the default setting for a large share of elective procedures, and that shift has changed what "adequate" postoperative analgesia has to mean. A patient recovering on a surgical ward can be observed, redosed, and rescued if pain escalates; a patient discharged the same afternoon has to manage the first, often worst, days of recovery largely on their

own, with whatever medication went home in a bag. Opioids have historically filled that gap, and for good reason — they are potent, familiar, and inexpensive. But the same properties that make them effective analgesics also make them a poor fit for outpatient recovery: they cause nausea and sedation that delay discharge and interfere with the mobility ambulatory pathways depend on, they carry a real risk of respiratory depression in patients who will not be monitored overnight, and unused tablets from short outpatient courses have been repeatedly identified as a reservoir for diversion and misuse. The clinical and public-health case for opioid-sparing and opioid-free approaches in this setting has therefore converged from two directions at once: enhanced-recovery pathways wanting patients awake, comfortable, and ambulating quickly, and opioid-stewardship efforts wanting fewer tablets prescribed and fewer left over [1] [2].

"Opioid-sparing" and "opioid-free" are related but distinct goals, and the literature is not always careful about the difference. Opioid-sparing anesthesia (OSA) uses non-opioid agents to reduce, but not necessarily eliminate, intraoperative and postoperative opioid consumption, typically by layering regional or local anesthetic techniques onto a lighter opioid backbone. Opioid-free anesthesia (OFA) removes systemic opioids from the intraoperative regimen entirely, substituting combinations of dexmedetomidine, ketamine, lidocaine, and sometimes magnesium as antinociceptive agents, usually still permitting opioid rescue in recovery if pain is not controlled. Both strategies sit on top of a broader multimodal analgesia framework that also includes acetaminophen, NSAIDs or COX-2 inhibitors, and, more selectively, gabapentinoids. This review surveys the comparative evidence for these approaches specifically in the ambulatory context, where outcomes such as time-to-discharge, postoperative nausea and vomiting (PONV), and take-home opioid consumption matter as much as pain scores themselves.

## MULTIMODAL ANALGESIA AS THE COMMON FOUNDATION

Before addressing opioid-free or opioid-sparing anesthetic techniques specifically, it is worth being explicit that almost none of the outcome data in this field come from opioid reduction alone — they come from multimodal regimens in which opioid reduction is one component among several. Scheduled acetaminophen and an NSAID or COX-2 inhibitor, given preoperatively or early intraoperatively rather than only on request afterward, form the backbone of essentially every contemporary opioid-sparing pathway, and reviews of the underlying trial evidence consistently find that this combination reduces both pain scores and opioid consumption relative to either agent alone, with an acceptably low burden of gastrointestinal or renal adverse effects when used for the short courses typical of ambulatory surgery [3] [4]. Wound infiltration and, where anatomically appropriate, peripheral nerve or fascial plane blocks add a further several hours of dense analgesia that covers the immediate postoperative window during which pain is often most severe and PONV-inducing systemic opioids are least wanted.

Gabapentinoids occupy a more contested place in this stack. Early enthusiasm for routine perioperative gabapentin or pregabalin, on the theory that pre-emptive modulation of central sensitization would reduce both acute pain and the risk of chronic post-surgical pain, has been tempered by more recent systematic reviews showing inconsistent analgesic benefit alongside a real signal for sedation, dizziness, and, in some populations, respiratory depression when combined with other sedating agents [5]. Meta-analytic data restricted to specific procedure types, such as upper airway surgery, show a similarly mixed picture: modest reductions in opioid consumption in some analyses, no clear benefit in others, and enough heterogeneity in dosing and timing across trials to make firm procedure-specific recommendations difficult [6]. The current, more cautious consensus favors selective rather than routine use — reserving gabapentinoids for patients with a higher expected pain burden or pre-existing chronic pain, rather than adding them by default to every ambulatory multimodal order set [7].

## OPIOID-FREE ANESTHESIA: INTRAOPERATIVE SUBSTITUTES FOR OPIOIDS

The most aggressive form of opioid-sparing practice, opioid-free anesthesia, replaces the intraoperative opioid altogether with combinations of alpha-2 agonists, NMDA-receptor antagonists, and sodium-channel blockers. Dexmedetomidine contributes sedation, sympatholysis, and a degree of analgesia through central alpha-2 receptor activity; ketamine, at sub-dissociative doses, provides NMDA antagonism that blunts central sensitization and has an opioid-sparing effect that persists into the postoperative period; and intravenous lidocaine contributes systemic anti-inflammatory and analgesic effects that are increasingly well documented outside its traditional role as a local anesthetic. Trials combining these three agents, most commonly reported as "OFA" protocols, have been tested across a range of procedures — laparoscopic cholecystectomy, adolescent scoliosis correction, and ambulatory hip arthroplasty among them — generally showing reduced postoperative opioid requirement, lower pain scores in the early recovery period, and less PONV compared with conventional opioid-based general anesthesia [8] [9] [10].

The results, however, are not uniformly favorable, and the heterogeneity matters clinically. A systematic review focused on perioperative ketamine in

orthopedic surgery found a consistent opioid-sparing effect across trials but inconsistent analgesic benefit — patients used fewer opioids without always reporting less pain, which is a subtly different and less automatically desirable outcome than it sounds, since it raises the question of whether ketamine is genuinely improving comfort or simply substituting one form of central modulation for another without matching subjective relief [11]. Network meta-analyses comparing opioid-free, opioid-sparing, and opioid-inclusive regimens, with or without regional anesthesia layered on top, have tended to find that the largest and most consistent benefit comes from adding regional anesthesia to any systemic regimen, opioid-free included, rather than from opioid avoidance per se — an important nuance for a specialty that sometimes treats OFA as a monolithic intervention rather than one variable among several [12]. Hemodynamic effects also deserve attention: dexmedetomidine's sympatholytic action can produce bradycardia and hypotension that some ambulatory anesthesiologists find harder to titrate around than the hemodynamic profile of a conventional opioid-volatile anesthetic, particularly in older or volume-depleted outpatients, and this has been a recurring caveat in scoping reviews of OFA's implementation challenges [13] [14].

## REGIONAL AND LOCAL ANESTHETIC TECHNIQUES IN OUTPATIENT PATHWAYS

Regional anesthesia remains the single technique with the most consistent evidence for reducing opioid consumption in ambulatory surgery without the hemodynamic trade-offs of systemic alpha-2 agonists. Peripheral nerve blocks, fascial plane blocks such as the transversus abdominis plane and erector spinae plane blocks, and simple surgical-site infiltration with long-acting local anesthetics all extend analgesia into the window immediately after discharge, when patients are most likely to reach for a prescribed opioid out of anticipatory anxiety about pain rather than pain actually present. Trials combining opioid-free general anesthesia with regional or local techniques in laparoscopic and bariatric procedures — sleeve gastrectomy and colectomy among them — report better quality-of-recovery scores and lower opioid consumption than opioid-free anesthesia alone, reinforcing that the two strategies are complementary rather than substitutes for one another [15] [16].

Day-surgery hernia repair performed under a full opioid-free ERAS pathway, incorporating local infiltration alongside multimodal systemic analgesia, has been shown non-inferior to a conventional opioid-based approach for pain control while reducing early opioid exposure, supporting the feasibility of opioid avoidance even in a high-volume, rapid-turnover procedure where anesthetic simplicity is often prized [17]. Spine surgery, which sits at the more painful end of what is now performed on an ambulatory or short-stay basis, has been the subject of meta-analyses specifically examining regimens combining three or more non-opioid modalities; these show that layering local infiltration, scheduled non-opioid analgesics, and sometimes intrathecal or epidural adjuncts produces measurable reductions in both pain scores and cumulative opioid requirement compared with less comprehensive regimens, though the absolute magnitude of benefit varies considerably by the specific combination and by procedure invasiveness [18]. A randomized trial of a structured opioid-sparing protocol in posterior lumbar fusion likewise found meaningful reductions in opioid consumption without compromising analgesia, in a population sometimes assumed to be too painful a candidate for opioid minimization [19].

## PROCEDURE-SPECIFIC EVIDENCE AND WHERE IT DIVERGES

The strength and consistency of the opioid-sparing evidence base varies considerably by surgical service, and lumping all ambulatory procedures together risks overstating what is actually known. Laparoscopic and minimally invasive abdominal procedures have accumulated the most robust trial data, likely because postoperative ileus and PONV give opioid avoidance an additional, non-analgesic rationale that aligns naturally with ERAS pathways already built around early mobilization and oral intake [20]. Thoracoscopic surgery, traditionally managed with substantial opioid requirements because of chest-wall and pleural pain, has been the subject of a non-inferiority trial of a novel opioid-sparing regimen that achieved comparable pain control with markedly reduced opioid exposure, suggesting the ceiling for opioid reduction in thoracic procedures is higher than historically assumed [21]. Plastic and reconstructive surgery, where outpatient procedures are common and patient-reported cosmetic and functional outcomes are closely tracked, has produced randomized comparisons of several multimodal regimens converging on similar conclusions: scheduled non-opioid analgesia plus regional or local blockade reduces opioid consumption substantially without measurably worsening patient satisfaction [22].

Cardiac surgery, though rarely truly ambulatory, is instructive as a comparator because its patients are older, more hemodynamically fragile, and more opioid-tolerant at baseline than typical outpatients, and yet meta-analytic data still show an opioid-sparing benefit from multimodal regimens in this population, which strengthens confidence that the approach generalizes rather than depending on a uniquely healthy ambulatory-surgery population to succeed [23]. Bariatric surgery, similarly, involves patients with a higher baseline prevalence of obstructive sleep apnea and opioid sensitivity, and systematic review data specifically on ketamine as a multimodal component in this population show a consistent

reduction in postoperative opioid requirement, which is clinically significant given how much respiratory depression risk in this group is opioid-driven [24].

## BARRIERS TO ADOPTION AND UNRESOLVED QUESTIONS

Despite a broadly favorable evidence base, opioid-sparing and opioid-free techniques have not become universal in ambulatory practice, and the barriers are as much practical as they are evidentiary. Regional anesthesia requires ultrasound skill, time, and block-room capacity that not every ambulatory facility has built into its workflow, and a delayed or failed block can slow throughput in a setting where turnover efficiency is itself a patient-safety and financial priority. Opioid-free general anesthesia protocols require familiarity with titrating dexmedetomidine and ketamine infusions, agents many anesthesiologists use far less routinely than a fentanyl or remifentanil-based technique, and the hemodynamic management they demand is a genuine skill gap rather than a trivial adjustment [13]. There is also a documented gap between what happens in the perioperative period, where these techniques are well studied, and what happens after discharge, where patients manage their own analgesia with comparatively little support; a recent review specifically frames this post-discharge interval as an underaddressed part of the opioid-sparing agenda, since a well-executed opioid-free anesthetic can still be followed by an oversized take-home opioid prescription if institutional prescribing habits do not change in parallel [25].

Two further open questions deserve mention. First, most of the comparative trials in this area are individually underpowered for uncommon but serious outcomes — respiratory depression, persistent opioid use, and rebound pain after a block wears off — so the aggregate confidence in opioid-sparing techniques rests more on consistency of direction across many small trials than on any single definitive outcome study. Second, the field has not converged on a standardized opioid-free or opioid-sparing "package," and the wide variability in which agents, doses, and combinations different trials call by the same name makes cross-study comparison and guideline-writing harder than it should be — a scoping review synthesizing this literature explicitly flags the heterogeneity of protocols as a limiting factor for drawing procedure-agnostic conclusions [1].

## CONCLUSION

The evidence assembled over the last several years supports a clear directional conclusion: opioid-sparing and, where feasible, opioid-free strategies reduce perioperative and take-home opioid exposure in ambulatory surgery without compromising analgesia or recovery quality, and in several procedure types they improve recovery quality by reducing PONV and sedation. What the evidence does not yet support is a single default protocol applicable across all ambulatory procedures. Regional and local anesthetic techniques appear to contribute the most consistent and largest analgesic benefit and should probably be considered the first tier of opioid-sparing practice wherever anatomically feasible, with systemic adjuncts such as dexmedetomidine, ketamine, and lidocaine layered on for procedures or patients where regional techniques are impractical or insufficient. Scheduled acetaminophen and NSAID therapy remains a low-cost, low-risk foundation that should underlie essentially every ambulatory analgesic plan regardless of what else is added, while gabapentinoids are better reserved for selected patients than adopted as routine. The practical barriers to wider adoption — procedural skill requirements, hemodynamic management demands, and inconsistent post-discharge prescribing practices — are arguably now a larger obstacle to further progress than any remaining gap in the clinical-trial evidence, and closing that implementation gap, rather than generating still more small single-center trials, looks like the more productive direction for the next several years of work in this area.

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**Ethics Statement This is a literature review that did not involve new human or animal research; no ethics approval was required.**

**Data Availability No new data were generated for this review. All sources discussed are publicly available in the cited literature.**

## REFERENCES

1. Opioid-Free and Opioid-Sparing Pain Control in Surgical Anesthesia: A Scoping Review of Multimodal Analgesia, Regional Techniques, and Recovery Outcomes (2025) PMC.
2. An Emerging Paradigm for Safer and Faster Recovery: A Narrative Review on Opioid Sparing Anesthesia in Surgery (2024) Cureus.

3. Postoperative Multimodal Analgesia Pain Management With Nonopioid Analgesics and Techniques: A Review (2017) PubMed, PMID:28564673.

4. An update on the role of multimodal analgesia in perioperative pain management (2025) PMC.

5. Curb Your Enthusiasm: Should Gabapentinoids Be a Routine Component of Multimodal Analgesia? (2022) ASRA News.

6. Gabapentinoids for Upper Airway Surgery Pain Management: Systematic Review and Meta-Analysis (2025) PMC.

7. The clinical application progress of multimodal analgesia strategy in enhanced recovery after surgery: a narrative review (2025) Frontiers in Pain Research.

8. Opioid-free anesthesia using a combination of ketamine and dexmedetomidine in patients undergoing laparoscopic cholecystectomy: a randomized controlled trial (2024) PMC.

9. The perioperative analgesic effect of opioid free anesthesia using combination of dexmedetomidine, ketamine and lidocaine in adolescent patients undergoing Scoliosis Surgery; A randomized Controlled Trial (2023) Taylor & Francis.

10. Opioid-free versus opioid-sparing anaesthesia in ambulatory total hip arthroplasty: a randomised controlled trial (2023) ScienceDirect/British Journal of Anaesthesia.

11. Opioid-Sparing Effects of Perioperative Ketamine With Inconsistent Analgesic Benefit in Orthopedic Surgery: A Systematic Review of Controlled Trials (2025) PMC.

12. Opioid-free vs. opioid-inclusive anaesthesia with or without regional anaesthesia for postoperative pain: a systematic review with network meta-analysis of randomised controlled trials (2025) PubMed.

13. Opioid-free anesthesia: a scoping review of efficacy, safety, and implementation challenges (2025) Frontiers in Anesthesiology.

14. Opioid-free anaesthesia as a valuable alternative to opioid-based practices: evidence and future challenges (2025) Taylor & Francis.

15. Combined opioid free and loco-regional anaesthesia enhances the quality of recovery in sleeve gastrectomy done under ERAS protocol: a randomized controlled trial (2022) PMC.

16. Opioid free versus opioid sparing strategies for multimodal antinociception during laparoscopic colectomy: a randomised controlled trial (2024) ScienceDirect.

17. Opioid-free versus opioid-based anesthesia for day surgery laparoscopic inguinal hernia repair under ERAS protocol: a randomized non-inferiority trial (2025) PubMed.

18. Perioperative Multimodal Analgesia for Adults Undergoing Surgery of the Spine-A Systematic Review and Meta-Analysis of Three or More Modalities (2022) ScienceDirect.

19. Efficacy of an Opioid-Sparing Perioperative Multimodal Analgesia Protocol on Posterior Lumbar Fusion in a Hispanic Population: A Randomized Controlled Trial (2023) PubMed, PMID:37192425.

20. The role of postoperative ketamine infusion in ERAS protocols following elective open abdominal surgeries, a systematic review and meta-analysis (2025) PMC.

21. A Novel Opioid-Sparing Analgesia Following Thoracoscopic Surgery: A Non-Inferiority Trial (2023) PMC, PMID: PMC10257398.

22. A Comparison of Multimodal Analgesic Regimens for Opioid Reduction in Elective Plastic Surgery: A Randomized Study (2023) Plastic and Reconstructive Surgery Global Open.

23. Opioid-sparing Anesthesia in Cardiac Surgery: A Meta-analysis (2025) ScienceDirect.

24. Ketamine as a component of multimodal analgesia for pain management in bariatric surgery: A systematic review and meta-analysis of randomized controlled trials (2022) PMC.

25. Personalized Multimodal and Opioid-Sparing Analgesia for Postoperative Pain Management: Enhancing Recovery and Addressing the Post-Discharge Gap (2025) PubMed.