

The Evolving Role of Clinical Pharmacists in Pre-, Peri-, and Post-Operative and Critical Care Settings: A Comprehensive Review

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ABSTRACT

Surgery is increasingly recognized as a complex, longitudinal therapeutic process spanning preoperative preparation, anesthesia, intraoperative care, and postoperative recovery rather than an isolated operating room event. Because this continuum is highly medication-intensive and subject to challenges like polypharmacy, rapid drug administration, physiological instability, multiple transitions of care, and communication failures, the perioperative environment carries a high risk for preventable medication errors. This review explores the evolving role of the clinical pharmacist, transitioning from a passive dispenser to an active, multidisciplinary collaborator throughout the surgical pathway. In the preoperative phase, clinical pharmacists improve patient safety by constructing a best possible medication history, clarifying continuation or cessation plans for high-risk home therapies (such as anticoagulants and antidiabetics), and delivering patient education to reduce morning-of-surgery non-adherence. In the intraoperative phase, they support anesthesia providers through system-level and case-level interventions, including the standardization of medication trays and labeling, antimicrobial prophylaxis stewardship, and multimodal analgesic design. Postoperatively, pharmacists collaborate with anesthesiologists to optimize acute pain management, support opioid stewardship, manage thromboembolism prophylaxis, and coordinate comprehensive discharge reconciliation to prevent drug duplication or omission. Collaborative models such as joint acute pain services and pre-anesthesia consultations render medication reviews clinically actionable and significantly enhance therapy optimization. Although challenges like staffing constraints, training gaps, and inconsistent clinical integration persist, the future of perioperative pharmacy lies in proactive, technology-enabled care incorporating clinical decision support, barcode administration, and artificial intelligence to solidify clinical pharmacists as core contributors to surgical patient safety.

Keywords: Clinical Pharmacist, Medication Safety, Multidisciplinary Collaboration, Perioperative Care, Postoperative Pain Management.

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INTRODUCTION

Surgery is no longer a purely technical event confined to the operating room; it is a longitudinal therapeutic process that begins before admission, continues through anesthesia and the operation itself, and extends into recovery, rehabilitation, discharge, and follow-up. In modern practice, the success of surgery depends not only on operative skill but also on how well the patient's physiology, chronic diseases, drug therapy, pain, infection risk, thrombosis risk, nutrition, glycemic control, and psychological preparedness are managed across the perioperative continuum. This broader

model of care is reflected in contemporary perioperative, anesthesia, and multidisciplinary safety frameworks, which view perioperative care as a coordinated, patient-centered pathway rather than a sequence of isolated encounters (Naserallah *et al.*, 2025). The perioperative period is generally divided into the preoperative, intraoperative, and postoperative phases. Although these divisions are convenient for teaching and workflow, in practice they are tightly linked. A medication decision made in the preoperative clinic can influence induction hemodynamics, postoperative pain, bleeding, delirium, nausea and vomiting, antimicrobial exposure, or time to discharge. For example, failure to identify an anticoagulant before surgery can increase bleeding risk; poor adjustment of antihypertensive therapy can contribute to peri-induction hypotension; inadequate planning of multimodal analgesia can lead to excessive opioid exposure and delayed mobilization; and errors in antibiotic prophylaxis can raise the risk of surgical site infection. Because drug-related decisions cross all three phases, perioperative care



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is fundamentally a medication-intensive specialty (Hillier *et al.*, 2020).

This complexity is magnified by the fact that a large proportion of surgical patients present with polypharmacy, chronic comorbidity, and multiple transitions of care. Reviews of perioperative pharmacy practice consistently emphasize that medication therapy management must address pain, nausea and vomiting, anticoagulation, infection prophylaxis, chronic disease therapy, blood pressure, blood glucose, and discharge continuity. In parallel, preoperative clinic and guideline-based reports show that incomplete or inaccurate medication histories are a major source of medication error during admission and early postoperative prescribing (Eid *et al.*, 2020).

These realities explain why the perioperative arena is widely recognized as a high-risk setting for medication harm. Published work on perioperative medication error detection, anesthesia drug administration safety, and operating room error mechanisms shows that medication-related incidents are often under-recognized and that preventable errors continue to occur across anesthesia practice (Table 1) (Nanji *et al.*, 2016).

The persistence of these errors is not surprising. Unlike many hospital settings, anesthesia professionals often prescribe, prepare, label, administer, and document medications themselves in real time, usually under severe time pressure and in a distracting environment. For that reason, perioperative medication safety is not only a question of individual vigilance but also of system design, standardization, communication, technology, protocol development, and support from medication experts (Merry *et al.*, 2011).

Against this background, the role of the clinical pharmacist has become increasingly important. Contemporary perioperative pharmacy literature no longer presents the pharmacist as a passive dispenser of medicines, but as an active participant in medication reconciliation, therapeutic optimization, antimicrobial stewardship, analgesic planning, discharge counseling, safety surveillance, and systems redesign. The key argument is simple: because the perioperative pathway is heavily dependent on safe and rational medication use, the professional most specifically trained in pharmacotherapy should be embedded within that pathway (Chapuis *et al.*, 2019).

This framing is consistent with systematic reviews, perioperative pharmacy guidance, anesthesia safety literature, and multidisciplinary safety programs (American Society of Health-System Pharmacists [ASHP], 2019).

Perioperative medication management as a continuum of care

Perioperative medication management can be defined as the planned assessment, continuation, modification, temporary cessation, substitution, re-initiation, monitoring, and education

surrounding all medicines used by or prescribed for the surgical patient across the entire surgical timeline. This includes not only anesthetic drugs, analgesics, antibiotics, anticoagulants, antiemetics, and vasoactive agents, but also the patient's chronic therapy: antihypertensives, antidiabetics, thyroid drugs, antiepileptics, antidepressants, steroids, immunosuppressants, inhalers, herbal supplements, and self-medicated OTC products (American Society of Health-System Pharmacists [ASHP], 2013).

The core challenge is that surgery creates a temporary physiological state in which the usual rules of outpatient pharmacotherapy do not fully apply. Fasting alters oral drug absorption; anesthesia and blood loss affect circulation and tissue perfusion; inflammatory stress changes insulin sensitivity and catabolism; renal or hepatic perfusion may fluctuate; nausea and ileus interfere with oral intake; and postoperative immobility increases thrombotic risk. Therefore, the clinician must repeatedly ask several questions: Which medicines should be continued? Which should be withheld, and when? Which require bridging? Which need dose reduction? Which should be converted from oral to parenteral form? What monitoring is required before re-starting them? And how will the patient understand the revised plan at discharge? (American Society of Health-System Pharmacists [ASHP], 2013).

From a practical standpoint, perioperative medication management has five recurring goals. First, it aims to preserve control of chronic disease without exposing the patient to unnecessary procedural risk. Second, it attempts to reduce predictable complications such as bleeding, infection, thromboembolism, postoperative nausea and vomiting, severe pain, stress hyperglycemia, delirium, and medication-related adverse effects. Third, it seeks to avoid medication discrepancies at handover points. Fourth, it tries to standardize time-sensitive practices such as prophylactic antibiotic administration or postoperative analgesia. Fifth, it ensures continuity after discharge so that the patient does not leave hospital with an unsafe or confusing medication plan (American Society of Health-System Pharmacists [ASHP], 2013).

A useful way to understand this is to view perioperative medication management as a drug-use pathway rather than a set of isolated prescribing moments. The available literature shows that safer perioperative pharmacotherapy depends on the design of the whole system: accurate medication histories, standardized preparation and labeling, protocol-driven prophylaxis, better communication across transitions, and deliberate medication review from preadmission to discharge (Eid *et al.*, 2020).

The Preoperative phase

The preoperative phase is the foundation on which the rest of perioperative medication management is built. It begins when surgery is planned and includes preadmission review, medication history-taking, anesthesia assessment, optimization of chronic disease, risk stratification, patient education, and preparation for

day-of-surgery care. If this phase is weak, downstream problems multiply. Many intraoperative and postoperative medication issues are not truly “new” errors; they are consequences of a poorly captured drug history, a missed interaction, an unclear continuation/withholding plan, or inadequate communication between the preoperative clinic and the surgical team (Smith *et al.*, 2010).

The first major task in the preoperative phase is the creation of an accurate best possible medication history. This goes beyond asking the patient to name their prescriptions. It requires active verification of generic and brand names, dose, frequency, indication, adherence pattern, recent changes, allergy history, previous adverse drug reactions, herbal products, supplements, alcohol and smoking exposure, and use of high-risk agents such as anticoagulants, insulin, corticosteroids, opioids, benzodiazepines, or immunosuppressants. Preoperative pharmacy and anesthesia guidance specifically recommend that pharmacists obtain a complete medication history and identify potential drug-treatment problems, especially in patients with chronic disease and polypharmacy (Apfelbaum *et al.*, 2021).

Why is this so important? Because surgical admission is a classic setting for unintended medication discrepancies. Reports from preoperative clinics, perioperative pharmacy guidance, and systematic reviews consistently show that structured pharmacist review improves the identification of medication-related risks, clarifies continuation and withholding plans, and strengthens postoperative prescribing accuracy (Smith *et al.*, 2010).

Prospective and department-level reports also suggest that pharmacist involvement before anesthesia review can improve the quality of medication histories available to anesthesiologists and support safer perioperative prescribing. When medication information is verified before admission orders are written, discrepancies involving omissions, wrong drugs, and wrong doses are less likely to reach the perioperative period (Apfelbaum *et al.*, 2021).

The broader perioperative pharmacy literature strengthens this argument by showing that medication reconciliation before admission improves patient safety, supports continuation planning for chronic therapy, and reduces avoidable medication problems during hospitalization. These findings are highly relevant to anesthesiology because anesthesiologists routinely depend on the accuracy of home-medication information when planning perioperative continuation, withholding, or bridging strategies (Cullen *et al.*, 2021).

The drug-specific decisions of the preoperative phase are equally important. Anticoagulants and antiplatelet agents must be evaluated in terms of procedural bleeding risk, thromboembolic risk, renal function, and timing of interruption or bridging. Antihypertensive agents require nuanced handling; antidiabetic drugs need adjustment based on fasting status and expected

postoperative intake; chronic opioids require tolerance-aware pain planning; and herbal products or OTC supplements may affect bleeding, sedation, or hepatic metabolism. Interaction review is also important, including consideration of serotonergic combinations and other medicines that may complicate anesthetic care (De Caterina *et al.*, 2015).

At this stage, the pharmacist benefits anesthesiology in several ways. First, the pharmacist can identify the exact medicines that matter for anesthesia planning and distinguish active from inactive or obsolete therapy. Second, the pharmacist can anticipate interactions and monitoring needs, such as QT-prolonging combinations, serotonin-related interactions, anticoagulant timing, or renal dose issues. Third, the pharmacist can save anesthesiologist time by preparing a verified medication record rather than leaving medication reconstruction to a brief clinic encounter (Gillman, 2005).

The preoperative phase also includes patient education, which is often underestimated. Patients frequently misunderstand which chronic medicines to stop, when to fast, whether to bring medicines to hospital, or how to restart drugs after surgery. This confusion is a major cause of omitted or duplicated therapy. Pharmacists are particularly well placed to translate complex medication instructions into patient-friendly language and to tailor counseling to literacy level, age, and drug burden (Smith *et al.*, 2010). A patient who clearly understands the preoperative drug plan is less likely to arrive with unexpected anticoagulant exposure, omitted inhalers, duplicated insulin use, or inappropriate self-medication on the morning of surgery (Table 2 and Figure 1).

The evidence for pharmacist benefit in this phase is strongest for medication review, discrepancy detection, counseling, and risk clarification before surgery (Smith *et al.*, 2010).

The Intraoperative phase

The intraoperative phase is often viewed as the domain of the anesthesiologist alone, but from a medication-safety perspective it is the point at which all prior planning is tested under maximal pressure. The operating room is a distinctive medication environment because it combines urgent decision-making, multiple high-alert medicines, rapid sequence preparation, frequent syringe handling, and immediate physiologic consequences when things go wrong. Unlike most inpatient settings, the anesthesia provider often controls the entire chain of medication selection, preparation, labeling, administration, and documentation in real time (Mertes *et al.*, 2011).

The drug classes used in the intraoperative phase are broad and pharmacologically potent: induction agents such as propofol or etomidate; volatile anesthetics; opioids such as fentanyl or morphine; benzodiazepines; neuromuscular blockers and reversal agents; vasopressors and inotropes; local anesthetics;

antiemetics; antibiotics; tranexamic acid; IV fluids; insulin; and emergency drugs. Each has the potential for dosing error, wrong route, duplicate administration, or hazardous interaction. In addition, the operating room often contains multiple look-alike vials and syringes, and many medicines are used in small volumes or titrated rapidly, increasing cognitive load (Tariq *et al.*, 2024).

This environment helps explain the persistently high rates of observed perioperative medication incidents. Evidence from perioperative error studies and anesthesia safety literature emphasizes that routine reporting systems can underestimate the problem, and that a large proportion of intraoperative medication errors are preventable when standardization and monitoring systems are strengthened (Mertes *et al.*, 2011).

From the anesthesiologist's perspective, intraoperative medication management is not just about giving the right anesthetic drugs. It also includes time-sensitive prophylaxis

and physiological support. For example, surgical antibiotic prophylaxis should be selected appropriately and administered at the correct interval before incision; antiemetic strategies should be risk-based; analgesic plans should support multimodal recovery; neuromuscular blockade should be monitored and reversed safely; and vasoactive therapy should reflect the patient's baseline pharmacology and comorbidity profile. Mistakes at this stage can affect not only immediate intraoperative stability but also postoperative infection, pain, nausea, mobilization, and length of stay (Gan *et al.*, 2014).

The pharmacist's role in the intraoperative phase can therefore be understood at two levels: case-level and system-level. At the case level, the pharmacist supports anesthesiology through protocol design, formulary optimization, antimicrobial stewardship, medication preparation pathways, and review of high-risk medication plans. At the system level, the pharmacist contributes to standardization of trays, labeling, storage, barcode systems,

Table 1: Why Perioperative Medication Management Is High-Risk.

Risk domain	Why it occurs in surgery	Typical consequences
Polypharmacy	Patients arrive on chronic cardiovascular, endocrine, antithrombotic, psychiatric, and OTC/herbal medicines	Omitted drugs, interactions, rebound effects
Rapid drug administration	Induction and intraoperative care require immediate preparation and administration	Wrong drug, wrong dose, wrong route
Multiple transitions	Home -> preadmission -> ward -> OR -> PACU -> ward -> discharge	Reconciliation errors, duplication, omissions
Physiological instability	Surgery and anesthesia alter hemodynamics, renal function, hepatic blood flow, and stress hormones	Altered pharmacokinetics and pharmacodynamics
Communication failures	Teams change across phases and handovers are frequent	Delayed prophylaxis, conflicting orders, poor continuity
Incomplete protocols	Variation in local practice and specialty-specific pathways	Non-standardized care and preventable variability

Legend: OR, operating room; PACU, post-anesthesia care unit; OTC, over-the-counter.

Table 2: Major Preoperative Medication Issues and Pharmacist Contributions.

Preoperative issue	Why it matters to anesthesiology	Pharmacist contribution
Inaccurate home-medication history	Wrong continuation/withholding decisions	Best possible medication history, source verification
Anticoagulant/antiplatelet use	Bleeding or thrombosis risk	Timing plans, bridging advice, discrepancy detection
Antihypertensives	Risk of peri-induction hypotension or rebound hypertension	Continuation review and individualized recommendations
Diabetes medicines	Fasting-related hypoglycemia/hyperglycemia	Dose adjustments and monitoring plans
Chronic opioid or benzodiazepine use	Tolerance, withdrawal, respiratory depression	Analgesia planning and high-risk medication review
Supplements/herbals/OTC use	Hidden bleeding, sedation, or interaction risk	Explicit questioning and documentation
Poor patient understanding	Non-adherence to pre-op instructions	Counseling and written medication instructions

Legend: OTC, over-the-counter.

prefilled products, and decision support (American Society of Health-System Pharmacists [ASHP], 2019).

One major intraoperative application is antimicrobial prophylaxis. Incorrect agent choice, poor timing, unnecessary redosing, and excessive postoperative continuation remain common. Perioperative pharmacy guidance and operating room safety literature support pharmacist involvement in antimicrobial stewardship, formulary management, standardization, and time-critical perioperative medication processes (American Society of Health-System Pharmacists [ASHP], 2013).

The intraoperative phase is also where collaboration affects analgesic architecture. A strong anesthetic plan today is rarely opioid-only; it is multimodal and considers regional techniques,

acetaminophen, NSAIDs where appropriate, ketamine or lidocaine infusions in selected settings, and antiemetic pairing. Pharmacists can support anesthesiologists by aligning perioperative analgesia protocols with patient-specific factors such as opioid tolerance, renal function, age, bleeding risk, sleep apnea, and interacting CNS depressants (Apfel *et al.*, 2004) (Table 3).

The Postoperative phase

The postoperative phase is sometimes described as recovery from anesthesia, but clinically it is much more than emergence and transfer to PACU. It is the period in which the patient's physiologic stress response, wound healing, mobilization, resumption of oral intake, management of drains and lines, and control of pain and

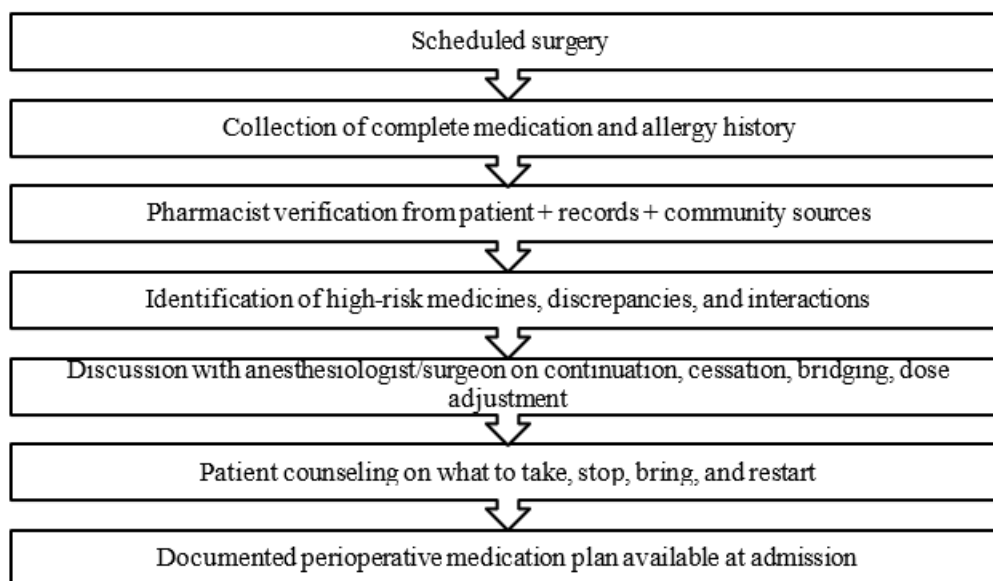


Figure 1: Preoperative medication management pathway.

Table 3: Intraoperative Medication Domains Relevant to Pharmacist-Anesthesiologist Collaboration.

Domain	Typical medications	Why collaboration helps
Antibiotic prophylaxis	Cefazolin, clindamycin, vancomycin, metronidazole	Correct selection, timing, redosing, allergy review
Hemodynamic support	Phenylephrine, ephedrine, norepinephrine, vasopressin	Standard concentrations, labeling, storage, preparation
Induction/maintenance	Propofol, volatile agents, adjunct sedatives	Protocol standardization and interaction awareness
Analgesia	Fentanyl, morphine, ketamine, acetaminophen, NSAIDs	Multimodal design and patient-specific risk balancing
Antiemesis	Ondansetron, dexamethasone, droperidol	Risk-based prophylaxis and interaction review
Reversal/rescue	Sugammadex, neostigmine, naloxone, flumazenil	Availability, protocols, dosing safeguards

Legend: NSAIDs, non-steroidal anti-inflammatory drugs.

complications all converge. From a medication perspective, this phase is defined by transition: IV to oral switching, re-starting chronic medicines, preventing avoidable complications, rationalizing antibiotics, adjusting anticoagulation, and preparing the patient for discharge (American Society of Health-System Pharmacists [ASHP], 2013).

Pain management is central to postoperative medication therapy. Poor pain control is not a minor comfort issue; it is linked to delayed mobilization, impaired respiratory effort, sleep disturbance, prolonged opioid use, higher readmission risk, and in some patient's progression to persistent postsurgical pain. Anesthesiologists design much of the perioperative pain strategy, but pharmacists can strengthen this by reviewing analgesic regimens for completeness, duplication, renal safety, sedation burden, constipation prophylaxis, patient counseling, and adherence after discharge (Dean, 2004).

Evidence for pharmacist impact on postoperative pain is growing. Systematic review evidence and collaborative practice reports suggest that pharmacist participation can improve pain-control processes, strengthen opioid stewardship, and support safer use of adjunct analgesics and bowel regimens after surgery (Naserallah *et al.*, 2025).

The collaborative study by Chen and colleagues offers another useful postoperative perspective. In hospitalized patients with poor pain control, collaboration between pharmacists and anesthesiologists improved pain-management processes and strengthened opioid-use quality indicators. This supports the view that pharmacist-anesthesiologist collaboration can improve pain-related outcomes when medication review is linked to specialist analgesic decision-making (Chen *et al.*, 2021).

Beyond pain, postoperative medicine includes antiemetic therapy, venous thromboembolism prophylaxis, stress-ulcer or gastrointestinal complication prevention in selected populations, glycemic management, fluid and electrolyte correction, and the safe reintroduction of chronic medications. The available

perioperative literature suggests that pharmacists may contribute most where postoperative therapy is protocol-based yet still requires individualization (Rengel and Pandharipande, 2021).

Discharge is another major vulnerability. A patient may leave with new anticoagulation, short-term opioid therapy, bowel regimen, antiemetics, antibiotic changes, held chronic medications, altered insulin schedules, and instructions to restart selected medicines only after a certain date. Without good medication reconciliation and counseling, the patient can easily duplicate therapy, omit essential chronic drugs, or continue medicines that were intended to stop. Perioperative pharmacy guidance explicitly includes medication education, individualized follow-up, and adverse-effect monitoring after discharge as pharmacist responsibilities (American Society of Health-System Pharmacists (Table 4 and Figure 2) (ASHP, 2019).

Pharmacist-Anesthesiologist collaboration

The phrase “pharmacist-anesthesiologist collaboration” should not be understood narrowly as the pharmacist advising on anesthetic drugs. In a robust perioperative model, it means that both professionals jointly shape the medication plan that surrounds anesthesia and surgery: what the patient comes in on, what is withheld, what is given in the operating room, what is used for prophylaxis, how pain is managed, and what the patient goes home with. The collaboration is strongest when it is structured, recurrent, and pathway-based, rather than occasional consultation after a problem has already occurred (Chapuis *et al.*, 2019).

Several models of collaboration are described in the literature. One model is pre-anesthesia medication consultation, where the pharmacist helps prepare a verified home-medication history and flags high-risk drugs for anesthesiology review. A second model is the shared pain-management service, where pharmacists and anesthesiologists round together and intervene on opioid selection, dosing, bowel regimens, and adjunct therapy.

Table 4: Key Postoperative Medication Domains.

Postoperative domain	Typical treatment focus	Pharmacist contribution
Pain	Multimodal analgesia, opioid minimization, bowel regimen	Regimen review, safety monitoring, counseling
PONV	Risk-based antiemetic combinations	Prophylaxis optimization and interaction checking
VTE prevention	LMWH, DOAC plans, mechanical + pharmacologic strategy	Dosing, timing, contraindication review
Re-start of chronic therapy	Antihypertensives, antidiabetics, anticoagulants, psychotropics	Re-initiation plan and reconciliation
Antimicrobial stewardship	Stop unnecessary continuation after prophylaxis	Duration review and protocol adherence
Discharge safety	Simplified medication list and patient understanding	Reconciliation, education, handover to primary care

Legend: PONV, postoperative nausea and vomiting; VTE, venous thromboembolism; LMWH, low-molecular-weight heparin; DOAC, direct oral anticoagulant.

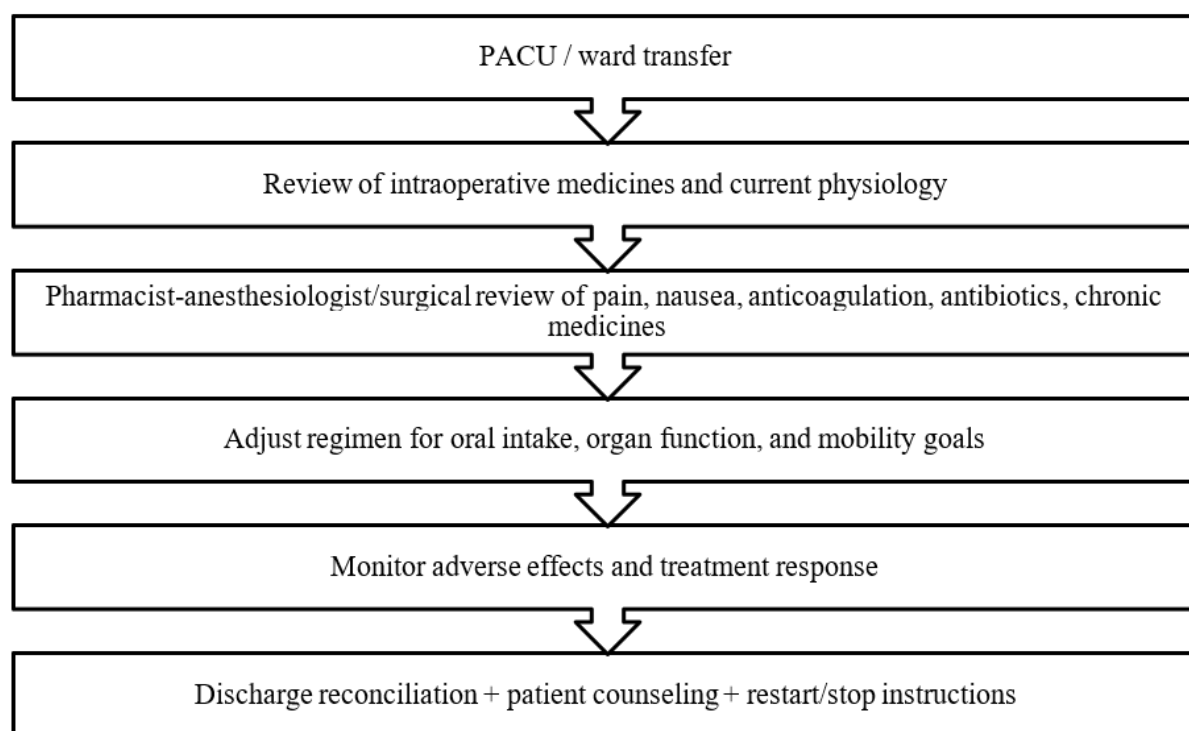


Figure 2: Postoperative medication optimization.

A third is the protocol and systems model, in which pharmacists and anesthesiologists jointly redesign workflows around operating-room medication preparation, prophylaxis, analgesia, and reconciliation (Chapuis *et al.*, 2019).

Why is this collaboration particularly valuable in anesthesiology? First, anesthesiologists must make rapid medication decisions that are highly dependent on an accurate medication background. Second, anesthesiology increasingly extends beyond the OR into preoperative assessment, acute pain services, and perioperative pathway design. Third, many anesthetic outcomes are medication-mediated rather than purely procedural: hypotension, delayed emergence, PONV, breakthrough pain, respiratory depression, and interactions with chronic drugs. Fourth, anesthesiology is already a discipline deeply engaged with patient safety science, making it especially receptive to pharmacist-led standardization and systems redesign (Evered *et al.*, 2018).

The best collaborations create benefits in both directions. Pharmacists help anesthesiologists by clarifying medication histories, optimizing prophylaxis, improving discharge planning, and identifying preventable discrepancies. Anesthesiologists help pharmacists by contextualizing surgical stress, timing, procedural bleeding risk, anesthesia implications, and the practical constraints of the OR and PACU. When the two work together, medication review becomes clinically actionable rather than purely administrative.

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Evidence for Pharmacist involvement in Perioperative care

The strongest overall evidence comes from contemporary reviews and departmental experience reports evaluating pharmacist participation in perioperative settings. These publications suggest that pharmacist-led interventions can improve medication review, discharge processes, pain-management quality, and broader perioperative medication optimization, although study quality is variable across the literature (Naseralallah *et al.*, 2025).

However, the evidence is not uniform across all domains. Pharmacist effects appear strongest in areas where medication use is protocolized but error-prone: reconciliation, prophylactic medication use, postoperative pain management, discharge counseling, and therapy optimization around transitions. Evidence is less consistent in areas where many perioperative confounders influence outcome. This nuance is important for thesis discussion: pharmacist impact is real, but it is most visible where the intervention directly addresses a known

Table 5: Comparative Evidence Supporting Pharmacist Participation.

Study	Setting	Intervention	Main finding
Naseralallah <i>et al.</i> , 2025	Systematic review	Perioperative pharmacist-care interventions	Improved therapy optimization and clinically relevant perioperative outcomes
Chen <i>et al.</i> , 2021	Inpatient pain service	Pharmacist-anesthesiologist collaboration	Improved pain-management processes and opioid-related care quality
Hillier <i>et al.</i> , 2020	Systematic review	Review of clinical pharmacists in perioperative care	Supported improved medication management and risk detection in surgical patients
Chapuis <i>et al.</i> , 2019	Anaesthesiology and critical care department	Integration of a pharmacist into the department	Improved medication-management processes and supported safer practice
ASHP, 2019	Perioperative pharmacy services guidance	Guideline-based pharmacy role definition	Defined pharmacist responsibilities across the perioperative continuum
Nanji <i>et al.</i> , 2016 ^[4]	Perioperative medication-safety study	Analysis of medication errors in the EHR era	Highlighted persistent error risks and need for systems-based prevention
Merry <i>et al.</i> , 2011	Anaesthesia medication-administration system	Multimodal safety intervention	Demonstrated that structured systems can reduce medication-administration errors
Smith <i>et al.</i> , 2010	Preoperative clinic	Pharmacist medication review and counselling	Improved identification of medication-related risks before surgery

Legend: ASHP, American Society of Health-System Pharmacists; EHR, electronic health record.

medication-system vulnerability (Table 5) (American Society of Health-System Pharmacists [ASHP], 2019).

Medication safety and Medication-error prevention

Medication safety is one of the most compelling reasons to embed pharmacists in perioperative care. The operating room and surrounding perioperative environment concentrate several known error-producing conditions: look-alike ampoules, unlabeled syringes, interruptions, time pressure, incomplete records, high-alert medicines, and frequent handovers. Anesthesia safety literature emphasizes that operating-room medication safety requires a combination of systems thinking, training, standardization, and process redesign rather than reliance on vigilance alone (Glavin, 2010).

A useful way to discuss pharmacist contributions is through the familiar safety domains of standardization, technology, pharmacy support, and culture. Standardization includes consistent concentrations, labels, tray layouts, and protocols. Technology includes barcode systems, computerized order entry, and safer documentation practices. Pharmacy support emphasizes shifting medication preparation away from ad hoc OR compounding toward standardized products and pharmacy-supported supply. Culture includes teamwork, speaking up, checklist use, and non-punitive reporting. Pharmacists contribute to all of these domains (Cohen, 2007).

The WHO Surgical Safety Checklist also intersects with medication safety because it formalizes communication at three key moments: before induction, before incision, and before the patient leaves the OR. Although the checklist is not a pharmacy tool, pharmacists reinforce its goals by helping ensure that medication-related parts of the pathway are reliable: accurate medication histories, appropriate prophylaxis, clear recovery plans, and consistent handover communication (World Health Organization [WHO], 2009).

In practical terms, pharmacist-supported medication safety in anaesthesiology includes standardized anesthesia trays, ready-to-administer syringes where feasible, segregation of look-alike products, barcoded dispensing and administration, clearly written continuation or stop plans, post-op analgesia algorithms, audit of antibiotic timing, and medication reconciliation at admission and discharge (Institute for Safe Medication Practices [ISMP], 2021).

Importance of Multidisciplinary collaboration

No single professional can safely manage the contemporary perioperative pathway alone. Surgical safety and perioperative medication management depend on structured cooperation among surgeons, anesthesiologists, pharmacists, nurses, and other clinicians. Deliberate communication, role clarity, and shared responsibility across the whole pathway are central to safe care (Naseralallah *et al.*, 2025).

Within this multidisciplinary model, the pharmacist occupies a unique niche. Surgeons focus primarily on the operation and its surgical consequences. Anesthesiologists focus on perioperative physiology, anesthesia, analgesia, and recovery. Nurses monitor implementation and continuity at the bedside. Pharmacists, by contrast, focus on the medication logic that connects all these domains. They are therefore well placed to bridge transitions, detect discrepancies, rationalize regimens, educate patients, and support pathway standardization (Naseralallah *et al.*, 2025).

A multidisciplinary team matters not simply because it pools expertise, but because it reduces blind spots. The anesthesiologist may know the hemodynamic consequences of a drug, while the pharmacist knows its interaction profile and safer formulation strategy; the surgeon may define bleeding risk, while the pharmacist helps translate that into antithrombotic management; the nurse may identify adherence barriers or side effects first, prompting refinement of the medication plan. In this sense, pharmacist-anesthesiologist collaboration is best seen not as a stand-alone partnership but as a core link inside a wider multidisciplinary network that improves continuity from scheduling to discharge (Figure 3) (Naseralallah *et al.*, 2025).

GAP AND CHALLENGES

Despite the potential of clinical pharmacists in perioperative care, their integration into anesthesiology and surgical teams remains inconsistent. Current practice often focuses on selected activities

such as medication reconciliation and discharge review rather than continuous involvement throughout the perioperative pathway. Evidence is also limited by variation in study designs, settings and outcome measures, making it difficult to establish standardized models of practice. The gap between potential and current practice highlights the need for formal collaborative protocols, defined clinical roles, adequate staffing, pharmacist training in perioperative and critical care pharmacotherapy, and high-quality multicentre studies. Bridging this gap could transform pharmacists from supportive medication reviewers into integral contributors to perioperative safety and patient outcomes.

FUTURE OUTLOOK

The future of clinical pharmacist in perioperative setup is likely to move toward proactive, integrated and technology-enabled medication management. Clinical pharmacists may increasingly become permanent members of perioperative and anesthesiology teams, contributing to medication reconciliation, individualized pharmacotherapy, antimicrobial stewardship, acute pain management and discharge optimization. Integration of electronic medication reconciliation, clinical decision-support systems, barcode technology and potentially artificial intelligence could further improve medication safety and enable earlier identification of high-risk patients. Future research should focus on standardized pharmacist-anesthesiologist collaboration models and clinically meaningful outcomes, including

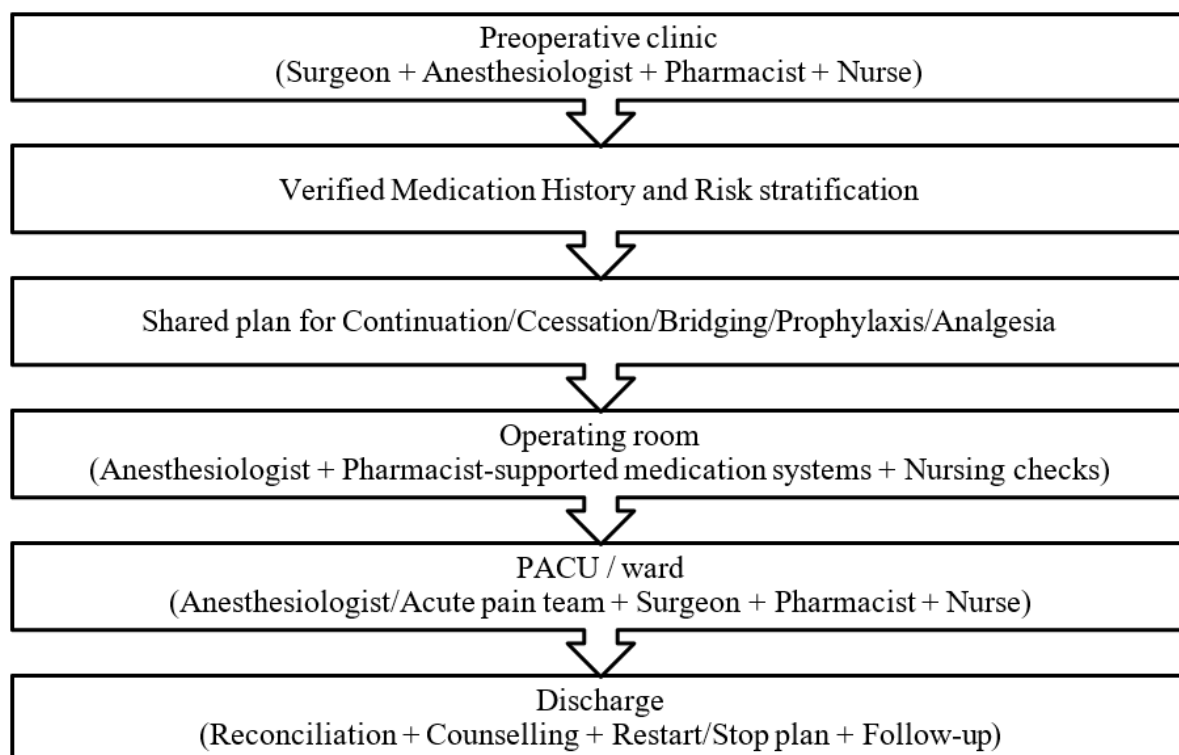


Figure 3: Multidisciplinary perioperative medication collaboration.

medication-related harm, complications, readmissions, length of stay and cost-effectiveness.

CONCLUSION

The evolution of surgical care into a longitudinal, medication-intensive therapeutic continuum has highlighted the critical need for systems-based safety strategies to mitigate preventable medication-related harm. This review demonstrates that clinical pharmacists have transitioned from traditional passive dispensing roles to active, indispensable collaborators across the entire perioperative pathway. By constructing accurate preoperative medication histories, supporting intraoperative standardization and antimicrobial stewardship, optimizing postoperative multimodal analgesia, and coordinating high-risk transitions of care, clinical pharmacists significantly enhance patient safety and therapy optimization.

The collaborative partnership between clinical pharmacists and anesthesiologists is particularly valuable, converting routine medication reviews into actionable clinical interventions that directly address medication-mediated anesthetic outcomes. However, widespread and consistent integration remains hindered by organizational variations, staffing constraints, and specialized training gaps. To fully realize the potential of this multidisciplinary model, future practice must focus on establishing formal collaborative protocols, expanding perioperative-focused pharmacy training, and leveraging integrated, technology-enabled systems such as clinical decision support and barcode administration. Ultimately, permanently embedding clinical pharmacists as core members of the surgical team represents a vital step toward safeguarding patients and achieving optimal outcomes across the perioperative journey.

ABBREVIATIONS

OR: Operating Room; **PACU:** Post-Anesthesia Care Unit; **OTC:** Over-the-Counter; **ASHP:** American Society of Health-System Pharmacists; **EHR:** Electronic Health Record; **NSAIDs:** Nonsteroidal Anti-Inflammatory Drugs; **PONV:** Postoperative Nausea and Vomiting; **VTE:** Venous Thromboembolism; **LMWH:** Low-Molecular-Weight Heparin; **DOAC:** Direct Oral Anticoagulant.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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