






Perioperative clinical pharmacy practice: Responsibilities and scope within the surgical care continuum

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Abstract

Current published guidelines for perioperative pharmacy services have limited information on the development and implementation of a robust clinical pharmacy program across the surgical continuum of care. This publication defines the responsibilities and scope of practice of the Perioperative Clinical Pharmacist (PCPh), supporting the PCPh as a critical member of the interprofessional surgical patient care team. Opportunities for pharmacist role integration into perioperative medication management processes are described along with published examples of successful PCPh practice models, including those with interventions targeted toward Enhanced Recovery Pathways (ERP). Recommended training and competencies for future and practicing perioperative pharmacists, in addition to considerations for precepting and scholarly activities, are also outlined. Finally, future developments in

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perioperative pharmacy practice are discussed, including technological advancements, improved predictive models, and expansion of collaborative practice agreements.

KEYWORDS

anesthesia, clinical pharmacist, pharmacotherapy, surgery

Globally, thousands of surgeries are performed every day.¹ Over 100 million surgeries were performed in the United States in 2010, and one estimate suggests that Americans will undergo about nine surgical procedures during their lifetime.^{2,3} Health care institutions frequently have surgical services for patient care that directly contribute to patient volumes, quality metrics, and overall financial and outcomes accountabilities. Clinical pharmacists have long been recognized for their impact on patient outcomes.⁴⁻⁸ They are licensed professionals with specialized advanced education and training obtained from either an accredited postgraduate clinical training program or from equivalent post-graduate clinical experience. This advanced education and training allow them to achieve and sustain clinical competencies necessary to practice in interprofessional, direct patient care environments.⁹ Specifically, the perioperative setting is largely a unique clinical environment that offers several opportunities in which the expertise of a clinical pharmacist can be leveraged to significantly impact patient outcomes.

Currently, the clinical pharmacist practice model supporting the perioperative patient often involves clinical pharmacists specializing in patient populations that transition to and from the perioperative and procedural environments. Specialties may include emergency medicine, transplant, and critical care (eg, surgical, trauma, neurological, and cardiac intensive care units), among others. Although this has been the accepted practice model for surgical patients for decades, clinical pharmacists operating in this manner often have varying degrees of understanding and involvement in perioperative operations and clinical care. This limited knowledge and integration into the perioperative phases of care of all patients may translate into suboptimal medication use practices and surgical outcomes. Meanwhile, the traditional "Operating Room" pharmacist role has historically focused on distributive and compliance functions, with more reactive clinical activities as needed.

The purpose of this opinion paper is to provide a reimagined vision for the standard of clinical pharmacy services within the perioperative and periprocedural arena. It will outline an optimal clinical pharmacist practice servicing patients across the continuum of surgical care and to demonstrate the value of such pharmacists to procedural patients and health care teams. While the role of clinical pharmacy services has been well described in specific areas that intersect with the perioperative continuum (eg, critical care, emergency medicine, and ambulatory care), this paper aims to broaden the scope and expectations of pharmacist impact on perioperative care. This piece will introduce perioperative clinical pharmacy as a unique practice area with a comprehensive approach to optimizing surgical patient outcomes through longitudinal integration into

interprofessional surgical teams. Herein, the Perioperative Clinical Pharmacist (PCPh) is described in terms of scope of practice, value to patients and institutions, professional roles, and daily responsibilities. This will include an overview of published examples of PCPh practice models and their impact on patient outcomes, a review of opportunities for optimizing the medication use process and pharmacist interventions across the surgical continuum of care, and suggested training and competencies to yield an effective PCPh. Finally, options for integration of perioperative clinical pharmacy competency areas into elective pharmacy learner experiences are discussed, in addition to evolving forces within health care with direct impact on PCPh practice.

We feel this treatise will be of interest to broad audiences within the pharmacy profession, including pharmacy administrators grappling with increased demands from surgery and anesthesia clinicians, clinical pharmacist practice leaders identifying institutional opportunities to improve surgical patient outcomes, and pharmacists currently practicing in perioperative arenas or otherwise providing pharmacy services to procedural patient populations. Potential uses of this document ultimately include to: (a) define or redefine clinical pharmacy scope of practice in perioperative arenas at one's own institution, (b) provide published evidence supporting PCPh practice as an evolving specialty, (c) provide guidance on optimal PCPh training and clinical competencies, (d) develop PCPh practice models based on provided examples, (e) provide guidance on optimal use of existing perioperative pharmacy resources to support clinical work, (f) support the financial justification of PCPh resources, (g) provide resources to support pharmacists' roles in enhanced recovery pathways (ERP), (h) provide ideas for incorporation of PCPh competencies into pharmacy learner experiences, and (i) inform forecasting for future PCPh priorities based on emerging practice shifts.

1 | IMPROVING OUTCOMES ACROSS THE SURGICAL CONTINUUM OF CARE: SCOPE AND EVIDENCE FOR PCPh PRACTICE

Published guidance on the scope of pharmacy practice in the realms of surgery and anesthesia has existed since 1991, and full guidelines on pharmaceutical services were first published by the American Society of Health-System Pharmacists (ASHP) in 1998.^{10,11} These guidelines, updated in 2019, focus primarily on operational activities, regulatory compliance, and supportive roles of the pharmacist in the perioperative arena. "Clinical activities" were the seventh listed



pharmaceutical service in the most recent guidelines and were broadly described to include medication regimen review, drug information, formulary, and medication use management, participation in patient care rounds and emergency response, and educational and scholarly roles.^{11,12} The American College of Clinical Pharmacy (ACCP) Perioperative Care Practice and Research Network (PRN) leadership has prepared this publication as a corollary to the ASHP guidelines to comprehensively describe the clinical interventions and services the perioperative pharmacist could pursue.

ACCP has long advocated that pharmacists work in a collaborative manner with physicians and other health care providers to achieve the best possible patient outcomes.¹³ The ongoing pharmacy practice trends driven by ASHP via the Pharmacy Advancement Initiative (PAI), as an evolution of the Pharmacy Practice Model Initiative (PPMI), continue to challenge clinical pharmacists towards full integration into interprofessional teams and accountability to patient outcomes, and this mindset should fully apply to perioperative pharmacy practitioners.¹⁴ Additionally, surgical quality improvement projects, such as the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP), NSQIP Pediatric, the NSQIP Trauma Quality Improvement Program, the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP), and the American Society for Enhanced Recovery (ASER) include detailed descriptions of perioperative pharmacotherapy considerations which offer opportunities for PCPh involvement and further highlight the importance of multidisciplinary, collaborative patient care in this space.¹⁵

The perioperative environment boasts unique medication use practices and opportunities for clinical intervention that arguably warrant its recognition as a discrete clinical pharmacy specialty area and as a distinct career path in health systems pharmacy. The PCPh has specialized therapeutic knowledge, experience, and judgment for the purpose of ensuring optimal medication use and patient outcomes throughout the surgical continuum of care, as exemplified by the interventions described in subsequent sections. The scope of practice of the PCPh, through specialized or integrated pharmacist roles, can be extensive. Optimally, it would support patients from every surgical service line and would encompass the patient's entire surgical journey, from pre-admission to post-discharge follow-up. Within this scope, the PCPh assumes the responsibility and accountability for optimizing medication-related perioperative outcomes for all surgical patients within their practice.

Evolving literature exists to support expanded clinical pharmacist presence in surgical patient care. PCPh practice has been described in a variety of roles including, but not limited to, enhanced recovery program (ERP) development and implementation, collaborative practice agreements, preoperative antimicrobial prophylaxis, venous thromboembolism risk assessment and prophylaxis, postoperative nausea and vomiting (PONV) prevention, pain management, and glycemic control.¹⁶⁻²¹ Several studies have identified clinical pharmacist practices that led to improved safety outcomes in perioperative patients. Stratman *et al.* described the successful implementation of a comprehensive anesthesia medication safety program guided by the 2010

Anesthesia Patient Safety Foundation consensus recommendations that focused on medication standardization, provision of ready-to-use products, utilization of technology, and the culture of medication error reporting.²² In an extensive literature review conducted by Wahr *et al.*, operating room medication safety strategies were collated to assist institutions in their assessment of vulnerabilities and application of system solutions.²³ A prospective analysis of pharmacist interventions on electronic prescriber medication orders in a post-surgical ward revealed a 28.2% rate of pharmacist-identified drug-related problems and data to guide subsequent prescriber education.²⁴ Neville *et al.* identified over 1000 interventions within 6 months that resulted in fewer adverse drug events, lower medication costs, and decreased hospital length of stay with the direct integration of clinical pharmacists on general surgery wards.²⁵ Recently, a prospective, randomized study assessed the impact of a pharmacist medication management service entailing comprehensive preoperative medication reconciliation and discharge prescription preparation in a high-risk elective surgery population.²⁶ The intervention group realized significant reductions in medication history and discharge prescription errors in addition to improved inpatient prescribing accuracy and more comprehensive discharge summaries as compared with usual care. These, and other evaluations, illustrate the value of clinical pharmacists in perioperative patient care units as well as in procedural settings.

Clinical pharmacists are also well positioned to support their institutions in achieving higher quality measure compliance, including associated clinical care and economic metrics. For example, Jordan *et al.* demonstrated an improved institutional compliance rate with the Surgical Care Improvement Project (SCIP) preoperative antibiotic selection quality measure following the implementation of an operating room clinical pharmacist service at a large Level 1 trauma and surgery center.²⁷ The service was also associated with a substantial increase in revenue through improved medication charge capture related to a collaboratively optimized anesthesia medication distribution and billing process. Indeed, the positive clinical and economic impact of pharmacist-managed surgical antimicrobial prophylaxis has been described previously, including significant reductions in surgical site infection, length of stay, and Medicare charges.²⁸ Another retrospective observational study quantified significant reductions in blood transfusion and associated cost savings in a total knee arthroplasty (TKA) population in which pharmacist intervention on antifibrinolytic therapy was implemented.²⁹ Significant improvements in postoperative complications and associated cost-savings through pay-for-performance reimbursement programs were realized in another total joint arthroplasty population with the integration of a comprehensive clinical pharmacy service.³⁰

Strong interprofessional relationships between perioperative clinical pharmacists and the surgical team were also proven to be vital in successful stewardship efforts of high-risk or high-cost medications employed in perioperative settings.³¹ Vincent *et al.* applied intravenous acetaminophen (IV APAP) guidelines within ERP implementation that saved one Massachusetts medical center over \$400 000, decreased IV APAP utilization by 83%, increased use of multi-modal



oral pain management strategies by 18%, and almost tripled pharmacist documentation of care provided.³² Hyland et al. demonstrated an estimated \$2.9 million annual drug expenditure savings for three high-cost medications associated with robust clinical perioperative pharmacy services at a large community hospital.³³ Furthermore, clinical pharmacists possess the knowledge and skills necessary to lead high-quality retrospective or prospective, randomized controlled trials to comprehensively assess comparative efficacy and costs of care related to perioperative medications.^{34,35} While these examples highlight the positive impact clinical pharmacists have already had on select institutions, there is further need for the clinical pharmacy profession to establish the PCPh as a vital component of standard patient care in the perioperative arena, as has been accomplished in so many other practice areas.

2 | PCPH ACTIVITIES, INTERVENTIONS, AND PRACTICE MODEL DEVELOPMENT

Patient care opportunities for PCPhs extend far beyond traditional operational and compliance functions, especially in light of advances in medication technology and pharmacy technician roles. The American College of Clinical Pharmacy has provided recommendations on standards for clinical pharmacists. The recommendations include the following: residency training or equivalent post-graduate training, Board of Pharmaceutical Specialties certification, collaborating with the health care team on treatment recommendations and monitoring patient therapy, obtaining a medication history to improve patient outcomes with transitions of care, privileging in areas of practice where deemed appropriate, and active participation in research and scholarship.³⁶ Furthermore, PCPhs should be active participants, if not primary drivers, in institutional process changes and quality initiatives aimed at improving perioperative medication management and surgical outcomes at the interdepartmental level and beyond.

As surgical outcomes play an increasingly influential role in both the long-term health of patients and the fiscal viability of health systems, PCPhs should focus their interventions on the goals of optimizing surgical success rates, mitigating perioperative complications, facilitating safe and effective transitions of care, and supporting a positive patient experience. Selected examples of PCPh areas of focus and clinical interventions across the phases of perioperative care are described in Table 1. This table includes diverse direct patient care opportunities throughout many different physical locations and temporal points, and is intended to provide a “menu” of potential activities that a PCPh could pursue in a given role or position. A particular PCPh, for example, could pursue all applicable medication management and clinical activities across every phase of care for a specific procedure type (eg, a bariatric surgery-focused PCPh position). An alternative PCPh model could focus interventions on fewer phases of care for a broader surgical population (eg, a post-anesthesia care unit [PACU]-based position).

While the perioperative space may be best served by clinical pharmacists with a focused expertise in perioperative medicine (ie,

dedicated PCPhs), the practice model may also be adapted to meet individual institutional needs and workflow. For the purposes of the vision described in this article, the role of the PCPh may be filled by any pharmacist or team of pharmacists with equivalent post-graduate clinical experience in the operating room setting who are functioning in a clinical capacity to serve perioperative patients. A dedicated PCPh may expand the outreach of clinical services by providing advanced training to inpatient operating room (OR) pharmacists, or these roles may combine into integrated clinical and operational positions.

Regardless of degree of specialization or integration of PCPh roles, full application of the ASHP PAI concepts should be applied to any existing perioperative pharmacy services to maximize clinical impact. The central tenets of this framework, as recommended at the Pharmacy Practice Model Initiative (PPMI) Summit, include the expansion of pharmacy technician roles, use of technology to liberate pharmacist resources, recognition of the pharmacist as clinical professional imbedded in interprofessional care teams, and pharmacist accountability to patients' medication-related outcomes.³⁷ Figure 1 describes representative examples of how traditional “OR Pharmacist” activities can be reimaged to maximize clinical impact as a PCPh.

After maximizing current resources, it may become necessary to garner additional support for PCPhs to realize the greater benefit to patient and institutional surgical outcomes. New personnel resource requests may be buoyed by relationships established by existing PCPh positions, after interprofessional stakeholders have a positive experience with a rotating pharmacy resident, after a successful pilot of a new PCPh service, and/or with support from external grant funding. New PCPh positions or pilot proposals should be designed to offer maximal PCPh impact on outcomes of greatest institutional interest, including those that will demonstrate the financial advantage of the position(s). Table 2 offers examples of target outcomes and associated pharmacist activities to ensure fiscal sustainability of new or evolving PCPh positions.

3 | ENHANCED RECOVERY PATHWAYS AND THE ROLE OF THE PERIOPERATIVE CLINICAL PHARMACIST

The development, implementation, and evaluation of ERPs provide a specific example of one significant advancement in perioperative clinical pharmacy practice. The principles of ERPs focus on elements such as optimizing preoperative status, avoidance of fluid overload, early feeding, early ambulation, opioid-sparing pain management, and patient engagement.³⁸ The interventions outlined in Table 1 may be used during development and implementation of an ERP to guide the incorporation of the PCPh into the process. Institutions embracing highly compliant ERPs have shown decreased length of stay, reduced complication rates, decreased practice variability, improved resource utilization, and decreased health care costs.³⁸



TABLE 1 Pharmacist intervention opportunities across the surgical care continuum

Phase of care	Pharmacist intervention opportunities	Example areas of contribution
Pre-admission	Optimize chronic disease states	<ul style="list-style-type: none"> • Diabetes management • Hypertension management • Nutrition assessment and optimization, in conjunction with dietician • Weight loss resources/referrals, where indicated • Hypoglycemia risk in special preoperative diets • Chronic pain
	Create perioperative medication management plan	<ul style="list-style-type: none"> • Medication reconciliation, including herbal and OTC supplement review • Allergy history and documentation, focusing on patient education and delabeling antibiotic allergies, referring to allergy testing when appropriate • Plan for chronic medications in days prior to surgery (eg, which medications to take and which to hold on day of procedure, insulin dose adjustments, cardiac medication considerations) • Postoperative VTE risk stratification and recommendations for anticoagulation management, bridging, and/or prophylaxis • Chronic pain assessment and plan, (eg, opioid optimization, tapering or identifying need for alternative dosage forms or routes, medication-assisted therapy) • Assessment and plan for the management of immunosuppressive agents (eg, antirheumatics, monoclonal antibodies, chronic steroids) • Assessment and management plan for patients with thrombophilias • Coordination of time-sensitive preoperative medication therapy (eg, prostacyclins)
	Create patient- and/or procedure-specific plans to reduce complications and risks	<ul style="list-style-type: none"> • Anemia management plan • Immunization assessment and planning, (eg, elective splenectomy or solid organ transplant) • Smoking cessation plan development and counseling • Bowel preparation, when indicated • Aspiration risk stratification and plan for when to initiate NPO status prior to surgery • PONV risk assessment and therapy plan • MRSA testing and decolonization • Skin preparation (eg, chlorhexidine bath product recommendation, dispensing) • Assessment for potential affordability or access barriers to postoperative medication plan adherence
	Complete patient education and counseling	<ul style="list-style-type: none"> • Education on appropriate postoperative pain expectations, use of multimodal analgesia regimens, and safe opioid use, storage, and disposal • Medication-related continuity of care, explanation of discharge prescription needs • Education on preoperative carbohydrate loading products for ERP protocols
Preoperative	Facilitate preoperative medication protocols	<ul style="list-style-type: none"> • PONV prophylaxis • Antimicrobial prophylaxis • Fluid status optimization • Preemptive analgesia as part of comprehensive multimodal pain management program • Venous thromboembolism prophylaxis
	Facilitate care coordination for high-risk therapies	<ul style="list-style-type: none"> • Therapy plan confirmation and communication for patients with preexisting medication delivery devices (eg, insulin pumps, intrathecal opioid pumps) • Execution of appropriate plan for prophylactic therapies for unique disease states (eg, hemophilia factor products, octreotide for carcinoid crisis prevention, stress-dose corticosteroids, antithrombotic bridging therapy)
	Support emergent surgery patient optimization	<ul style="list-style-type: none"> • Hemostasis strategies, reversal of anticoagulation • Resuscitation, hemodynamic stabilization

(Continues)



TABLE 1 (Continued)

Phase of care	Pharmacist intervention opportunities	Example areas of contribution
Intraoperative	Developing medication use criteria and monitoring compliance	<ul style="list-style-type: none"> Medication safety considerations for high-risk therapies (eg, concentrated formulations, blood factor products, insulin, heparin, vasoactive agents) Stewardship of high-cost medications (eg, sugammadex, liposomal bupivacaine, IV acetaminophen)
	Support execution of intraoperative medication-related protocols by surgical team	<ul style="list-style-type: none"> Antimicrobial prophylaxis redosing Medication-containing irrigations Local medication injections by surgeon
	Support anesthesia provider medication needs and optimization	<ul style="list-style-type: none"> Allergy implications for anesthetic plan Regional anesthetic strategies Total local anesthetic exposure assessment Total intravenous anesthesia Intravenous fluid management
	Facilitate safe use of high-risk intraoperative medication therapies	<ul style="list-style-type: none"> Cardioplegia formulations Verification of appropriate setup of anesthesia vasoactive infusions for use after cardiopulmonary bypass completion Use of direct thrombin inhibitors for patients with contraindications to heparin Safe use of intraoperative chemotherapy
	Complete necessary controlled substance compliance activities	<ul style="list-style-type: none"> Anesthesia audits and resolution of discrepancies Automated dispensing cabinet inventory optimization
	Emergency response	<ul style="list-style-type: none"> Bedside support in the event of intraoperative arrest or other medical emergencies (eg, urgent medication availability, bedside compounding, guiding resuscitative medication strategies) Medication protocols for malignant hyperthermia, local anesthetic systemic toxicity
PACU	Optimize fluid status	<ul style="list-style-type: none"> Fluid management plan monitoring and optimization
	Support PACU medication-related protocols	<ul style="list-style-type: none"> PONV treatment Delayed anesthesia emergence Glucose monitoring and optimization
	Execute and monitor pain management plan	<ul style="list-style-type: none"> Safe use and optimal dosing of epidural infusions, successful transition if initiated in PACU Appropriate opioid dosing based on tolerance and risk factors for opioid-related adverse events
Postoperative	Facilitate medication continuity through transitions of care	<ul style="list-style-type: none"> Anticoagulation bridging and monitoring Appropriate reinitiation of necessary home medications (eg, antidiabetic regimens, anti-parkinsonian medications, psychiatric regimen)
	Optimize pain management and opioid stewardship	<ul style="list-style-type: none"> Proactive pain regimen monitoring and adjustment including patient-specific optimization of multimodal analgesia Appropriate re-initiation of medication-assisted therapy for substance use disorders Verification of epidural or PCA orders, communication of dosing adjustments to nursing staff Controlled substance waste documentation
	Optimize medication use to prevent complications, ensure adherence to perioperative clinical practice standards	<ul style="list-style-type: none"> Duration of antimicrobial prophylaxis Glucose control Preventative therapy protocols (eg, bowel regimen) Dosing adjustments for special populations or conditions (eg, obesity, end organ dysfunction) Verification of medication administration for critical therapies and address nonadherence (eg, VTE prophylaxis, bowel regimens) Prevention/optimization of high-cost, low-value medication choices (eg, transition IV acetaminophen to PO) Early nutrition initiation
	Provide evidence-based recommendations for management of complications	<ul style="list-style-type: none"> Postoperative atrial fibrillation management High ileostomy output management

(Continues)



TABLE 1 (Continued)

Phase of care	Pharmacist intervention opportunities	Example areas of contribution
	Participate in interprofessional teaching rounds Explore collaborative practice and credentialing opportunities to streamline interventions	<ul style="list-style-type: none"> • Urinary retention therapies • Ileus therapies • VTE treatment • Postoperative infection treatment, including empiric and targeted antimicrobial selection and duration • Interprofessional collaboration • Provision of teaching moments for surgical residents and teams • Pain management/multimodal analgesia • VTE prophylaxis • Bowel regimen • Diabetes management
Discharge	Optimize discharge medication prescribing Ensure patient and/or caretaker understanding of medication changes at discharge Assess for and address barriers to patient execution of discharge medication plan Facilitate transition of medication plan for patients discharged to nursing or rehabilitation facilities	<ul style="list-style-type: none"> • Comprehensive discharge medication reconciliation (eg, individualized opioid prescribing, applicable chronic medication regimen changes, appropriate dosing and duration of new therapies) • Medication therapy management for complex care changes (eg, implications of bariatric surgery on chronic medication selection and dosage forms) • Prescription coordination for non-opioid analgesics (eg, celecoxib, acetaminophen) as scheduled multimodal pain management • Assessment for extended VTE prophylaxis • Compliance with state and federal regulations on opioid prescribing • Education on new medications and changes to chronic medications • Education on safe opioid use, storage, disposal, and weaning plan • Medication education tools where appropriate (eg, medication schedule grids, pillboxes, mobile applications) • Medication cost assessment and access programs/coupons • Verification of correct pharmacy for electronic prescribing • Discharge medication filling (eg, "Meds-to-Beds" programs) • Discharge huddles with surgical and pharmacist team prior to transition • Confirmation of opioid prescription handling according to post-discharge facility or state requirements (ie, printed vs electronically prescribed)
Follow-up	Monitor compliance with medication care plan	<ul style="list-style-type: none"> • Post-discharge follow-up calls and appointments to monitor discharge medication plan • Medication adverse effects monitoring and prescription changes as needed • Opioid taper monitoring and adjustment

Abbreviations: IV, intravenous; MRSA, methicillin-resistant *Staphylococcus aureus*; NPO, nothing by mouth; OTC, over the counter; PACU, post-anesthesia care unit; PCA, patient-controlled analgesia; PO, oral/by mouth; PONV, postoperative nausea and vomiting; VTE, venous thromboembolism.

Although compliance with ERP elements positively predicts better surgical outcomes, many unanswered pharmacotherapeutic questions remain.³⁹ The most successful ERPs are developed and implemented by surgery-specific interprofessional teams with an established cadence for team meetings. Post-implementation meetings primarily focus on pathway compliance and review of outcome data.³⁸ The PCPh often serves as the common communicative interface between anesthesia, surgery, nursing, and administration during various phases of the ERP. This involvement provides the PCPh with the opportunity to influence several aspects of the patient's surgical journey throughout the perioperative continuum of care, both directly and indirectly.

The PCPh can add direct value on an individual patient basis by incorporating a pharmacotherapy review into the preoperative planning process. Incorporation of perioperative medication review and

reconciliation provides an opportunity to eliminate duplication, decrease errors with inpatient medication reconciliation, and educate patients on their current medications including providing instructions on how to adjust insulin, anticoagulants, or other high-risk medications around their surgery. Finally, incorporating counseling on opioid and non-opioid pain management options including realistic pain management expectations plays an important role in successful implementation of ERP programs, results in improved patient satisfaction with the entire perioperative experience, and may meet regulatory requirements of many states regarding patient rights to decline opioids.³⁸ PCPhs are well-poised to provide and/or inform such education.

The PCPh may also engage in quality and performance improvement projects and research focused on evaluating the impact of medication management and stewardship-related interventions within



Conventional Operating Room Pharmacist Activities	Suggested Adjustment	Perioperative Clinical Pharmacist Activities
Manual verification of anesthesia medication trays Medication distribution Sterile compounding of surgeon/anesthesia medications Anesthesia narcotic compliance auditing Transcription of PREOP surgeon orders	Delegate to non-pharmacist	Electronic verification of barcode labels in automated anesthesia medication tray refill process Efficient advance and/or protocolized order processing Anesthesia narcotic discrepancy reconciliation
Inefficient order processing on day of surgery Reactive processing of high risk and/or high cost medication orders Anesthesia narcotic discrepancy reconciliation	Increase efficiency	Prospective clinical review of medication orders and collaborative bedside decision making for high-risk and/or high-cost medications Proactive optimization of perioperative antibiotic orders Multimodal pain management and opioid stewardship, e.g. preemptive analgesia, dosing in opioid tolerance Emergency response/ACLS and bedside support for emergent surgeries, e.g. anticoagulation reversal Drug information and staff support at bedside
Limited prospective clinical review of medication orders Emergency medication compounding/distribution Drug information	Prioritize and expand	Active involvement in perioperative services committees Medication-related protocol development and process improvement leadership Medication use evaluations and prescriber feedback Precepting, teaching, research and scholarly activities
Ad hoc representation on surgery quality committee(s) Medication use evaluations	Allot due time	
■ = Necessary tasks without added value to patient outcomes in being completed by a pharmacist ■ = Tasks that must be completed by a pharmacist but with lower direct impact on patient outcomes ■ = High-value pharmacist interventions directly focused on improving patient outcomes ■ = High-value pharmacist activities indirectly improving patient outcomes and/or contributing to healthcare advancement		

FIGURE 1 Example advancement of perioperative pharmacist responsibilities. ACLS, Advanced Cardiac Life Support

ERPs.^{40,41} Studies have assessed compliance with an ERP as a key indicator for the benefits of the pathway.^{42,43} The PCPh can play a major role in order set creation and electronic medical record documentation of ERP interventions to aid in standardization, pathway compliance assessment, and actions from data collection.

The following three examples illustrate the potential impact of a PCPh in the ERP era. Pharmacists at one institution developed a new multimodal pain management plan with the anesthesia and surgical team to incorporate intrathecal (IT) regional anesthesia rather than epidural for postoperative analgesia. This transition was driven by both safety and efficacy data for IT analgesia and emerging rationale supporting IT as a more favorable modality to improve recovery.⁴¹ PCPhs at another institution developed an ERP for total joint replacement surgery incorporating standardized oral multimodal analgesics in the preoperative and postoperative phases of care. The PCPh then ensures protocol compliance or appropriate adjustment for applicable patients.^{30,31} Finally, a third example of PCPh involvement in ERP includes the bariatric and other gastrointestinal surgery populations. The PCPh can encourage the surgical team to initiate a diet the night of surgery instead of on the first postoperative day to facilitate earlier resumption of home medications and, potentially, earlier hospital discharge. Models like these have been determined transferable to other institutions as shown in a recent collaborative example for colorectal surgery and in the goals for the American College of Surgeons, which include improvement in patient experience, teamwork, and safety culture as well as reductions in opioid use, hospital-acquired infections, and venous thromboembolic events.^{17,44}

4 | SUGGESTED TRAINING AND COMPETENCIES OF THE PCPH

The vast scope and complexity of surgery, anesthesia, and perioperative care demand a broad professional competency from the PCPh. This dynamic raises unique challenges for PCPh practice, but is also necessary to provide unique value to patients, providers, and institutions. The effective PCPh therefore has the knowledge base necessary to optimize medication use across the surgical continuum of care within his/her area of practice, including clinical skill sets, interdepartmental workflow understanding, transitions of care oversight, and appreciation of institutional and external factors influencing surgical outcomes.

Adding value to this complex orchestra first requires a working knowledge of the perioperative landscape and the interprofessional players involved in each part. Figure 2 and Table 3 provide an overview of the perioperative continuum of care, defining each phase and listing representative examples of interprofessional team member roles. A new PCPh should invest time observing the workflows of this team across different surgical specialties and settings to gain a functional understanding of the perioperative care process. This approach also provides an opportunity to identify potential medication-related interventions and establish lines of communication to foster interprofessional collaboration.

A working knowledge of the perioperative care continuum and interprofessional familiarity lend greatly to the implementation of the Pharmacists' Patient Care Process within this setting,⁴⁵ which can be

TABLE 2 Applied examples of sustainable PCPh practice model targets

Target for PCPh resource justification	Suggested pharmacist activities and workflow considerations
Quality metric compliance impacting CMS reimbursement penalties	
Postoperative VTE rate	<ul style="list-style-type: none"> • Assist with patient-specific VTE risk stratification • Develop method for prospectively identifying and reviewing patients such that VTE prophylaxis recommendations are available on day of surgery • Optimize pharmacologic VTE prophylaxis selection, dose, timing, duration, and affordability/accessibility • Round with surgical team to monitor and adjust VTE prophylaxis plan as needed • Counsel patient on VTE prophylaxis plan prior to discharge • Work with nursing to embed pharmacist counseling into discharge process for target patient populations
SSI rate	<ul style="list-style-type: none"> • Facilitate penicillin allergy documentation, assessment, and/or referral for skin testing when appropriate • Implement and monitor MRSA screening protocols • Proactively optimize all preoperative antibiotic orders including assessment of patient- and procedure-specific factors
Other postoperative complication rates, PSI-90 Quality Indicator	<ul style="list-style-type: none"> • Ensure protocolized and compliant ordering of prophylactic therapies (eg, scheduled stimulant bowel regimen to prevent postoperative ileus) • Pursue targeted medication management interventions to mitigate postoperative complication risks (eg, delay resumption of home ACEI therapy to decrease postoperative AKI risk, ensure appropriate opioid dosing in patients with OSA to decrease postoperative respiratory failure risk) • Ensure VTE prophylaxis strategy is appropriately monitored and adjusted when appropriate to ensure it does not unduly contribute to postoperative hemorrhage/hematoma or wound dehiscence complication risks
Postoperative readmission rates	<ul style="list-style-type: none"> • Provide preoperative patient education on likely new medications and discharge needs • Educate patients on new prescriptions at point of discharge, including indication/importance, appropriate use, expected side effects, and how to triage any medication issues that arise • Ensure affordability and accessibility (eg, transportation plan) of new prescriptions prior to discharge • Facilitate charity dispensing of medications to uninsured patients and/or execute comprehensive discharge prescription program (ie, "Meds-to-Beds")
Medication use management impacting perioperative drug expenditure	
Stewardship of high-cost intraoperative meds, MUEs for perioperative medications	<ul style="list-style-type: none"> • Implement automatic stop dates, defined therapy duration (eg, limit to one-time dose) • Inform usage criteria guidance - target patient population(s), prescriber restrictions (eg, attending or specialist approval required), advance ordering requirements • Inform clinical algorithms, order sets • Provide medication utilization surveillance, benchmarking and prescriber feedback
Medication waste reduction	<ul style="list-style-type: none"> • Optimize stocked vial sizes (eg, thrombin) • Optimize stocked concentrations (eg, heparin, factor products, ketamine)
340b Discount drug program	<ul style="list-style-type: none"> • Optimize intrauterine device formulary • Provide review for high-use medication eligibility
Formulary management	<ul style="list-style-type: none"> • Proactively and collaboratively drive evidence-based ordering consistency and/or protocol development to facilitate formulary control of perioperative medications (eg, limiting available colloid preparations) • Facilitate consignment or central stocking strategies for low-use surgical formulary items (eg, uncommon blood factor products for hemophilia surgery patients)
Perioperative medication charge capture	
Medication administration documentation	<ul style="list-style-type: none"> • Optimize intraoperative medication database used by nursing to document surgeon-administered medications to ensure alignment with stocked medication dosage forms • Build preference lists, order sets, and navigators as appropriate to optimize intraoperative CPOE functionality • Educate nursing and anesthesia users on appropriate medication documentation (eg, importance of placing a complete medication order vs narrative/comment/note)
Anesthesia drug delivery	<ul style="list-style-type: none"> • Inform sustainable process that prioritizes ready-to-use products (eg, pre-filled syringes) to reduce waste and improve safety

(Continues)



TABLE 2 (Continued)

Target for PCPh resource justification	Suggested pharmacist activities and workflow considerations
	<ul style="list-style-type: none"> • Inform a standardized case setup to limit interprovider variability in medications prepared before case start • Pursue provider auditing and feedback
Medication distribution and management impacting surgery center throughput/efficiency	
Same-day surgery case cancellation rate	<ul style="list-style-type: none"> • Integrate into preadmission patient optimization process to help improve chronic disease state management (eg, diabetes control and perioperative management of antidiabetic agents to avoid case cancellation due to hyperglycemia on day of surgery) • Advance review of surgery schedule to ensure receipt and processing of special orders needed for case (eg, hemophilia therapies, carcinoid crisis prophylaxis) • Collaborate with local compounding pharmacy(ies) to ensure reliable process for supply of surgical preparations not available commercially (eg, "brilliant blue g" ophthalmic dye, sterile alum)
Operating room case time/room turnover efficiency	<ul style="list-style-type: none"> • Optimize nursing and anesthesia medication automated dispensing cabinet stock lists and par levels to facilitate advance case set up • Promote and inform medication-related aspects of ERPs that reduce surgery/anesthesia time (eg, lighter sedation strategies, avoidance of intraoperative paralysis where possible, hemostatic strategies)
PACU length of stay	<ul style="list-style-type: none"> • Promote and inform medication-related aspects of ERPs that reduce anesthetic recovery time (eg, lighter sedation strategies, paralytic avoidance or dose optimization and reversal strategies) • Incorporate multimodal and opioid-sparing analgesia strategies into anesthesia order sets and practice • Improve identification and treatment of patients at risk for PACU complications (eg, PONV prophylaxis, delirium mitigation through decreasing anticholinergic burden in elderly patients)
Reduction of other medication-related perioperative care costs/increased revenue	
Postoperative hospital length of stay	<ul style="list-style-type: none"> • Optimize multimodal and opioid-sparing pain management to facilitate early ambulation and physical therapy • Recommend early postoperative diet initiation and early resumption of home medications when appropriate • Limit anticholinergic burden, especially in elderly patients, to avoid hospitalization-prolonging complications (eg, postoperative urinary retention, ileus)
Patient satisfaction	<ul style="list-style-type: none"> • Improve positive patient perception of care transitions by educating patients on new therapies at point of discharge, providing customized educational materials/visual aids
Bundled payment systems	<ul style="list-style-type: none"> • Drive medication cost reduction strategies for procedures in fixed reimbursement programs (eg, changing to single-dose from multi-dose tranexamic acid protocol, using conventional periarticular injection cocktails instead of liposomal bupivacaine in total knee arthroplasty)
Cost avoidance related to regulatory noncompliance	
TJC accreditation	<ul style="list-style-type: none"> • Demonstrate compliance with National Patient Safety Goals (eg, collaboratively create protocols and guidelines for perioperative management of oral anticoagulants, ensure comprehensive medication reconciliation through perioperative care transitions) • Optimize medication labeling practices
DEA compliance	<ul style="list-style-type: none"> • Collaborate with anesthesia department on efficient and transparent narcotic auditing process that protects providers and mitigates diversion

ACEI, angiotensin-converting enzyme inhibitors; AKI, acute kidney injury; CPOE, computerized prescriber order entry; DEA, Drug Enforcement Agency; MRSA, methicillin-resistant *Staphylococcus aureus*; MUE, medication use evaluation; PSI-90, patient safety indicator/patient safety and adverse events composite quality measure; SSI, surgical site infection; TJC, The Joint Commission; VTE, venous thromboembolism.

adapted into a systematic approach to surgical patient care as described in Figure 3. This approach is multifactorial and requires knowledge of anatomy, physiology, procedure indication, surgical technique, potential medical and surgical complications, procedure-specific medications, and consideration of implications for medication management throughout the entire perioperative continuum. The medication review process should evaluate therapy received during

the preoperative, intraoperative, PACU, and postoperative periods and encompass a comprehensive evaluation of indication, route of administration, monitoring parameters, duration of effects, impact on organ function, and appropriateness of administration at various levels of care.

In addition to these foundational skills and a systematic approach to care, anesthesia- and surgery-specific competencies must then be



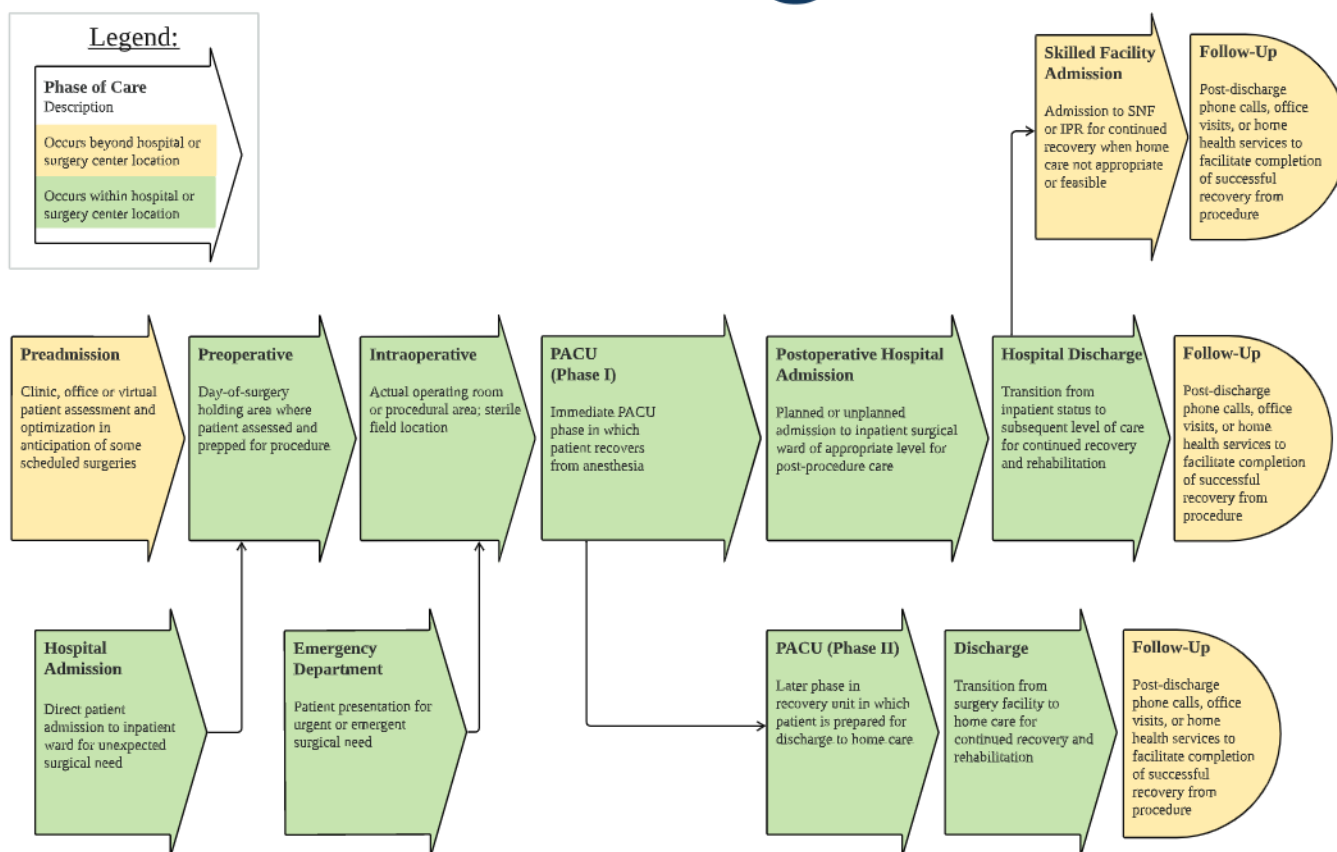


FIGURE 2 The perioperative continuum of care. IPR, inpatient rehabilitation facility; PACU, post-anesthesia care unit; SNF, skilled nursing facility (or other post-acute care facility)

layered on to tailor medication management toward optimizing surgical outcomes. Recommended discrete competencies and training elements for PCPhs are listed in Table 4.

5 | EDUCATIONAL AND SCHOLARLY ACTIVITIES FOR THE PCPH

The optimal responsibilities of the PCPh extend beyond the essential patient care activities already described to include teaching and scholarship. The education, training, and mentorship of pharmacy students (introductory pharmacy practice experience [IPPE] and/or advanced pharmacy practice experience [APPE]) and residents (postgraduate year one pharmacy residency [PGY1] and postgraduate year two specialty pharmacy residency [PGY2]) participating in required and elective learning experiences in the perioperative area, as well as members of the interprofessional team, are important aspects of being a PCPh. Although PGY2 specialty residency programs in surgery or perioperative care are not currently available, elective learning experiences in perioperative pharmacy services should be offered to PGY2 residents in critical care, emergency medicine, and solid organ transplantation. Scholarly activities challenge the PCPh to improve perioperative pharmacy services and patient outcomes in ways that generate new knowledge and advance the

role of the PCPh. The PCPh's educational and scholarly roles can facilitate growth within the practice of pharmacy, provide the PCPh opportunities to develop professionally, and inspire future pharmacists.

5.1 | Pharmacy student education in perioperative care

Student exposure to perioperative pharmacy didactic content may be somewhat limited, although some perioperative topics may overlap in other areas of disease management (eg, antiemetics for postoperative nausea/vomiting, analgesics for postoperative pain, etc.).⁴⁶ Johnson and Oylar recently described an elective course that provided instruction about perioperative pharmacy services, shadowing experiences in satellite pharmacy locations and intraoperative shadowing of an anesthesiology resident. Students demonstrated improvements in knowledge related to common surgical complications, anesthetic agents, and perioperative pharmacotherapy management, and provided favorable feedback about the course, which could serve as a model for the development of similar electives.⁴⁷

Outside of the classroom, the perioperative area and associated pharmacy practice areas can provide a valuable introduction to both operational and clinical pharmacy services during IPPEs. The PACU



TABLE 3 Overview of the Interprofessional Perioperative Care Team

Team member with whom the PCPh interacts	Key responsibilities
Pre-admission RN and/or staff (eg, medical assistant, medication history pharmacy technician)	<ul style="list-style-type: none"> Obtain medical/medication history Obtain baseline vitals, labs, and other medical testing (eg, ECG) Provide pre-surgical care instructions (eg, bathing, preoperative medication management, hydration or carbohydrate loading product or instructions)
Pre-admission medical physician or advanced practice provider	<ul style="list-style-type: none"> Complete pre-admission history and physical Provide medical/cardiac surgical clearance or referral to other outpatient medical specialist as needed
Preoperative RN	<ul style="list-style-type: none"> Obtain IV access and complete any day of surgery lab work or testing Confirm execution of pre-surgical patient preparation Administer or prepare preoperative medications (ie, preoperative antibiotics, oral cardiac medications, pre-emptive analgesia or anti-nausea agents)
Surgical team	<ul style="list-style-type: none"> May include attending surgeon, mid-level providers, and/or surgical residents Complete surgical assessment and planning (eg, dictate need and timing of procedure scheduling, procedure technique/approach) Order necessary supplies, blood products, etc., for procedure Explain the procedure, obtain patient consent Order medications needed for procedure (eg, infection prophylaxis protocol, topical/intraoperative antibiotics, medications administered in the surgical field) Perform procedure Manage surgical components of patient recovery and postoperative follow up Provide guidance on perioperative management of anticoagulant/antiplatelet agents
Anesthesia providers	<ul style="list-style-type: none"> May include attending anesthesiologist, anesthesia resident physicians, and/or certified registered nurse anesthetist Explain anesthetic technique and obtain patient consent for anesthesia/sedation procedures to be performed Execute anesthetic plan by providing regional, neuraxial, and/or general anesthesia for procedure Manage patient airway, respiratory and hemodynamic functions (eg, blood pressure), and fluid status during the surgical procedure Ensure sufficient recovery from anesthesia and confirm adequate respiratory/hemodynamic function prior to transferring patient to PACU Order PONV prevention and treatment medications Order PACU medications (eg, pain, blood pressure, nausea management) Manage PACU complications (eg, airway issues, PONV, acute pain, postoperative shivering) Manage epidural therapy postoperatively or pursue any other postoperative assessments indicated for employed anesthetic strategy
Circulator RN	<ul style="list-style-type: none"> Transport patient from preoperative holding area to OR and ultimately to PACU Provide continuity throughout intraoperative phase of care Ensure pre-procedure pause and checklist completion (eg, "time out") Document intraoperative events and medication administrations by surgeon(s) Retrieve necessary medications from automated dispensing cabinet for surgeon(s) as needed Aseptically transfer and label needed medications or supplies to sterile field as needed
Scrub RN	<ul style="list-style-type: none"> Prepare sterile supplies and medications, set up sterile field prior to procedure Scrub/prepare patient body site(s) for incision Assist surgeon(s) in sterile field during procedure
Scrub technician	<ul style="list-style-type: none"> More limited scope of practice than RN Prepare sterile supplies, set up sterile field prior to procedure Scrub/prepare patient body site(s) for incision Assists surgeon team in sterile field during procedure
Anesthesia technician	<ul style="list-style-type: none"> Assist with acquiring/setting up anesthesia equipment and supplies
OR pharmacy technician	<ul style="list-style-type: none"> Execute medication distribution and compounding tasks for procedural areas Narcotic compliance audit preparation
Perfusionist	<ul style="list-style-type: none"> Set up and provide CPB circuit for applicable procedures, including management of cardioplegic solutions Manage patient hemodynamic functions while on CPB

(Continues)



TABLE 3 (Continued)

Team member with whom the PCPh interacts	Key responsibilities
	<ul style="list-style-type: none"> Facilitate sedation maintenance while on CPB Set up and provide extracorporeal membrane oxygenation management for applicable procedures Manage autologous blood collection and processing Implement and manage intra-aortic balloon pumps Facilitate left ventricular assist device placement and management Facilitate/prepare platelet gel or related injections/procedures Facilitate other miscellaneous procedures (eg, hyperthermic intraperitoneal chemotherapy, isolated limb perfusion)
Device/supply representatives	<ul style="list-style-type: none"> Test and validate medical device placement in the operating room (eg, total joint implant, cardiac device implant, intrathecal pain pump placement)
Sterile processing	<ul style="list-style-type: none"> Sterilize and process reusable surgical supplies Prepare standardized and customized sterile supply kits by procedure
PACU RN <i>Note: Role may be fulfilled by a critical care RN for intensive care patients bypassing the PACU</i>	<ul style="list-style-type: none"> Monitor for and treat immediate postoperative surgical/anesthesia complications Provide family/caregiver discharge instructions (for outpatients) Call report to floor RN (for inpatients)
Floor/inpatient RN	<ul style="list-style-type: none"> Acknowledge/release postoperative orders from surgery and/or anesthesia team Provide postoperative monitoring and care for procedures requiring hospitalization Facilitate care coordination Provide patient/caregiver discharge instructions or call report to admitting post-hospital facility
Floor/inpatient pharmacist (ie, any other pharmacists involved in the care of surgical patients)	<ul style="list-style-type: none"> Verify postoperative orders Ensure appropriate timing of key medications such as anticoagulation, antimicrobial agents, and pain medications with respect to when last dose given in the surgical area or administration of neuraxial analgesia Discontinuation of any intraoperative or PACU orders not appropriate for use on the floor (eg, anesthetic sedatives, vasopressors if going to a medical/surgical floor unit) Direct appropriate prescribing of opioids and other pain medications at discharge
Case manager/social worker	<ul style="list-style-type: none"> Facilitate discharge planning (eg, inpatient/outpatient rehabilitation placement, discharge medication/supply/equipment needs)
Ancillary services	<ul style="list-style-type: none"> May include PT, OT, ST, RT, WOCN or others as needed to facilitate and optimize postoperative care

Note: Provided by anesthesia practitioners in some practice models.

Abbreviations: OT, occupational therapist; PACU, post-anesthesia care unit; PT, physical therapist; RN, registered nurse; RT, respiratory therapist; ST, speech therapist; WOCN, wound ostomy care nurse.

affords abundant opportunities to apply direct content from didactic education into tangible, real-world patient care. Introductory pharmacy practice experience students could receive an overview of outpatient surgery, same-day surgery hospital admissions, and inpatient surgical procedures, and interprofessional staff roles (Table 3). Introductory pharmacy practice experience pharmacy students can also gain experience with medication reconciliation, sterile preparations, perioperative medication safety practices, and familiarity with perioperative pharmacotherapy topics (Table 5). Perioperative APPEs should expand on the IPPE curriculum via increased participation in direct patient care and more in-depth learning in perioperative pharmacotherapy and surgical complications (Table 5). Important aspects of perioperative care for APPEs are opportunities to learn about the medications used by perioperative clinicians and to observe procedures in operating rooms, interventional radiology, and/or the cardiac catheterization laboratory. Optimal aspects may include participation in patient care rounds with the anesthesia pain service, perioperative anesthesia team, and/or surgery team, and observation during

perioperative Advanced Cardiac Life Support (ACLS) resuscitation and rapid response team patient assessment.

5.2 | Postgraduate residency training in perioperative care

The advancement of residency training opportunities in surgery and perioperative pharmacy services has lagged in comparison to other pharmacy specialty areas. For example, surgical-oriented rotations are sparsely offered during PGY1 residencies and, currently, there are no ASHP-accredited PGY2 specialty residency training programs in the area of perioperative pharmacy. PGY1 and PGY2 residency training programs in critical care, solid organ transplantation, cardiology, and emergency medicine commonly include exposure to patients located in medical/surgical acute care and critical care settings following surgical or interventional procedures but may not necessarily emphasize learning in perioperative care. Additionally, this gap in training



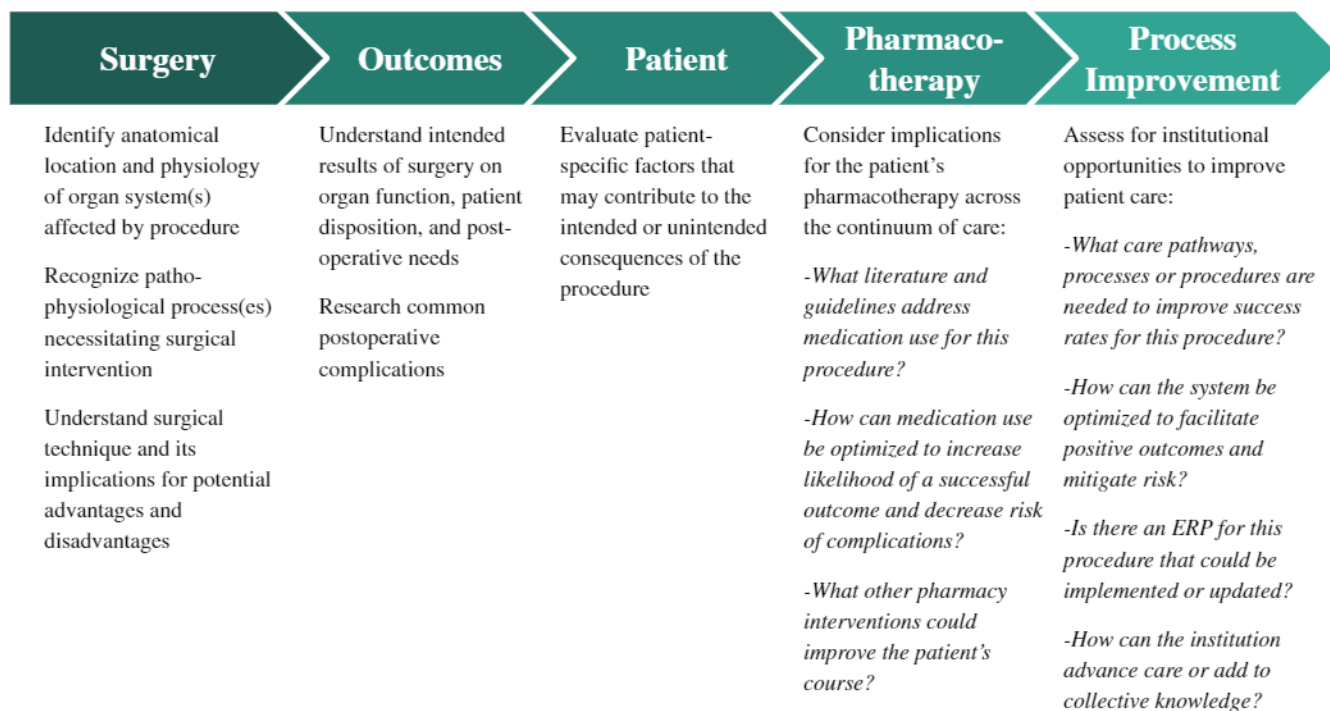


FIGURE 3 Clinical pharmacist systematic approach to medication management in the context of surgical practice. ERP, enhanced recovery pathway

opportunities reflects a significant disparity when compared with pharmacy residency programs that span the continuum of care for medically ill patients including ambulatory care, emergency medicine, internal medicine, critical care, and specialties within medicine. Comparable educational needs for pharmacists exist within surgery and should include the entire perioperative continuum of care, with an emphasis on transitions of care between surgical areas and the acute, critical, and ambulatory care settings. Overall, despite the high degree of specialized skills and knowledge needed for the provision of perioperative clinical pharmacy services, the paucity of residency training opportunities is a significant barrier to the advancement of the profession in the care of surgical patients.

PGY1 pharmacy residency learning experiences in surgery/perioperative care could emphasize unique pharmacotherapy and medication use system considerations compared with other care settings and the daily interventions of the PCPh (Table 1). A few suggested activities would include exposure to perioperative use of common high-alert medications (eg, opioids, local anesthetics, neuromuscular blockers, epinephrine, heparin) as well as medication order entry, verification, distribution, administration, and documentation, all of which vary depending on the phase of perioperative care. Although every IPPE or APPE student may not have the opportunity to shadow an interprofessional team member or observe a procedure, these experiences are beneficial for PGY1 residency learning experiences. A few published experiences offer guidance for PGY1 pharmacy residency programs interested in creating electives with in perioperative pharmacy practice.^{48,49} Pharmacy residents are also well-poised to conduct research projects and drug utilization reviews in surgical care arenas.

PGY2 critical care and emergency medicine pharmacy residents who participate in multiple learning experiences in surgical intensive care units (eg, cardiothoracic, neurosurgical, trauma) should also have access to elective rotation opportunities in perioperative pharmacy practice, and PGY2 solid organ transplantation residents would benefit from similar electives with an emphasis on perioperative care of the transplant surgery patient. Until a formal direct training pathway exists for training PCPhs, it is advisable that PGY1 residents and PGY2 residents in select specialties receive training in perioperative and periprocedural areas to help offer alternative pathways for becoming a PCPh.

5.3 | Interprofessional perioperative care education

The PCPh should provide educational opportunities to pharmacists practicing in other capacities as well as to other perioperative health care providers whenever appropriate. It is recommended that the PCPh actively and regularly participate in perioperative safety huddles, morbidity and mortality case review meetings, medication safety and variance committee meetings, and institutional research meetings. The information from these meetings could be incorporated into learning modules for other pharmacists and/or health care providers as needed to optimize perioperative medication use and ensure self-sustaining operational efficiency when the PCPh is not present. The PCPh should develop standardized learning competencies that are regularly updated and provided at least annually for pharmacists

TABLE 4 Suggested training and clinical competencies of the PCPh

Education and training components	PCPh practice benefits
Hospital-based post-graduate year 1 pharmacy practice residency	<ul style="list-style-type: none"> • Knowledge of surgical procedures and phases of care • Clinical skills/patient assessment • Health care team communicating effectively with other members of the team and/or working with other members of the care team to deliver high-quality, coordinated care • Knowledge of transitions of care process and challenges • Equivalent experience with concomitant board certification may constitute a reasonable alternative pathway
Post-graduate year 2 pharmacy residency	<ul style="list-style-type: none"> • Certain applicable specialties (eg, critical care, cardiology, or emergency medicine) may offer additional expertise/advantage, depending on practice site and role
Board certification	<ul style="list-style-type: none"> • Competency in clinical judgment and problem-solving is maintained through board certification • Pharmacotherapy (BCPS) may be useful due to broad spectrum of patients who undergo surgery and the need to understand chronic disease state management in order to effectively facilitate perioperative management • Critical Care (BCCCP) may include many applicable acute care knowledge and skills
Basic Life Support certification	<ul style="list-style-type: none"> • Essential skills
Advanced Cardiovascular Life Support certification	<ul style="list-style-type: none"> • Essential skills
Pediatric Advanced Life Support certification	<ul style="list-style-type: none"> • If also serving pediatric patients
Emergency Neurological Life Support certification	<ul style="list-style-type: none"> • May be useful if serving neurosurgery/neurovascular population
Advanced Trauma Life Support certification	<ul style="list-style-type: none"> • May be useful if serving a trauma center
Neonatal Resuscitation Program certification	<ul style="list-style-type: none"> • If also serving neonatal patients
Sugar, Temperature, Airway, Blood pressure, Laboratory work, and Emotional support certification	<ul style="list-style-type: none"> • If also serving neonatal patients
Clinical Competencies to be Maintained	
<ul style="list-style-type: none"> • Systematic approach to care – medication management considerations in the context of the surgical practice • Malignant hyperthermia prevention, recognition, and management • Local anesthetic systemic toxicity management • Hemostasis strategies based on populations served - may include trauma/massive transfusion considerations, hemophilia management, factor product stewardship, topical hemostatic strategies, antifibrinolytics, postpartum hemorrhage, blood product management, etc. • Surgical site infection prophylaxis and perioperative antimicrobial stewardship • Anesthetic strategies - general anesthesia, procedural sedation, neuraxial anesthesia (intrathecal and epidural), regional anesthesia, local anesthetic agents and additives • Anesthetic induction, rapid sequence intubation, difficult airway management • Neuromuscular blockade, reversal, and monitoring • Pain management and opioid stewardship • Venous thromboembolism prophylaxis and perioperative anticoagulation management • Postoperative complications prevention and management (ie, PONV, ileus) • Medication safety principles and compliance/regulatory considerations for areas served 	

Abbreviations: BCCCP, board certified critical care pharmacist; BCPS, board certified pharmacotherapy specialist; PONV, postoperative nausea and vomiting.

involved in any aspect of surgical patient care (eg, medication order processing, postoperative medical rounding teams) and/or as needed for orienting new hires.

In addition to ensuring pharmacist and student learning, opportunity for perioperative medication-related education to inter-professional providers is inexhaustive. Regular in-service education to perioperative nursing staff may contribute to decreased medication errors, ensure appropriate medication handling, and further solidify the PCPh as a key information resource. Introductory pharmacology and drug-name recognition for anesthesia/surgical technicians may decrease errors associated with intraoperative look-alike/sound-alike medications, which are commonly supplied in non-profiled (ie, “over-ride”) automated dispensing cabinets in OR settings. Recent Food and

Drug Administration medication approvals provide an excellent opportunity to draw a multidisciplinary audience for the provision of detailed presentations, allowing the PCPh to build and strengthen communication pathways with physicians and inform prescribing practices for high-cost intraoperative medications.

Beyond educating pharmacy learners, colleagues or other health care providers, the PCPh should be challenged to develop a scholarly presence. Conducting research is an expectation for clinical pharmacists recognized by the Standards of Practice for Clinical Pharmacists produced by ACCP.³⁶ Furthermore, ACCP and the Society of Critical Care Medicine published a joint position paper for the scope of the critical care pharmacist that describes research as a “desirable activity.”⁵⁰ PCPhs navigate daily through an environment rich with



TABLE 5 Opportunities to Incorporate Perioperative Clinical Competencies into Pharmacy Learner Experiences

Competency Area	Topic	IPPE	APPE	PGY1	PGY2
Introduction to perioperative care	Procedure observation	+	++	+++	+++
	Perioperative health care professional shadowing	+	++	+++	+++
Perioperative pharmacy services	Overview of surgical operations	+	++	++/+++	+++
	Sterile compounding	+	++	+++	+++
	Perioperative medication distribution (eg, medication tray/cart/kit preparation, automated medication delivery systems)	+	++	+++	+++
	Perioperative medication order processing	+	++	+++	+++
	Charge capture and cost minimization	+	++	++/+++	+++
	Medication reconciliation across perioperative transitions of care	+	++	++/+++	+++
	ERPs	+	++	++/+++	+++
	Justification of the role of the PCPh	+	++	++/+++	+++
	Medication safety, compliance, and regulatory standards (eg, Joint Commission standards, high-alert medications, sound-alike/look-alike medications)	+	++	++/+++	+++
	General perioperative pharmaco-therapeutics	VTE prophylaxis	±	++	++
PONV prevention and management		±	+	++	+++
Pain management (eg, preemptive analgesia, postoperative acute pain management, opioid stewardship, pain management in patients with chronic pain or opioid use disorder)		±	+	++	+++
Surgical site infection prophylaxis (eg, systemic therapy selection and duration, local irrigations and topical antimicrobials, skin preparation solutions, methicillin-resistant <i>Staphylococcus aureus</i> testing and decolonization)		±	+	++	+++
Anesthetic strategies (eg, general anesthesia, procedural sedation or monitored anesthesia care, neuraxial anesthesia, regional anesthesia, local anesthetic agents and additives)		±	+	++	+++
Neuromuscular blocking agents and reversal agents		±	+	++	+++
Bowel preparation		±	+	++	+++
Perioperative nutrition assessment and optimization (eg, assessment, immunonutrition, enteral and parenteral nutrition)		±	+	++	+++
Perioperative management of adrenal insufficiency		±	+	++	+++
Acute postoperative hypertension		±	+	++	+++
Perioperative fluid management and resuscitation		±	+	++	+++
Perioperative diabetes and hyperglycemia management		±	+	++	+++
Anemia management		±	+	++	+++
Infections requiring surgical interventions (eg, necrotizing fasciitis, bone/joint infections)		±	+	++	+++
Specialized perioperative pharmaco-therapeutics		Procedural competency for relevant common procedures at the institution (eg, cardiac, thoracic, vascular, orthopedics)	–	±	+
	Surgical complications and management	–	±	+	++
	Malignant hyperthermia prevention, recognition, and management	–	±	+	++
	Local anesthetic systemic toxicity management	–	±	+	++
	Postoperative atrial fibrillation	–	±	+	++
	Perioperative beta blockade	–	±	+	++

(Continues)



TABLE 5 (Continued)

Competency Area	Topic	IPPE	APPE	PGY1	PGY2
	Rapid sequence intubation	–	±	++	
	Perioperative medical emergencies	–	±	+ / ++	++ / +++
	Perioperative antithrombotic management	–	±	+ / ++	++ / +++
	Hemostasis strategies (eg, topical, factor products, antifibrinolytics, massive transfusion)	–	±	+ / ++	++ / +++

Notes: (–) no/limited understanding, (+) basic understanding/dependent, (++) proficient/competent, (+++) independent/expert.

Abbreviations: APPE, advanced pharmacy practice experience; ERP, enhanced recovery pathways; IPPE, introductory pharmacy practice experience; PGY1, postgraduate year one pharmacy resident; PGY2, postgraduate year two pharmacy resident; PONV, postoperative nausea and vomiting; VTE, venous thromboembolism.

potential research material but may fail to realize and capitalize on these opportunities due to barriers like operational logistics and/or department focus. Demonstrating favorable financial outcomes via cost savings analyses of expensive perioperative medications may help garner departmental support for such activities. Pharmacists may also align with research accreditation requirements for Level 1 Trauma Centers, Magnet status, and Stroke Certifications to facilitate PCPh research and scholarship.⁵¹

6 | CONCLUSIONS AND FUTURE OF PERIOPERATIVE CLINICAL PHARMACY

The PCPh is described as a value-added, fully-integrated expert in pharmacotherapy and medication use providing interventions across the complete surgical continuum of care. Areas of contribution include ERP development, implementation, and optimization, in addition to impacting quality metrics related to perioperative antibiotic selection and timing, surgical site infection rates, and incidence of postoperative complications. In addition, the PCPh can assist with regulatory and financial goals such as maximizing the Centers for Medicare & Medicaid Services (CMS) reimbursement.

A number of trends in surgical and anesthesia practice, including full prehabilitation of surgical patients, PCPh collaborative practice with surgeons and/or anesthesiologists, and telemedicine, will influence the development and sustainability of PCPh practice. The growth of ambulatory surgery centers and the perioperative surgical home movement during the past 25 years affords an opportunity for transformative collaboration regarding pharmacotherapy for improved outcomes, namely a reduction in the rate and severity of post-procedural complications and more rapid recovery.^{52,53} Furthermore, improved quality in the surgical patient experience and satisfaction will drive future efforts to incorporate proven patient safety practices that reduce operative stress in all phases of perioperative care.

Involvement in prehabilitation and optimization of physical state prior to surgery in chronic disease management, nutrition, and physical health remain opportunities for the PCPh. Reduction of postoperative readmissions is another area of future focus for various surgical specialties. To date, most ERP studies have shown similar readmission rates to traditional care, and application of readmission predictive

models and scoring systems await systematic study in the surgical population.^{54,55} These models emphasize optimal medication management and avoidance of adverse events as areas in which the pharmacist can be the liaison between the surgeon and primary care provider to foster improvements in transitions of care.

Another approach to reach improved outcomes in patient care within the perioperative area is the expansion of collaborative practice agreements (CPAs). CPAs between surgeons and pharmacists have demonstrated improved medication management and safety in multiple perioperative settings.^{18,20} These agreements often allow the PCPh to assess, review, and modify drug therapy independently, allowing the pharmacist to practice at the highest level within licensure. Examples of potential targets for CPAs may include the management of pain, delirium, gastric acid secretion, antimicrobial prophylaxis, blood glucose, and anticoagulation based on previously reported outcomes.^{18,21,56–59}

Telemedicine-based clinician support systems, when applied to the intraoperative and postoperative settings, will open numerous opportunities for PCPh involvement. This model allows the PCPh to be actively engaged in the care of multiple surgical patients in varying locations in real time. A clinical pharmacist can leverage the use of machine learning-based forecasting algorithms and alerts to guide interventions such as timely antimicrobial infection prophylaxis administration and documentation, perioperative glycemic control, and neuromuscular blockade monitoring and reversal.⁶⁰ The clinical pharmacist can have a direct impact on the quality of perioperative care provided, potentially resulting in improved clinical and safety outcomes.

These trends portend continued integration of clinical pharmacists within the perioperative care team.^{61,62} Institutions expanding clinical pharmacy roles and training programs to encompass perioperative pharmacy services should develop PCPh practices focused on improving surgical patient outcomes and consider integrating perioperative clinical competencies into various levels of elective or related pharmacist learner experiences. Future advancements in perioperative pharmacy practice will be driven by patient experience, quality improvements reducing surgical stress and further hastening postoperative recovery, and the development of more reliable predictive models. Telemedicine-based clinician support and expanded use of CPAs may best leverage the PCPh to help improve and raise the standards of perioperative care.



CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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