

ASHP guidelines on perioperative pharmacy services

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Historically, pharmacy involvement in perioperative areas primarily consisted of providing medication stock for access by operating room (OR) staff, confirming appropriate storage conditions, checking expiration dates, submitting billing, and maintaining controlled substance accountability. In the early 1980s, pharmacists recognized the need for increased involvement and OR satellite pharmacies began to appear, particularly in academic institutions.¹ Even so, the focus remained primarily on medication distribution and regulatory compliance. Evolving standards from regulatory and accrediting agencies as well as the need for improved charge capture and greater controlled substance accountability over the last decade drove increased pharmacy involvement in the

perioperative medication-use process. Ongoing rapid changes in healthcare now demand that our attention be turned toward incorporating additional activities, such as supporting institutional quality and safety goals, developing perioperative treatment algorithms and order sets, and collaborating with the perioperative team to provide patient-centered, medication-related care in inpatient and outpatient settings. Finally, the challenge of cost-effective perioperative medication use has never been greater, with the movement from fee-for-service payment to value-based payment systems.

Purpose

In 1991, the first ASHP Technical Assistance Bulletin on Surgery and Anesthesiology Pharmaceutical Services was published.² It was revised in 1998 and published as the ASHP Guidelines on Surgery and Anesthesiology Pharmaceutical Services, and it was reviewed without revision in 2003. This updated guideline is intended to provide guidance to health systems on perioperative pharmacy services.

Two levels of perioperative pharmacy services are described: essential services, which should be in place in every healthcare setting; and desirable best practices, which must be tailored to the changing demands of healthcare, specific needs of the institution, and available resources.

Services to perioperative areas as well as to procedural areas may be provided from an OR satellite pharmacy but may also be provided from a central or other satellite pharmacy location. While an OR satellite pharmacy with dedicated staff facilitates the development of the specialized expertise and close collaboration with OR personnel, these guidelines are intended for any pharmacy serving the areas noted above. Some or all of the services described may be provided

by a dedicated perioperative pharmacist, a management or leadership-level pharmacist, or other pharmacy staff. Pharmacists may also use telepharmacy when suitable to remotely verify sterile compounding verification, pre- and postoperative medication order review, interactive postoperative patient medication counseling, or provide drug information to a facility that is geographically isolated.³ Consequently, the terms *pharmacy*, *satellite pharmacy*, *perioperative environment*, and *perioperative pharmacist* are used in the broadest sense.

The perioperative environment

To understand and optimize the unique role of the perioperative pharmacist, significant differences found in the perioperative environment must be recognized, specifically the following:

1. The medication-use process is fundamentally different from that in the patient care unit. Medications are administered by anesthesia care providers (ACPs) (anesthesiologists, certified registered nurse anesthetists [CRNAs], and anesthesiologist assistants), surgeons, others (e.g., perfusionists, physician assistants), and, very rarely, nurses.
2. Medications are almost always administered by licensed independent practitioners such as ACPs or surgeons.
3. A significant proportion of medications are high-alert medications.
4. Medications may be used for off-label indications or administered by routes with which pharmacists may be unfamiliar.
5. Multiple unique documentation systems exist within the perioperative setting.

Medications administered by the surgeon are typically identified by the

individual surgeon's case-specific preference card, requested and obtained by the circulating nurse, placed on the sterile field, and administered by the surgeon or physician assistant as needed. There is often no pharmacist review prior to administration, particularly for commonly requested medications such as local anesthetics and topical hemostats. Some medications may be time sensitive, with reliance on verbal communication if the patient requires rapid intraoperative intervention and the surgeon is scrubbed in with his or her full attention on the patient. Pharmacy oversight in the OR may be complicated by medications, glues, and other agents in supply kits, which may be acquired through OR purchasing or a centralized supply department.

Medications administered by ACPs differ from those used by surgeons, with few exceptions (e.g., local anesthetics). ACPs are typically the only practitioner involved in the entire medication-use process—prescribing, formulating and preparing, dispensing, administering, and monitoring the medication. The protection afforded by double checks (pharmacist, nurse, pharmacy technician) and barcode medication scanning that exists in most areas of the hospital is not present. Medications typically administered by ACPs are provided in one of 2 ways: (1) a drug tray stored in a drawer of the anesthesia cart or (2) individual bins or pockets in drawers of an automated anesthesia cart (AAC). Infusions, irrigations, or compounded/diluted high-risk medications are best prepared by pharmacy as needed.

Essential roles of the perioperative pharmacist

Drug therapy management services that are consistently provided to all hospitalized patients should also be provided for patients in the perioperative area if applicable and to the fullest extent possible. These services are available for review elsewhere, including the ASHP Guidelines: Minimum Standard for Pharmacies in Hospitals.⁴ Essential roles of the

perioperative pharmacist or pharmacy team include the following:

- Medication procurement, preparation, distribution, and flow
- Promotion of safe medication use according to regulations and institutional policies
- Controlled substance management and surveillance
- Preoperative and postanesthesia care unit (PACU) order review
- Provision of drug information and education
- Performance improvement and quality assurance
- Leadership duties and professional service
- Financial management

Medication procurement, preparation, distribution, and flow

Procurement and preparation. It is important to know the procurement pathway of all medications used in the perioperative environment. For example, medications may be included in procedural kits procured by OR purchasing or the central supply department (e.g., 1.5 % lidocaine with epinephrine in an epidural kit, 0.75% hyperbaric bupivacaine in a spinal kit). Medications may also be supplied by the manufacturer of a particular diagnostic, surgical, or robotic instrument, or as part of a vendor-assembled tray. Regardless of procurement pathway, medications should be appropriately stored and controlled. Collaboration between pharmacy, central supply, anesthesiology, and surgical services is recommended to identify these items and ensure appropriate storage and control.

In the perioperative setting it is not unusual to receive requests for medications that are not commercially available. Such requests place additional pressure on the pharmacy to obtain these unavailable medications by either in-house compounding (many of which may be high risk) or

outsourcing. It is critical to proceed carefully with these requests to avoid serious or catastrophic consequences. Guidance on outsourcing sterile products may be found in the ASHP Research and Education Foundation's vendor assessment tool for outsourcing sterile product preparation (<http://outsourcingassessment.org/>).

Drug shortages. Federal regulations, product changes, and supply-chain issues leading to shortages have had a significant impact in the perioperative setting.⁵ As in other areas, there are medications commonly used perioperatively that are the standard of care. When these medications are unavailable, even for short periods of time, there is potential for significant impact on patient care. In a 2013 survey of approximately 2,500 CRNAs, 90% reported that their institutions were currently experiencing shortages, and approximately 6% of CRNAs reported that a drug shortage was responsible for procedure cancellations.⁶ Drug shortages have had such an impact on anesthesiologists' practice that the Anesthesia Quality Institute Anesthesia Incident Reporting System contains a required field to report if the event was impacted by a drug shortage.⁷

An interdisciplinary, collaborative approach to discuss alternatives and strategies with those most impacted by a critical shortage (i.e., ACPs or surgeons) is critical to ensuring patient safety during the time of a drug shortage. Strategies may be pharmacy-based (e.g., centralization of medication supply, preparation of unit doses from bulk medication or compounded) or involve other disciplines (e.g., develop and implement temporary restrictions, use alternative products or medications).^{8,9} Use of technology (automated anesthesia information management systems [AIMS]), multiple conservation strategies involving ACPs or surgeons, timely communication, and close monitoring are necessary to ensure that a critical drug in short supply for a prolonged period of time will be available to all patients for whom it is an optimal choice.⁸

Distribution. In the perioperative setting, medications may be distributed to the PACU and preoperative units, or to the operating or procedural rooms. Medications distributed to the PACU and preoperative units should be dispensed manually (i.e., direct delivery from pharmacy of compounded or unit-of-use medications) or through an automated dispensing device. Careful review of state and hospital accrediting body rules or guidelines should be considered when determining whether to profile an automated dispensing cabinet (ADC) in 1 or both units. For safety purposes, it is recommended that ADCs in the nursing units be profiled; however, profiling of medications in the preoperative unit can be challenging when turnover of patients is high. Some ADCs and electronic health record systems have the ability to allow automatic medication-order verification, which verifies a medication order when entered into the electronic health record and allows the medication to be immediately available to the nurse for dispensing. The system would still then allow the pharmacy final review of the medication order. However, such a system does not prevent a nurse or provider from removing and administering the medication prior to the pharmacy review, but instead allows the opportunity for the pharmacy to review an order and potentially catch and correct an error if identified. Such a system may be helpful for a PACU or preoperative unit to maintain medication profiling while allowing flexibility with timeliness of order verification. Without automatic order verification, profiling ADCs may not be feasible and should be carefully reviewed to determine the associated safety risk-benefit ratio.

Distribution to the OR setting may be accomplished by using (1) a manual dispensing system (e.g., drug trays or boxes, pharmacy-prepared infusions, airway emergency kits, and compounded or diluted high-risk drugs); (2) automated dispensing devices (e.g., ADCs, AACs); or (3) a combination of manual and automated dispensing systems. When manual

systems are used, the pharmacy should be responsible for stocking, tracking, and delivering drug trays and boxes. To the fullest extent possible, the pharmacy should prepare infusions as well as compounded or diluted high-risk drugs used in the OR.^{10,11} Each institution should evaluate all options (i.e., cleanroom-prepared, satellite pharmacy-prepared, provider-prepared, or outsourced product), then determine the best method for providing each infusion, compounded, or diluted high-risk drug in a timely manner with minimal waste.¹²

Automated dispensing devices can improve accountability and storage of medications, as well as improve accuracy and timeliness of medication distribution.¹³ In the OR setting, ADCs are generally not pharmacy profiled (as they are in patient-care units, where medication orders are placed and reviewed) and create limitations such as configuration, storage space, and proximity to the end user. Smaller ADCs may be located within each OR suite and contain medications frequently administered by ACPs (e.g., controlled substances) and surgeons (e.g., local anesthetics, topical hemostats). Another option for ACPs would be an AAC in each OR suite and anesthetizing location.

Regardless of the medication distribution system used, the following conditions apply:

- The medication distribution system must ensure medication security by (1) limiting access to authorized persons only, (2) locking all controlled substances while in the OR in an enclosed area not accessible by unauthorized individuals when not under the direct control of the ACP, and (3) including procedures to ensure ACPs have immediate access to emergency drugs while preventing unauthorized access. Anesthesia carts and machines may remain unlocked and medications other than controlled substances left in or on top of an unlocked anesthesia cart or machine immediately

prior to, during, and immediately after surgical cases when authorized OR personnel are in the OR suite.¹⁴ Auto-locking anesthesia carts should be set to the narrowest window of time appropriate for the setting. Carts located in offsite anesthetizing areas or procedural rooms should be locked at all times, with medications inaccessible when not in use. The medication-distribution system will have benefits and challenges. For example, medication trays or ADCs can be standardized and exchanged, refilled after each case or on a daily basis, but will often require a manual pharmacy check and manual tracking of medications. ADCs improve medication inventory and tracking but are often insufficient in number, limited in space, not optimally located, dependent on accurate removal by the ACP, and labor intensive to stock.

- The medication distribution system must be developed with the end users to optimize accurate medication selection and stocking and to provide an acceptable level of efficiency and safety.

Promotion of safe medication use according to regulations and institutional policies, and medication errors

The OR is a complex, dynamic, time-sensitive, and sometimes chaotic environment. The anesthetic plan for a patient is largely executed by a carefully selected series of medications administered in anticipation of or in response to specific events during the surgical procedure. ACPs have complete responsibility for all steps in the medication-use process from preparation to monitoring and hand-off. Furthermore, many recommended safe medication-use practices are difficult or impossible to implement in the OR.¹⁵ In the OR, AACs and machines do not select and dispense medications for each patient based on a physician order (via computer order entry and clinical decision support)

and pharmacist verification. Barcode medication administration to confirm the right drug and dose, as well as documentation of medication administration, is rarely available in the OR. Such critical differences can result in different types of medication errors occurring in the OR than elsewhere in the hospital, where such medication-use practices are in place. The most common types of anesthesia medication errors are:

- Wrong dose as a result of miscalculation of dose, concentration, or infusion rate^{10,16,17};
- Wrong drug due to accidental administration of the wrong syringe (“syringe swap”) or vial or ampule swap during medication preparation^{10,17};
- Extra dose¹⁰; and
- Omitted dose/failure to act.^{10,16}

The Society for Pediatric Anesthesia created Wake Up Safe (<http://wakeupsafe.org/>), a multicenter collaborative quality improvement initiative. When a medication error that harmed or has the potential to harm occurs in a participating institution, a team of pediatric anesthesiologists analyzes the medication error, arrives at a consensus, and reports the error to Wake Up Safe. Lobaugh and colleagues¹⁷ reviewed 6 years of medication errors reported to Wake Up Safe. The most common medication error was administration of the wrong dose (30%), followed by accidental administration of the wrong syringe (“syringe swap”) (18%), wrong dose prepared (15%), and vial or ampule swap during drug preparation (9%). Of the 276 medication errors analyzed,

- >80% reached the patient;
- >50% caused patient harm, with 5% requiring a life-sustaining intervention;
- Approximately 20% involved medications prepared as infusions; and
- 97% were perceived by the reporting institution as being preventable.

The literature has demonstrated that fatal or potentially fatal anesthesia medication errors occur, and that such errors include wrong route, miscalculation of a dilution, failure to dilute, infusion pump programming error, administering a medication to a patient with a known allergy, and failure to flush the line after a drug is administered.¹⁰

Relying on voluntary reporting alone provides a partial view because the vast majority of medication errors are not reported.¹⁸ Webster and colleagues reported that 0.36% to 4% of anesthesia cases have reportable medication errors.¹⁹ A more reliable method of medication error data collection is direct observation. Merry and colleagues²⁰ found a medication error rate of 11.6% (1 error in every 11.6 medications administered) using direct observation when a paper anesthesia recordkeeping system was used. Also using direct observation, Nanji and colleagues¹⁶ found that approximately 1 in 20 medication administrations and every second operation resulted in a medication error or adverse drug event. Approximately one-third of the errors did not result in any observed patient harm, and the remaining two thirds had the potential for patient harm. The most prevalent medication errors that led to an adverse drug event were inappropriate medication doses (47.1%) and omitted medications or failure to act (31.4%). The most common medication errors associated with a potential adverse drug event were labeling error (22.9%), wrong dose error (22.9%), and omitted medications or failure to act (17.6%). There were no significant differences in the medication error rates between resident physicians, nurse anesthetists, and attending anesthesiologists (5.1%, 5.5%, and 4.5%, respectively; $p = 0.79$), demonstrating that medication errors are not rare, inconsequential events caused by inexperienced ACPs.

Medication safety strategies.

Select OR medication safety strategies include the following:

- Medications, medication tray, or medication cart:
 - Avoid look-alike medications when possible; if not possible, do not store in proximity, and add alert labels.¹⁰
 - Use single-use vials; discard multidose vials at end of case; use only preservative-free local anesthetic products.¹⁰
 - Stock only 1 drug concentration on cart; include alert label on concentrated or high-alert drugs.¹⁰
 - Standardize medication trays, clearly label divisions, and place drugs to minimize confusion and hidden labels.^{10,11,21}
 - Store regional anesthesia drugs in a separate regional cart.¹⁰
- Medication administration:
 - Label all medications using standardized preprinted labels or labels generated by barcode scan of vial in accordance with standards established by ASTM International, the International Organization for Standardization, and the Institute for Safe Medication Practices.^{10,11,22}
 - Minimize provider-prepared syringes when possible; use prefilled syringes and premixed intravenous (i.v.) solutions when possible; use compounded and diluted drugs prepared by pharmacy^{10,11}; and perform 2-person or careful single-person double check if ACP prepares dilutions of high-alert drugs.¹⁰
 - Read and verify every vial, ampule, and syringe label before administration.¹⁰
 - Administer infusions via smart pumps that have a drug library with guardrails and alerts, and that are standardized across units to eliminate the need to change infusion solutions, rates, or area of the drug library when a patient moves between the OR, PACU, intensive care unit, and the floor^{10,11}; upper and lower limits may be customized based on the patient care area

- (e.g., OR, intensive care unit, floor); infusion concentrations should be standardized.
- Connect infusions to the most proximal intravenous port.¹⁶
- Standardize route-specific, color-coded tubing (yellow epidural, red arterial line), and label all infusion lines.^{10,11}
- Pass only 1 medication at a time in the sterile field; for all medications, check, label, and verify aloud by 2 persons; segregate topical or irrigation fluids (e.g., do not place in parenteral syringe).¹⁰
- Ensure adequate venous access and safe administration of magnesium and oxytocin during transfer to the OR for emergency cesarean delivery.²³
- Pharmacy:
 - Assign a pharmacist or pharmacists to support the OR or perioperative team; ensure that a pharmacist is available 24/7 for questions, that the pharmacist participates in educational activities, and that the OR pharmacist receives specialized education on fundamental OR concepts.^{10,11}
 - Stock and manage anesthesia and other medication trays.¹⁰
 - Alert staff, especially ACPs, to changes in how drugs are supplied (e.g., new labels or concentrations)—one method of doing this is by adding alert labels on new drugs.¹⁰
 - Provide cognitive aids, rescue protocols, and infusion rate charts to ACPs.
- Governance:
 - Formalize the process of decision-making, implementing decisions, educating staff, and monitoring.²⁴
 - Provide anesthesiology department representation on the medication safety committee, keeping in mind that crucial differences between anesthesia medications and those used elsewhere may warrant a separate anesthesia medication safety committee.²⁴

Standardization and visual cues are important examples of system-based approaches to anesthesia medication safety. Standardization is a framework that provides recognizable patterns and should not always be interpreted as a single uniform approach for all areas within the OR or between the OR and non-OR areas. Standard medication setups can vary with the type of case (e.g., adult, child, neonate, open heart, or obstetric), and having more than one standard concentration is often necessary to meet patient care needs. ACPs identify the correct medication syringe by a number of factors—text, shape, size, color, and location—often with minimal cognitive processing. This observation may explain why Fasting and Gisvold²⁵ found that color-coded syringe labels alone did not eliminate syringe swap and that nearly all (27/28; 96%) syringe swaps occurred between syringes of the same size. Grigg and colleagues²⁶ created an anesthesia medication template (AMT) that defined a formal way of organizing and identifying medication syringes in the anesthesia workspace. In Phase 1 of the study, ACPs participated in simulated scenarios to evaluate the time to locate and complete scripted administrations of different medications in 2 emergency scenarios (anaphylaxis and laryngospasm), using the AMT and a control setup. All medication errors were dosing errors; the correct medication was administered every time. Surprisingly, there were fewer dosing errors when the AMT was used compared with the control setup at 2.4 (95% confidence interval [CI], 1.0–6.1) versus 10.4 (95% CI, 6.6–16.0) errors per 100 medication administrations. The authors proposed that the cognitive load theory may explain why reorganizing medication syringes with the AMT could help with dose calculation. Specifically, searching for the correct medication, calculating the correct dose, and converting the dose to a volume to administer has a lower processing requirement when the AMT is used compared with performing the same functions when the control

setup is used. In Phase 2 of this study (implementation of the AMT in clinical practice), the number of medication errors related to the AMT (syringe swap, preparation, miscalculation, timing) decreased from 0.97 (95% CI, 0.64–1.48) pre-AMT implementation to 0.35 (95% CI, 0.17–0.70) errors per 100 anesthetics postimplementation. Other medication safety initiatives were initiated prior to AMT implementation and included reorganization of medication trays, medication practice guidelines with standard syringe sizes and concentrations, and a 2-provider infusion checklist to reduce infusion pump-related errors. The authors concluded that medication safety in the OR is a complex problem that will benefit from a multifaceted approach such as color coding, prefilled syringes, barcoding, and cognitive aids.²⁶

Technology solutions that can promote medication safety and should be considered include systems that integrate technologies such as radio frequency identification and cloud-based software; automated barcode medication scanning with audible prompt and real-time medication identification; dose measurement and wireless communication with the electronic anesthesia record to document medication administration; or label generation from point-of-care barcode scan of a medication vial or ampule. Merry and colleagues²⁰ described the impacts on documentation and administration medication errors when a conventional medication system is replaced with a multimodal medication system. The multimodal medication system included (1) medication trays designed to promote a well-organized workspace and aseptic technique; (2) prefilled syringes for the most commonly used medications; (3) large, legible, color-coded medication labels; and (4) a barcode reader with auditory and visual verification before administration and real-time documentation in the anesthesia record. The conventional system included (1) standard medication tray/cart; (2) standard tray to hold syringes; (3) all medications prepared

by ACP; and (4) manual documentation by ACP in anesthesia record. The mean error rate when using the multimodal system was 21% lower than when using the conventional system (mean error rate of 1 in 11.6 medication administrations with the conventional system versus 1 in 9.1 with the multimodal system). Furthermore, when the ACP complied with 2 key elements (scanning the medication barcode before administering and keeping the voice prompt active), the mean error rate was even lower (6.0 medication errors per 100 administrations when the ACP complied versus 9.7 per 100 administrations when the ACP did not comply with these 2 key elements). As with all system implementation initiatives, especially those that involve technology, early and continuous involvement of end users, full evaluation of pros and cons, a complete cost analysis, and a vendor site visit are recommended before proceeding.

Promotion of a nonpunitive culture with open disclosure is essential to encourage robust reporting, analysis, and interventions.^{10,27} Medication errors that occur in the perioperative setting should be reported via the standard hospital adverse drug or medication event reporting system, AIMS, or Anesthesia Quality Institute Anesthesia Incident Reporting System.²⁸ A method should be in place for routine review of all reported events, as well as a process to monitor medication error trends and the impact of interventions. There should also be a process to determine the root cause and failure modes associated with significant or serious errors. Case review of serious errors should be routine practice within the anesthesiology department's quality assurance division, as well as through medication safety committees and formal presentations at departmental morbidity and mortality conferences when appropriate. Errors due to manufacturer labeling or packaging should be reported to the Food and Drug Administration via the MedWatch program (<https://www.fda.gov/Safety/MedWatch/default.htm>) and to the Institute for Safe Medicine Practices

(<https://www.ismp.org/report-medication-error>). When appropriate, laboratory analysis of causative agents or concentrations of medications in specific products involved in an incident should be performed.

Incorporation of the culture of safe medication handling in the OR, safe worker behavior, and safe work environment should be included in a hospital or health system's patient safety goals. An interdisciplinary team, with significant representation from ACPs, should lead efforts to maintain and improve medication safety in the perioperative environment, focusing on system issues that have an opportunity for modification and improvement that would reduce the likelihood of a medication error by the ACP and OR staff. The team should:

1. Identify and document errors, adverse events, near misses, and high-alert practices;
2. Systematically review such events and conduct root cause analysis when appropriate;
3. Identify and correct hazardous conditions;
4. Define best practices by policy or guideline to prevent similar events in the future;
5. Provide staff education (simulation-based if possible); and
6. Conduct ongoing monitoring to assess success of educational efforts and recent system or process changes.

The team should also prepare a report to present to upper management (e.g., quality and safety leadership or perioperative leadership) regarding significant events, as well as trends that have been identified. Follow-up should be in place for rapid-cycle feedback when breaches in practice or medication errors occur. This follow-up could include, but is not limited to, review by the perioperative pharmacist, anesthesiology quality assurance, medication safety committee, alert management, OR steering committee, and patient safety committee.

Contamination issues. Pharmacists should participate in the

institution's infection control department to ensure surgical services personnel and ACPs follow safe medication practices, such as aseptic technique when preparing, transferring (to sterile field), and administering medications; single medication withdrawal; and single patient administration of medications. The Anesthesia Patient Safety Foundation Consensus Recommendations for Improving Medication Safety in the Operating Room,¹¹ the Centers for Disease Control and Prevention and Safe Injection Practices Coalition One and Only Campaign,²⁹ the recommendations in the Standard Precautions section of the Centers for Disease Control and Prevention 2007 Guidelines for Isolation Precautions for Preventing the Transmission of Infectious Agents in Healthcare Settings,³⁰ the American Society of Anesthesiologists (ASA) Committee on Occupational Health Task Force on Infection Control Recommendations for Infection Control for the Practice of Anesthesiology (third edition),³¹ American Association of Nurse Anesthetists Infection Control Guide for Certified Registered Nurse Anesthetists,³² and Association of periOperative Registered Nurses perioperative standards and recommendations³³ are excellent resources. Pharmacists should share responsibility with ACPs and nurses for ensuring that all staff whose role may require preparation, handling, or administration of medications receive appropriate education to ensure that multiple patients do not receive medications from the same syringe, vial, or bag; single-use products are not used on multiple patients; aseptic technique is followed; and appropriate practices regarding contact precautions are in place. Anesthesia kits, trays, and carts, including ADCs and AACs, should be periodically cleaned and decontaminated. Institution-specific protocols should be followed when a patient with an infection such as *Clostridium difficile* undergoes surgery. Cleaning medication preparation areas such as the tops of anesthesia carts should also follow institutional policy. All medications should be disposed of according to institutional

policy and local regulations. The pharmaceutical waste stream should also be determined in collaboration with the infection control department, as special handling may be required for waste associated with patients with contaminative diseases.

Controlled substance management and surveillance

ACPs are unique in that they obtain and administer addictive substances, on a daily basis, to patients undergoing anesthesia, in order to provide analgesia (opioids, ketamine); blunt the stress response to intubation and surgical stimulation (opioids); induce general anesthesia (methohexital); and provide sedation, amnesia, and anxiolysis (benzodiazepines). Exposure and access to such addictive substances, familiarity with the pharmacology of these drugs, the relative ease of diverting small quantities for personal use, and a high-stress work environment are factors that contribute to substance use disorder (SUD) in ACPs.³⁴⁻³⁶ Warner and colleagues³⁷ conducted a retrospective cohort study of physicians who began their training in U.S. anesthesiology residency programs from 1975 to 2009 to describe the incidence and outcomes of SUD among anesthesiology residents. The authors found that 0.86% of these anesthesiology residents had evidence of SUD during training, with a high risk of relapse and death. At least 11% of anesthesiology residents with evidence of SUD died of a cause directly related to SUD. The most common substance abuse category was intravenous opioids (57%), followed by alcohol (35%), marijuana or cocaine (21%), anesthetics/hypnotics (19%), and oral opioids (11%). Of the anesthetics/hypnotics, benzodiazepines were the most common substances used at the initial episode, followed by propofol, ketamine, and inhaled anesthetic agents. Although little research exists, other anesthesia care providers (e.g., CRNAs) and sedation nurses are also

at risk. These providers have occupational exposure and access to highly addictive substances, can relatively easily divert small quantities for personal use, practice in remote settings, and may not fully appreciate the risks of experimenting with highly addictive substances.³⁸

ASHP recently published guidelines to assist health systems in planning and implementing best practices for establishing a controlled substance diversion prevention program.³⁹ As with all controlled substances, anesthesia controlled substances must be:

- Managed in accordance with federal and state laws, as well as regulatory and compliance requirements.
- Accountable from the time the controlled substance is dispensed to (received by) the ACP to its final disposition (i.e., administration to patient, returned, or wasted), with amounts documented. The total amount administered, returned, and wasted must equal the total amount dispensed to (received by) the ACP. Although hand-offs of controlled substances are discouraged, a system should be in place to ensure retrievable documentation of all controlled substances handed off, should a hand-off be necessary.
- Under the direct physical control of the ACP or stored in a locked and secure location such that controlled substances are not accessible to unauthorized individuals.
- Disposed of in a manner that renders it nonretrievable—disposal systems that neutralize controlled substances on contact are preferred as these systems decrease the amount of controlled substances introduced into the environment, particularly in the water stream.

Historically, anesthesia controlled substances were dispensed to ACPs on a per-day or per-case basis. With increasing focus on diversion prevention, per-day dispensing of anesthesia controlled substances can no

longer be recommended. Dispensing controlled substances on a per-case basis can be accomplished by manual dispensing from an OR pharmacy or automated dispensing from an ADC or AAC. Automated dispensing or pharmacy dispensing using an electronic controlled substances tracking tool is preferred to manual dispensing with paper records. Electronic data is more readily retrievable, allowing creation of scheduled and on-demand reports that may facilitate earlier detection of diversion. Having an AAC in every OR and procedure room (e.g., anesthetizing location) is preferred to a large ADC that services many ORs. A greater distance between the ADC and the OR room (or other point of care) can result in a provider obtaining:

1. More controlled substances than may be needed (because he or she cannot leave the OR room to obtain additional controlled substances);
2. Multiple controlled substances for multiple patients at the start of the day (due to rapid turnover of cases); or
3. Controlled substances long before the start of a case without the ability to securely store them until needed.

Having an AAC at every anesthetizing location facilitates the ACP obtaining only the quantity needed at the time it is needed and allows for creation of a dedicated secure pocket or bin for storage of controlled substances when the ACP is not physically present. If controlled substances are obtained from an ADC or pharmacy and there is a need to temporarily store the controlled substances (e.g., when a case is delayed), options may include a secure (locked) drawer or box in the anesthesia cart with authorized access (e.g., badge swipe, access tracked) and a secure bin or drawer in the anesthesia cart that locks with a key. If a key is used, a procedure must be in place to track keys, secure keys, and change locks if necessary.

Although ADC and AAC manufacturers promote enhanced controlled substances accountability in the OR setting, anesthesia controlled substances discrepancies will occur with the use of this technology. In 2007, Vigoda and colleagues⁴⁰ reported reconciliation errors between the pharmacy information management system (PIMS) (e.g., dispensing and waste records from ADCs) and the AIMS (e.g., administration record) in 15% of cases. Errors occurred in both systems, with most (>75%) errors being clerical (e.g., error in recording amount wasted or amount administered). Factors that contributed to errors included the need for double documentation (ACP must document in the AIMS [amount administered] and in the PIMS [amount administered or wasted]), as well as the ACP not receiving real-time feedback. Epstein and colleagues⁴¹ also compared PIMS and AIMS documentation and found a comparable reconciliation error rate for anesthesia controlled substances (15.8% of cases), with most errors also being clerical. Shortening the feedback time to next-day reporting decreased the reconciliation error rate to 8.8% of cases. When feedback was shortened further to near real time (same day), the error rate dropped to 5.2% of cases. Similarly, when Brenn and colleagues⁴² compared AIMS and PIMS records during a 1-month audit period, the mean number of discrepancies per ACP was 5.7.

Pharmacy should reconcile all anesthesia controlled substances. Reconciliation should be timely, with prompt notification to the ACP if a discrepancy is discovered. Resolution should occur within 24 hr. When circumstances do not allow for resolution within 24 hr, the time period for resolution should not exceed 72 hr. If a discrepancy cannot be resolved, it is reported to the drug diversion compliance officer or team as well as appropriate internal anesthesia team member(s). If the loss is deemed significant following an investigation, it is reported to the Drug Enforcement Administration and the state licensing board, if required

by state law. Discrepancy trend reports should be prepared and reviewed at least quarterly. A trend of poor documentation or unresolved discrepancies should be reviewed for possible diversion. Progressive discipline is enforced when a trend of unresolved discrepancies is identified, even if each loss is a small amount.^{39,43}

Behaviors more specific to an addicted ACP who is diverting a drug from the workplace include:

1. Removing the contents of syringes, vials, or ampules and replacing them with saline;
2. Documenting the anesthetic was opioid-based but administered an inhaled anesthetic agent and a beta blocker; and
3. Diverting waste.

An addicted ACP can be extraordinarily attentive at work and rarely put patients at risk, likely because maintaining their job, with its close proximity to their source of drugs, is so important to them. ACPs know the signs and symptoms of addiction, generally have the means to hide them, and are psychologically capable of developing sophisticated denial strategies.⁴⁴ Therefore, a comprehensive and interdisciplinary approach to diversion surveillance for anesthesia is necessary and should include the following strategies:

- **Provide controlled substances in ready-to-use concentrations and volumes.** If a ready-to-use concentration is not available (e.g., morphine, hydromorphone, remifentanyl, or fentanyl for pediatric patients), pharmacy should provide such controlled substances in a ready-to-use concentration whenever possible to limit dilution by the ACP at the point of care. Providing controlled substances in ready-to-use concentrations will help to standardize dilutions, facilitate controlled substances reconciliation and analysis of waste, and reduce the likelihood of an error by the ACP

when preparing a dilution of a high-risk medication. Using appropriate volume size minimizes waste and risk for diversion.

- **Pharmacy reconciliation of all anesthesia controlled substances and records.** Controlled substances removed by an ACP for a cancelled case, after case completion, or from a different location than the scheduled case must be accounted for (e.g., returned unused or documented as administration to a different patient who was cared for by that ACP as a result of an OR schedule change).
- **Regular review of atypical usage reports.** Atypical usage, such as escalating activity and excessive waste, should be regularly reviewed. Reports should compare the amount of drug (e.g., fentanyl) removed over time (per case, month, or quarter) by individual ACPs with peers for similar types of cases, as well as the amount of a drug wasted over time by individual ACPs with peers' waste for similar types of cases.⁴⁵⁻⁴⁷ While such reports are useful screening tools, manual review of transactions and other documentation (e.g., type of anesthesia, type of surgery) is necessary to properly evaluate the likelihood of the outlying activity constituting diversion. Expert knowledge is necessary to determine reasonable ranges for various types of procedures, as well as typical activity by ACPs for handling and administration of controlled substances.⁴⁶ Building a close partnership between pharmacy and anesthesiology is critical to ensure that the screening tools, methods, and metrics are appropriate for the institution, while avoiding bias and conflict. A "one size fits all" approach cannot be used since anesthesiology departments are vastly different in the number of ACPs (<10 to >400), ACP status (full time, part time, providing services at more than one institution, trainee), type of procedure or patients cared for (specialist or generalist), and employer (institution, anesthesia group contracted to provide services

to the institution, locum tenens company that provides physician staffing services).

- Waste content is verified by the pharmacy on a random basis and when suspect.** On a random basis and when suspect (e.g., diversion is suspected, syringe returned under unusual circumstances), waste should be returned to the pharmacy to verify content. Analysis of the contents may be done with the use of a refractometer standard or a spectrophotometric devices that measure the refractive index of a substance relative to a reference standard (e.g., the dispensed product).^{45,48} Many refractometers are relatively inexpensive and easy to use. Such analysis has its limitations; however, the refractive index of undiluted fentanyl is identical to that of water, and the diluent can affect the refractive reading of a diluted drug. If these limitations are not known to ACPs, an inexpensive refractometer may provide an economical first line of defense.⁴⁸ Although the cost is significantly higher, there are machines that provide a more accurate refractive index measurement to detect if the controlled substances waste does not match that of the reference standard. Such machines are small enough to house in the pharmacy, provide real-time results to reference standards, and maintain results in a searchable database. Suspect or random syringes may be definitively analyzed internally or sent to an outside laboratory for analysis. If a controlled substance is sent to a laboratory for analysis, a clear chain of custody for the sample, as well as any required internal standard, must be maintained.
- Staff education.** Education on SUD is required annually by Graduate Medical Education for anesthesiology residency training programs. The American Association of Nurse Anesthetists strongly recommends every ACP view the *Wearing Masks* video series and other videos on SUD in anesthesia.⁴⁹ The ASA Committee on Occupational Health posts SUD

information on their website, such as key articles, a link to the *Wearing Masks* series, an SUD curriculum, and more.⁵⁰ ACPs and other health-care workers authorized to access or handle controlled substances (e.g., OR nurses who may obtain an opioid for a surgeon to administer to the patient) should be trained and competent in controlled substances policies, procedures, and regulatory requirements.³⁹

In the early 1990s and in response to several episodes of fentanyl diversion, the Department of Anesthesiology at the Mayo Clinic in Rochester, Minnesota, created a comprehensive system to reduce the incidence of diversion of anesthesia controlled substances.⁵¹ The system included (1) ADCs in the OR, (2) secure return bins to collect waste for analysis, (3) random analysis of waste, (4) reconciliation of AIMS and PIMS records, (5) investigation of discrepancies (reconciliation errors) until resolved, and (6) frequent educational sessions for ACPs and OR staff on the risk of addiction and diversion. If diversion was suspected, all waste returned by the individual in question was assayed until diversion was confirmed or disproved. In the years following implementation of this improved and comprehensive system, the frequency of anesthesia controlled substances diversion dramatically decreased (unpublished data, Keith Berge, MD, Department of Anesthesiology, Mayo Clinic, June 7, 2012).⁵¹

Although provider pre-employment urine drug testing is common, random (suspicionless) drug testing is controversial. Although a majority of academic anesthesiology department chairs favor random testing, there are obstacles that require thoughtful consideration before such a program can be implemented.⁵² These considerations include the logistics of the testing process itself, legal ramifications, costs, what tests to include in the panel (e.g., whether or not to limit the panel to only the drugs to which the ACP has occupational

exposure), how to manage a positive or reasonably suspicious test result, risk of loss of privacy or damage to employees' reputation, and how to manage employees who refuse testing.⁵³⁻⁵⁵ An article by Rice and colleagues presents possible approaches to implement random drug testing among ACPs.⁵⁵

Preoperative and postanesthesia care unit order review

Pharmacists have the ability to help guide practice and ensure safe medication therapy for patients in the postoperative period via prospective order review. The goal should be prospective order review of all PACU orders by pharmacists. Analgesics and antiemetics represent the majority of PACU medication orders.⁵⁶ Pharmacists should be involved in developing or reviewing PACU order sets (e.g., dose, dosing frequency, maximum dose, opioid hierarchy, rescue antiemetic dose and hierarchy) and performing medication histories to avoid unintended discontinuation or alteration of chronic medications when transitioning from the PACU to the surgical floor.

Provision of drug information and education

The perioperative pharmacist should provide timely and accurate drug information proactively for known needs as well as in response to professional inquiries. The perioperative pharmacist should have ready access to electronic resources such as a drug information handbook and a clinical resource tool as well as journals and textbooks. Scientific journals are the source for practice guidelines, meta-analyses, systematic reviews, and randomized controlled trials that support recommendations. References should be current, easily accessible, and provide information in the following areas: pharmacology, pharmacokinetics, dosages, adverse effects, formulations, administration, incompatibilities, indications for use, drug interactions, and use

during pregnancy and lactation. The perioperative pharmacist may also prepare a newsletter, make available articles of interest, and provide staff education. Participation in journal clubs and other educational activities (e.g., morbidity and mortality conference) is encouraged. A pharmacist should be available to answer questions that arise when the perioperative pharmacist is not available (e.g., off shifts, weekends). Ideally, a dedicated cross-coverage pharmacy team should provide services to the perioperative area. If that is not feasible, then other pharmacists should be trained in basic perioperative skills that enable them to answer questions.

Performance improvement and quality assurance

Performance improvement and quality assurance are critical to providing a high level of patient care. Quality assurance is also linked to healthcare reimbursement and regulatory requirements.^{57,58} An interdisciplinary approach to implement and maintain a robust quality assurance system, including medication management, is recommended for the perioperative environment. Training in methodologies to systematically improve processes and reduce waste (e.g., Six Sigma, lean principles) is helpful to ensure that the initiative's scope and stakeholders are appropriate, changes are well planned and implemented, and change is sustained.⁵⁹⁻⁶¹ Outlined below are activities in which participation by a pharmacist is considered essential.

Interdisciplinary committees.

The pharmacy leadership should promote, provide, and include a pharmacy representative on perioperative interdisciplinary committees charged with reviewing and improving safety, processes, culture, and productivity if medications are involved. This representative (e.g., pharmacy manager, coordinator, team lead, or designated pharmacist covering perioperative service area) should be an active participant to promote proper medication use in the perioperative area.

Medication-use guidelines, protocols, and medication-use evaluation.

Evidence-based guidelines and protocols are important tools to guide clinical practice and appropriate use of high-cost medications. Pharmacists should lead efforts to develop such guidelines and protocols in the perioperative environment. Once approved, institutions using an AIMS with clinical decision support can create alerts or reminders to improve adherence (e.g., reminder to administer the prophylactic antibiotic if one has not been recorded or a reminder to administer prophylactic antiemetics to a patient at high risk for developing postoperative nausea and vomiting).⁶²⁻⁶⁴ A Medication-use guidelines, protocols, and medication-use evaluation may be conducted to determine compliance with institutional protocols or restrictions and, possibly, impact on patient outcomes. Audits should be ongoing to ensure sustainability. High-cost, high-risk, or high-use medications such as recombinant factor VII, albumin, topical hemostats, liposomal bupivacaine, and intravenous acetaminophen are examples of perioperative medications that may be selected for evaluation.

Waste reduction. ORs generate an estimated 20% to 30% of hospital waste, primarily due to volatile anesthetics, pharmaceuticals, packing, and supplies. With a goal of greening the OR, the ASA recommends that ORs reduce, reuse, recycle, and redesign.⁶⁵⁻⁶⁸ To identify where medication waste may be occurring, the AIMS or electronic medical record may be used to determine usage, and compounding software may be used to determine compounding productivity or volume. Good relationships between surgeons, anesthesia, OR nursing, and pharmacy staff will assist in opening communication about strategies that are likely to be successful in reducing waste. For information about hazardous pharmaceutical waste, the reader is referred to the Environmental Protection Agency website.⁶⁹

Culture. Culture has been an increasing focus within organizations, because it plays a vital role in how employees accept and manage change. Using an interdisciplinary approach, the perioperative team should establish a culture of identifying, analyzing, resolving, and monitoring change. Although this culture should be encouraged in the workplace, it starts with education in the classroom setting. Ideally, institutions would provide formal team training in the perioperative setting that includes pharmacy staff. As previously mentioned, an important factor to improve culture is the establishment of a just culture around medication safety reporting and sharing of lessons learned. Tools exist to measure the culture of safety and should be used and shared with the affected teams.⁷⁰

Leadership duties and professional service

Depending on the health system's organizational structure and the size and scope of the OR, a pharmacy manager or supervisor may be assigned to oversee the perioperative pharmacy service. However, many perioperative pharmacy services or pharmacy satellites will use frontline staff and designate those staff pharmacists to assist with leadership tasks for pharmacy services in the perioperative area. The ASHP Statement on Leadership as a Professional Obligation asserts that all pharmacists have a professional obligation to serve as leaders in the safe and effective use of medications and encourages those practitioners to advance patient care and strengthen the pharmacy profession by embracing the responsibility to exert leadership in their practices.⁷¹ ASHP maintains that frontline staff must display leadership each time they enter the workplace and advocates that pharmacists should take personal responsibility for leadership in the medication-use process.⁷¹ The perioperative pharmacy management or designated perioperative pharmacist may be tasked with the role to lead as well as oversee the delivery of services

by the perioperative pharmacy. The role should include responsibilities to both the main pharmacy department as well as perioperative areas. Maintaining involvement in both departments permits the perioperative pharmacist to be a liaison between groups to facilitate joint efforts.

The perioperative pharmacist leader should collaborate with health-care professionals in all areas within operative services to develop and monitor medication-use systems that promote safe and effective medication use. By this collaboration, the practitioners can ensure that medication use in the OR is evidence based, cost effective, and in compliance with national guidelines. The perioperative pharmacist can take a lead role in ensuring these collaborations occur. To accomplish this task, the perioperative pharmacy lead should understand the OR culture and practices, work effectively with interdisciplinary teams, and recognize the medication needs of the providers and the surgical patient. In addition, the perioperative pharmacist should ensure correct handling of medication waste to meet EPA hazardous waste handling requirements.

Goals for perioperative pharmacy should be developed annually. The pharmacy lead should seek input in establishing goals for the service from other perioperative departments. The goals should be aligned with the main pharmacy department and the hospital or health system's goals.

If the perioperative pharmacist is assigned leadership responsibilities, pharmacy administration will need to provide support that will allow the pharmacist to participate in various functions, such as committee meetings, project implementations, guidelines development, financial reviews, educational endeavors, regulatory and compliance assignments, operational duties, and teaching or research efforts.

It is important for the perioperative pharmacist to stay current with new and emerging trends. Involvement within the profession through participation in local, state, and national

professional organizations will be beneficial. Perioperative pharmacists should also consider involvement with other professional organizations such as ASA, Association of periOperative Registered Nurses, or the American Society of PeriAnesthesia Nurses, which may facilitate collaboration leading to further development of the perioperative pharmacy practice and the role of the pharmacist as an important member of perioperative services.

Financial management

Financial performance of the OR pharmacy should be managed in accordance with the requirements set forth by pharmacy administration and the institution's finance department. If perioperative pharmacy services are provided through an OR pharmacy satellite, it should be determined whether the satellite will be considered a separate accounting unit or part of the overall pharmacy budget. If the OR pharmacy is a separate cost center, the OR pharmacist leader may be assigned to provide input or to oversee the following:

- Revenue and expenses (particularly expenses such as drugs, supplies, technology leases, and salary and benefits costs),¹²
- Budget development and analysis of budget variances,
- Equipment requests and acquisition,
- Volume projections, and
- Justification of new personnel according to workload productivity standards.

Drug cost for anesthesia and surgery may encompass a sizeable portion of the pharmacy's drug budget. Chernin found that anesthetic drugs were 10% to 13% of the overall pharmacy department's drug budget. The author noted that pharmacy is held responsible for the budgetary effect of the cost of the anesthetic drugs as well as the patient outcomes resulting from the use of these drugs.⁷² Therefore, much of the financial oversight needed for the perioperative pharmacy service will include audits and analysis of medication

use to assure appropriateness and timely capture of charges and expenses.

There are several factors, such as price and use, which can drive growth in overall drug expenditures. The physician and nursing groups may be able to anticipate their future medication needs and new service development, such as adding surgery specialists, opening additional ORs, and implementing new procedures that may increase the cost of drugs. It is important to collaborate with other leaders in the OR to plan and prioritize strategies focused on cost-effective use of medications (e.g., just-in-time dispensing of high-cost medications or determining the most appropriate sterile product preparation and dispensing method for select medications; in-house versus outsourced compounding; bedside prepared or commercial product use).

The perioperative pharmacist should keep apprised of the pipeline of potential new drugs used in anesthesia or surgery, and whether the new drug has the capacity to reduce length of stay, decrease use of other drugs, or offset the cost by other means. The perioperative pharmacist should assist with or directly manage addition of new perioperative medications to the formulary. Safe handling and disposal of drugs such as chemotherapy or hazardous waste should be managed according to any special handling needs.

Pharmacy benchmarking systems or best practice models that accurately assess and compare the impact of pharmacy services on patient outcomes, staffing, and costs can be valuable tools for pharmacy and organizational leadership.

Desirable roles of the perioperative pharmacist

Desirable roles of the perioperative pharmacist may be considered best practices but depend on the level of practice experience of the perioperative pharmacist and the available resources. Whatever pharmacy services are able to be provided should be consistent and available to all patients in the

perioperative setting. Desirable roles of the perioperative pharmacist include:

- Preoperative medication history/ medication reconciliation/transitions of care,
- Participation in PACU huddles/ rounds,
- Care of boarded patients,
- Discharge prescription service,
- Participation in resuscitation,
- Education,
- Research and other scholarly activities,
- Consideration for inclusion on the Pharmacy and Therapeutics (P&T) Committee, and
- Quality and safety initiatives.^{63,73-76}

Preoperative medication history, medication reconciliation, and transitions of care

It is important to obtain an accurate medication history (prescription and nonprescription) of the patient to identify allergies and medications the patient is currently taking or has recently stopped taking that may affect their perioperative care. The medication history may be taken while the patient is located in the preoperative unit and getting prepared for surgery or, preferentially, during a preoperative screening visit or call that occurs prior to the scheduled procedure. A preoperative medication history review by a pharmacist (or trained technician or student pharmacist with pharmacist oversight) with a mechanism for follow-up has been shown to reduce the number of missed doses of chronic medications, postoperatively.^{77,78} Furthermore, patients on chronic opioids can be identified prior to surgery to allow time to develop an appropriate pre-, intra- and postoperative pain management plan.⁷⁹ With sufficient time (months) and support, patients identified as high risk for uncontrolled postoperative pain, respiratory depression, or other complications from opioids may benefit from an appropriate downward

taper of their opioid dose prior to surgery.⁸⁰ One area for particular scrutiny would be any medications the patient may be on preoperatively that could interfere with neuraxial procedures, including but not limited to low-molecular-weight heparins, heparin, warfarin, or direct thrombin inhibitors. Additional populations at high risk for anticoagulation-antiplatelet drug interaction should receive pharmacist review for medication reconciliation. Familiarity with the American Society of Regional Anesthesia guidelines is necessary.⁸¹ Prior to or at discharge, pharmacists are well positioned to perform patient counseling and medication reconciliation and assist with medication management at home during recovery.⁸²

Participation in PACU huddles and rounds

The pharmacist has a unique opportunity to increase visibility and serve as the medication safety specialist during a critical transition period, from the OR to the PACU and from the PACU to the floor. During this transition, decisions are made regarding the postoperative pain, nausea, and surgery-related infection therapy, along with continued chronic (home) medication therapy. Studies have shown the impact on reducing preventable adverse drug events by including pharmacist participation in medical rounds in both the general and critical care environments.^{83,84} Patient rounding should be explored in the postoperative setting as well. Interdisciplinary PACU rounds can provide a definitive plan of care and increase bedside education, as well as identify systems and processes that can be improved.⁸⁵ Pharmacist participation in rounding on every PACU patient may not be feasible; however, development of criteria to identify high-risk patients in PACU may be beneficial in optimizing medication usage.

Care of boarded patients

Patients accommodated overnight in the PACU area should ideally be treated as an inpatient and

have an inpatient status from the admitting department. Medications should be dispensed according to a predetermined patient location distinct from the PACU so that pharmacy services can identify them as boarded patients separate from general PACU patients. Depending on the institution's workflow and processes, the perioperative pharmacist may or may not be assigned as the caregiver for these patients. If a profiled ADC is not physically present, medications can be centrally distributed in patient-specific packaging and delivered to a secure location in the PACU. Depending on how long a patient is boarded in PACU, pharmacy services may include medication reconciliation, order verification, pharmacokinetic monitoring, antimicrobial stewardship, anticoagulant monitoring, i.v. to oral (PO) conversion monitoring, discharge medication counseling, and cardiac arrest response. Review of high-risk patients being admitted should also include a hand-off of care.

Discharge prescription service

The process of discharge following surgery can often be rushed and fraught with opportunities for misinterpretation by providers, families, and patients. Additionally, obtaining prescriptions for a surgical patient after leaving the facility can be challenging if they traveled a long distance. For outpatients, improving transitions of care from a PACU setting to home and reducing delays in PACU discharge can be accomplished by a collaborative effort between surgeons, PACU, and an outpatient pharmacy facility able to provide timely discharge medication dispensing. Ideally, discharge prescriptions should be planned for at the surgical preoperative visit or at the time of surgery to allow for the necessary processing time.⁸² Identification of outpatient and short-stay (<24 hr) patients that may require a discharge prescription should be done at the beginning of the day. Communication between an outpatient pharmacy facility

and the PACU can facilitate obtaining prescription insurance information, prescriptions, and a fast-track filling procedure in the pharmacy. Ideally, the majority of prescriptions are processed by the time the patient reaches Phase II of recovery.

An effort should be made to standardize medications prescribed, such as analgesics and antimicrobial agents. In addition, encouraging electronic prescribing of medications, including electronic prescribing of controlled substances (unless mandated by state law) can improve throughput. Discharge prescriptions written for medications that require prior authorization or are difficult to obtain in an outpatient setting should be discouraged. With early intervention and coordination of services, the pharmacist can assure that the patient's discharge medications are accurate, counsel the patient on their new regimen, and ensure delivery of medications at bedside prior to patient discharge from the facility. Provision of a list of nearby 24-hour pharmacies should be provided if the patient is discharged after an internal pharmacy is closed or the patient desires to have their prescriptions filled outside of the institution.

Participation in resuscitation

It is recommended that pharmacists practicing in the perioperative setting be certified in advanced cardiac life support (ALCS) and pediatric advanced life support (PALS). At a minimum, pharmacists should have a practical knowledge of cardiopulmonary response and drugs used in resuscitation efforts. If feasible, pharmacists should assist in arrest response in individual ORs, the preoperative area, and the PACU area until the patient's condition has stabilized. Medications should be prepared either in a syringe or in an intravenous infusion with standardized concentrations. Pharmacists should be familiar with the infusion devices and drug libraries used in the perioperative areas as well as crash cart locations and content. Finally, pharmacists and other

healthcare providers (including nurses) should be regularly trained to recognize and respond to other emergencies that may occur in the perioperative area, such as malignant hyperthermia and local anesthetic systemic toxicity. Dantrolene and lipid emulsion (respectively, for treatment of malignant hyperthermia and local anesthetic systemic toxicity) must be readily available in the OR and other areas where medications that may trigger these emergencies are used.⁸⁶⁻⁸⁹ For specific recommendations, refer to the Malignant Hyperthermia Association of the United States recommendations.⁸⁷

Education

Educational needs and opportunities can be variable and extensive in the OR. In addition to having a working knowledge of commonly used medications and the medication-use process, the perioperative pharmacist should receive specialized education about the OR environment. The perioperative pharmacist can provide education for pharmacists, technicians, students, and pharmacy residents. Topics of interest include the perioperative medication-use process, medication safety, practice guidelines, medications primarily used in the OR setting (e.g., inhaled, intravenous, and local anesthetics; intravenous opioids; neuromuscular blocking agents and reversal agents; and antiemetics), aseptic technique, regulatory requirements, drug diversion prevention and surveillance. Providing such educational topics for nurses, ACPs, and surgeons solidifies the perioperative pharmacist as a medication expert and should be offered on an ongoing basis.

Research and other scholarly activities

The perioperative pharmacy should support an organization's research mission. Pharmacists are in a strong position to identify research questions, write protocols, foster resident research, assist with study randomization, provide study drug or placebo, and document study-related information. Pharmacists

can be involved as the principal investigator, co- or subinvestigator with other investigators, or as the pharmacist of record for the study. Pharmacists, students, and residents should be encouraged to participate in research or other projects (e.g., process or quality improvement) as much as possible to improve efficiency, safety, or outcomes; reduce cost; and foster future collaborative endeavors.

P&T committee

The P&T committee is responsible for managing the formulary system, as well as review and revision of medication-use policies. For medications used primarily by ACPs or intraoperatively by surgeons, the perioperative pharmacist should participate in developing, implementing, and monitoring guidelines on criteria for use and educating users in the perioperative setting on pertinent portions of medication-use policies when possible. Although patient safety issues are incorporated in the P&T committee's decision-making process, the unique medication-use process in the OR may not be fully appreciated by P&T committee members who rely on those with more expertise to incorporate appropriate safety strategies for the perioperative setting.

Quality and safety initiatives

In today's healthcare environment, there are many issues related to quality and safety in the perioperative setting, including external pressures, technology integration (advancements and constraints), human factors, and process improvement. Anesthesia departments often have a quality assurance committee to evaluate the current state and determine how to improve processes in the future. Pharmacists can provide valuable contributions to improvement efforts, particularly ones that involve medications (e.g., standardization of medication trays and concentrations, safe injection and administration practices, or optimal ways to provide a drug, especially when that drug is in short supply).

Competency

Pharmacists. To make effective clinical contributions, the pharmacist should become familiar with all medications used in the perioperative setting, including those used by ACPs and surgeons (e.g., contrast media, dyes, topical hemostats, irrigations). There is little focus on intraoperative medications in pharmacy school curricula, and residency programs do not consistently offer training in the perioperative arena.⁹⁰ Therefore, expertise is often acquired by self-motivated learning. Ongoing review of surgical and anesthesia literature, observation of surgery and anesthesia procedures, attendance at anesthesia and surgery conferences, presentation of assigned topics or journal clubs, and direct involvement in patient care will all contribute to the pharmacist's knowledge. In addition, the perioperative pharmacist should have a working knowledge of relevant regulatory requirements, accreditation bodies, National Patient Safety Goals, and quality initiatives.

Pharmacy technicians. Typical activities performed by pharmacy technicians in a satellite pharmacy under the supervision of the pharmacist are drug distribution, handling of controlled substances, sterile drug preparation, drug ordering and restocking, orientation and training of new staff, and quality assurance activities. For routine accuracy-checking activities (e.g., anesthesia medication trays), a tech-check-tech process may be validated and implemented where permitted by state law. Use of barcode or radio frequency identification-based tray checking technology can add additional accuracy to the process.⁹¹ Barcode scanning technology also allows the technician to restock ADCs and anesthesia workstations independently of a pharmacist check, where permitted by law.⁹²

Pharmacy technicians assigned to the OR satellite pharmacy should become certified by passing an accredited, national exam (ASHP recommends the Pharmacy Technician Certification

Exam) and should receive specialized training about the OR environment to prepare them for this role. Technician training and experience should include parenteral drug preparation, drug distribution procedures, anesthesia and OR record interpretation (if doing manual billing from anesthesia record), and controlled substances record-keeping. Specialized training should include the following areas:

1. Procedures unique to the OR environment, including special apparel (e.g. scrubs, caps, masks, foot covers), restricted movements in areas within OR suites, and infection control guidelines;
2. Roles of personnel in the OR and who may handle medications;
3. OR terminology, including abbreviations and acronyms that may be used when OR staff communicates with the pharmacy;
4. Drug classes, indications for use, and proper handling of drugs routinely used in OR (e.g., special packaging, preservative requirements for spinal and epidural drugs, infusion concentrations);
5. Controlled substances procedures;
6. Emergency medications; and
7. Role in the OR and OR pharmacy.

An orientation checklist, workflow sheets, and task lists are helpful tools. As with pharmacists, an OR pharmacy technician training module would be a helpful tool to provide a consistent baseline knowledge level for technicians. If a pharmacy technician career ladder is in place in the institution, an examination evaluating this knowledge base may be useful in facilitating advancement to this specialized position.

Looking to the future: the perioperative surgical home and enhanced recovery after surgery

The goal of a patient-centered medical home is to improve health and delivery of care and reduce cost. The perioperative surgical home (PSH) is

a counterpart to the patient-centered medical home and is carried out through a physician-led interdisciplinary and team-based system of coordinated care that assists the patient through the surgical experience.⁹³ With improvements in the perioperative process, the PSH can have shared savings and incentive payments for achieving quality measures. The PSH model ensures communication with surgical patients early in the process, which facilitates reducing unrealistic expectations and ensures that patients are educated in decision-making so they can participate in the process. With less variability in perioperative care, shared decision-making, and patient-centered care, it is anticipated that a change to a PSH model would reduce duplicative or unneeded tests, delays, length of stay, and complications.⁹⁴

Similar to the PSH, enhanced recovery after surgery (ERAS) is an evidence-based, multimodal, interdisciplinary approach to the care of the patient throughout the entire surgical experience. Components of ERAS may include carbohydrate drinks 2 hr prior to surgery (rather than overnight fasting), minimally invasive surgical approaches (rather than large incisions and open procedures), goal-directed i.v. fluid management (rather than large volumes of i.v. fluid), no drains or early removal of drains and tubes, early mobilization, and starting food and drinks on postoperative day 0 (the day of surgery). Adherence to ERAS protocols have resulted in 30% to 50% reductions in length of hospital stay, with similar reductions in complications, as well as lower costs and readmission rates when compared with traditional care of the surgical patient.⁹⁵

With the PSH and ERAS team, the perioperative pharmacist can be involved in protocol development as well as identifying and caring for patients who may be at high risk for readmission or anticipated to have challenging postoperative pain or anticoagulation management. Pharmacists may also assist with medication reconciliation at admission, identifying high-risk drugs, polypharmacy, disease or drug

interactions, and opioid-tolerant or chronic pain patients, whose postoperative pain management is often quite challenging. However, the more important impact of pharmacist involvement may be during the coordination and transition of care at discharge. Pharmacists can evaluate the discharge medications along with the prior-to-admission chronic medications and the inpatient medication list to determine appropriateness, confirm omissions and deletions, and follow up with the patient following discharge to answer questions and assess whether the patient is experiencing any difficulties with the discharge medication regimen.

Conclusion

Pharmacists responsible for services to the perioperative area should be knowledgeable in OR practice, the OR medication-use process, regulatory requirements, and medications that are administered perioperatively. By using this knowledge and working in close partnership with OR staff (e.g., ACPs, nurses, and surgeons), pharmacists are well positioned to optimize medication processes and safety in the perioperative setting. Pharmacists are also well equipped to perform or oversee medication histories and make recommendations, provide discharge medication counseling, participate in in PACU huddles and rounds, and perform other beneficial activities.

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Additional Information

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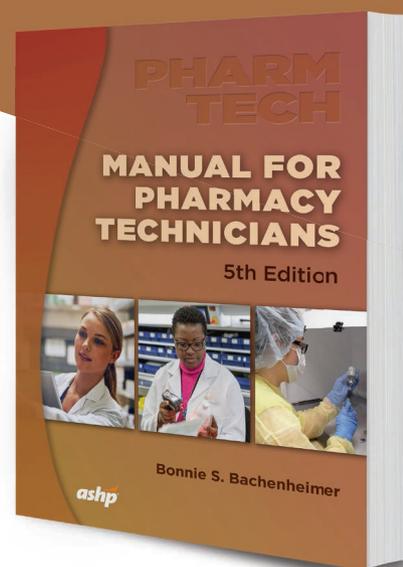
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