Key Vulnerabilities in the Surgical Environment: Container Mix-Ups And Syringe Swaps

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The perioperative area is one of the most medication-intensive locations in a hospital, often with more medications, particularly high-alert medications, administered per patient when compared with other patient care units. Yet this area of the hospital often operates with fewer medication-safety strategies in place than most other patient care units. For example, the anesthesia provider often selects, prepares, labels, and administers medications without the benefit of electronic clinical decision support, pharmacy review of medication orders prior to administration, barcode scanning of products prior to administration, and other secondary checks by other health care providers.1,2 This lack of normal checks and balances, along with the use of multiple medications, time-sensitive tasks, complex and stressful working conditions, distractions, and fatigue, all contribute to making the perioperative area particularly error-prone when medications are administered.

While there are many opportunities for anesthesia providers to make medication errors in the perioperative area, two specific tasks are especially vulnerable to errors.3 The first is selecting a drug container from which a medication dose must be withdrawn. The anesthesia provider could accidentally pick up the wrong vial or ampule, especially if it looks similar to another container or is placed near another medication on the anesthesia tray or cart. For example, the Institute for Safe Medication Practices reported container mix-ups between VAZCULEP® (phenyl-ephrine, Avadel Legacy Pharmaceuticals) and BLOXIVERZ (neostigmine, Avadel Legacy Pharmaceuticals) by anesthesia providers. The second task is selecting the prepared syringe for administration, which can result in a “syringe swap” in which an anesthesia provider accidentally administers the wrong medication from a different syringe than intended. Given that in many hospitals most anesthesia syringes are prepared in the surgical suite by the anesthesia provider, the tasks associated with selecting the medications, preparing the syringes, and administering the medications by a single practitioner can be a source of significant iatrogenic patient harm as described in the medication errors that follow.

Medication Errors

A 68-year-old woman undergoing a total knee replacement received tranexamic acid intrathecally instead of the intended bupivacaine and morphine. The surgeon had planned to irrigate the open knee with tranexamic acid to minimize blood loss, and the anesthesiologist had intended to administer bupivacaine and morphine intrathecally for pain control. The pharmacy had dispensed 10-mL vials of both the tranexamic acid (100 mg/mL) and bupivacaine (2.5 mg/mL) to the surgical suite for staff to prepare in syringes just prior to administration (morphine was available in unit stock). The vials looked similar in size, and despite label dissimilarities, the anesthesiologist picked up a 10-mL vial of tranexamic acid believing it was bupivacaine. He added this vial to his anesthesia tray and later administered the drug intrathecally, believing he had prepared the syringe using a vial of bupivacaine. Apparently, he had quickly glanced at the label and never noticed that he had grabbed the wrong 10-mL vial when setting up the medications required for this patient’s anesthesia. There was no opportunity to barcode scan the medication before preparation and administration.

The patient immediately developed myoclonus of her lower extremities and seizures. The surgical procedure was stopped, and the patient received 300 mg of intravenous (IV) fosphenytoin. She continued to experience seizures and self-terminating runs of ventricular tachycardia. She was intubated and placed on a ventilator while receiving a neuromuscular blocker. She required treatment in the intensive care unit, and after 23 days of hospitalization, the woman was finally discharged to a skilled nursing facility for physical rehabilitation.

A search of the literature easily found nearly a dozen additional foreign cases of mix-ups between tranexamic acid and bupivacaine in which tranexamic acid was inadvertently administered via the intrathecal route. Four of the cases in the literature resulted in fatalities.4–7 One fatality reported in the 2010 Anesthesia Patient Safety Foundation [APSF] Newsletter involved a 21-year-old woman pregnant with twins, who was scheduled for a cesarean section due to vaginal bleeding and placenta previa. The anesthesiologist decided to administer spinal anesthesia and asked a technician for bupivacaine. The technician accidentally opened and handed the anesthesiologist an ampule of tranexamic acid instead of bupivacaine, which the anesthesiologist administered after confirming free flow of cerebrospinal fluid. Within minutes, the patient complained of severe pain from her waist to lower extremities. She became dysphoric and dizzy, and after emergency delivery of her twins, she required mechanical ventilation, experienced severe myoclonus and seizures, and developed tachycardia that required treatment with antiarrhythmics. She later developed ventricular tachycardia followed by ventricular fibrillation refractory to treatment.

In this case, both bupivacaine and tranexamic acid were available in look-alike containers with the same volume of medication and red printing on the label. While tranexamic acid was not typically used in the surgical suite, it had been used several weeks prior to the event...
control nonobstetric bleeding. Residual unused product had been added to the medication supplies instead of sending it back to the pharmacy.

Another fatal error happened while performing spinal anesthesia on a 55-year-old woman undergoing orthopedic surgery. Tranexamic acid rather than bupivacaine was injected intrathecally, and the patient experienced immediate, severe burning pain in her lower extremities. She subsequently developed myoclonic twitching of the facial muscles, hypotension, and became unconscious. She was intubated and mechanically ventilated but died after 10 hours due to ventricular fibrillation refractory to treatment.

Incidence and Causes Of Perioperative Errors

While the literature is sparse on perioperative medication errors and consists mostly of self-reported events, the results of a published prospective study found that about one in 20 perioperative medication administrations and half of all surgical procedures resulted in a medication error and/or adverse drug event. This error rate is higher than reported in many retrospective surveys, even though the large hospital involved in the study was often using a barcode-assisted syringe labeling system that scans drug containers, prints a syringe label, and provides audio and visual feedback regarding the drug name and concentration. All of the medication errors and 80% of the adverse drug events were deemed preventable. More than one-third of the medication errors led to actual patient harm, and the remaining two-thirds had the potential to cause harm. While more than half of all errors occurred within the first 20 minutes of anesthesia induction, procedures longer than six hours or requiring 13 medications or more had higher error rates. The most common errors were associated with absent or incorrect labeling, wrong doses, a failure to act, omitted doses, and wrong medications. The least frequent errors were related to inadvertent boluses of medication remaining in the tubing and wrong timing of medications.

Common causes of perioperative medication errors often can be linked to both human and system causes. Examples of human causes may include unlabeled syringes when medication labeling is regarded as desirable but not mandatory; overreliance on the expected location of medications and syringes on the cart or tray; overreliance on color-coded labels; failure to carefully read labels; and repetitive task designs that foster automatic behavior with little conscious attention required. Examples of system causes may include a failure to standardize medication concentrations; a changeable, chaotic anesthesia work area; a hodgepodge of medication storage; sound-alike and look-alike medication names, containers, and labels; workflow problems; use of a distal instead of proximal port to inject medications; and compatibility of access ports intended for differing routes of administration.

Safe Practice Recommendations

In 2010, the APSF proposed a paradigm to reduce medication errors causing harm to patients in the surgical suite based on standardization, technology, pharmacy/prefilled/prefixed, and culture. Some of these and numerous other recommendations listed below remain a challenge in many hospitals. Please note, these recommendations move beyond the important but traditional emphasis on label format and the admonishment to “always read the label” to more robust system- and technology-based strategies.

Standardization and Storage

- Standardize the concentrations of all high-alert medications used in the perioperative area, such as phenylephrine and EPINEPHrine, so they can be prepared in the pharmacy as often as possible.
- Standardize the anesthesia workspace, especially the locations where medications are stored.
- Set up storage in anesthesia carts or automated dispensing cabinets (ADCs) so the labels on vials and ampules are readily visible (instead of the caps).
- Organize anesthesia carts and trays to avoid the proximity of sound-alike or look-alike medications, or look-alike packaging and labeling.
- Reduce the number of multiple-dose vials, and use single-dose or single-use vials as much as possible.
- Limit the types and quantities of medications in the perioperative area to those necessary at the anesthesia workspace or cart until refill within 24 hours.
- Regularly review and remove rarely used or no longer needed medications from the anesthesia workspace, ADCs, and drug storage carts.
- Remove used and unused medications from the anesthesia workspace when a case is completed to prepare for the next case.
- When available, use only standardized, route-specific connectors for tubing that will not allow misconceptions to an unintended route (e.g., IV, arterial, epidural).

Technology

- Deliver all medication infusions via a smart pump with activated dose error-reduction software with dose-checking capabilities.
- Employ a barcode scanning system to identify medications before preparing and/or administering them.
- Provide a standardized, machine-readable, barcoded label on all drug containers and/or syringes dispensed to the perioperative setting, or employ a similar just-in-time labeling system that can be used in the surgical setting.
- Employ an electronic mechanism to provide feedback, decision support, and documentation of important data during the perioperative encounter.
- Provide large and loud visual and auditory stimuli to target multiple senses to verify drugs and concentrations and to communicate important alerts.

Pharmacy/Prefilled/Premixed

- Require the use of commercially available, outsourced, or pharmacy-prepared prefilled or premixed syringes and infusions rather than anesthesia provider-prepared syringes and infusions. Use premade medication kits or drug trays by case type when feasible.
- If it is impractical for pharmacy to dispense all prefilled syringes for all medications used in all perioperative locations, employ the use of a barcode-assisted, automated syringe label printer that will visually and audibly aid in the verification of medications prepared and administered by an anesthesia provider.

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- Consider locating a satellite pharmacy in the perioperative area to help maintain medication surgical case trays and to dispense ready-to-administer medications.
- Include clinical pharmacists with enhanced specialty training on the perioperative team or make them available as perioperative consultants.
- Consider establishing a pharmacy liaison who works in the perioperative setting to drive safe medication use and implementation of error-reduction strategies, disseminate drug information, control the formula, identify contraindications (e.g., allergies), and work with the dispensing pharmacy to ensure products are provided when feasible in a ready-to-administer form.
- Provide dedicated anesthesia ADCs in operating rooms and procedural areas that communicate with the pharmacy and its information management system when medications are removed.
- Establish a practice to keep all used syringes and drug containers until each case has concluded.

Culture

- Establish an environment that promotes reporting, learning, just culture, and interdisciplinary respect and cooperation in the perioperative setting to promote teamwork and safety.

REFERENCES


The reports described in this column were received through the ISMP Medication Errors Reporting Program (MERP). Errors, close calls, or hazardous conditions may be reported on the ISMP website (www.ismp.org) or communicated directly to ISMP by calling 1-800-FAIL-SAFE or via email at ismpinfo@ismp.org.