

## Patient Safety Tip of the Week

June 4, 2019

### Medication Errors in the OR – Part 3

In our Patient Safety Tips of the Week for March 24, 2009 [“Medication Errors in the OR”](#) and November 3, 2015 [“Medication Errors in the OR - Part 2”](#) we discussed multiple reasons that medication errors are prone to occur in the OR. First, the OR is a complex environment where multiple disciplines interact on patients with complicated medical problems. Second, many of the medication safety tools we use elsewhere in healthcare are often not used in the OR. Specifically, one person (the anesthetist) is often responsible for ordering, dispensing, and administering medications. That bypasses the usual steps where at least 3 individuals (ordering clinician, pharmacist, and nurse) set eyes on a medication and have the opportunity to spot an error. And many OR’s still lack the other key medication safety tools, like CPOE and barcoding, that can help stop an error before it reaches the patient. Toss in the distractions and interruptions that frequently occur in the OR and “the perfect storm” is brewing.

In our Patient Safety Tip of the Week for November 3, 2015 [“Medication Errors in the OR - Part 2”](#) we noted a study showing medication errors in the perioperative setting are extremely common ([Nanji 2015](#)). In fact, one in every 20 perioperative medication administrations resulted in a medication error or adverse drug event. The **overall rate of 5.3%** is pretty close to the rates we typically see on inpatient units. And almost **half of all surgery cases had at least one medication error or adverse drug event**.

Since our last column on medication errors in the OR, there have been several reviews on the topic.

Wahr et al. ([Wahr 2017](#)) did a literature review and found 138 unique recommendations for OR medication safety, then used a modified Delphi process to whittle the list down to 35 specific recommendations. The authors note that, given the lack of randomized controlled studies to direct intraoperative medication safety strategies, definition of best practices must rely on expert opinion. Consensus statements regarding medication safety strategies have been published by multiple entities (ISMP, APSF, AORN) over the past two decades. We refer you to Table 4 in the Wahr review for the full list of the 35 recommendations. Most of them are covered in the recommendations listed below.

AORN (Association of periOperative Registered Nurses) has been a pioneer in addressing medication safety in the perioperative period. Boytim and Ulrich ([Boytim 2018](#)) conducted a systematic literature review of perioperative medication errors. They found that, in the OR, substitution, an incorrect dose, omission, and the wrong medication given accounted for more than 70% of MEs in eight of ten studies. Wrong route was also noted in many of the studies but wrong dosage form was seldom noted. Analgesics, antibiotics, and vasopressors had the highest incidence of medication errors across all perioperative areas.

Contributing factors included distraction, communication, haste, inattention, performance deficits, and knowledge deficits. Labeling mistakes and syringe swaps were the most common causes of substitution errors. Appearance of the vials and packaging often contributed. Environmental and workflow issues that contributed included transfers, fragmentation, change in providers, and an increase in workload. Length of surgery and emergency surgery were sometimes cited as contributing factors. Human factors that contributed included haste, stress, and pressure to proceed. Workarounds were also noted in some studies (see, for example, our April 5, 2016 Patient Safety Tip of the Week "[Workarounds Overriding Safety](#)"). As you'd expect, fatigue, distractions and interruptions were also noted as contributing factors. Of patient characteristics, higher level of acuity was often mentioned as increasing the likelihood of errors. And problems with medication reconciliation were also noted as contributing factors.

Suggested interventions included:

- Improved labeling (eg, label printers, barcode scanners)
- Eliminating provider-prepared medications (use instead pharmacy or commercially-available preparations in standardized concentrations or diluents in ready-to-use bolus or infusion form such as prefilled syringes)
- Use an electronically controlled smart device that contains a medication library
- Use a system that supports independent double-checks
- Use clinical pharmacists to improve medication reconciliation

And Outpatient Surgery (a division of AORN, Inc.) has had several articles with solid recommendations to improve medication safety in the perioperative period ([Novak 2015](#), [Litman 2018](#), [Sones 2019](#)). To summarize some of the recommendations in these three articles:

- Avoid "do not use" abbreviations in the medical records to limit the potential for confusion and mistakes.
- Use "Tall Man Lettering" to highlight distinctive syllables in similar looking drug names.
- Screen your drug drawers for look-alike and sound-alike drugs.
- Always separate LASA medications in drug storage areas.
- To avoid mixing up two similar looking medication ampules, change vendors for one of the medications.
- Don't "intermingle" or have compartments of carts or trays with more than 1 drug inside them.

- Use a label-printing machine in the OR if possible (though some studies found that only about 40% actually used it).
- For pre-printed labels, color-code by classifications (for example, induction agents in yellow, benzodiazepines in orange, muscle relaxants in fluorescent red, narcotics in blue, vasopressors and hypotensive agents in violet and local anesthetics in gray).
- If you can't use pre-printed labels, clearly write information on labels using a ballpoint pen or felt-tip marker that won't smudge or run.
- Ensure each drug label on each syringe or container that reaches the sterile field notes the drug, strength, date, time drawn and the drawer's initials. Best practice would include the expiration date as well but anesthesia providers often fail to check that date.
- Whenever possible, leave drugs in their already correctly labeled ampoules until it's time to administer them. Prepare a lineup of empty syringe-needle combinations and use one each time you need to open an ampoule and administer a drug.
- Whenever possible, transfer the dose from the ampoule to the patient's IV immediately, and skip the step of labeling a syringe. (Note: we do not agree with this recommendation. Interruptions occur so frequently in the OR that you might end up in the dangerous situation of having an unlabeled syringe in the field. Also, if an untoward event occurs, you may have an empty syringe lacking identification of what was in it.)
- When less than a full ampoule is administered, leave the remainder of the drug inside the already labeled ampoule. Save all used ampoules until the end of the case in case confusion arises about which drugs were administered.
- Use prefilled syringes (advantages: They banish ampoule swaps, those cases where you fill your syringe with the wrong drug, because they eliminate the need for ampoules. They can also eliminate accidental needle sticks and prevent certain unsafe injection practices, like reusing syringes.)
- Use a barcoding system for medication administration and integrate with your other IT systems. This can help prevent syringe swap. "You can't just mindlessly pick up a syringe. You have to stop, and look at its label. And what you enter has to match what pops up on the computer. There's an added benefit to such a system, because you can also program in alerts."
- Avoid stocking more than one strength of the same drugs unless it's unavoidable.
- Operating room carts should contain only drugs for daily non-emergent use. Store emergency ACLS drugs in immediate-use syringes separately from routinely used drugs.
- Don't stock harmful medications such as epinephrine, undiluted phenylephrine, potassium chloride, nitroprusside, or insulin in general storage locations.
- Supplies and quantities of narcotics and scheduled drugs must be secured and controlled in all settings, either by 2 signatures from nurses or physicians at the beginning and end of the day, or by the use of automated storage units.
- Access to narcotics and controlled drugs should be limited to nurses, anesthesia providers and pharmacists. Conduct a correct count at the beginning and end of each surgical day to document that no drugs have been stolen or lost.

A report from the PPSA (Pennsylvania Patient Safety Authority) analyzed over 1000 reports on perioperative medication errors in the Pennsylvania Patient Safety Reporting System (PA-PSRS) from 2017 ([Cierniak 2018](#)). 73% of the reports were from the intraoperative setting (the remaining 27% were from the post-anesthesia care units). Over half the errors reached the patient but only 1.6% resulted in patient harm. The PPSA notes that is a good “good catch” rate.

Types of error included:

- Wrong dose/over dosage 10.2%
- Dose omission 9.8%
- Wrong time 9.3%
- Wrong drug 7.9%
- Prescription/refill delayed 7.7%
- Wrong dose/under dosage 5.4%
- Other 20.3%

Analgesics and antibiotics accounted for over 60% of the errors.

Many of the reports included information about factors contributing to the errors.

**Communication breakdowns** were cited in 75% of the reports, and the medication ordering process was involved in just under half of those reports. Medication ordering issues were cited in 36.7% of all reports.

**Transitions and handoffs** contributed to many of the errors. For example, a second dose of a medication might be administered because the healthcare professionals were unaware the first dose had already been given. In other cases, a patient might be pre-medicated and sedated for a procedure at the wrong time, resulting in being sedated for longer than necessary. **Documentation errors**, which were present in 9.3% of cases with poor communication, often led to subsequent errors.

As we noted above, a major contributing problem is that one provider (the anesthetist) orders the drug, prepares it, and administers it. That bypasses many of the safety mechanisms involved in the medication process in other areas (no second set of eyes reviews the process). In the PPSA study, 29.3% of all reports involved issues that occurred while handling medications during **preparing and administering** (misprogramming of infusion pumps, medication mix-ups, and mislabeled, unlabeled, or otherwise unidentifiable medications, etc.). Problems programming smart infusion pumps were especially problematic (see our March 5, 2019 Patient Safety Tip of the Week “[Infusion Pump Problems](#)”). But sometimes the issues were related to things like line disconnects or pump malfunction during patient transfer.

**Accidentally swapping** one medication for another while a provider is handling several medications at one time either inside or outside the sterile field led to some medication mix-ups.

**Improper storage** of medications contributed to some errors. Many of these involved automated dispensing cabinets (ADC's) and instances in which a medication was accidentally stocked or returned to the wrong pocket or bin in the ADC. See our January 1, 2019 Patient Safety Tip of the Week "[More on Automated Dispensing Cabinet \(ADC\) Safety](#)" for other issues related to ADC's.

**Container mix-ups** and **syringe swaps** were cited as key vulnerabilities in an ISMP alert in 2015 ([ISMP 2015](#)). ISMP noted the anesthesia provider might 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, ISMP recently reported container mix-ups between VAZCULEP (phenylephrine) and BLOXIVERZ (neostigmine) by anesthesia providers.

They go on to discuss that, in many hospitals, most anesthesia syringes are prepared in the surgical suite by the anesthesia provider. When multiple syringes are prepared, it is possible for the anesthesia provider to inject from the wrong syringe ("syringe swapping"). ISMP found multiple cases of mix-ups between tranexamic acid and bupivacaine in which tranexamic acid was inadvertently administered via the intrathecal route of administration. In these cases, look-alike containers with the same volume of medication and red font print on the label contributed to the mistakes.

The latter mix-up is worth reiterating. Tranexamic acid is only used for a few procedures, so one would question why it would even be included in most OR setups. Don't forget the mix-up we've pointed out several times where methylene blue dye was erroneously used in eye surgery instead of trypan blue (see our May 20, 2014 Patient Safety Tip of the Week "[Ophthalmology: Blue Dye Mixup](#)" and our September 2014 What's New in the Patient Safety World column "[Another Blue Dye Eye Mixup](#)"). There is little reason to keep methylene blue in most OR setups since it is used only in a few select instances.

Recommendations from PPSA and ISMP:

- Employ BCMA (bar-code medication administration) across all patient care areas, including intraoperative areas and the PACU
- Standardize the workflow for electronic entry of intraoperative orders to support BCMA Implementing barcode-assisted syringe labeling systems replace manual syringe labeling
- Review current handoff procedures for patient transitions to, from, and within perioperative care areas for vulnerabilities
- Redesign and standardize handoff procedures to reduce the risk that incomplete or inaccurate information (e.g., failure to account for patient allergies or the timing of previous medication doses) is exchanged
- Establish a procedure for evaluating infusion pump settings and pump stability (i.e., make sure there are no line disconnections) prior to patient transfer, during transfer, and upon arrival at the new care unit
- Work with the organization's EHR/CPOE/AIMS and mobile-application vendors to optimize and streamline patient information exchange among these systems
- Optimize clinical decision support capabilities in these systems

- Avoid pre-labeling empty syringes prior to intraoperative use
- Develop institution-specific practices and protocols for drug handling and labeling in the procedural areas
- Verify each medication and label at the time of preparation
- Standardize stock and use pre-filled syringes supplied by manufacturers to minimize risks from mislabeling
- Make sure that pre-filled syringes from outside sources follow USP labeling requirements
- Consider storing look-alike products separate from one another when feasible

We also refer you back to our November 3, 2015 Patient Safety Tip of the Week “[Medication Errors in the OR - Part 2](#)” for a discussion about the Anesthesia Patient Safety Foundation’s video on medication safety in the operating room ([APSF 2012](#)), including the recommendation about the use of the “**STPC**” system:

**S** Standardization  
**T** Technology  
**P** Pharmacy/Prefilled/Premixed  
**C** Culture

And a study just published ([Black 2019](#)) throws in yet another factor contributing to medication errors: **calculation errors**. The researchers administered a 15-question computational test to anesthesia residents and faculty at 7 academic institutions. Both groups committed a median value of 2 errors per test, for a mean error rate of 17.0%. The error rate for postgraduate year 2 residents was less than for postgraduate year. The error rate for faculty increased with years of experience. Error rates were independent of the number of hours of sleep. As you might expect, error rates varied with the number of operations needed to calculate the answer. The frequency of large errors (100-fold greater or less than the correct answer) by residents was twice that of faculty.

**Some of our prior columns on medication errors in the OR:**

March 24, 2009      “[Medication Errors in the OR](#)”  
 May 20, 2014      “[Ophthalmology: Blue Dye Mixup](#)”  
 September 2014   “[Another Blue Dye Eye Mixup](#)”  
 November 3, 2015 “[Medication Errors in the OR - Part 2](#)”

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