



Medication Safety in Anesthesia: Risks and Opportunities

Caitlin Aberle, PharmD, BCCCP, BCPS
Assistant Director, Clinical Pharmacy Services
Westchester Medical Center
Instructor of Medicine, New York Medical College



Objectives

- Recognize the risk of medication errors inherent in the anesthesia environment
- Discuss evidence-based opportunities for improved medication safety practices for pharmacists and anesthesiologists
- Evaluate current anesthesia workflow and assess for opportunities for improvement in medication safety



Disclosures

- Will discuss some product brands but I have no affiliation with any brands and do not endorse any specific brands



Audience Question

Does your institution have dedicated pharmacy resources for anesthesia/procedural areas?

1. Yes
2. No



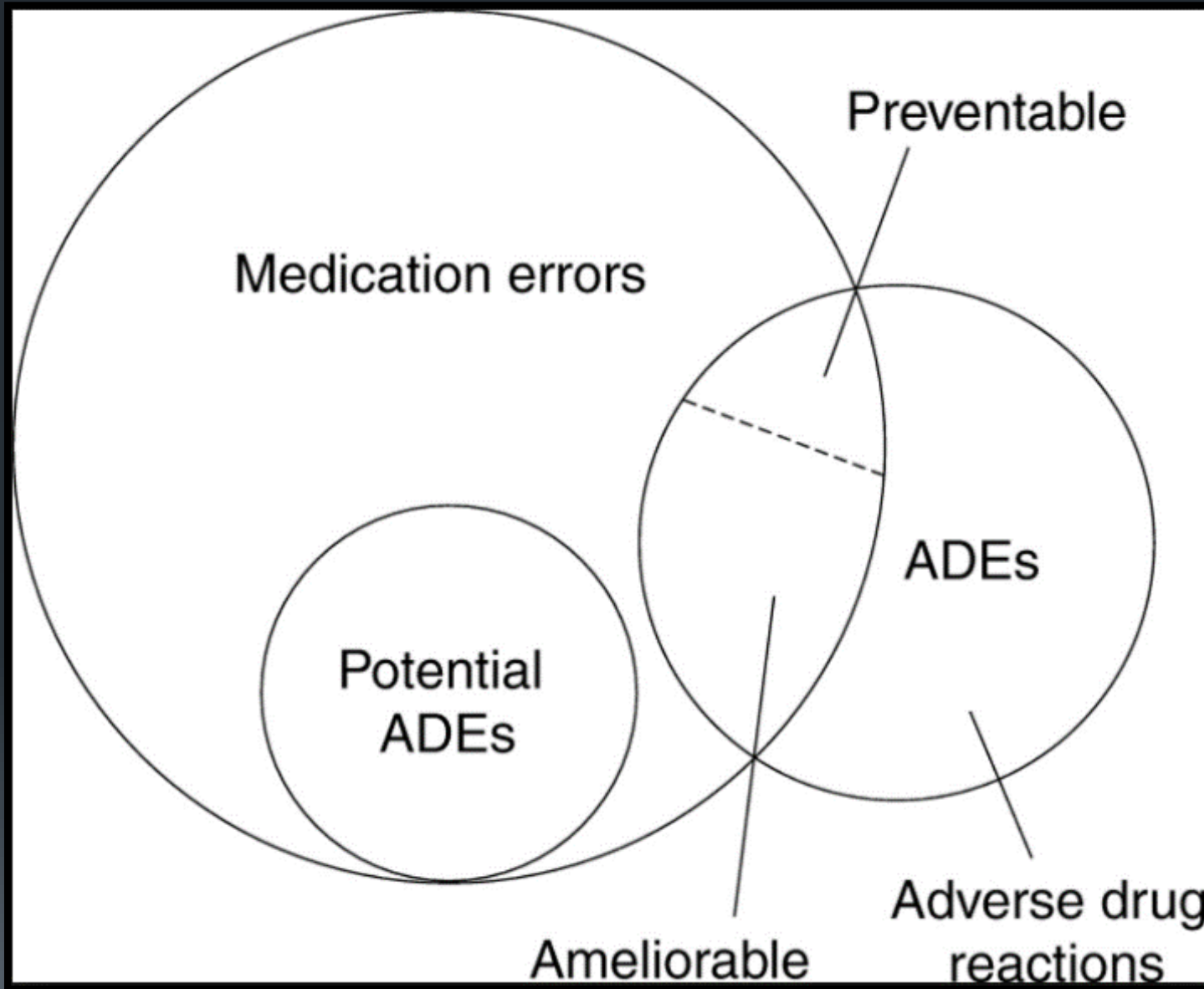
Medication Safety

- *To Err is Human: Building a Safer Health System*
 - Highlighted the risks of medical errors, one of which are medication errors
- Medication errors cannot be eliminated
- Goal is to decrease risk of errors as much as possible
- Institute for Safe Medication Practices
- Anesthesia Patient Safety Foundation



Medication Errors

- NCC MERP definition:
 - “Any preventable event that may cause or lead to inappropriate medication use or patient harm...”
- Medication error that causes harm is an adverse drug event
 - Not all adverse drug events are preventable





Anesthesia Workflow

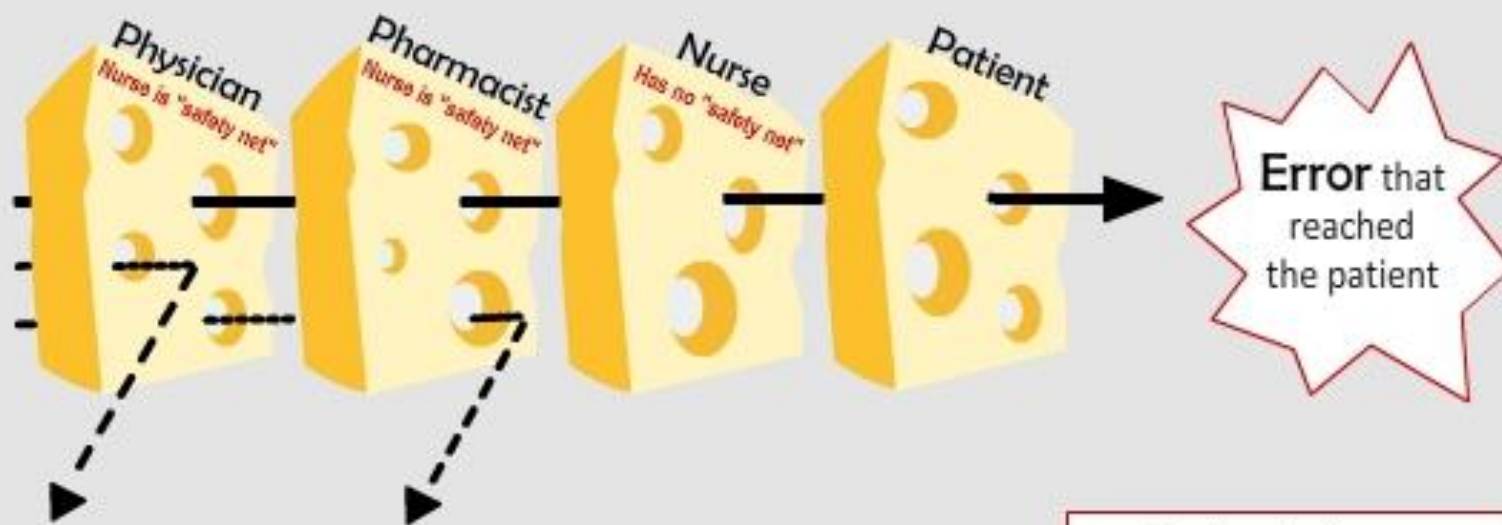
- Anesthesiologist functions as prescriber, pharmacist and nurse in the medication process
- Limited decision support
- Isolated system, cannot receive feedback from others
 - Restricted environment- Limited exposure for other disciplines
- High risk medications
 - Neuromuscular blocking agents
 - Respiratory depressants
 - Narrow therapeutic index
- When errors occur they can be more severe

Medication Error

The Swiss Cheese Model

Originator: Reason

High Reliability Organizations (HROs) deploy "Independent Redundancies"



"Near Miss"
Error that was intercepted

Latent Errors
(examples) →

- Poor handwriting
- Incomplete information
- Unclear labeling
- High workload



Audience Question

When you have observed a medication error made by yourself or a colleague, how often have you reported the incident into an incident reporting system?

1. I always report errors made by myself and others
2. I report only serious errors made by myself and others
3. I report most errors, but only those made by others
4. I rarely report errors that I observe



Risks by the Numbers

- Error rate in anesthesia is difficult to quantify
 - Relies on voluntary self-reporting
 - Errors may not be reported and may not be realized
 - Minor errors are underrepresented
- Studies from 2001-2012 report medication error rate ranging from 1:133-1:450 events per anesthetic administered
 - Average of landmark trials is 1 error per 211 anesthetic administrations

Literature Review: Risks

Error type	Webster et al	Khan and Hoda	Yamamoto	Llewellyn	Cooper et al
Error rate per anesthetic	1:133	1:265	1:450	1:274	1:203
Incorrect dose	32%	35%	25%	23%	37%
Substitution	27%	16%	23%	60%	24%
Omission	19%	9%	21%	4%	20%
Repetition/insertion	11%	N/A	7%	6%	18%
Incorrect route	2%	N/A	8%	6%	0%
Other	9%	38%	3%	N/A	2%



Literature Review: Risks

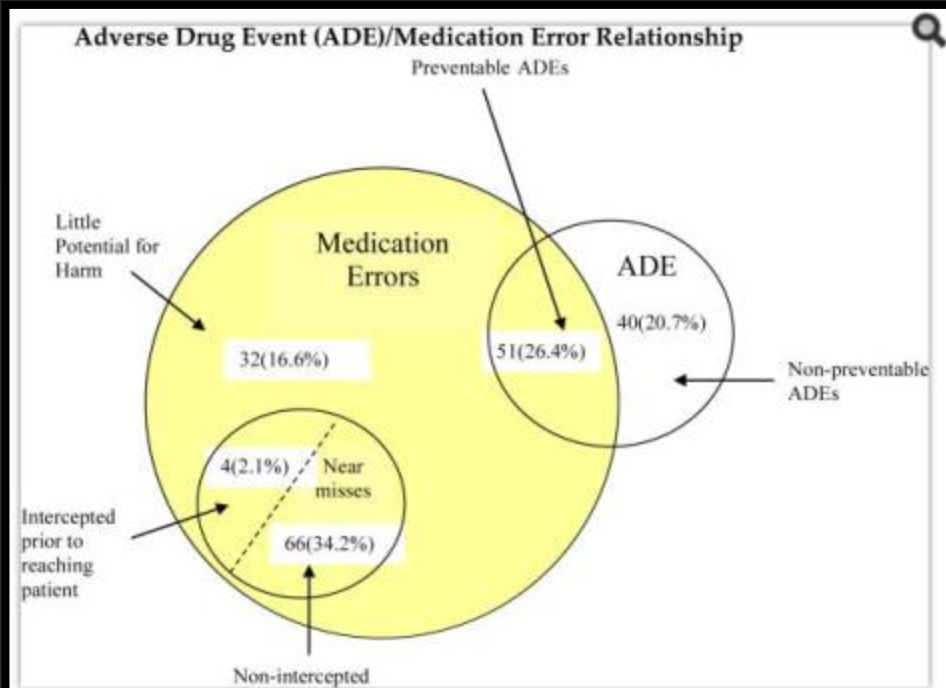
- Nanji et al 2016:
 - Prospective, observational, single-center study
 - Primary outcomes were the incidence of medication errors and adverse events
 - Study site:
 - Partners Healthcare System, Boston, MA
 - Electronic anesthesia information system (MetaVision)
 - Bar-code assisted syringe labeling system (Codonics)

Nanji et al: Methods

Methods

Medication process	From requesting to monitoring
Medication error	Failure to complete a required action in the medication administration process or or the use of an incorrect plan or action to achieve a patient care aim
Adverse drug event	Patient harm or injury due to a medical intervention related to a drug regardless of whether an error in the medication process occurs
Observers	Fully trained on above definitions, completed training course 3 anesthesiologists and 1 nurse anesthetist Trained on a minimum of 10 cases
Data collection	Excluded pediatric, cardiac, and off-site surgeries Began when anesthesia provider assumed care, ended when patient arrived in PACU or ICU
Event classification	Identified events underwent review by two independent members

Nanji et al: Results



The 193 events detected included 153 (79.3%) medication errors (MEs) and 91 (47.2%) adverse drug events (ADEs). A single event can involve both an error and an ADE. Of these events, 40 (20.7%) were ADEs that did not involve a ME, 51 (26.4%) were MEs that led to an observed ADE, 70 (36.3%) were MEs with the potential for an ADE (four intercepted and 66 non-intercepted), and 32 (16.6%) were MEs with little potential for harm.

- Observed 3,671 medication administrations for 275 patients
 - 193 medication safety events observed
 - 153 medication errors (preventable), 91 adverse drug events (40 not preventable)



Nanji et al: Results

- Longer procedures (greater than 6 hours) associated with higher event rates
- More administrations per case (13 or more) associated with higher event rates
- Most common ADEs were incorrect dose (47%) and omitted medications/failure to act (31%)
 - Most common medications leading to a ME were:
 - Propofol (26%), phenylephrine (10%) and fentanyl (9.4%)
- There was no difference in the observed event rate between house staff, CRNA and attending anesthesiologist staff
- Technology and process contributing factors



Nanji et al: Conclusions

- One in twenty peri-operative medication administrations led to a ME or ADE
- No difference in error rates based on level of training/expertise
- Many safety mechanisms already in place at the study site
- Author's suggest the following:
 - Bar-code assisted syringe labeling systems
 - Specific drug decision support
 - Thoughtful alerts
 - Timing of documentation (prior to administration)
 - Reducing opportunity for work-arounds
 - Thoughtful vendor selection with appropriate training



Summary of Risks

- Varying rate of medication errors in self-reported versus observational studies
 - 1:211 in self-reported
 - 1:20 in directly observed
- Only one prospective observational study has been conducted
- Most common errors:
 - Dosing errors, substitution, omission
 - Often involve high-risk medications
- Severity of errors:
 - Serious>significant>life-threatening



Literature Review: Opportunities

- Wahr et al: literature review of all peer-reviewed articles published from 1994-2014 related to medication safety guidelines for anesthesia and the operating room
- Reviewed 78 articles and created a list of graded safety recommendations
 - Completed by a group of 6 anesthesiologists, one pharmacist and two human process engineers
 - 35 recommendations put forth
 - Graded based on how many articles recommended each and the strength of each publication



Wahr et al: Recommendations

- Patient information
- Drug information
- Cart inventory
- Administration
- Culture
- Pharmacy

Table 3 Top recommendations by points and number of citations

Topic	Sub-topic	Recommendation	Points	Citations*
Culture	Culture	Incident or error reporting system	190	30
Case Medications	Labeling	Every medication labeled with drug name, date, concentration	178	29
Case Medications	Administration	Read and verify every vial, ampule, syringe label before administration	170	28
Case Medications	Labeling	Colour code labels by drug class	152	25
Cart Inventory	Organize/Standardize drug drawers	Standardize drug trays across all locations	136	21
Culture	Culture	Adequate teaching and in-service training	134	23
Case Medications	Labeling	Bar code and scanner	114	17
Case Medications	Preparation	Use prefilled whenever possible	104	17
Culture	Culture	Written policies for medication safety	100	20
Patient Information		Single location for recording medications	98	15
Patient Information		Automated alerts for dose, allergy, interactions	96	15
Pharmacy	Pharmacy	Pharmacist assigned to support OR	90	15
Case Medications	Preparation	Verify high risk med doses with 2 people	88	13
Cart Inventory	High Risk Meds on Cart	Standardize concentrations across units	84	14
Case Medications	Administration	Bar code scan with audible and visual alert	84	12
Bulk Inventory	Look-alikes	Avoid buying look-alikes	82	14
Patient Information		Verify allergies	74	14
Cart Inventory	High Risk Meds on Cart	Only one concentration of drug on cart	74	12
Case Medications	Administration	Smart pump used for all infusions	68	13
Case Medications	Administration	Retain all vials, ampoules, syringes until end of case	66	10
Case Medications	Administration	Smart pumps have libraries that are standardized across units	66	11
Case Medications	Labeling	Preprinted labels with room for concentration, date, time	64	10
Cart Inventory	High Risk Meds on Cart	Dangerous drugs not stored on cart	62	10
Cart Inventory	Organize/Standardize drug drawers	Drug trays have modular system	62	9
Case Medications	Administration	Colour coded infusions sets for epidural vs i.v.	62	12
Culture	Culture	Establish a just culture	62	10
Case Medications	Preparation	Compounded and diluted drugs are prepared by the pharmacy	60	10
Cart Inventory	High Risk Meds on Cart	No concentrated drugs on cart	58	11
Culture	Culture	Adequate supervision	56	10
Case Medications	Administration	2 person verification of all medications administered	52	9
Case Medications	Communication	At handover, review drugs given and all drugs on cart, field	52	10
Case Medications	Communication	Verbal orders are verified by speak back using protocol	52	12



Best practice recommendations

Institute for Safe Medication Practices (ISMP)

- Epidural tubing without ports, specially labeled
- Smart infusion pumps
- Barcode technology
- Standardize concentrations, diluents and container sizes
- Commercially available products rather than compounding
- Improve readability of labels

Anesthesia Patient Safety Foundation

- Medication safety conference in 2010
- Recommendations to focus on four areas
 - Standardization
 - Technology
 - Pharmacy/Prefilled/Premixed
 - Culture



Audience Question

What technology does your institution use to enhance medication safety in the operating room?

1. Smart infusion pumps
2. Barcode scanning
3. Labeling hardware/software
4. Automated dispensing machines

Technology: Smart Pumps

- Recommendations:
 - Smart pumps used for all infusions
 - Smart pumps are standardized across all units
 - Pumps have libraries with guardrails and alerts
 - Infusion device has prompts for weight-based limits



Technology: Smart Pumps

Alaris pumps have infusion libraries with anesthesia drugs in anesthesia mode

Opportunity: ensure all appropriate medications and guardrails are included

Cannot obtain data for infusions when in anesthesia mode
Overall compliance with guardrails is about 90%

Opportunity: ensure all staff are trained to use pumps to maximize safety



Automated Dispensing Cabinets

- Recommendations:
 - Drug trays in anesthesia carts:
 - Standardized across locations
 - Tray divisions labeled clearly
 - Drugs placed to minimize confusion
 - Modular system
 - Pharmacy manages drug trays
 - Eliminate unusual drugs from usual locations
 - Only preservative free local anesthetics

ADC Standardization Project

Remove all products that contain preservatives

Group like medications together, separate high risk drugs

Avoid stocking unusual drugs in anesthesia stations

Separate look-alike products

Standardize contents of all drawers except top drawer



Bar-code Assisted Administration

- Recommendations:
 - Every medication labeled with name, date concentration
 - Unlabeled syringe is immediately discarded
 - Minimize provider prepared syringes
 - Verify high-risk medications and weight-based doses with two people
 - Read and verify every vial/ampule or syringe label before administration

Technology: Bar-code Assist

- Codonics Safe Label System®:
 - Upon scanning a product provides audible and visual verification
 - Produces a label with all necessary components
- Double check mechanism with only one provider
- Labels can be scanned at a later time, even after hand-off
 - Integrate into electronic health record





EHR/Decision Support

- Recommendations:
 - Medications in standard format in chart
 - Single location for recording medications across surgery
 - Automated alerts in anesthesia system for dose, allergies, drug-drug interactions
 - Establish weight-based dose limits
 - Drug information readily available
 - Malignant hyperthermia, cardiac arrest, rescue protocols

Pharmacy

Procurement

- Avoid purchasing look-alike products
- Changes in drugs supplied require alerts to staff

Storage

- Unique IV solutions stored separately from regular solutions
- Return of unused unusual products
- Pharmacy stocks, tracks and delivers drugs to anesthesia cart

Preparation

- Pharmacy responsible for medication flow
- Pharmacy prepares all compounded or diluted high risk drugs
- Pharmacy prepares infusions

Education/support

- Pharmacist assigned to support OR
- OR pharmacists receive specialized education
- Pharmacists available 24/7 for questions
- Pharmacists participate in departmental education/M&M



Culture

- Recommendations:
 - Non-punitive quality assurance system
 - Written policies and procedures for medication safety, adequate training of new staff on policies
 - Respect and collaboration
 - Workflow changes to enhance safety
 - Read and verify every vial/ampule/syringe before administration
 - Discard unlabeled syringes
 - Sterile field medications: one at a time, labeled, verified



Future Opportunities

- Conduct a gap analysis of anesthesia workflow
- Partner with other departments to improve safety
 - Monthly meetings with anesthesia and pharmacy leadership
- Stay up to date with best practice recommendations
- Engage the EHR
- APSF medication safety video:
 - <https://www.apsf.org/videos/medication-safety-video/>



Summary and Conclusion

- Medication errors in anesthesia are difficult to quantify
- Varying rates of medication errors among studies, rates as high as 1:20 anesthetic administrations
- Best practice recommendations are available from several articles/organizations
- Changes in culture need to accompany changes in technology and products
- Anesthesia, pharmacy and other departments are partners in ensuring safe medication use



Medication Safety in Anesthesia: Risks and Opportunities

Caitlin Aberle, PharmD, BCCCP, BCPS
Caitlin.Aberle@WMCHHealth.org