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PATIENT SAFETY NETWORK

# Medication Administration Errors

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## Background

Medication errors have been a key target for improving safety since Bates and colleagues' reports in the 1990s characterized the frequency of adverse drug events (ADEs) and the relationship between medication errors and ADEs in hospitalized patients. As described in related primers on medication errors and adverse drug events and on the pharmacist's role in medication safety, the medication-use process is highly complex with many steps and risk points for error. This primer will focus on nurse-related medication administration errors.

Medication administration errors are typically thought of as a failure in one of the five “rights” of medication administration (right patient, medication, time, dose, and route). These five “rights” have been historically incorporated into the nursing curriculum as the standard processes to ensure safe medication administration. Recent literature, however, has emphasized that medication administration is part of a complex medication use process, in which a multidisciplinary care team works together to ensure patient-centered care delivery. As such, it has been emphasized that the five “rights” do not ensure administration safety as a standalone process. Therefore, four additional “rights” were proposed to include right documentation, action/reason, form, and response.[1] As modern healthcare delivery systems continue to evolve, emphasis on system design (i.e. technology & clinical workflows) has become a priority to complement the medication administration process. System-related causes of medication administration errors may include inadequate training, distractors, convoluted processes, and system misconfiguration.[2]

Despite error reduction efforts through implementing new technologies and streamlining processes, medication administration errors remain prevalent. In a review of 91 direct observation studies of medication errors in hospitals and long-term care facilities, investigators estimated median error rates of 8%–25% during medication administration. Intravenous administration had a higher error rate, with an

estimated median rate (including timing errors) ranging from 48%–53%.

A substantial proportion of medication administration errors occur in hospitalized children. This is largely due to the complexity of weight-based pediatric dosing, which encompasses medication doses based on calculations from weight and sometimes height. Variability of weights used for calculation can increase medication dose errors.[6] Given this variability, dose preparation is uniquely challenging in pediatric populations, which increases risk for wrong dose administration.

Outside of the hospital setting, patients and caregivers are also at high risk for making errors. Errors in the home are reported to occur at rates between 2-33%. Wrong dose, missing doses, and wrong medication are the most commonly reported administration errors. Contributing factors to patient and caregiver error include low health literacy, poor provider–patient communication, absence of health literacy, and universal precautions in the outpatient clinic.

#### Prevention

Both low- and high-tech strategies have been designed to ensure safe medication administration and align with the nine rights of medication administration. Many low-tech strategies support all nine rights, including the use of standardized communication strategies and independent double check workflows.

### Low-tech solutions

Standardized communication**:** Health system communication standards are used to ensure right medication. Tall man lettering is used in various electronic health records (EHRs), product labeling, and drug information resources to alert readers to “look alike, sound alike” drug names.  Additionally, standard abbreviations and numerical conventions are recommended by The Joint Commission.[3] The ‘do not use’ list includes general standards for expression of numeric doses. Of note, leading and trailing decimals (i.e., 0.2mg and 2.0 mg) are discouraged due to the potential for misreading (i.e., 20 mg).[3]

Patient Education**:** To mitigate risk of error in the home, it is important for health care professionals to use clear communication strategies and routinely provide education to patients, especially when medication regimens are modified.[4] A related primer on health literacy outlines some of the difficulties patients and family members encounter in understanding their medication regimens, as well as interventions for improving communication and understanding.

Patient education is a core component of medication management, particularly with high-risk medications such as anticoagulation therapy. Patients are educated routinely to ensure understanding of indication for therapy, intended outcomes, and signs and symptoms of adverse events. To help mitigate of wrong dose errors, warfarin tablet colors are standardized by their strength across all manufacturers. Patients are often advised to double check their tablet color upon getting a new prescription refill. If the prescription didn’t change, the tablet color shouldn’t either.

Optimizing Nursing Workflow to Minimize Error Potential**:** In health care settings, distractors during the medication administration process are common and associated with increased risk and severity of errors. Minimizing interruptions during medication administration and building in safety checks through

standardized workflows are key strategies to facilitate safe administration. There are many challenges associated with a true distraction-free zone; a study assessing feasibility of a "do not interrupt" bundle found that it was moderately effective but had limited acceptability and sustainability. Areas of increased high-risk medications administrations, such as the intensive care unit or emergency department, may have decreased compliance with non-interruption zones due to workflows and frequency of medication passes and titration events. Health systems should identify the area where medication administration preparation by nurses occurs to ensure that minimal disruptions are present (i.e., medication rooms, medication carts).

Additionally, strategies such as independent double checks are part of optimizing medication safety through nursing workflows. The Institute for Safe Medication Practices (ISMP) also recommends judicious use of independent double checks involving two different nurses to intercept errors prior to administration with key high-alert medications.[4] Double check processes involve a completely independent evaluation by a second nurse prior to administration. Research by Campbell et al. suggests that 93% of errors may be detected through this workflow, but only when performed as a true independent double check. Due to the additional time burden added to existing nursing workload, these double checks should be strategically targeted to the highest-risk medications and processes. Independent double checks should include "walking" or tracing the infusion lines from the infusion pump to the vascular access to ensure the intended medication is attached and infusing.

Some medications are available in a specific format to ensure the correct route is utilized during administration. For example, the epinephrine auto injector (EpiPen) for treatment of anaphylaxis is provided in a ready-to-use pen. This device, used for intramuscular injection in an emergency, does not connect to an intravenous (IV) line, thus preventing unintended administration via the IV route. Similarly, Enfit connectors and syringes for oral/g-tube/NG tube help to prevent inadvertent connection and administration of oral medications into an IV line.

Another crucial educational tool for health systems is the use of medication pass audits or medication safety rounds. These sessions involving an institution's managers and clinical experts serve as method of validating correct individual practice and serve as an opportunity to provide 'just in time' education. Audits of the administration process not only validate adherence to protocols but may highlight system processes that may need improvement to facilitate nurses' compliance.

Focusing in on High-Risk Agents**:** Some classes of medications have a higher likelihood to result in patient harm when involved in an administration error. Examples of these "high alert" medications include anticoagulants, insulins, opioids, and chemotherapeutic agents. The ISMP recommends a multipronged approach to mitigating risk with use of these agents. Strategies to mitigate potential for an administration error include protocolized prescribing, simplified instruction, robust documentation, and use of standardized administration practices such as dual nurse verification at the bedside. Health systems are encouraged to develop robust guidelines for use of these agents.

Standardized labeling, clear storage requirements, and various clinical decision support strategies are used to ensure correct medication selection and administration technique. The appearance of the medication itself may serve as a valuable safeguard. As an example, one type of eye drops (prostaglandins) has a turquoise cap on the bottle, across all manufacturers, while another completely different type of eye drop

has a pink cap (steroids). This distinguishing feature may be helpful for caregivers and patients alike, especially given that low-vision patients frequently use these drops. Similar techniques are employed with institutional labeling. If a medication is supplied in a consistent manner with specific labeling, this may also reduce error. Pharmacy-prepared emergency kits frequently employ standardized labeling and instructions for this reason. Ensuring that certain medications are only supplied in a 'pharmacy kit' is one strategy for helping to standardize process and reduce opportunity for error during administration.

**High Tech Solutions**

High-tech solutions commonly implemented within health systems include: barcode scanning of medication to ensure right medication, patients arm bands to confirm the right medication and the right patient, and smart infusion pumps for IV administration to confirm the right administration rate (a derivative of right dose and route) with technology that inhibits over- and underdosing of titratable drips during pump programming.

Barcode medication administration: When used appropriately, barcode medication administration (BCMA) technology reduces errors in health system settings by using barcode labeling of patients, medications, and medical records to electronically link the right dose of the right medication to the right patient at the right time. A study of non-timing medication errors in a system with comprehensive barcoding/electronic medical administration technology found a 41% reduction in errors and a 51% decrease in potential adverse drug events. Timing errors were also reduced by 27% in this study. However, BCMA is subject to a number of usability issues and workarounds that can degrade its effectiveness in practice. Users may encounter blockades in the BCMA workflow, for example, when the patient's arm band is not readable, the medication is not labeled or not in the system, or the scanning equipment malfunctions. A Dutch study using direct observation in four hospitals found that nurses used workarounds to solve BCMA workflow blockades in more than two-thirds of medication administrations, and workarounds were associated with a threefold higher risk of medication error.

Smart infusion pumps: The use of smart infusion pumps, or infusion pumps with Dose Error Reduction Software (DERS), has increased substantially in recent years. According to a 2017 survey, 88% of hospitals in the United States utilized smart infusion pumps. Although smart pumps offer numerous safety advantages, they are also prone to implementation and human factors problems, such as difficult user interfaces and complex programming requirements that create opportunities for serious errors. Use of the drug library to ensure accurate pump programming is a key workflow step; not using the drug library as intended may negate the benefits of smart pump technology. Evidence suggests variable use of the drug library as intended; one study noted use ranging from 62% to 98%.

Given the complexity of manual pump programming, technologic advances allow for smart pump interoperability with the EHR, which allows the smart infusion pump screen to be pre-populated with information from the EHR. With an interconnected system of prepopulated smart pumps, additional resources may be needed to keep the system working its best. Challenges include keeping DERS in the smart pump aligned with most current hospital practice, ensuring standardization across care areas and devices, and data collection and ongoing quality improvement.

Some new technology supports the caregiver in assessing for the correct patient response to a medication. For example, some patient controlled analgesia pumps (PCAs) can be linked to an End Tidal CO2 monitor. If retention of CO2 is detected, above a set threshold, this may indicate over sedation and respiratory depression. Based on this trigger, the pump can stop the PCA infusion, which may, in turn, reduce the possibility of further respiratory decline. While this a helpful tool, manual assessment of patient response for medication therapy still remains of the upmost importance.

## Current Context

Steps in the medication pathway are complex and interconnected. The healthcare industry utilizes a number of low-tech and high-tech strategies to mitigate risk of medication administration errors. Safety advancements require a comprehensive, systems-oriented approach that considers all aspects of the medication-use process in a multidisciplinary approach with input from clinical specialists (nurses, physicians, pharmacists), informatics & automation specialists, safety & regulatory experts, as well as patients and family.

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