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Medication Safety in the ICU

Medication use is the most common form of medical treatment in the intensive care unit (ICU) setting. Adverse events related to medication use are also the most frequent type of ICU adverse events. [1] Critically ill patients are at higher risk for adverse drugs events for many reasons including illness severity, complexity of care, the frequent use of complex drug regimens incorporating high alert medications, and the need for frequent drug dosing. One research study noted that nearly 50 percent of all ICU adverse events were medication related.[2] Health care costs associated with adverse drug events range from $6,000 to $9,000 per event. [1] The Institute of Medicine has estimated that the national annual cost of preventable adverse drug events is over $3.5 billion dollars.[3]

From a medical malpractice perspective, 70 percent of the ICU related medication cases are of high severity, significantly higher than the national percentage of 47 percent of overall events. A review of CRICO's Comparative Benchmarking System (CBS) data notes that issues related to medication *administration* were identified in 32 percent of ICU medication cases in contrast with 12 percent of overall cases in this domain.

Because of the high-risk nature of medication administration, particularly in the critical care setting, it is imperative that safety leaders have an understanding of the contributing factors that lead to medication related safety events, as well as the clinical and financial implications of these incidents.

Recently adopted medication safety technologies such as computerized provider order entry (CPOE), bar code medication administration systems, and smart pump technology are showing significant impact in decreasing risks associated with medication use. [4, 5, 6] Our CBS data shows that malpractice claims related to medication related events have decreased approximately 40 percent over the past five years, likely due in part to the adoption of new safety technologies.

Despite significant advances in patient safety strategies, medication administration, particularly in the ICU setting, still presents significant risks for both patients and providers. The AMC|PSO has performed an in-depth review of adverse drug events with a focus on the ICU setting and has identified the following risks and vulnerabilities:

Risks Associated With Adverse Drug Events in the ICU

Interruptions and Distractions:

Nurses often represent the "last line of defense" against medication errors. Research has shown that as many as 73 percent of medication related errors are intercepted by critical care nurses. [7] Nurses at the bedside are often presented with several workflow challenges as they balance medication related and non-medication related tasks. [8] Nurses are likely to be interrupted or distracted several times during the medication administration process. One study noted as many as 17 interruptions during one medication administration pass. [8] Interruptions can range from questions from other staff members, patients, families, monitors, alarms, and pagers, to patient activity during the time of medication administration. Researchers have found that the risk of an error actually increases with the number of interruptions. [9] Medication administration with no interruptions poses a risk of error at 2.3 percent. Adding as few as four interruptions to this same task more than doubles this risk. [9] Interruptions disturb a clinician's focus and concentration, requiring additional time to re-orient to the original task. In an effort to reduce risks associated with medication administration in the ICU setting, organizations should consider strategies aimed at minimizing interruptions. Examples include:

- Performing a proactive risk assessment of the medication use process in the ICU to identify potential failure points[10]

- Identifying environmental, systemic, and workflow hazards
- Creating an environment that incorporates visual cues and physically designed areas that allow nurses to remain uninterrupted during the medication administration process[11]
    - Using the "sterile cockpit" to prevent staff from carrying out "non-essential" duties while performing high risk, complex tasks
    - Creating "no distraction zones," "red zones," or "vests" to serve as visual cues to signify areas dedicated to medication related activities and personnel performing these functions
    - Empowering clinicians to ask co-workers to manage interruptions (telephone calls, patient bells, etc.) to allow them to concentrate on medication preparation or administration
- Scheduling time for patient and family education and meetings, as well as designating one family member as the point person for updates and information

Some interruptions are clearly necessary for the prompt communication of critical clinical information. Therefore, efforts should only be aimed at reducing those interruptions that are **not** relevant to patient care[12], while "enhancing the positive effects of delivering real-time clinical information".[13]

Health Information Technologies to Reduce Medication Administration Risks

Automated Dispensing Devices

Automated dispensing devices (ADDs) promote patient safety by providing organized storage for medications and an interface between the patient's medication profile and the medication storage unit in the device. 83 percent of hospitals report using ADDs.[14] ADDs store medications in closed pocket drawers, which allow clinician access to a medication ***only after*** an order has been approved by a pharmacist. In limited emergency situations the medication is accessible without pharmacist review through an over-ride process.

Barcode Medication Administration Systems

Barcode technology combined with an electronic medication administration record (eMAR) is being widely adopted and showing significant promise in mitigating medication administration risks. Barcode/eMAR technology incorporates the Five Rights of Medication Administration; providing verification of the right patient, right drug, right dose, right route, and right time. A landmark study conducted at a large academic tertiary care center and published in the New England Journal of Medicine, noted that 38 percent of all serious medication errors occur at the administration stage. After adoption of barcode/eMAR technology, the rate of "non-timing" potential adverse drug events decreased by almost 51 percent. Additional analysis also noted that the adverse drug events identified in this study were most often associated with a small number of drug classes; most notably, 50 percent of drugs responsible for causing patient harm were antihypertensives. Dose errors were a leading type of error in these events.[8] Incorporating computerized warnings during the administration of high-risk drug classes along with displays of drug and patient data are strategies that can help further mitigate administration errors.

Smart Pump Technologies

Smart infusion technologies can add another layer of safety to the medication administration process. Similar to older pump devices, most intravenous systems with smart pump technology have traditional safety features such as dose calculation functions, free-flow protections, and occlusion alerts. Additionally, smart intravenous pumps have decision support capabilities such as drug libraries with standardized concentrations for commonly used drugs, automated weight-based volume and rate calculations, dose and rate limits, and alerts based on predetermined limits.[6]

New Risks Associated with Innovative Technologies

It is important to note that although new, emerging technologies are showing significant advancements in error reduction, inherent in the adoption of these innovative technologies are new risks, vulnerabilities, and limitations that all clinicians need to be aware of:

- Providers should be cautioned to avoid over-reliance on technology. Educational efforts should stress the importance of ***critical thinking***, not only as it relates to drug dosage, timing, and selection, but also as it relates to the overall clinical situation, patient condition, and interpretation of clinical data.[11]
- Clinical information must be accessible and formatted correctly to effectively communicate the required information with the appropriate level of urgency. Innovative technology systems must be able to identify emerging problems and warn of potential errors.[14]
- A significant challenge to smart infusion pump devices is the need for constant updates to the drug library as drug information changes, new drug regimens are introduced, or drug shortages necessitate drug substitutions. Fragmentation of information and timeliness of clinical updates and advisories, particularly related to drug shortages are ongoing concerns that often lead to duplicative work to accurately update the drug library. The ability to update drug libraries in a timely manner is particularly challenging in hospitals without wireless capabilities, requiring time consuming manual updates and trips to locate individual pumps.
- Understand the impact technology has on the workflow of the end-user. Hassan et al. note that the two most important considerations in determining successful adoption of current technologies is "the degree of clinical assessment required by the clinician to appropriately evaluate and disposition the issue identified by the technology and the complexity associated with effective implementation.[14]"

Strategies for Mitigating Risk and Improving Medication Safety

The AMC|PSO would like to highlight the following practice recommendations to aid in decreasing risks and improving safety in medication delivery:

Educational Strategies

- Add **independent** RN double-checks for high-risk and newly approved medications
- Create educational materials/forms that can be placed at the bedside that detail all conversion rates to help prevent calculation errors
- Ensure that specific information about medications, infusions, and drug allergies are clearly communicated during all hand-offs

Intravenous Pump Safety Considerations

- Assemble one centralized pump committee to assume responsibility and command oversight of all drug library updates. This especially mitigates the effects of fragmentary and sporadic updates to the infusion devices.
- Document all changes to medication delivery systems. A change by the pump team can affect five other systems or more. Consider creating an advisory committee that has line of sight to the downward impact of these system changes. The ability to create a process map to assess the downward impact is particularly useful. The entire updating process is time consuming and time sensitive. Consider identifying a project manager to help oversee these efforts.
- Work with intravenous pump vendors to wirelessly/regularly update drug libraries, as well as create drug libraries that show displays of both fluids (allows entry by rate) and drugs (allows entry by dose). Explore the ability to

develop a wireless dashboard to update the drug library. An additional goal should include getting all drugs in the fluid library to include guardrails.

- Use unit measurements familiar to end-users and keep them consistent across your clinical systems (e.g., pumps, Provider Order Entry, etc.). This will enable point of care clinicians to utilize the software in "smart" infusion devices to decrease the amount of manual calculations that may need to be performed, greatly reducing the chance for error.
- The Joint Commission recommends standardizing and limiting the number of drug concentrations available in an organization.
- Conduct regular technology refreshes for nursing staff. Simulate reported errors in a laboratory environment to educate staff on common device issues and end-user errors.
- Maximize scanning capabilities and include non-formulary items in the drug library. Consider closing the loop by scanning the infusion bag at every dose, every change in EMR order, every pump dosing, and every bar code encounter.
- Consider labeling all tubing. Multiple infusions with multiple IV lines are frequently required in the ICU. It is important that staff be educated on the need for clear and accurate labeling of **all** IV infusions. One strategy includes labeling of each specific medication, including the following: on the medication itself, on the IV tubing, at, or in the infusion pump, and at the infusion site. Having visible infusion labels at multiple points between the drug source and the patients is particularly helpful in emergencies.[11]
- Consider a linear set up for IV pumps and labeling tubing as it comes right up out of the infusion device. Educate staff to run infusion lines one-at-a-time.

It is imperative that clinicians have an understanding of the risks and vulnerabilities associated with medication use in order to prioritize safety interventions and implement effective strategies that target areas of greatest risk.

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