Special Article

Executive Summary: Clinical Practice Guideline: Safe Medication Use in the ICU

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Medication errors (MEs) and adverse drug events (ADEs) are a common and significant concern in the ICU since they represent a leading cause of iatrogenic errors in the critically ill population. MEs occur more frequently and with a greater likelihood of harm in ICU patients compared with non-ICU patients. MEs can lead to ADEs associated with deleterious outcomes and enormous economic burden on the healthcare system.

An ideal patient safety culture in an ICU setting should incorporate multiple ME prevention strategies at all phases of the medication use process. Several strategies seem promising in circumventing MEs and improving patient outcomes. The use of technology including computerized prescriber order entry (CPOE), clinical decision support systems (CDSS), bar-coded medication administration (BCMA) systems, and smart IV infusion pumps can minimize the risk of error. Also, implementing new practices such as medication reconciliation and standardized IV medication concentration practices may reduce MEs (1). An active patient safety surveillance system may identify possible drug-related events to either prevent injury in real time or prevent events in future patients (2).

TABLE 1. A Summary of Population, Intervention, Comparator, Outcome Questions and Evidence Statements Not Discussed in the Executive Summary

Question/Statement	Recommendation	Final Quality Grade or Recommendation
Environment and patients		
In adult and PICU patients, the severity or harm associated with MEs/ADEs is greater than non-ICUs.		B
In ICU patients, do changes in the climate or culture of safety in the environment of the medication use process reduce the incidence of MEs or ADEs?	We suggest implementing changes in the climate and culture of safety to reduce the incidence of MEs or ADEs.	2D
Adult and PICU patients have different risk factors for ADEs compared with general care (non-ICU) patients.		C
Adult and PICU patients have different risk factors for MEs compared with general care (non-ICU) patients.		C
Prescribing node		
In adult and PICU patients, does CPOE reduce MEs and preventable ADEs when compared with not having CPOE?	We suggest implementing CPOE to decrease MEs and preventable ADEs.	2B
In adult and PICU patients, does computerized drug dosing software without clinical decision support systems reduce ME/ADEs compared with medication management without drug dosing software?	We suggest using computerized drug dosing software to decrease the number of MEs/ADEs for insulin prescribing.	2C
In adult and PICU patients, does the use of protocols/bundles prevent MEs/ADEs compared with not using protocols/bundles	We suggest the use of protocols/bundles in the ICU to ensure ME/ADE reduction.	2B
The Broselow tape is reliable in predicting patient weight for United States, European, Indian, New Zealand, Filipino, and Korean pediatric populations especially in younger (< 3 yr) and lower weight children (< 26 kg).		A
In critically ill neonatal and pediatric patients, does using the Broselow system/length-based weight drug dosing reduce MEs/ADEs when compared with not using the Broselow/length-based system in emergency situations?	We suggest using the Broselow tape in pediatric emergency situations, when patient weight is not available in pediatric emergency situations, to determine the child's length and then the associated color-coded, weight-based dosing for emergency drug doses to reduce MEs and ADEs.	2C
Dispensing node		
In adult and PICU patients, does the use of automated vs nonautomated (i.e., human personnel) methods for dispensing (ADM or ADM with bar-code technology) of medications impact outcomes such as MEs/ADEs?	We suggest that the implementation of automation strategies in the medication dispensing process may reduce MEs.	2C
In adult and PICU patients, do medication labeling practices using "tall man" lettering for Sound-Alike-Look-Alike Drugs compared with medication labeling practices that do not use tall man lettering reduce the frequency of MEs/ADEs?	We suggest that the implementation of automation strategies in the medication dispensing process may reduce MEs.	2B
In adult and PICU patients, does a pharmacist participating in medication passes vs no pharmacist involvement impact outcomes such as ME or ADE rates?	We make no recommendation regarding pharmacist involvement in medication passes to reduce the number of ME or ADE due to lack of evidence.	0NE
In adult and PICU patients, do independent double-checks vs no double-checks during dispensing impact outcomes such as ME or ADE rates?	We suggest the use of independent double-checks during the dispensing phase for high-risk medications or processes in the ICU to reduce the number of ME.	2C

(*Continued*)

TABLE 1. (*Continued*) A Summary of Population, Intervention, Comparator, Outcome Questions and Evidence Statements Not Discussed in the Executive Summary

Question/Statement	Recommendation	Final Quality Grade or Recommendation
Administration node		
In adult and PICU patients, does the use of BCMA impact outcomes such as MEs/ADEs?	We suggest the use of BCMA to reduce MEs/ADEs in the ICU.	2C
In adult and PICU patients, does the use of "smart" IV infusion pump technology reduce MEs/ADEs in ICU patients?	We suggest smart IV infusion pumps be used to reduce the rate of MEs/ADEs in the ICU.	2C
In adult and PICU patients, does the use of subjective assessment tools (e.g., Richmond Agitation Sedation Scale, Ramsay Sedation Assessment Scale) to titrate medications administration impact outcomes such as ME/ADE rates?	We suggest using validated assessment tools to achieve therapeutic goals during administration/titration of medications in the ICU.	2B
Monitoring node		
In adult and PICU patients, do alerts suggesting laboratory ordering vs clinician initiated practice for laboratory ordering impact outcomes such as reducing DRHCs?	We suggest alerts prompting laboratory ordering during the drug prescribing process be used to reduce the rate of DRHCs.	2C
In adult and PICU patients, does hand-off communication techniques used at shift change vs no hand-off communication impact outcomes such as ME/ or ADE rates?	We make no recommendation for the use of hand-off communication technique to prevent MEs/ADEs based on the lack of supporting evidence.	0D
In adult and PICU patients, does point-of-care testing vs not using point-of-care testing impact outcomes such as ME/ADE rates?	We make no recommendation for the use of point-of-care testing to prevent MEs/ADEs based on the lack of supporting evidence.	0D
In adult and PICU patients, does notification of medication regimens to the patient or family members vs no notification impact outcomes such as ME/ADE rates?	We make no recommendation regarding notification of medication regimens to the patient or family members to reduce the number of MEs/ADEs due to lack of evidence.	0NE
Patient safety surveillance systems: Reporting		
In adult and PICU patients, does the use of electronic (web-based, handheld collection devices, electronic medical record) vs analog (article-based) systems impact the quantity or quality of ADE reporting?	We make no recommendation on the use of electronic vs analog systems impacting the quantity or quality of ADE reporting in ICU patients based on the lack of supporting evidence.	0C
Patient Safety surveillance systems: Methods of detection		
In adult and PICU patients, does a targeted chart review (e.g., administrative coding, trigger alerts) vs voluntary reporting strategies improve the rate of identifying MEs and ADEs?	We suggest the use of trigger-initiated target chart review in addition to voluntary reports to improve the rate of identifying ADEs.	2B
In adult and PICU patients, do trigger alert systems identify more severe ADEs compared with alternate detection methods?	We make no recommendation as to the benefit of using trigger systems to identify more severe ADEs in critically ill patients compared with alternate detection methods.	0C
Patient safety surveillance systems: Evaluate a possible event after suspicion		
In adult and PICU patients, a reliable and valid ADE causality assessment instrument can aid in the evaluation of suspected drug induced events.		B

(*Continued*)

TABLE 1. (*Continued*) A Summary of Population, Intervention, Comparator, Outcome Questions and Evidence Statements Not Discussed in the Executive Summary

Question/Statement	Recommendation	Final Quality Grade or Recommendation
Patient safety surveillance systems: Methods of evaluating data		
In adult and PICU patients, does ICU differentiation (type of ICU or comparing ICU to general ward) vs not differentiating impact quantity or quality of ADE reporting?	We suggest performing ICU-specific ADE surveillance and evaluation but evaluation between types of ICU units seems unnecessary to improve the quantity and quality of reporting.	2C
In adult and PICU patients, do prospective patient safety surveillance strategies (e.g. Failure Mode and Effects Analysis, Probabilistic Risk Assessments, six sigma, lean process) reduce MEs/ADEs compared with retrospective approaches (e.g., root-cause analysis)?	We make no recommendation on the effectiveness of prospective vs retrospective strategies at detecting MEs/ADEs in medication safety surveillance.	0D
In adult and PICU patients, does benchmarking for patient safety surveillance strategies compared with no benchmarking impact outcomes such as ME/ADE rates?	We make no recommendation on the effectiveness of benchmarking for patient safety surveillance strategies on improving outcomes such as ME/ADE rate.	0NE
In adult and PICU patients, does strict compliance with patient safety standards set forth by regulatory bodies (e.g., The Joint Commission) vs no formal adherence policy impact outcomes such as ME/ADE rates?	We make no recommendation on the effectiveness of strict compliance with patient safety standards set forth by regulatory bodies on impacting outcomes such as ME/ADE rates.	0NE

ADE = adverse drug event, ADM = automated dispensing machine, BCMA = bar-coded medication administration, CPOE = computerized prescriber order entry, DRHC = drug-related hazardous conditions, ME = medication error.
Quality of Evidence: very low (VL); low (L); moderate (M); high (H); no evidence (NE).

MEs and ADEs in the ICU remain problematic despite increased awareness, regulatory mandates, and technological advances. Unfortunately, most hospitals face logistic, financial, and cultural challenges in implementing safe medication practices. Given the complexity of critically ill patients throughout the continuum of care and limited hospital resources, each institution must evaluate potential strategies to adopt in their respective ICUs. Patient safety is a priority for several government agencies, nonprofit organizations, and regulatory bodies considering the detrimental and financial consequences associated with MEs and ADEs. Despite the focus to improve safe medication use in the acute care setting, recommendations for safe medication practices are not specific to the ICU setting. We addressed this unmet need by developing this clinical practice guideline that recommends safe medication use practices based on supporting evidence, specifically in the critically ill. This is the first national guideline to evaluate safe medication use in the ICU.

The authors collectively developed Population, Intervention, Comparator, Outcome (PICO) questions and quality of evidence statements pertaining to MEs and ADEs based on three key components: 1) environment and the patient; 2) medication use process; and 3) patient safety surveillance system. A total of 34 PICO questions, five quality of evidence statements, and one commentary on disclosure were developed. A sample of 11 key PICO recommendations is provided in this executive summary. A summary of the remaining questions and statements is provided in **Table 1**.

GRADE RECOMMENDATIONS

Grade Recommendations for the Environment and Patients

Safety Culture. Question: In adult and PICU patients, do changes in the climate or culture of safety in the environment of the medication use process increase the frequency of reporting MEs, or ADEs?

Answer: We "suggest" implementing changes in the culture of safety to increase the incidence of ME reporting (2D).

Environment: Educational Efforts. Question: In adult and PICU patients, do educational efforts reduce the incidence of MEs/ADEs?

Answer: We "suggest" including education as part of any comprehensive program to reduce MEs in the ICU (2C).

Grade Recommendations for the Medication Use Process Node: Prescribing

Critically ill patients are at high risk for prescribing errors since they receive twice the number of medications compared with non-ICU patients (3). Over the past 2 decades, efforts have been made to address these prescribing and transcribing issues by introducing new standards and technologies designed to correct these problems. These strategies include CPOE, and CDSS and medication reconciliation.

CDSS. Question: In adult and PICU patients, does CDSS (electronic or article format) reduce ME/ADEs when compared with traditional medication decision-making?

Answer: We "suggest" the use of CDSS (either electronic or article format) to decrease the number of MEs/ADEs (2C).

Medication Reconciliation. Question: In adult and PICU patients, does medication reconciliation reduce MEs/ADEs when compared with not having medication reconciliation?

Answer: We make "no recommendation" regarding the use of medication reconciliation to decrease MEs/ADEs, in ICU patients (OD).

Grade Recommendations for the Medication Use Process Node: Dispensing

Dispensing medications is a complex process under the close supervision of the pharmacist. Traditionally, the dispensing process involved pharmacy staff manually selecting medications from shelves, counting the correct amount of medication, transferring this amount to a container, and labeling this product. However, because of the concern for dispensing errors, there has been a paradigm shift from this traditional process to the implementation of robotic automated dispensing systems and automated dispensing machines that use bar-code technology. This shift occurred to improve efficiency, maximize storage capacity, and minimize dispensing errors. Strategies including medication labeling practices and safer medication concentration practices have been implemented to further resolve dispensing issues (4).

Automated Dispensing of Medications. Question: In adult and PICU patients, does the use of robotics versus human personnel for the preparation of medications impact outcomes such as MEs/ADEs?

Answer: We "suggest" installing robot automated dispensing systems as a component of the medication dispensing process of solid dosage forms to reduce MEs (2C).

Medication Concentration Practices. Question: In adult and PICU patients, does the use of safe medication concentration practices versus not establishing safe medication concentration practices impact rates of MEs/ADEs?

Answer: We "recommend" compliance with safe medication concentration practices (i.e., use of premade IV preparations, requirement of pharmacists to prepare all IV medications) to reduce the number of MEs and potential ADEs (1B).

Grade Recommendations for the Medication Use Process Node: Administration

Medication administration in the ICU is a multifaceted process requiring communication among nurses, pharmacists, and physicians. The complexity of the process of medication administration creates competing demands on caregivers with distractions and interruptions creating an opportunity for MEs. The administration phase is the final step in the medication process and hence is the last chance for detection of an error before reaching the patient. New processes and technological advancements targeted to improve the medication administration phase include BCMA and smart infusion pump technology (5). To address additional aspects of medication administration, changes in systems of care delivery (i.e., double-checks) have been implemented.

Double-Checking during Medication Administration. Question: In adult and PICU patients, does mandatory double-checking versus no mandatory double-checking during administration of high-risk medications impact outcomes such as ME/ADE rates?

Answer: We make "no recommendation" for the inclusion of mandatory double-checking during administration of high-risk medications to prevent MEs/ADEs based on the lack of supporting evidence (OD).

Grade Recommendations for the Medication Use Process Node: Monitoring

Inadequate monitoring is a contributing factor to MEs. Medications with complex dosing strategies, narrow therapeutic indices, and unique administration techniques may require intense monitoring to ensure safe and effective use. Clinical decision support that generates alerts as a reminder for monitoring drugs has the potential to be useful.

Reflex Laboratory Monitoring. Question: In adult and PICU patients, does reflex (automatic) versus clinician initiated laboratory orders impact outcomes such as reducing drug-related hazardous conditions?

Answer: We "suggest" the use of reflex (automatic) ordering of laboratory values with the addition of a dosing suggestion for heparin orders since there is the potential of avoiding ADEs from this high-risk drug (2C). It is unclear if this benefit could also be achieved by providing recommendations for heparin dosing suggestions alone without the reflex laboratory monitoring.

Grade Recommendations for Patient Safety Surveillance Systems Methods of ME and ADE Detection

Several methods of detection can be considered for an active patient safety surveillance system including family and patient involvement, targeted and nontargeted chart review, and direct observation (2).

Family and Patient Involvement. Question: In adult and PICU patients, how do patient/family interviews compared with other methods of reporting (voluntary reporting, medical chart review, etc) impact the quantity of ME/ADE reporting?

Answer: We "suggest" the application of a patient/family reported outcome interview at or after ICU discharge to improve ME/ADE reporting (2C).

Nontargeted Chart Review. Question: In adult and PICU patients, does nontargeted chart review (manual or electronic) versus voluntary reporting strategies improve the rate of identifying MEs and ADEs?

Answer: We "suggest" performing chart reviews for detecting ADEs as part of a surveillance system (2C).

Direct Observation. Question: In adult and PICU patients, does direct observation compared with other reporting methods (voluntary reporting, chart review) impact the quantity of ME/ADE reporting?

Answer: We "recommend" including direct observation as a component of an active medication surveillance system since it provides the advantage of detecting more events and is likely to detect more administration errors than other surveillance methods (1A).

SUMMARY

This is the first clinical guideline to evaluate the safe use of medications in the ICU. The ICU environment as a risk for medication-related events and environmental changes that can improve safe medication use is appraised. Prevention strategies for medication-related events are reviewed at the medication use process nodes. Considerations for an active surveillance system that includes reporting, identification, and evaluation are discussed. Also, highlighted in this document is the need for future research related to important safe medication practices such as medication reconciliation and double-checking during medication administration.

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