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Pediatric Medication Safety in the Emergency Department

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Reaffirmed With Reference & Data Updates

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abstract

Pediatric patients cared for in emergency departments (EDs) are at high risk of medication errors for a variety of reasons. A multidisciplinary panel was convened by the Emergency Medical Services for Children program and the American Academy of Pediatrics Committee on Pediatric Emergency Medicine to initiate a discussion on medication safety in the ED. Top opportunities identified to improve medication safety include using kilogram-only weight-based dosing, optimizing computerized physician order entry by using clinical decision support, developing a standard formulary for pediatric patients while limiting variability of medication concentrations, using pharmacist support within EDs, enhancing training of medical professionals, systematizing the dispensing and administration of medications within the ED, and addressing challenges for home medication administration before discharge.

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BACKGROUND

Despite a national focus on patient safety since the publication of the Institute of Medicine (now the National Academy of Medicine) report "To Err is Human" in 1999, medical errors remain a leading cause of morbidity and mortality across the United States.[1] Medication errors are by far the most common type of medical error occurring in hospitalized patients,[2] and the medication error rate in pediatric patients has been

found to be as much as 3 times the rate in adult patients.[3,4] Because many medication errors and adverse drug events (ADEs) are preventable,[1] strategies to improve medication safety are an essential component of an overall approach to providing quality care to children.

The pediatric emergency care setting is recognized as a high-risk environment for medication errors because of a number of factors, including medically complex patients with multiple medications who are unknown to emergency department (ED) staff, a lack of standard pediatric drug dosing and formulations,[5] weight-based dosing,[6,7] verbal orders, a hectic environment with frequent interruptions,[8] a lack of clinical pharmacists on the ED care team,[9,10] inpatient boarding status,[11] the use of information technology systems that lack pediatric safety features,[12] and numerous transitions in care. In addition, the vast majority of pediatric patients seeking care in EDs are not seen in pediatric hospitals but rather in community hospitals, which may treat a low number of pediatric patients.[13] Studies also outline the problem of medication errors in children in the prehospital setting. A study of 8 Michigan emergency medical services agencies revealed errors for commonly used medications, with up to one-third of medications being dosed incorrectly.[14] Medication error rates reported from single institutions with dedicated pediatric EDs range from 10% to 31%,[15,16] and in a study from a pediatric tertiary care center network, Shaw et al[6] showed that medication errors accounted for almost 20% of all incident reports, with 13% of the medication errors causing patient harm. The authors of another study examined medication errors in children at 4 rural EDs in northern California and found an error rate of 39%, with 16% of these errors having the potential to cause harm.[17] The

following discussion adds to the broad topic of medication safety by introducing specific opportunities unique to pediatric patients within EDs to facilitate local intervention on the basis of institutional experience and resources.

STRATEGIES FOR IMPROVEMENT

A multidisciplinary expert panel was convened by the Emergency Medical Services for Children program and the American Academy of Pediatrics (AAP), through its Committee on Pediatric Emergency Medicine, to discuss challenges related to pediatric medication safety in the emergency setting. The panel included emergency care providers, nurses, pharmacists, electronic health record industry representatives, patient safety organization leaders, hospital accreditation organizations, and parents of children who suffered ADEs. The panel outlined numerous opportunities for improvement, including raising awareness of risks for emergency care providers, trainees, children, and their families; developing policies and processes that support improved pediatric medication safety; and implementing best practices to reduce pediatric ADEs. Specific strategies discussed by the panel, as well as recent advances in improving pediatric medication safety, are described.

Decreasing Pediatric Medication Prescribing Errors in the ED

Computerized Physician Order Entry

Historically, the majority of pediatric medication errors were associated with the ordering phase of the medication process. Specific risks related to pediatric weight- based dosing include not using the appropriate weight,[6] performing medication calculations based on pounds instead of the recognized standard of kilograms,[6] and making inappropriate calculations, including tenfold dosing errors.[18–20] Childhood obesity introduces further opportunity

for dosing error. In addition to the lack of science to guide medication dosing in patients with obesity,[21] frequent underdosing[22] is reported, and currently available resuscitation tools are commonly imprecise.[23] Furthermore, there are limited opportunities for prescription monitoring or double-checking in the ED setting, and many times calculations are performed in the clinical area without input from a pharmacist.[9] The implementation of computerized physician order entry (CPOE) and clinical decision support (CDS) with electronic prescribing have reduced many of these errors, because most CPOE systems obviate the need for simple dose calculation. However, CPOE systems have not fully eliminated medication errors. Commercial or independently developed CPOE systems may fail to address critical unique pediatric dosing requirements.[12,24] Kilogram-only scales are recommended for obtaining weights, yet conversion to pounds either by the operator or electronic health record may introduce opportunity for error into the system. In addition, providers may override CDS, despite its proven success in reducing errors.[16,25] Prescribers frequently choose to ignore or override CDS prescribing alerts, with reported override rates as high as 96%.[26] Allowing for free text justification to override alerts for nonformulary drugs may introduce errors. The development of an override algorithm can help reduce user variability.[27] As the use of CPOE increases, one can expect that millions of medication errors will be prevented.[28] For EDs that do not use CPOE, preprinted medication order forms have been shown to significantly reduce medication errors in a variety of settings and serve as a low-cost substitute for CPOE.[29–32]

Standardized Formulary

The Institute of Medicine (now the National Academy of Medicine)

recommends development of medication dosage guidelines, formulations, labeling, and administration techniques for the pediatric emergency care setting.[5] Unfortunately, there are currently no universally accepted, pediatric- specific standards with regard to dose suggestion and limits, and dosing guidelines and alerts found in CPOE are commonly provided by third-party vendors that supply platforms to both children's and general hospitals. The development of a standard pediatric formulary, independent of an adult-focused system, can reduce opportunities for error by specifying limited concentrations and standard dosage of high-risk and frequently used medications, such as resuscitation medications, vasoactive infusions, narcotics, and antibiotics, as well as look-alike and sound-alike medications.[33,34] A standard formulary will allow for consistent education during initial training and continuing medical education for emergency care providers, creating a consistent measure of provider competency.[35] At least 1 large hospital organization has successfully implemented this type of change.[36] In addition, the American Society of Health-System Pharmacists is working with the Food and Drug Administration to develop and implement national standardized concentrations for both intravenous and oral liquid medications.[37]

ED Pharmacists

Currently, many medications are prepared and dispensed in the ED without pharmacist verification or preparation because many EDs lack consistent on-site pharmacist coverage.[9,38] In a survey of pharmacists, 68% reported at least 8 hours of ED coverage on weekdays, but fewer than half of EDs see this support on weekends, with a drastic reduction in coverage during overnight and morning hours.[39] The American College of Emergency Physicians (ACEP) supports the integration of pharmacists within the ED team, specifically recognizing the pediatric population as a high-risk group that may benefit from pharmacist presence.[40] The Emergency Nurses Association (ENA) supports the role of the emergency nurse as well as pharmacy staff to efficiently complete the best possible medication history and reduce medication discrepencies.[41,42] The American Society of Health-System Pharmacists suggests that ED pharmacists may help verify and prepare high- risk medications, be available to prepare and double-check dosing of medications during resuscitation, and provide valuable input in medication reconciliation, especially of medically complex children whose medications and dosing may be unknown to ED staff and who present without a medication list or portable emergency information form.[43] Medically complex patients typify the difficulty with medication reconciliation, with an error rate of 21% in a tertiary care facility.[44] In this study, no 1 source from the parent, pharmacy, and primary provider group was both available and appropriately sensitive or specific in completing medication reconciliation. Pharmacist-managed reconciliation has had a positive impact for admitted pediatric patients and may translate to the emergency setting.[45,46] ED pharmacists can also help monitor for ADEs, provide drug information, and provide information regarding medication ingestions to both providers and patients and/or families.[47]

Dedicated pharmacists can be integrated through various methods, such as hiring dedicated pharmacy staff for the ED,[7] having these staff immediately available when consulted, or having remote telepharmacy review of medication orders by a central pharmacist.[48,49] Although further research is needed on the potential outcomes on medication safety and return on investment when a pharmacist is placed in the ED, current experience reveals improvements in medication safety when a pharmacist is present.[50] Studies from general EDs reveal significant cost savings as well,[51] with the authors of 1 study in a single urban adult ED identifying more than $1 million dollars of cost avoidance in only 4 months.[52]

Training in Pediatric Medication Safety

Dedicated training in pediatric medication safety is highly variable in the curricula of professional training programs in medical, nursing, and pharmacy schools.[53] Although national guidelines support the training of prehospital personnel with specific pediatric content and safety and error-reduction training,[54,55] a nearly 35% prehospital medication error rate for critical medications for pediatric patients remains.[56] At the graduate medical education level, the curricula of pediatric and emergency medicine residency programs and pediatric emergency medicine fellowship programs do not define specific requirements for pediatric medication safety training.[57–59] The same is true for pharmacy programs.[60] Although schools of pharmacy include pediatric topics in their core curricula, pediatric safety advocates believe there is an opportunity for enhanced and improved training.[61]

Experts in pediatric emergency care from the multidisciplinary panel recommend development of a curriculum on pediatric medication safety that could be offered to all caregivers of children in emergency settings. A standard curriculum may include content such as common medication errors in children, systems-improvement tools to avoid or abate errors, and the effects of

developmental differences in pediatric patients. Demonstrating competency on the basis of this curriculum is 1 means by which institutions may reduce risks of medication errors.

Decreasing Pediatric Medication Administration Errors in the ED

The dispensing and administration phases serve as final opportunities to optimize medication safety. Strategies to reduce errors include standardizing the concentrations available for a given drug, having readily available and up-to-date medication reference materials, using premixed intravenous preparations when possible, having automated dispensing cabinets with appropriate pediatric dosage formulations, using barcoded medication administration,[62] having pharmacists and ED care providers work effectively as a team, and having policies to guide medication use.[63,64] Although yet to be studied in the ED environment, smart infusion pumps have shown promise in other arenas in reducing administration errors for infusions.[65]

Nurses are held accountable by each state's nurse practice act for the appropriateness of all medications given. Nursing schools teach the 5 rights of medication administration: the right patient, the right medication, the right dose, the right time, and the right route.[66] Elliott and Liu[67] expand the 5 rights to include right documentation, right action, right form, and right response to further improve medication safety. Simulated medication administration addresses opportunities beyond those captured within these rights and may have implications within the ED.[68] Additionally, given the association of medication preparation interruptions and administration errors,[69] the use of a distraction-free medication safety zone has been shown to enhance medication safety.[70,71] Implementation of an independent

2-provider check process for high-alert medications, as suggested by The Joint Commission, also reduces administration errors.[72] Both the Institute for Safe Medication Practices and The Joint Commission provide excellent guidance on these topics.[73]

Decreasing Pediatric Medication Errors in the Home

Recognizing and addressing language barriers and health literacy variability in the ED can affect medication safety in the home. Nonstandardized delivery devices continue to be used in the home, and dosing error rates of greater than 40% are reported.[74] Advanced counseling and instrument provision in the ED are proven to decrease dosing errors at home.[75] Pictograms provided to aide in medication measurement have also been shown to decrease errors and may be considered as part of discharge instructions.[76] The AAP supports policy on the use of milliliter-only dosing for liquid medications used in the home and suggests that standardized delivery devices be distributed from the ED for use with these medications.[77] As the body of literature regarding health literacy evolves, further addressing these issues in real time may influence out-of-hospital care.

SUMMARY

Pediatric medication safety requires a multidisciplinary approach across the continuum of emergency care, starting in the prehospital setting, during emergency care, and beyond. Key areas for medication safety specific to pediatric care in the ED include the creation of standardized medication dosing guidelines, better integration and use of information technology to support patient safety, and increased education standards across health care disciplines. The following is a list of specific recommendations that can lead to improved pediatric medication safety in the emergency care setting.

RECOMMENDATIONS

1. Create a standard formulary for pediatric high-risk and commonly used medications;
2. standardize concentrations of high-risk medications;
3. reduce the number of available concentrations to the smallest possible number;
4. provide recommended precalculated doses;
5. measure and record weight in kilograms only;
6. use length-based dosing tools when a scale is unavailable or use is not feasible;
7. implement and support the availability of pharmacists in the ED;
8. use standardized order sets with embedded best practice prescribing and dosing range maximums;
9. promote the development of distraction-free medication safety zones for medication preparation;
10. implement process screening, such as a 2-provider independent check for high-alert medications;
11. implement and use CPOE and CDS with pediatric-specific kilogram-only dosing rules, including upper dosing limits within ED information systems;
12. encourage community providers of children with medical complexity to maintain a current medication list and an emergency information form to be available for emergency care;
13. create and integrate a dedicated pediatric medication safety curriculum into training programs for nurses, physicians, respiratory therapists, nurse practitioners, physician assistants, prehospital providers, and pharmacists;
14. develop tools for competency assessment;
15. dispense standardized delivery devices for home administration of liquid medications;

16. dispense milliliter-only dosing for liquid medications used in the home;

17. employ advanced counseling such as teach-back when sharing medication instructions for home use; and

18. use pictogram-based dosing instruction sheets for use of home medications.

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ABBREVIATIONS

AAP: American Academy of Pediatrics
ACEP: American College of Emergency Physicians
ADE: adverse drug event
CDS: clinical decision support
CPOE: computerized physician order entry
ED: emergency department
ENA: Emergency Nurses Association

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