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Preventing pediatric medication errors

Errors associated with medications are believed to be the most common type of medical error and are a significant cause of preventable adverse events. Experts agree that medication errors have the potential to cause harm within the pediatric population at a higher rate than in the adult population. For example, medication dosing errors are more common in pediatrics than adults because of weight-based dosing calculations, fractional dosing (e.g., mg vs. Gm), and the need for decimal points.

Research shows that potential adverse drug events occurred three times more frequently among pediatric patients than among adults.[1] Also, errors in prescribing, dispensing, and administering medications represent a substantial portion of the preventable medical errors in children despite electronic prescribing.[1] For this reason, health care providers must pay special attention to the specific challenges relating to the pediatric population.

Children are more prone to medication errors and resulting harm because of the following:

- Most medications used in the care of children are formulated and packaged primarily for adults. Therefore, medications often must be prepared in different volumes or concentrations within the health care setting before being administered to children. The need to alter the original medication dosage requires a series of pediatric-specific calculations and tasks, each significantly increasing the possibility of error.
- Most health care settings are primarily built around the needs of adults. Many settings lack trained staff oriented to pediatric care, pediatric care protocols and safeguards, and/or up-to-date and easily accessible pediatric reference materials, especially regarding medications. Emergency departments may be particularly risk-prone environments for children.[2]
- Children – especially young, small and sick children – are usually less able to physiologically tolerate a medication error due to still developing renal, immune and hepatic functions.
- Many children, especially very young children, cannot communicate effectively to providers regarding any adverse effects that medications may be causing.

The Institute for Safe Medication Practices (ISMP) performed a data analysis of medication errors reported to the Pennsylvania Patient Safety Authority from January 2013 through October 2014. During that time period, 4,065 medication errors involving pediatric patients in a general acute care hospital not specializing in pediatrics were reported, and nearly 18% of the reported events reached the patient and either required additional monitoring to preclude harm or caused actual harm.[3]

Risk reduction strategies

Pediatric-specific strategies for reducing medication errors include:

Standardize and identify medications effectively, as well as the processes for drug administration.

- Establish and maintain a functional pediatric formulary system with policies for drug evaluation, selection and therapeutic use.[4]
- To prevent timing errors in medication administration, standardize how days are counted in all protocols by deciding upon a protocol start date (e.g., Day 0 or Day 1).
- Limit the number of concentrations and dose strengths of high alert medications to the minimum needed to provide safe care.
- For pediatric patients who are receiving compounded oral medications and total parenteral nutrition at home, ensure that the doses are equivalent to those prepared in the hospital (i.e., the volume of the home dose should be the same as the volume of the hospital prepared products).
- Use oral syringes to administer oral medications. The pharmacy should use oral syringes when preparing oral liquid medications. Make oral syringes available on patient care units when "as needed" medications are prepared. Educate staff about the benefits of oral syringes in preventing inadvertent intravenous administration of oral medications.

Ensure full pharmacy oversight and, when possible, a clinical pharmacist – as well as the involvement of other appropriate staff – in the verifying, dispensing and administering of both neonatal and pediatric medications.

- Assign a practitioner trained in pediatrics to any committee that is responsible for the oversight of medication management.
- Provide ready access, including website access, to up-to-date pediatric-specific information for all hospital staff. This information should include pediatric research study data, pediatric growth charts, normal vital sign ranges for children, emergency dosage calculations, and drug reference materials with information about minimum effective doses and maximum dose limits.
- Standardize the measurement unit (i.e., milliliters to milliliters, not milligrams to milliliters).
- Orient all pharmacy staff and practitioners involved in ordering, preparing and administering medications to pediatric patients in all settings to specialized neonatal/pediatric pharmacy services in your organization.[5]
- Provide a dosage calculation sheet for each pediatric critical care patient,[6,7] including both emergency and commonly used medications.[5]
- Develop preprinted medication order forms and clinical pathways or protocols to reflect a standardized approach to care. Include reminders and information about monitoring parameters.
- Create pediatric satellite pharmacies or assign pharmacists and technicians with pediatric expertise to areas or services such as neonatal/pediatric critical care units and pediatric oncology units.[1,5] At a minimum, pediatric medications should be stored and prepared in areas separate from those where adult medications are stored and prepared.

Use technology judiciously.

- Use methods to ensure the accuracy of technology that measures and delivers additives for intravenous solutions, such as for total parenteral nutrition.
- If dose and dose range checking software programs are available in hospital or pharmacy information systems, enable them to provide alerts for potentially incorrect doses, and to calculate and/or check doses based on the patient's weight.

- Medications in automated dispensing cabinets that do not undergo appropriate pharmacist review should be limited to those needed for emergency use and/or to those medications under the control of a licensed independent prescriber, as specified in Joint Commission standard MM.05.01.01 EP 1.
- Recognize that the use of infusion pumps, or smart pumps, is not a guarantee against medication errors. Appropriate education for nurses, pharmacists and other caregivers regarding these technologies is important for all institutions caring for pediatric patients. (For more information, see *Sentinel Event Alert* 63: "Optimizing smart infusion pump safety with DERS.")
- To prevent adverse outcomes or oversedation, use consistent physiological monitoring – particularly pulse oximetry[8] – while children are under sedation during office-based procedures. Use age- and size-appropriate monitoring equipment and follow uniform procedures under the guidance of staff appropriately trained in sedation, monitoring and resuscitation.
- Providers are encouraged to develop bar-coding technology with pediatric capability. Potential errors should be carefully considered while adapting this technology to pediatric processes and systems. For example, a pediatric bar-coding solution must be able to provide readable code for small-volume, patient-specific dose labels.

Existing Joint Commission requirements

The Medication Management (MM) chapter of the accreditation manuals include standards and elements of performance (EPs) that apply to medication safety, including:

MM.02.01.01: The hospital selects and procures medications.

MM.02.01.01 EP 1: Members of the medical staff, licensed independent practitioners, pharmacists, and staff involved in ordering, dispensing, administering, and/or monitoring the effects of medications develop written criteria for determining which medications are available for dispensing or administering to patients.
Note: This element of performance is also applicable to sample medications.

MM.02.01.01 EP 2: The hospital develops and approves criteria for selecting medications, which, at a minimum, include the following:
- Indications for use
- Effectiveness
- Drug interactions
- Potential for errors and abuse
- Adverse drug events
- Sentinel event advisories
- Population(s) served (for example, pediatrics, geriatrics)
- Other risks
- Costs

Note: This element of performance is also applicable to sample medications.

MM.02.01.01 EP 6: The hospital standardizes and limits the number of drug concentrations available to meet patient care needs.

MM.05.01.01: A pharmacist reviews the appropriateness of all medication orders for medications to be dispensed in the hospital.

MM.05.01.01 EP 1: Before dispensing or removing medications from floor stock or from an automated storage and distribution device, a pharmacist reviews all medication orders or prescriptions unless a licensed independent practitioner

controls the ordering, preparation, and administration of the medication or when a delay would harm the patient in an urgent situation (including sudden changes in a patient's clinical status), in accordance with law and regulation.
Note 1: The Joint Commission permits emergency departments to broadly apply two exceptions in regard to Standard MM.05.01.01 EP 1. These exceptions are intended to minimize treatment delays and patient back-up. The first exception allows medications ordered by a licensed independent practitioner to be administered by staff who are permitted to do so by virtue of education, training, and organization policy (such as a registered nurse) and in accordance with law and regulation. A licensed independent practitioner is not required to remain at the bedside when the medication is administered. However, a licensed independent practitioner must be available to provide immediate intervention should a patient experience an adverse drug event. The second exception allows medications to be administered in urgent situations when a delay in doing so would harm the patient.
Note 2: A hospital's radiology service (including hospital-associated ambulatory radiology) will be expected to define, through protocol or policy, the role of the licensed independent practitioner in the direct supervision of a patient during and after IV contrast media is administered including the licensed independent practitioner's timely intervention in the event of a patient emergency.

Standard MM.05.01.11: The hospital safely dispenses medications.

MM.05.01.11 EP 4: Medications are dispensed in the most ready-to-administer forms commercially available and, if feasible, in unit doses that have been repackaged by the pharmacy or licensed repackager.

Joint Commission suggested actions
The Joint Commission offers the following suggested actions to prevent pediatric medication errors and their related adverse events in pediatric care settings:

1) Since patient weight is used to calculate most dosing (either as weight-based dosing, body surface area calculation, or other age-appropriate dose determination), all pediatric patients should be weighed in kilograms at the time of admission (including outpatient and ambulatory clinics) or within four hours of admission in an emergency situation. Kilograms should be the standard nomenclature for weight on prescriptions, medical records and staff communications.
2) No high-risk drug should be dispensed or administered if the pediatric patient has not been weighed, unless it is an emergency.
3) On inpatient medication orders and outpatient prescriptions, require prescribers to include the calculated dose and the dosing determination, such as the dose per weight (e.g., milligrams per kilogram) or body surface area, to facilitate an independent double-check of the calculation by a pharmacist, nurse or both.[5] Exceptions to this are medications that do not lend themselves to weight-based dosing, such as topicals, ophthalmics, and vitamins.
4) Whenever possible, use commercially available pediatric-specific formulations and concentrations. When this is not possible, prepare and dispense all pediatric medications in patient-specific "unit dose" or "unit of use" containers, rather than in commercially available adult unit doses.[5] For oral liquid preparation medications, use oral syringes to ensure correct dosage. Use the appropriate size syringe based on dose volume.
5) Clearly differentiate from adult formulations all products that have been repackaged for use in pediatric populations. Use clear, highly visible warning labels. To prevent overdoses, limit concentrated adult medications (not required for care) on pediatric care units (e.g., superconcentrated

epinephrine). Avoid storing adult and pediatric concentrations in the same automated dispensing machine/cabinet drawer.

6) Ensure comprehensive specialty training for all practitioners involved in the care of infants and children, as well as continuing education programs on pediatric medications for all health care providers. Training and education should include information on how adverse effects should be reported.[4,9]
7) Communicate verbally and in writing information about the child's medication to the child, caregivers and parents/guardians, including information about potential side effects. Ask the caregiver/parent/guardian to repeat back their understanding of the drug and how it is to be administered. Encourage the asking of questions about medications. Take into consideration the primary language of the primary adult or care provider.
8) Have a pharmacist with pediatric expertise available or on-call at all times.
9) Establish and implement medication procedures that include pediatric prescribing and administration practices.

Should a serious error or adverse event occur, the organization should conduct a root cause analysis and develop and implement a corrective action plan which should be monitored to assure that it is effective. The Joint Commission also encourages apology and transparency about the error with both staff and the families involved.

In addition, The Joint Commission encourages pharmaceutical manufacturers to develop pediatric-specific formulations as well as to standardize the labeling and packaging for all types of medications. Researchers are encouraged to conduct additional research on interventions to reduce pediatric medication errors, especially in emergency departments, ambulatory clinics and home environments.

In conclusion, since parents and caregivers play an extremely important role in the health care of children, The Joint Commission encourages parents and caregivers to seek out information and ask questions about their child's medications and to repeat back instructions to clinicians in order to ensure understanding about the drug, dosages, timing and routes of administration. This is done both to reassure staff that parents or caregivers have a true understanding of the medications the child is taking and, most importantly, to ensure that everyone involved can safely administer medications to this most vulnerable population.

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