EDITORIAL

Medication Errors: Neonates, Infants and Children Are the Most Vulnerable!

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Medical errors continue to plague the increasingly complex inpatient medical care system. Pediatric patient populations continue

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to be those most vulnerable to serious and sometimes fatal adverse drug events. Studies have shown that up to 93% of medication errors in children might have been prevented by computerized physician order entry (CPOE) and unit-based clinical pharmacists.[1-4] A recent study reported that adverse drug event (ADE) rates in hospitalized children are substantially higher (15.7 per 1000 patient-days) than previously described.[5] Professional organizations have provided detailed guidelines for preventing medication errors in pediatrics.[6-8] With practice guidelines, prevention strategies and the benefits of unit based clinical pharmacists, why do these errors continue to happen? The following issues still need to be addressed by organizations treating pediatric patients, pharmaceutical manufacturers, medical software vendors and technology innovators:

1. Hospitals must invest in unit-based clinical pharmacists to address patient safety and drug use issues; educate medical and nursing staffs; promote clinical research, and decrease resource utilization.
2. Most drugs are available in unit dose packaging for adult patients (e.g., 1 tablet, 1 capsule, 1 vial, 1 ampule equals 1 adult dose). Very few medications are available in pediatric or neonatal dosage forms or concentrations from pharmaceutical manufacturers. This results in hospital pharmacies repackaging drugs and diluting drugs to accurately measure and make unit dose medications for children.
3. Factor of 10 errors or decimal place errors are common. Especially when drugs are available in multiple concentrations (e.g., heparin, which is commercially available in 10, 100, 1000, 5000, 10000, and 20000 units/mL concentrations). In Neonatal Intensive Care Units it is not unusual to have patients weighing from 0.5 kg up to 5 kg, a 10 fold difference in dosing within the same patient care unit. The large variation in patient weights can also lead to errors with decimal points and units of measure: nanogram (ng), microgram (mcg), milligram (mg) and gram (gm).

ABBREVIATIONS ADC, Automated Dispensing Cabinets; ADE, adverse drug event; CPOE, computerized physician order entry

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4. Greater than 70% of the drugs used in pediatrics have not been studied scientifically in these patient populations to assess patient safety. Investigational drug studies need to include pediatric patient populations.
5. Weight-based (mg/kg) or body surface area (mg/M^2) dosing results in an infinite number of possible doses. Neonatal and pediatric patients can vary in weights from the 0.5 kg premature neonate to the 200 kg obese adolescent which makes for the potential of a 400-fold dosing error. In adult patients a 2-fold dosing error is usually the maximum encountered. While weight based dosing addresses the large variation in pediatric patient sizes, it can result in doses that exceed adult maximum doses in larger, older pediatric patients.
6. Medical software vendors designing CPOE systems have focused on solving the issues of adult hospitals. More than 95% of the hospitals in the United States treat primarily adults, yet the most vulnerable patients are infants and children. Hospital CPOE systems are widely marketed as technology solutions to prevent medication ordering errors. More recently, however, CPOE systems have been reported to actually facilitate medication errors.[4] The authors concluded that as CPOE systems are implemented, clinicians and hospitals must focus on errors these systems cause in addition to those errors they prevent.
7. Companies making robotics to address pharmacy workload are also focused on the preparations for adults. Automated Dispensing Cabinets (ADC) are another technology that was associated with the deaths of 3 infants in Indiana in 2006 and the recent highly publicized heparin over doses in Southern California of a well known actor's twin babies. Technology is a tool and not a substitute for reading a product's label.
8. Investigational drugs often have product-related issues that increase error potential.[9] Routine practices in place to name, label, package and store investigational agents raise serious patient safety concerns.
9. The use of bar code technology at the point of care has demonstrated merits, but not all drugs are bar coded from the manufacturer and when doses are repackaged new bar codes must be used and another potential for error is created.

On April 11, 2008, The Joint Commission published a "Sentinel Event Alert" on preventing pediatric medication errors.[10] This alert outlines pediatric specific risk reduction strategies for reducing medication errors: 1) Standardize and identify medications effectively, as well as the processes for drug administration. 2) Ensure full pharmacy oversight as well as the involvement of other appropriate staff-in the verifying, dispensing and administering of both neonatal and pediatric medications. 3) Use technology judiciously.

Other Joint Commission suggested actions are also included in this document. Although most, if not all of these recommendations, are in place in the nation's Children's Hospitals, they are not common in hospitals where infants and children are only a small portion of the patient population. All hospitals that treat any infants or children should make every effort to make their medication—related systems and processes safe for the most vulnerable patients. Getting to zero errors will require the constant vigil of all healthcare professionals. CPOE, barcoding, the use of robotics and ADCs are tools that can help but they need careful application in the pediatric arena.

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