Keeping it safe in the paediatric emergency department – drug errors and ways to prevent them

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The emergency department (ED) is the gateway to the hospital and an area of rapid transition for many patients. Children and their families, usually in large numbers, move relatively quickly between different health care providers and stages – from triage, to nursing care, to physician care, and then to admission or discharge. Furthermore, the ED is an area of considerable stress and anxiety due to diagnostic uncertainty, the need to conduct investigations in a timely manner and the necessity to resuscitate some of the patients. It has become clear in recent years that overcrowding in EDs contributes significantly to potential tribulations (1). It is also evident that crowded EDs may have unfavourable outcomes for patients and that patient safety may be in danger (1).

MEDICAL ERRORS

Medical errors rank as the eighth leading cause of death in the United States (2) and according to a recent report by the Institute of Medicine, 44,000 to 98,000 patients die each year from preventable medical errors. The estimated cost of lost lives, extended care, lost income, disability and medical liability is between US$17 billion and US$29 billion (2).

Current reports (3-7) on errors in hospitalized paediatric patients suggest that the phenomenon is not uncommon. Young children and those from a low socioeconomic background are the most vulnerable (3,4,8-10); there are several explanations for the relatively high risk for paediatric patients in the health care environment. In infants and young children, nonverbal communication is a barrier to understanding the history and previous exposure as well as to understanding early detection of symptoms associated with adverse events. Children are also smaller, thus, their 'reserves' may allow a narrow margin for error. This is also why it is more difficult to perform procedures in children; the success rate of procedures, such as intravenous catheter insertion, is smaller compared with adults. Finally, drug doses are administered to children using a weight-based calculation rather than fixed doses, and this can increase the potential for a calculation error.

Medication errors

Medication errors are one of the most common types of medical errors (11). It has been estimated that 1% to 2% of patients admitted to hospitals in the United States and the United Kingdom are harmed as a result of medication errors (12,13), the majority of which are prescription errors (14). Another report (2) estimated that as many as 75% of these errors originated from prescribing mistakes.

Adverse drug events (ADEs) are a result of a medical intervention related to a medication, which can be attributed to preventable and nonpreventable causes (15). ADEs can be further defined as potential ADEs (an adverse event that did not, in fact, happen) and true ADEs (when harm happened). Numerous types of errors have been previously described (Table 1) (16). Adverse reactions to medications are either erratic, such as idiosyncratic or unexpected allergic responses, or expected, such as adverse effects or toxic reactions related to the inherent pharmacological properties of the drug. A medication error occurs as a result of human mistakes or system flaws. It is a preventable event that occurs in the process of ordering or delivering a medication, regardless of whether an injury occurred or whether the potential for injury was present.

Several studies (17) have tried to classify types of medical errors, their timing in the treatment chain of events and the specific circumstances that may lead to an error. (Table 2). Among these are the lack of information available on paediatric drug doses and administration, the need for individualized doses for every child based on their weight and the unique pharmacokinetic characteristics in the young age group.

Most studies (18) have focused on medication errors in adults or in admitted children. While the inpatient setting is different in many ways from the ED environment,

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TABLE 1
Sources of errors in medication ordering and administration

Prescribing errors
Omission (failure to administer medication)
Wrong time of administration
Unauthorized drug error (drug given to the wrong patient)
Improper dose
Wrong dosage form
Wrong drug preparation
Administration technique
Administration of a deteriorated drug (physical or chemical integrity breached)
Monitoring failure
Compliance failure

Adapted from reference 16

TABLE 2
Factors placing paediatric patients at increased risk for adverse drug reactions

- Different and changing pharmacokinetic parameters between patients at various ages and stages of maturational development
- Need for calculation of individualized doses based on the patient's age, weight (mg/kg), body surface area (mg/m^2) and clinical condition
- Lack of available dosage forms and concentrations appropriate for administration to neonates, infants and children – frequently dosage formulations are extemporaneously compounded and lack stability, compatibility or bioavailability data
- Need for precise dose measurement and appropriate drug delivery systems
- Lack of published information or Food and Drug Administration approved labelling regarding dosing, pharmacokinetics, safety, efficacy and clinical use of drugs

Adapted from reference 17

understanding risk factors for errors and ways to overcome these barriers can help the emergency provider cope with the ever increasing complexity of the problem.

In a study of more than 10,000 medication orders written for hospitalized children, 616 (5.7%) medication errors were reported, with 115 potential ADEs (1.1%) and 26 true ADEs (0.24%). Of the latter, five ADEs (19%) were preventable. Potential ADEs were found to be three times higher compared with hospitalized adults (19). In reviewing two paediatric facilities, medication errors were found in 55 of 100 admissions. Sixteen per cent of ADEs were thought to be life-threatening, 45% serious and 39% otherwise significant. The most common medication errors were dosing (28%), followed by route of administration (18%), entry into the medication administration record or documentation (14%), a missing or incorrect date (12%) and the frequency of administration (9%). Ordering atypical doses, ignoring known allergies and omitting a route of administration were among the most common prescription errors. Most of the prescription errors were thought to be preventable due to the use of a computerized order entry system or pharmacist involvement (19). In a series from New York (USA) (20), 200 cases of 10-fold errors were detected over an 18-month period; 19.5% of the errors occurred in paediatric patients. In contrast, in a retrospective series (21) from the United Kingdom, medication errors occurred in only 0.15% of admissions. The reason for such a low error rate was not established in the report.

The Canadian Adverse Events study (22), using sampling technique from several hospitals in five provinces, reported an ADE rate of 7.5 per 100 hospital admissions (95% CI 5.7 to 9.3). More than one-third (37%) of ADEs were considered preventable (95% CI 32% to 42%); death occurred in 21% of patients (95% CI 8% to 34%). Physician reviewers estimated that 1521 additional hospital days were associated with ADEs.

One of the most significant errors has been named '10-fold errors' – giving a medicine at a dose 10 times the recommended amount (21). These '10-fold errors' can be due to misplacing a decimal point, errors in converting units (milligram to micrograms and vice versa) or misreading a drug's concentration on its vial (23). They are well documented and with the continued use of vials containing adult concentrations, administration errors are still a possibility (24). Nearly one-third of intravenous drug prescriptions in one neonatal unit in the United Kingdom were for doses less than one-tenth of a single-drug vial (25). Other sources of 10-fold errors are communication difficulties with parents and illegible writing of orders by physicians (24).

Paediatric ED errors

The increased acuity within the ED appears to increase the risk of adverse events in the paediatric ED (9). In a prospective, observational study (9) from an academic ED, staff were interviewed during and at the end of every shift. Of 1935 ED patients registered during the seven-day study period, 346 errors were reported. Errors were related to diagnostic studies (22%), administrative procedures (16%), pharmacotherapy (16%), documentation (13%), communication (12%), environmental (11%) and others (9%). Patients involved in errors were more likely to be of older age ($P<0.0001$) and more likely to have higher visit level intensity ($P<0.0001$) than all other ED patients. Seven errors (0.36 per 100 registered patients; 95% CI 0.14 to 0.72) were associated with an adverse outcome.

In the ED, paediatric ADEs are more frequent than in the adult population. In a retrospective cohort study (26) of the ED of a Canadian paediatric tertiary care hospital, prescribing errors were identified in 10% of patients. Trainees were more likely to commit errors, and the most seriously ill patients were more likely to be subjected to prescribing errors.

There are common themes in medication-related errors in the ED environment. Selbst et al (27) tabulated the different errors (Table 3). The reasons for errors stem from the unique hectic environment in the ED. Patient identification may be difficult after a short encounter with the child and the family. In addition, the stressful environment, the

TABLE 3
Sources of error in the paediatric emergency setting

Improper identification of the patient
Patients may be unfamiliar to the nurse or physician; patients are often moved from one room to another due to needs of the department; different spoken language and similar sounding names may lead to confusion
Presence of trainees
Nonpaediatric trainees who may be less familiar with paediatric dosing
Inadequate nursing staff or nursing shortage
Younger, less experienced nurses may not recognize a potential error
Overcrowding
Increased demands on staff, limited space and hallway examinations are compromised
Inadequate support staff
Stress
Rapid decisions, incomplete information and frequent interruptions
Fatigue
Cognitive function decreases with sleep deprivation: after 24 h, psychomotor function is impaired similar to having blood alcohol level of 0.1%; physicians who do not recognize the effect of sleep deprivation on their performance
Communication
Change of shift, patients who speak a different language, interpreters who may not represent history accurately or give erroneous directions

Adpated from reference 27

TABLE 4
Ways to avoid medication errors

Prescribing
Prescribe only if you are familiar with the drug and the paediatric practice
Check for drug allergies, interactions and contraindications
Confirm that the patient's weight is correct
Write the weight of the patient on each drug chart
Make sure not to exceed the recommended maximal dose
Write legible prescriptions
Calculation
Write out each step of a calculation
Have the dose double-checked
Administration
Check the drug name, dose and patient identity before administration
Verify unusual volumes or doses
Listen to a patient, parent or caregiver
Hospital environment
Ensure suitable work environment for safe and effective use of medicines
Ensure sufficient training and continuing education in the use of paediatric medications
Make sure equipment is standardized
Develop a medication error reporting system

Adapted from reference 32

need to make decisions in conditions of uncertainty, the frequent 'hand-over' from one shift to the next and the overcrowding and noisy environment in the ED, can all contribute to the increased risk for error.

Another factor to consider is the abundance of trainees in the ED, from medical students, residents of multiple specialties to fellows. Trainees should be tested and instructed in calculating appropriate drug dosages. Most trainees fail to recognize significant over- or underdoses (28) and, thus, higher rates of errors occur at the beginning of the academic year (OR 1.67; 95% CI 1.06 to 2.64) (26). When residents' skills in basic mathematical calculations for paediatric prescribing were tested, the mean test score of each resident class was less than 70%. There was no significant difference between residents' levels of training and whether they double-checked their calculations (P=0.633) or considered each patient's weight relative to the dose prescribed (P=0.869). Seven residents committed 10-fold dosing errors and one resident committed a 1000-fold dosing error (29). In a prospective observational study (30) of simulated emergencies among trainees from Toronto, Ontario, 17% of the orders did not specify the exact dose. Nine dosing errors occurred during the ordering phase, of which five were intercepted before the drug reached the patient. Four 10-fold errors were identified. In nine (16%) and four (7%) of 58 syringes analyzed, measured drug concentrations showed a deviation of at least 20% and 50% from the ordered dose, respectively. The authors concluded that errors commonly occur during all stages of paediatric resuscitation and that such errors may be a major source of morbidity and mortality in resuscitated children (30).

Other factors that increase drug errors include patients being seen in the early morning, especially between 04:00 and 08:00, and patients seen over the weekends (26). Other studies (27) found drug dosing errors to be associated with recording of an inaccurate weight. Converting weight from pounds to kilograms may be another source of error.

PREVENTION

The best way to manage medication errors in the ED is by preventing them. This is a significant task that entails a change in the culture of the ED. The process of culture change needs to include both the system as well as the human factor. A recent review (31) suggests three main steps to enhance culture change and prevent errors – patient-doctor communication, interprofessional communication, and researcher or professional dialogue. Another systematic review (32) from the United Kingdom suggested ways to prevent medication errors in the inpatient population (Table 4). The recommended areas for safety improvement included factors associated with health care providers and the environment (system) they work in.

Finally, electronic physician order entry may assist in preventing errors; however, the way to effectively implement these systems is yet to be discovered (33).

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