

Pediatric Medication Errors: How, where and why they happen and what to do about it.

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Disclosure

- I have a **Employee** relationship with **CertaDose**.
- I do intend to discuss an unapproved/investigative use of a commercial product/device

Pediatric Medication Error Reduction

OBJECTIVES

- **DEFINE A MEDICATION ERROR AND IDENTIFY FACTORS THAT CONTRIBUTE TO MEDICATION ERRORS.**
- **EXPLAIN THE RELATIONSHIP OF STANDARDS OF CARE TO REDUCING PEDIATRIC MEDICATION ERRORS.**
- **IDENTIFY SPECIFIC EXAMPLES OF THE CATEGORIES OF MEDICATION ERRORS AND DESCRIBE THEIR SEVERITY.**
- **DESCRIBE THE IMPACT OF A PEDIATRIC MEDICATION ERROR ON ALL ASPECTS OF AN AGENCY OR INSTITUTION.**
- **PRESENT STRATEGIES TO REDUCE THE NUMBER OF PEDIATRIC MEDICATION ERRORS AND INCIDENTS.**

Case Study

- 5 year old girl with history of asthma presents with worsening asthma attack.
- Albuterol nebs are started as well as IV steroids, Magnesium and Terbutaline IM, but child is getting worse and starting to get tired.
- O2 sats start dropping even though child is on oxygen.

Case Study Continued

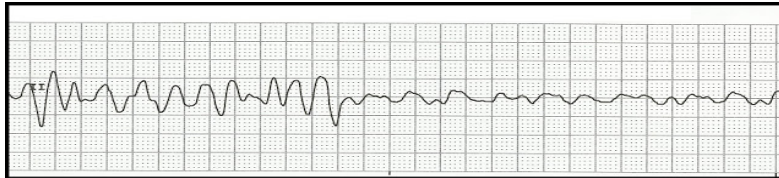
- Decision to intubate made with Ketamine as induction agent.
- RSI is started and patient immediately gets worse.

Case Study Continued

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- RSI is started and patient immediately gets worse.

Case Study Continued

- Monitor shows the following rhythm



- Decimal point error = 10x overdose
- Child does not respond to PALS

MATH: Multiple equations

Calculating Weight in kg

$$\frac{2.2 \text{ lbs}}{1 \text{ kg}} = \frac{42 \text{ lbs}}{X} \quad \parallel \quad \frac{42 \text{ kg}}{2.2 X} \quad \parallel \quad X = 19.2 \text{ kg}$$

{02080010}

Math Continued

Calculating Dose Based on Weight

$$\frac{0.04 \text{ mg}}{1 \text{ kg}} = \frac{X}{19.1 \text{ kg}} \quad \parallel \quad \frac{0.7 \text{ mg}}{1 X} \quad \parallel \quad X = 0.76$$

$$\frac{0.2 \text{ mg}}{1 \text{ kg}} = \frac{X}{19.1 \text{ kg}} \quad \parallel \quad \frac{3.82 \text{ mg}}{1 X} \quad \parallel \quad X = 3.82 \text{ mg}$$

(02080020)

What do we do?

- Our goal is to avoid these situations.
- How do we do that?
- We need to understand Error, how it happens and the High risk areas to address.
- We need to have safe habits that we use all the time (even if we think we don't need them). Like a seatbelt, it can't help you unless you use it.

How big of a problem are Pediatric Medication errors?

Depends on who you ask:

If you ask Pediatric hospital administrators they will tell you

“We are Pediatric specialists, we don’t make mistakes!”

However Pediatric nurses, physicians and pharmacists will tell you “We see mistakes all the time.”

Why the disconnect?

US Senate Subcommittee 2015 Findings

- Medical error is the **3rd leading cause of death** after heart disease (#1) and cancer (#2), Over 440,000 deaths per year.
- That is equivalent to two Boeing 747’s crashing every day.
- National Council of State Boards of Nursing annual survey found that 50% of Nurses had made a medical mistake that year, with 75% of those errors being medication errors.

What are the Pediatric Metrics?

- Pediatric hospitals **make more mistakes** than adult hospitals: (1,2,3,4)
- Adult: **1 in 20** orders result in a downstream error, with **13%** of these causing harm.
- Pediatric: **1 in 6.4** orders translate into a mistake, with **31%** of those resulting in harm.
- Another study: Hospitalized children are 3 times, (300%) as likely to experience a mistake than adult inpatients. (5)

1. Bates DW, Boyle DL, Vander Vliet MB, Schneider J, Leape L. Relationship between medication errors and adverse drug events. *J Gen Intern Med.*1995;10:199–205
2. Raschke RA, Gollihare B, Wunderlich TA. A computer alert system to prevent injury from adverse drug events: development and evaluation in a community teaching hospital. *JAMA.*1998;280:1317–1320
3. Marino BL, Reinhardt K, Eichelberger WJ, Steingard R. Prevalence of errors in a pediatric hospital medication system: implications for error proofing. *Outcomes Manag Nurs Pract.*2000;4:129–135
4. Crowley E, Williams R, Cousins D. Medication errors in children: a descriptive summary of medication error reports submitted to the United States Pharmacopeia. *Curr Ther Res.*2001;26:627–640
5. Kaushal R, Bates DW, Landrigan C, et al. Medication errors and adverse drug events in pediatric inpatients. *JAMA.*2001;285:2114–2120

More Concerning Statistics

- Medication errors are the single most common type of medical error in hospitals. (1)
- Multiple studies show that medication errors are also the major cause of iatrogenic illness, prolonged hospitalization and injury to patients. (2)
- In Pediatrics, incorrect dosing is the most common error. (3-6)

1. *Pediatr Nurs.* 2004;30(4)
2. (Fiesta 1998; Kushal et al., 2001; Lesar, Lomaestro & Pohl, 1997).
3. Crowley E, Williams R, Cousins D. Medication errors in children: a descriptive summary of medication error reports submitted to the United States Pharmacopeia. *Curr Ther Res.*2001;26:627–640
4. Kaushal R, Bates DW, Landrigan C, et al. Medication errors and adverse drug events in pediatric inpatients. *JAMA.*2001;285:2114–2120
5. Vincer MJ, Murray JM, Yuill A, Allen AC, Evans JR, Stinson DA. Drug errors and incidents in a neonatal intensive care unit. A quality assurance activity. *Am J Dis Child.*1989;143:737–740
6. Leape LL, Bates DW, Cullen DJ, et al. Systems analysis of adverse drug events. ADE Prevention Study Group. *JAMA.*1995;274:35–43

Cost of Error

- **Greatest cost is to patient and family harmed.**
- Hospitals and medical professionals incur financial and legal burden.
- 5th most common lawsuit in Pediatrics is medication error with and 30% resulting in a paid claim with indemnity of \$14.7 million. (1)
- Total economic burden of \$100 Billion in USA alone. (2)
- Increased medical costs: \$4,700 per admission. (3)
- Even minor (non-critical) errors in dosing for opiates increased the length of stay for Pediatric hospital admissions. (4)

1. Physician Insurers Association of America. Medication Errors Symposium White Papers. Washington, DC: Physician Insurers Association of America; 2000
2. Schumock GT. Methods to assess the economic outcomes of clinical pharmacy services. *Pharmacotherapy*. 2000;20(suppl 2):2435-2525
3. Institute of Medicine, Committee on Quality Health Care in America. *To Err is Human: Building a Safer Health System*. Report of the Institute of Medicine. Kohn LT, Corrigan JM, Donaldson MS, eds. Washington, DC: National Academy Press; 2000
4. *Pediatrics*. 2008 Oct;122(4):e861-6. doi: 10.1542/peds.2008-1011. Sharek et al.
An intervention to decrease narcotic-related adverse drug events in children's hospitals.

Why are Pediatric patients at higher risk, and why are medical mistakes the most common error?

- The **inability to calculate the correct therapeutic volume** of a drug dose accounts for the majority of Pediatric medication errors. (1)

Why?

For every Pediatric dose there are a minimum of two **algebra** equations:

Physician: Mg/Kg

Nurse: Mg/mL

No one scores 100% on the algebra test, so even an A+ student (95%) success rate is a 1 in 20 error rate.

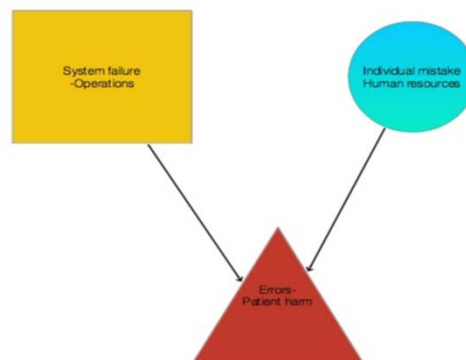
It is also harder to keep track of a decimal point in algebra, and this can lead to 10-fold dosing mistakes.

1. Lessar TS et al. Factors relating to errors in medication prescribing. *JAMA* 1997;277(4): 312-7

Causes of Medical Error: Epidemiology

- Error Definition: To deviate from intended action.
- Patient Safety: Freedom from accidental injury caused directly by the **healthcare system**.
- Error is **multi-factorial**, it happens in a complicated environment with multiple interacting departments, high-stakes situations, inadequate workforce and many distractions.

Errors are preventable deficiencies in quality of the intended task that are the result of human mistakes or system flaws.



Chain of Error

- An error can happen at any point in the healthcare delivery chain.

Physician (order)>Transcription> Pharmacy (formulate)> Dispensing>Nurse (administer)

According to meta-analysis of Pediatric epidemiology, errors are more likely at certain points of the order **chain;72-75%** of errors happen at the **administration phase**. (1)

Errors are also less likely to be caught during the administration phase(2%) vs ordering phase (48%). (2)

1. Miller MR et. al. Medication errors in paediatric care: as systemic review of epidemiology and an evaluation of evidence supporting reduction strategy recommendations. Qual Saf Health Care 2007;16:116-126

2. Dowdell EB, Pediatr Nurs. 2004;30(4) (Kohn, Corrigan, & Donaldson, 2000).

Nursing Error

- Nurses get the short end of the stick: Studies show that in a survey of medical professionals; 90% of physicians, administrators and pharmacists assigned primary responsibility to nurses, regardless of the factors that contributed to that error. (1)
- However, studies show that nurses are the profession most likely to intercept and identify a medical error (86%) vs. pharmacy (12%). (2)
- They are the ideal gate keepers as they are the last line of defense before administration of the medication.

1. Hughes RG, Edgerton EA, First do no harm: Reducing pediatric medical errors. AJN, May 2005, Vol. 105, No. 5.

2. Dowdell EB, Pediatr Nurs. 2004;30(4)

Factors Affecting Error

- **Expertise:** Float nurses cause more errors. Floating a Nurse that is not familiar with the environment or patient population is illegal in many states and there is a precedent for civil suits against hospital administrators who implement floating of unqualified nurses.
Iowa State board of nursing, 2003, Winkleman versus Beloit Memorial Hospital (Govis, 2002)
- **Leadership:** IOM has charged that CEO and Board of Trustees should be “Held accountable for making serious, visible and ongoing commitment to creating safe systems of care”.
- **Staffing:** For every 10% increase in nurse staffing there is a 14% reduction in medical error. Walter Reed study (Dukes 2004).
- **Environment:** ERs, ICU and other distracting environments increase likelihood of errors. (Kushal et al)
- **Drug Types:** High-alert drugs cause more harm when errors are made. Opiates caused the most harm in a 5 year study of 10-fold errors, followed by other high-alert drugs. Pediatrics, May 2012, VOLUME 129 / ISSUE 5

Tenfold Medication Errors: 5 Years' Experience at a University-Affiliated Pediatric Hospital, Catherine Doherty, Conor Mc Donnell

Factors in Error *continued*

There are other factors that contribute to children having a higher risk than adults for medical error. These include the following factors identified by the Joint Commission: (The Joint Commission, Sentinel Event Alert, Issue 39, April 11, 2008, Preventing Pediatric Medication Errors).

1. 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.
2. The need to alter the original medication dosage requires a series of pediatric-specific calculations and tasks, each significantly increasing the possibility of error.
3. 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 with regard to medications. Emergency departments may be particularly risk-prone environments for children. (Committee on the Future of Emergency Healthcare in the United States; the Institute of Medicine; Emergency Care for
4. Children: Growing Pains.)
5. 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.
6. Many children, especially very young children, cannot communicate effectively to providers regarding any adverse effects that medications may be causing.

Prescriber Errors

- Opposite end of the spectrum: Garbage in garbage out effect on the rest of the order chain.
- Up to 37% of errors originate here. Miller MR et. al. Medication errors in pediatric care: as systemic review of epidemiology and an evaluation of evidence supporting reduction strategy recommendations. *Qual Saf Health Care* 2007;16:116-126
- Computer physician order entry (CPOE) can help reduce error.
Crowley E, Williams R, Cousins D. Medication errors in children: a descriptive summary of medication error reports submitted to the United States Pharmacopeia. Curr Ther Res.2001;26 ;627– 640
Kaushal R, Bates DW, Landrigan C, et al. Medication errors and adverse drug events in pediatric inpatients. JAMA.2001;285 :2114– 2120
- However, CPOE systems designed for adults and not specifically for Pediatric patients, do not reduce Pediatric error and may even increase errors in this population. McPhillips HA et al. Potential medication dosing error in outpatient pediatrics. *J Pediatr.* 2005;147(6):761-767

10 fold dosing Error

- This is the worst one.
- Can definitely kill your patient.
- **Tenfold Medication Errors: 5 Years' Experience at a University-Affiliated Pediatric Hospital** *PEDIATRICS* Vol. 129 No. 5 May 1, 2012 pp. 916 -924

PEDIATRICS Vol. 129 No. 5 May 1,
2012 pp. 916 -924

- 55% of all 10-fold medication errors with potentially toxic high-risk medications originated during the administering phase of the medication process

PEDIATRICS Vol. 129 No. 5 May 1,
2012 pp. 916 -924

- Eight medications were identified as potentially toxic high-risk medications in this institution. Of these, 5 medications (morphine, heparin, hydromorphone, fentanyl, and insulin) accounted for 71 (28%) of 252 10-fold medication errors reported.
- In the 22 reports that described patient harm, opioids were the most frequently identified class of drug and morphine was the most frequently identified medication.
- Seven 10-fold opioid errors required acute airway intervention and 3 required emergent intervention to sustain life.

Solutions

- Many organizations have recognized the magnitude of the problem of medical errors:

Joint Commission

American Academy Of Pediatrics

National Council of State Boards of Nursing

CMS-Medicare and Medicaid (may not pay for some errors)

Medical Error Prevention Council

Institute for Safe Medical Practices

Pediatric Focused Strategies

- The American Academy of Pediatrics has taken a lead in making recommendations to reduce error.
- They have released policy statements on reducing Pediatric error.
- The most recent **Policy Statement-Principles of Pediatric Safety: Reducing Harm due to Medical Care** is a must read for practitioners and hospital leadership.
- The following recommendations are taken from it.

3 Main Strategies

1. Understand **Epidemiology** of errors
2. Understand the **Science** behind improvement
3. **Incorporate** solutions and science into practice

Ways to fail:

1. Think it's someone else's responsibility
2. Ignore the science
3. Think your system is good enough and you don't have to improve or incorporate new ideas

Patient Safety Strategies

Must first **understand** that medicine is a **complex** system and thus is **prone to error**. **Awareness** is paramount.

We can learn from **High-Reliability Organizations**: such as power grid dispatching centers, air traffic control systems, nuclear aircraft carriers, nuclear power plants, aviation and petrochemical industries.

These organizations operate under very trying conditions all the time and yet manage to have fewer than their fair share of accidents.

Culture of Safety

Must establish a **Culture of Safety**:

Starts with the **attitude** that errors can happen to **you** and at **your institution**.

Starts with **human factors**: High-reliability organizations recognize that **variability is constant**.

This requires a culture of safety to:

1. Do **reporting** of errors/mistakes
2. Be **just/fair**
3. Be **flexible**
4. **Learn** from mistakes

Reporting Culture

- You can't be informed if you don't have accurate information.
- Like looking in the mirror, you may not like what you see, but it won't improve unless you realize your status.

This requires a "reporting culture"

Reporting must be:

1. Easy, confidential and anonymous
2. Data collection/analysis duty should be separate from those in charge of disciplinary function

Just Culture

- Was the accident intentional?

If not then punitive action will not correct the problem. Someone else will make the same mistake unless the root cause is found.

A just culture understands that systems can be the cause of a problem, many times people fail because the system they work in has failed.

Flexible Culture

- We must understand that healthcare delivery is a team effort. Many working parts, Physicians, Nurses, Pharmacy, Administration.
- These parts must work together smoothly to yield the correct result, just like an orchestra.
- Negative attitudes, superiority complexes and territoriality will create mistakes and must be relinquished.

Learning Culture

- Information gathered has to be **implemented**.
- If changes are not made, then learning did not happen.
- Must adhere to Best Practices, and these constantly improve.
- Root cause analysis and research should result in constant improvement and a willingness to change.

Institute of Medicine Recommendations

General goal of establishing:

1. **Redundancy**
2. **Simplification**
3. **Standardization**

Specific goals should have:

1. **Checklist**
2. **Double-checks**
3. **Cognitive forcing strategies** (bar codes or other required steps)

Both general and specific levels must always have an **attitude of alertness** and understanding that it is a **high risk environment**. You must be able to understand when a patient has a change in status or when something is not right.

Role of Technology

- Technology can be a tremendous help, but it must be used appropriately and blind-sides must be acknowledged or else there is a false sense of security and errors will happen.
- Many CPOE systems are modified adult designs. They are customizable to add pediatric data, but that is usually done locally. Make sure your system is ordering what you want and flagging what you don't want.
- Implement technology that works (smart pumps).

Role of Leadership

- Can't have "auto-pilot" attitude. Must be striving for continuous improvement.

Acknowledge that:

1. Providers work in **high-risk**, complex environments
2. Providers are **fallible**, mistakes happen
3. Healthcare team is **independently** and **collectively** responsible for patient safety
4. **Human resources are integral** to the success of a system's change.

What Works?

- A systematic review of the causes and evidence of Pediatric error found that 26 commonly recommended strategies (policies on verbal orders, automated dispensing devices, CPOE) did not have any basis in scientific evidence, and based on expert opinion.

Miller MR et. al. Medication errors in pediatric care: as systemic review of epidemiology and an evaluation of evidence supporting reduction strategy recommendations. Qual Saf Health Care 2007;16:116-126

What Works? *continued*

- Appropriate staffing: For every 10% increase in nurse staffing there is a 14% reduction in medical error.
Walter Reed study (Dukes 2004).
- Common sense, but necessary. This is proven, so if you want to adhere to best practices put your money where your mouth is...and hire more nurses!

What Works? *continued*

- **Eliminate intimidation and increase communication.** Institute for safe medicine practices (2004) reported that 2/3 of nurses have been intimidated by physicians.
- Multiple studies have found that when nurse to nurse and nurse to physician communication is free of **intimidation** and has increased **collaboration** there is a reduction in negative outcomes and risk adjusted mortality.

Baggs and Ryan, 1990; Baggs, Ryan, Phelps, Richardson and Johnson, 1992; Baggs and Schmidt, 1997; Baggs, Schmidt, Mushlin, Eldredge, Oakes, & Hutson et al, 1997; Mitchell, Armstrong, Simpson, Lentz, 1989; Boyle and Kochinda, 2004. (Catlin A, *Pediatr Nurs.* 2004;30(4)).

What Works? *continued*

Standardized dosing:

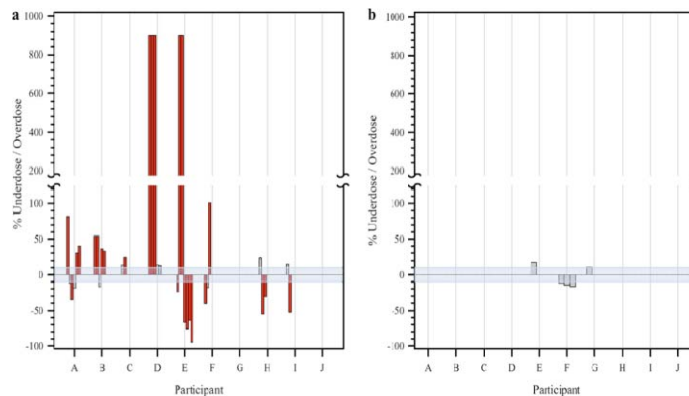
Dose ranges vs doing a custom calculation on each patient dramatically reduced medical errors. The use of a Pediatric, antibiotic standard dosing table with pre-calculated dosages for different weight ranges, has significantly reduced the incidence of dosing errors. From **41%** of prescriptions for hospitalized patients having a calculation error to **5.8%**

J Pediatr Pharmacol Ther. 2013 Jul-Sep; 18(3): 220-226. The Impact of a Pediatric Antibiotic Standard Dosing Table on Dosing Errors, Mohammed A. Aseeri, PharmD

What Works? *continued*

- Another strategy that was useful in administration errors was color-coding. In these studies, critical dosing errors as well as 10-fold dosing errors were completely eliminated when color-coding was used, compared to 37% critical error for paramedics and 17% critical error for pediatric emergency room nurses using standard methods.
- Color-coded prefilled medication syringes decrease time to delivery and dosing errors in simulated pre-hospital pediatric resuscitations: A randomized crossover trial. *Resuscitation* 2015 Nov 3;96:85-91. Epub 2015 Aug 3. Allen D Stevens, Caleb Hernandez, Seth Jones, Maria E Moreira, Jason R Blumen, Emily Hopkins, Margaret Sande, Katherine Bakes, Jason S Haukoos. *Ann Emerg Med.* 2015 Aug;66(2):97-106.e3. doi: 10.1016/j.annemergmed.2014.12.035. Epub 2015 Feb 18.
- Color-Coded Prefilled Medication Syringes Decrease Time to Delivery and Dosing Error in Simulated Emergency Department Pediatric Resuscitations. Moreira ME1, Hernandez C2, Stevens AD3, Jones S4, Sande M5, Blumen JR4, Hopkins E1, Bakes K1, Haukoos JS6.

Before and After Color Coding



Conclusion

Know your medications:

- The dangerous ones

- Know your personal blind spots and limitations

- The doses you give, very different volumes per med (Fentanyl vs. Midazolam)

Know your patient:

- How big are they?

- How sick are they?

- Preempt, don't panic

Know your system:

- Find a system that works for you and stick to it.

- Don't Gueestimate!**

- Practice, Practice, Practice!!!

Conclusion

Errors are costly.

Society, Patients, Families, Government, Medical Governing Bodies and Patient Safety Organizations are demanding better performance.

We can't afford to be complacent. We must become **High-Reliability Organizations.**

We need to look in the mirror of anonymous reporting, assess our status, implement best practices and strive every day to do the best for our patients.