Clinical Decision Support System
Enhancements to Reduce Order Entry Errors for Pediatric Infusion Orders

Amy Chan, MS, Pharm.D
Elena Mendez-Rico, Pharm.D
Disclosure

- The program chair and presenters for this continuing education activity have reported no relevant financial relationships.
Learning Objectives

- Identify types of medication errors associated with medication infusion orders.
- Describe the process for medication drip concentration auto-selection.
- Outline how automation processes improves patient safety.
Self-Assessment Questions

- Question 1
  Implementing clinical decision support in the medication order entry process will improve patient safety.

- Question 2
  Using patient’s daily fluid maintenance as a guide to determine medication drip concentration can avoid potential fluid overload.

- Question 3
  Pharmacists are not equipped to provide input in system design.
- Ranked #1 New York metropolitan area and #6 nationally
- 2650 beds (2,515 certified beds and 135 bassinets), 6,900 affiliated physicians (residents/fellows and attending physicians)
  - Columbia University Medical Center
  - Weill Cornell Medical Center
  - The Komansky Center for Children's Health
  - The Allen Hospital
  - Morgan Stanley Children’s Hospital
  - Lower Manhattan Hospital
  - Westchester Division
Rationale/Challenges
Rationale for the project

- Intravenous medications account for more than 56% of total medication errors\(^1\)

1. Am J Health Syst Pharm. 2003;60(10):1046-2487
Rationale for the project

- Intravenous medications account for more than 56% of total medication errors\(^1\)

- Delivering continuous infusions in pediatric and neonatal patients is an error-prone process\(^2,3,4,5\)

1. Am J Health Syst Pharm. 2003;60(10):1046-2487
4. BMJ. 1995 May 6;310(6988):1173-4
Rationale for the project

- Intravenous medications account for more than 56% of total medication errors\(^1\)

- Delivering continuous infusions in pediatric and neonatal patients is an error-prone process\(^2,3,4,5\)
  - Weight – based dosing

1. Am J Health Syst Pharm. 2003;60(10):1046-1048
4. BMJ. 1995 May 6;310(6988):1173-4
Rationale for the project

- Intravenous medications account for more than 56% of total medication errors\(^1\)

- Delivering continuous infusions in pediatric and neonatal patients is an error-prone process\(^2,3,4,5\)
  - Weight – based dosing
  - Critically ill

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Rationale for the project

- Intravenous medications account for more than 56% of total medication errors\(^1\)

- Delivering continuous infusions in pediatric and neonatal patients is an error-prone process\(^2,3,4,5\)
  - Weight – based dosing
  - Critically ill
  - Multiple infusions
  - High alert meds

1. Am J Health Syst Pharm. 2003;60(10):1046-2487
4. BMJ. 1995 May 6;310(6988):1173-4
Rationale for the project

- Complex calculations
  - Weight based dose - per minute vs per hour

- Various units of measure
  - Milligram, microgram, gram – 1000X difference
  - microgram/kg/min vs microgram/min

- Higher risk of medication error
Other Challenges

- Potential errors during order entry
  - Wrong dose
  - Inappropriate infusion line
  - Inappropriate concentration
  - Conversion error between dosing and concentration units
  - Wrong infusion rate calculation
  - Misplacement of decimal points
  - Inappropriate infusion volume
  - Drug and diluent incompatibility
Other Challenges

- Fluid maintenance in critically ill patients
  - Weight gain first week of ICU stay\textsuperscript{6,7}
  - Children with respiratory failure\textsuperscript{7}
  - Worsening oxygenation in pediatric ICU patients\textsuperscript{8,9}
  - Worse outcome and mortality for adults and children\textsuperscript{10,11,12}

\textsuperscript{6} Crit Care Med. 2002 Oct;30(10):2175-82
\textsuperscript{7} Pediatr Crit Care Med. 2012 May;13(3):253-8
\textsuperscript{8} Crit Care Med. 2004 Aug;32(8):1771-6
\textsuperscript{9} Pediatrics. 2001 Jun;107(6):1309-12
\textsuperscript{10} Pediatr Nephrol. 2004 Dec;19(12):1394-9
\textsuperscript{11} Crit Care. 2008;12(3):R74
\textsuperscript{12} Blood Purif. 2010;29(4):331-8
Clinical Background
Maintenance Daily Fluids

Fluid that is needed to maintenance homeostasis and daily physiologic processes (urine, sweat, respiration, and stool)
Maintenance Fluids

- Calculation of Fluid Therapy:\(^\text{17}\)
  - Body Weight Method
    - < 10kg = 100 mL/kg/day
    - 10-20 kg = 1000 mL + 50 mL/kg for each kg > 10 kg
    - > 20 kg = 1500 mL + 20 mL/kg for each kg > 20 kg
  - Hourly Rate Method
    - < 10 kg = 4 mL/kg/hour
    - 10-20 kg = 40 mL/hr + 2 mL/kg for each kg > 10 kg
    - > 20 kg = 60 mL/hr + 1 mL/kg for each kg > 20 kg

- Specific Requirements
  - VLBW neonates may need 180-220 ml/kg/day
  - Neonates with congenital heart disease (PDA) may require fluid restriction to < 100 ml/kg/day

\(^\text{17}\) Holliday-Segar Method. Pediatrics 1957;19:823-832
Optimization of Concentrations

- Standardization of infusion concentrations\textsuperscript{13,14,15,16}
  - Pediatric patients come in different sizes
  - One size (infusion concentration) does not fit all
  - Limit each infusion med to 2-3 different concentrations
  - Premixed infusion concentration

- Percentage of maintenance fluid each infusion occupies\textsuperscript{13,14,15,16}
  - Fluid load management on patient with multiple medications
  - Standardized fluid restriction
  - 3-8% of daily maintenance fluid

- Standardization infusion diluent\textsuperscript{13,15,16}
  - Compatibility and stability considerations
  - Separate nutrition with medication administration

\textsuperscript{15. Hospital Pharmacy Volume 41, Number 11, pp 1102–1106} \hfill \textsuperscript{16. Hospital Pharmacy Volume 39, Number 5, pp 433–459}
Peripheral vs. Central infusion

- Osmolarity is a limiting factor in the ability to infuse an IV peripherally.
  - A hyperosmotic infusion may destroy vascular cells by pulling water out of those cells in an attempt to regain isotonicity.
  - A solution with high osmolarity infused into a small peripheral vein may cause irritation and pain, with damage to the vessel, which may necessitate frequent changes in the IV site.
Automation designs
## Define data

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Simplify order selection

Before

New ordering process
Design the front – order entry form
1. **Dose alerts**

**Hard stop – Out of range, unconfirmed dose**

**Soft stop – Out of range dose**

- **Dose:** 21  
  **Dose Unit:** microgram/kg/min  
  **Important Medication Info:**  
  - Usual Initial Dose: 2 microgram/kg/min  
  - Dose Range: 1 to 20 microgram/kg/min  

**Sunrise Clinical Manager**

- **WARNING:** The dose is ABOVE the NORMAL dose range for this medication. Please check the CONFIRM DOSE box before submitting the order.

**Confirm Dose:**
Dose alerts

- Hard stop – when applicable
### Concentration Selection

#### Important Medication Info

- **Usual Initial Dose:** 2 microgram/kg/min
- **Dose Range:** 1 to 20 microgram/kg/min

#### Concentrations (Based on 1X Maint Fluid)

- **400 microgram/ml** provides 9% of daily maintenance fluid
- **800 microgram/ml** provides 4.5% of daily maintenance fluid **<--PREFERRED**
- **1600 microgram/ml** provides 2.3% of daily maintenance fluid
- **CENTRAL LINE ONLY: 3200 microgram/ml** provides 1.1% of daily maintenance fluid
Concentration Selection

- 24 hour maintenance fluid
- 3-8% of the maintenance fluid load
Concentration Selection – Titration

Discontinue and re-order

Previous concentration → 24 hours → Recalculate concentration
Concentration Selection – Use preferred

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3. Infusion Line

Central Line

Is this medication being given via a CENTRAL LINE?

Yes | No

Concentrations (Based on 1X Maint Fluid)
- 400 microgram/ml provides 8% of daily maintenance fluid
- 800 microgram/ml provides 4% of daily maintenance fluid <PREFERRED>
- 1600 microgram/ml provides 2% of daily maintenance fluid

(CENTRAL LINE ONLY) 200 microgram/ml provides 1% of daily maintenance fluid
UOM Conversion

Dose: 5
Dose Unit: microgram/kg/min

Concentration: 4
Conc Unit: mg/ml
Infusion Volume

Solution/Volume/UOM

D5w  212 ml

Solution/Volume/UOM

D5w  250 ml
Diluent

- Default diluent
- Alternative compatible diluent choices
- Alerts when change to a diluent that is not available for the concentration selected
Data Analysis and Results
Events reported

Voluntary Reporting System

Medication Infusion Events

- Pre: 36%
- Post: 7%

Prescribing events
Dosage Data

** Hard stop alert prevented 30 significant prescribing events over 12 months **
Team Members

Adrienne Hewryk, Pharm.D.
Amy Chan, MS, Pharm.D.
Bobby Lee, Pharm.D.
Elena Mendez-Rico, Pharm.D.
Ibis Lopez, Pharm.D., BCPS
Jason Topolski, Pharm.D.
Jessica L. Jacobson, Pharm.D., BCPS
Keith Fester, Pharm.D.

Departments

Nursing / Medical staff / Pharmacy / EMT / BioMed / Service Desk
Equipment Center / IT
Self-Assessment Question 1

- Implementing clinical decision support in medication order entry process will improve patient safety.

**Answer:** True
Self-Assessment Question 2

- Using patient’s daily fluid maintenance as a guide to determine medication drip concentration can avoid potential fluid overload to a patient.

**Answer:** True
Self-Assessment Question 3

- Pharmacists are not equip to provide input in system design.

Answer: False
Key Takeaways

- Key Takeaway #1
  • Review and limit existing infusion concentration to 2-3 concentrations

- Key Takeaway #2
  • Systemic approach to identify and involve all impacted departments at the start of the project

- Key Takeaway #3
  • Design logic to record alerts and user decisions that can be used for post deployment analysis and enhancements
References


