Considerations for Sterile Compounding of Parenteral Products for Pediatric Use: Part 2
PharMEDium Lunch and Learn Series

Considerations for Sterile Compounding of Parenteral Products for Pediatric Use: Part 2
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Featured Speaker: Kirsten H. Ohler, PharmD, BCPS, BCPPS
Neonatal / Pediatric Clinical Pharmacist
Clinical Associate Professor, Pharmacy Practice
Program Director, PGY2 Pediatric Pharmacy Residency
University of Illinois at Chicago College of Pharmacy

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Attendance Code

Code will be provided at the end of today’s activity
Attendance Code not needed for On-Demand

Ask a Question

- Submit your questions to your site manager.
- Questions will be answered at the end of the presentation.
Disclosure

• The speaker, Kirsten H. Ohler, has no actual or potential conflicts of interest related to the information included in this presentation.

• The practice of off-label medication use in pediatric patients will be discussed.

Objectives

At the conclusion of Part 2, participants will be able to:

1. Identify considerations in drug formulation and drug delivery processes specific to the pediatric population.
2. Discuss medication safety issues specific to the pediatric population and potential methods to address them.
3. Describe the role a compounding pharmacy team can have in the care of pediatric patients.
Drug Delivery Process

• Considerations
  – Availability of a “pediatric friendly” formulation
    • Need for multiple concentrations
    • Need to make dilutions for measurable volumes
  – Availability of appropriate drug delivery device
    • Measurable rates
    • Pediatric-specific safety features
    • Impact of “dead space” in syringe
    • Impact of “priming volume” in tubing
    • In-line filters may adsorb drugs
  – Risk of catheter occlusion

• Methods to manage solution overfill
  • Simple admixture – may be used if entire bag to be infused to single patient
  • Withdrawal drug volume – may be used if volume of medication to be added is large
  • Withdrawal drug & overfill volume – may be used if volume of medication to be added is large
  • Empty container – may be used when final concentration of drug must be precise
  • Must have defined process with clear labeling
Drug Delivery Process

- Methods of intravenous administration
  - IV push (IVP)
    - Check compatibility
    - Physiologic effects of rapid administration
      - Example: Sodium bicarbonate & intraventricular hemorrhage
    - Dead space
      - Area between the syringe hub and needle
        » ~0.05mL for a 1mL syringe
      - Example: Digoxin 100 mcg/mL
        » 0.5kg x 5 mcg/kg/day = 2.5 mcg/day = 1.25 mcg every 12 hr
        » 1.25 mcg = 0.0125 mL using 100 mcg/mL
        » 1.25 mcg = 0.125 mL using 10 mcg/mL dilution
        » 0.05 mL dead space = 40% increase in volume/dose

Drug Delivery Process

- Methods of intravenous administration
  - IV piggyback (IVPB) / intermittent infusion
    - Check compatibility with fluids and other drugs

  - Fluid considerations: Mini-bag vs. syringe
    - Typical mini-bag volume 50 – 100 mL
    - Example: 0.5 kg, total daily fluid requirement = 120 mL/kg/day
      = 60 mL/day including TPN, feedings, medications

  - Priming volume of tubing
Drug Delivery Process

• Methods of intravenous administration
  – Continuous IV infusion
    • Check compatibility with fluids and other drugs
    • Variability in dosing units (e.g., mL/hr, mcg/kg/hr, mg/hr)
    • Measurable rates
      – Example: Dopamine
        – 0.55 kg x 5 mcg/kg/min = 0.1 mL/hr using 1600 mcg/mL
        – 0.55 kg x 5 mcg/kg/min = 0.2 mL/hr using 800 mcg/mL
        – 0.55 kg x 1 mcg/kg/min = 0.04 mL/hr using 800 mcg/mL
  • Considerations for priming tubing

Drug Delivery Devices - Buretrol

• Holding chamber between IV bag and infusion pump
• Safety mechanism to prevent accidental large fluid bolus
• Medications can be added to chamber
  – Low IV flow rate affects drug delivery
• Not routinely used
Drug Delivery Devices – Syringe Pump

• May be used for intermittent doses or continuous infusion

• Considerations
  – Minimum / Maximum syringe sizes
  – Minimum rate
    • Usually 0.1 mL/hr
  – Minimum rate change
    • Usually at least 2 decimal places (e.g., 0.01 mL/hr)
  – Microbore tubing
    • Typically small priming volume (~1 mL)
  – May not have “smart” pump features
Drug Delivery Devices – Large Volume IV Pumps

• May be used for IVPB or continuous infusion

• Considerations
  – Minimum rate
    • Depends on pump, usually 0.1 mL/hr or 1 mL/hr
  – Minimum rate change
    • Usually only 1 decimal place (e.g., 0.1 mL/hr)
  – Large bore tubing
    • Typical priming volume: 20 – 25 mL
  – May not have “smart” pump features
Medication Error

• Definition
  – Preventable event
  – Result of system flaw or human error
  – Occurs during ordering, preparation, administration
  – Harm or potential harm does not have to be present

• Near miss
  – Error caught before it reached the patient

Medication Error – What’s the Risk?

Why are Children at Higher Risk?

- Minimal information in the PharmD curriculum
- Developmental pharmacokinetics
- Off-label medication use
- Metric confusion
  - Grams vs. Kilograms vs. Pounds

Why are Children at Higher Risk?

• Weight-based dosing
  – mg/kg/dose vs. mg/kg/day

<table>
<thead>
<tr>
<th></th>
<th>Ampicillin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient weight</td>
<td>10 kg</td>
</tr>
<tr>
<td>Dose</td>
<td>50 mg/kg/dose</td>
</tr>
<tr>
<td>Frequency</td>
<td>4 times a day</td>
</tr>
<tr>
<td>Correct dose</td>
<td>50 mg/kg/dose x 10 kg = 500 mg every 6 hours</td>
</tr>
<tr>
<td>Common error</td>
<td>125 mg every 6 hours</td>
</tr>
</tbody>
</table>

– mcg/kg/min vs. mcg/kg/hour
– Body weight vs. body surface area
– “Adult” dose

Why are Children at Higher Risk?

• Growth / weight gain necessitates dose recalculations
  – Lack of dose adjustment can result in subtherapeutic effect

• Need for multiple concentrations / lack of standardized concentrations

• Less physiologic reserve than adults
Methods for Decreasing Errors

• In general...
  – Avoid abbreviations
    • Drug names (e.g., MSO4)
    • Units of measure (e.g., U)
    • Instructions (e.g., QD)
  – Always include a leading zero (e.g., 0.5 mg), never a trailing zero (e.g., 5.0 mg)

Methods for Decreasing Errors

• Utilize pharmacist consultation
• Preparation of medications by pharmacy staff rather than nursing staff
• Integrate pharmacists into patient care rounds
  – >80% reduction in error rate
• Pharmacy staff should be adequately trained to care for children
• Provide ongoing educational system for staff
• Offer pediatric-specific formulary with criteria for evaluation, selection, use

Methods for Decreasing Errors

• Standardize units of weight (i.e. kg vs. pounds)

• Standardize concentrations
  – For continuous, intermittent, and IVP medications
  – Eliminate “rule of 6” calculations for continuous infusions
    • Example: $6 \times \text{weight (kg)} = \frac{\text{amount of drug (mg)}}{100 \text{ mL of solution}}$
    • Then $1 \text{ mL/hr} = 1 \text{ mcg/kg/min}$
  – ASHP “Standardize 4 Safety” initiative
  – Institute for Safe Medication Practices (ISMP) standard concentrations for neonatal infusions

AAP. Pediatrics. 2003. 27

Methods for Decreasing Errors

• Computerized prescriber order entry (CPOE)
  – Needs to be pediatric-specific
    • Dose-range checking
    • Renal dosing alerts
    • Clinical decision support features
  – May prevent some errors and create others
    • Beware of “alert fatigue”
  – Not all CPOE systems have the same capabilities

AAP. Pediatrics. 2003. 28
Methods for Decreasing Errors

- Utilize technology during compounding
  - Bar-code scan
  - Specific gravity / product weight measurement

- Comprehensive labeling of final product
  - Drug name and dose
  - Base solution
  - Final volume
  - Final concentration

- Standardize equipment (e.g., infusion pumps)

- Utilize double-checks


Methods for Decreasing Errors

- Bedside bar-code scanning
  - Beware of work-arounds

- Utilize smart pump technology
  - Must utilize pediatric-specific information
    - Weight range limits
    - Pressure limits

  - Drug library
    - Pre-programmed concentrations
    - Dose range limits
    - Automated calculations

“Smart” Pump Technology

Methods for Decreasing Errors

• Clear communication

• Error tracking system
  – Include all errors regardless of severity / potential for harm
  – Voluntary reporting typically underestimates true error rates
  – System flaws vs. individual fault

• Eliminate barriers to reporting errors
  – “Just culture”

Role of the Pharmacy Team

• Promote a culture of safety
• Utilize technology
• Insure use of standard concentrations
• Conduct research on stability / compatibility
• Pursue additional pediatric-specific education
  – PGY2 pediatric residency training
  – Board certified pediatric pharmacy specialist (BCPPS)

Conclusions

• Children are a vulnerable population
• Medication errors occur more frequently and with greater severity in children
• Awareness of unique safety concerns is imperative for identifying preventative strategies throughout the drug delivery process
• Get “pediatric smart” and practice in a “just culture”
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References