

### How do we come to know so little about pediatric pharm?

- >75% most common medications given to children lack any pediatric specific studies
- Lessons learned from peds studies:
  - Children are more dynamic and variable than anticipated
  - Adverse reactions in pediatric populations are specific and in some cases different than adults

### Pharmacokinetics: Dose

- BSA or Wt used to calculate meds (mg/kg or mg/m<sup>2</sup>)
  - This gets us in the ballpark...may need to adjust based on response.
- Body composition:
  - Less muscle mass than adults...perfusion of muscles is more erratic than in adults.
  - Variable fat %: some meds are fat soluble (ex: barbituates/Valium). These drugs first saturate fat sites...what's left goes into the serum. The proportion of fat in the child's body is going to make differences in the amount of drug you are going to give. A typical infant is 16% body fat...but a toddler gets to about 23-35% body fat...a pre-schooler is at around 12% body fat. So, will need proportionally more in a toddler.
  - Greater total body water (TBW)
    - Infant is 80% fluid
    - Child goes down to 60%
    - More of the fluid in a child is extracellular than intracellular (ECF>ICF) Ex...ampicillin is a drug that is based on AGE b/c it is water-soluble.

### Pharmacokinetics: Systemic vs. Local

- Skin is much thinner and there is proportionally more of it (higher BSA). There is more absorption in the skin (d/t thin epidermis and dermis) than in an adult...so a topical steroid cream is more likely to cause a systemic effect.
- Eye: drops are readily absorbed thru nasolacrimal duct (you don't want them to go down the duct...you want the drug to stay in the eye, so you need to put pressure on the duct to keep the med in the eye)

### Pharmacokinetics: Absorption & Elimination

- GI: more delayed and irregular absorption
  - NB emptying time delayed...can be up to 6 hours. Have very irregular peristalsis, so the absorption of the oral meds may be erratic.
  - More neutral pH 0-6mo
- Liver is immature in babies
  - Decrease enzymes
  - Decrease plasma proteins
  - So, will need proportionally less drugs that bind to plasma proteins...a drug for which this is an issue is Dilantin (phenytoin?)

### Pharmacokinetics: Absorption & Elimination

- Immature blood-brain barrier...it is more like a sieve than an actual barrier; much more likely to get CNS side effects than in adults
  - Encephalopathy more common toxic effect
  - CNS medications w/ unpredictable results. For example, phenobarb will make kids go "psycho"...but it puts adults to sleep.
- Kidneys are less mature
  - GFR 30-50% of adults
  - Half-life of drugs excreted by the urinary tract is likely to be longer (gentamycin, digoxin are common ones)

### Key Points about How Drugs Work

- Dosage roughly determined by BSA or weight
- Absorption/distribution altered according to body make up & route as kids grow and change
- Elimination (half-life) influenced by maturity of liver/kidneys
- Desired and toxic effects influenced by development

**Safety in Administration**

- Accurate Dosage Calculations (must calculate EVERY drug):
  - Recommended dosage in mg/kg/day...some are mg/kg/dose
  - Number of divided doses recommended
  - Recommended route of administration
- 6 rights:
  - Right child
  - Right drug
  - Right dose
  - Right time (half hour before, half hour after scheduled time)...shoot for the half-hour before with kids
  - Right route
  - Right documentation

Check blood levels of aminoglycosides after every third dose.

**Medication Administration: Oral**

- If they're little babies, can do a syringe thing in the mouth...put toward cheek, not straight back.
  - Toddlers in particular will take it better if parent gives it to them.
- Older kids...give them a choice...syringe or cup
- Mix it with stuff...(not honey!) Mix with non-essential fluids in case it tastes bad, and mix only with a little bit. Chocolate covers up a lot of flavors...some kids will take pills with a little scoop of ice cream.

**Case Study:**

3 y/o s/p T & A, POD #1, readmitted for dehydration. Per parents pt. refuses to take Tylenol w/codeine elixir. The pt. has received fluids and morphine during the night. You arrive at 7am and assume care...

- What are your nursing priorities?
  - need to get kid on oral meds
  - kid needs to drink
  - need to teach parents how to get kid to take meds (rewards work well)
- How will you implement this plan?

**Medication Administration**

- Eye
  - Pressure
  - Ointment vs. drops
- Ear
  - < 3 y/o pull ear pinna down & back; do not put cotton in the ear.

**IM: Vastus Lateralis**

- EMLA is a topical anesthetic...put it on, cover it and leave it for 30 mins; this may cause the kids to flip out if they know the shot is coming in half an hour. Older kids will want the EMLA b/c they understand it will help in the long run. It only takes away the stick at the surface...doesn't take away sting of the med.
- This chart shows how much volume can be given in vastus lateralis in one injection:
- If have to do two injections, have two nurses do them simultaneously

0-18mo	18mo-3y/o	3-6 y/o	6-15 y/o
0.5-1ml	1ml	1.5ml	1.5-2ml

**Medication Administration: NG vs. ND vs. NJ vs. GT**

- Important to know where the tub ENDS, b/c this restricts what you can put in the tube
  - cannot put hypertonics into intestines...water will be pulled into intestines and cause osmotic diuresis

- no bolus in intestines
- pH makes a difference for some meds and their absorption
- Clogged tubes d/t smaller size
  - flush after meds and feedings
  - 3-5 mL is enough usually

### Medication Administration: IV medications (HIGH RISK)

- Correct Dose (also check levels for aminoglycosides after 3rd dose)
  - Wt calculations
  - Drug levels?
- Correct Dilution
  - Minimum dilution
  - Patient situation... can they take more fluid? Are they on fluid restriction?
- Administration:
  - Route: know where the end of the IV is.
  - Rate
  - Compatibility
- Medication Administration: IV Safety.
- IV FLUID ADMINISTRATION IS A HIGH RISK PROCEDURE IN PEDIATRICS
- ALWAYS CHECK SITE EVERY HOUR!!!
- No standard for changing IV...just change when it goes bad. Gotta watch it!

### IV Medication Case Example

- Decision Making: Discussion Cases
  - 4 kg patient, order Fentanyl 0.4 mg IV q 2 hours prn pain; night shift recorded 40 mcg given one time; Fentanyl vial = 100 mcg/2ml
  - Pt is complaining they are having pain...what other info do you need?
    - Got med at 3am, it is now 8am
    - Check normal dose of Fentanyl (1-4 mcg/kg)
    - Key issue is that the order is wrong (that would be 400 mcg)
- Pt on Methadone weaning order is for change from IV to PO, pt diagnosis SBS (short bowel syndrome)
  - Kids on methadone b/c intubated...very easy to self extubate...so we give them morphine and need to give them methadone to wean it down.
  - Kid has lost his IV and now they are changing it to PO
  - You need to go back and tell doc that the PO med will have questionable absorption d/t SBS
- Pt on Dilantin w/o IV access, receiving cont. NG feeds but tolerating < maintenance fluids, Dilantin ordered q 6 hours
  - When pts start to wake up from seizure, they thrash about a lot and take out IVs
  - need to stop feedings two hours before Dilantin, and 2 hours afterwards in order for it to absorb...this is an issue b/c she is not getting enough fluid/feed already.
  - Look at options to dose Dilantin q 12 instead...will also turn up feedings a bit to get to goal
- 10 kg patient, Gentamycin order 30 mg q 8 hours.
  - Need to know the dose (2.5 mg/kg/dose)...so this dose is high
  - Need to know his level of gentamycin in the blood...the level was low after 3rd dose, so they increased the dose to therapeutic range of 30 mg...so the order is OK.
- IV Erythromycin
  - 5 kg infant admitted for Pertussis.
  - Order = IV Erythromycin 125 mg q 12 hours (correct dose)
  - Delivered to the unit via pharmacy is a piggyback bag with Erythromycin 125mg/100 ml
  - Concerns = lots of fluid for this baby...need a different bag.

Anytime giving something via Volutrol...you give at least 60 mL with the med and the flush. So if they can't take fluids you go with a syringe pump.

- Summary Points
  - Pharmacokinetics in children are highly variable, and largely still undefined
  - Use of pediatric specific resources is necessary for safe medication administration
  - Check and double check doses
  - Always check 6 rights in medication administration
  - Creativity and critical thinking are often needed – Multiple variables and no one right means to the end

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