Welcome to Children's Mercy!

- **You will be attending Nursing Orientation on Wednesday and Thursday of orientation week.**
- **Please refer to the schedule you received from your unit educator or department director for your specific times and locations.**
- **It will be important for you to check in with your Department Director or Unit Educator to find out if they have anything additional planned for you on the unit/clinic during orientation week.**

- **The Nursing Orientation program will offer a high level overview of programs, services and resources that you will interact with and have access to as a nurse at Children's Mercy.**
- **Multiple learning modalities will be utilized throughout the day, including lectures, videos, gaming, group discussion and scenarios.**
- **Coffee, tea, water and cereal/granola bars will be provided on Wednesday morning.**
- **Lunch will be on your own. (You may choose one of the Crown Center restaurants or bring your own lunch. We do have access to a refrigerator.)**
- **Please remember that the dress is business casual or you may wear scrubs. As it is often difficult to control the temperature of the classrooms, please dress in layers.**

- **The Medication Calculation Test will be given on Thursday morning in the computer lab.**
- **This packet contains conversion formulas, practice calculations, and other information that will help you prepare for the test. If you review this packet thoroughly, you will be well prepared for the test.**
- **You will take the test on the computer and will immediately know your results (a 100% score is required for all nurses).**
- **There is no time limit for taking the test.**
- **If you do not pass the test the first time, you will be eligible to retake the test 24 hours after your first attempt, or when your Unit Educator can set up time to proctor you.**
- **You will not be allowed to independently administer medications until you pass this test.**

If you have any questions, please do not hesitate to contact me. I look forward to meeting you!

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Basic Medication Calculation

P1. Overview and Objectives:

Overview
Health care providers may frequently find that the medication dose ordered is different than the dose that is on hand to administer. Consequently, it is essential that each clinician who has responsibility for ordering, dispensing and/or administering medications is competent in medication calculation. This course provides a review of common methods for calculating basic medication dosages. Additionally, several case–based practice opportunities are included.

Objectives

1. Identify common sources of error in medication calculation and related strategies for safe medication delivery.
2. Explain common conversions and accurately convert simple measurements from one system of weight and measure to another.
3. Successfully perform basic medication calculations utilizing either the ratio–proportion method or formula method of calculation.
4. Utilize appropriate rounding guidelines when calculating medication dosages.
5. Confirm appropriateness of ordered doses of medications using recommended dosages by weight.

P2. Medication Errors: Facts

Let's review some known facts about medication errors.

- Pediatric medication errors can often occur when a decimal point is misplaced in a medication dose or an incorrect weight conversion from pounds to kilograms is made.
- The most common dosage calculation error is the misplacement of a decimal point, leading to a tenfold dosage error.
- During calendar years 2006–2007, data submitted to the United States Pharmacopeia's (USP) MEDMARX® reporting program revealed that nearly 2.5 percent of pediatric medication errors led to some level of patient harm. The most common types of harmful pediatric medication errors were: improper dose/quantity (37.5 percent), omission error (19.9 percent), unauthorized/wrong drug (13.7 percent), and prescribing error (9.4 percent), followed by wrong administration technique, wrong time, drug prepared incorrectly, wrong dosage form and wrong route.

Because the consequences of medication errors can be far more devastating when children are involved, it is all the more important to check the accuracy and verify the dose of every medication before it is given. There is no manufacturer or pharmaceutical dose that is safe for all age ranges in the pediatric population.

P3. Calculation Competency: Required Skills

Competent performance of medication calculation is critical and requires mastery of:

- Basic math skills
- Common conversions
- Calculations with formulas
- Percentage calculations
- Cross multiplication in ratios

Multiple–step division and multiplication of numbers are error–prone tasks. If you feel the need to refresh your knowledge of these essential math skills, contact your manager or educator for available educational resources.

P4. Calculation Competency: Rounding Rules

Completing calculations accurately includes rounding to a final answer that is appropriate for the method of delivery. The vehicle for delivery, for example the size of the syringe, will determine how a final answer should be rounded.

General guidelines for rounding include:

- For amounts greater than one milliliter (mL) the math should be carried two decimal points and rounded to tenths.
- For amounts less than one milliliter (mL) the math should be carried out three decimal points and rounded to hundredths.

For consistency and accuracy, basic principles of rounding should be followed according to your organization's rounding policy.

P5. Common Conversions: Conversion Units

Because the metric, apothecary and household systems are all used in the United States at this time, it is occasionally necessary to convert from one system of weight and measure to another, such as from pounds to kilograms. Common measurement units are listed below.

Weight	Volume
1 kilogram (kg) = 1000 gram (gm) 1 gm = 1000 milligram (mg) 1 mg = 1000 microgram (mcg) 2.2 pounds (lbs) = 1 kg 1 microgram (mcg) = 1000 nanogram (ng)	1 liter (L) = 1000 milliliter (mL) 1 fluid ounce (oz) = 30 mL

P6. Common Conversions: Ratio Conversion

Pediatric dosage handbooks provide recommended safe dosages based on weight in kilograms. If the child's weight is reported in pounds it will be necessary for the clinician to convert the child's weight to kilograms to verify that the ordered dose is within the recommended range. A simple ratio conversion method can be used.

Convert a weight of 66 pounds into kilograms by clicking the box below to see each step.

Go Given Conversion (C) : $\frac{\text{Known Amount (K)}}{\text{Unknown Amount (X)}}$

STEP 1 of 3 $\frac{\textbf{2.2 lb}}{\textbf{1 kg}} : \frac{\text{Known Amount (K)}}{\text{Unknown Amount (X)}}$

Fill in the given conversion on the left side of the equation. In this case, 2.2 pounds equals 1 kilogram.

STEP 2 of 3 $\frac{\text{2.2 lb}}{\text{1 kg}} : \frac{\textbf{66 lb}}{\textbf{Unknown Amount (X)}}$

Fill in the known amount on the right side of the equation. In this example, it is 66 pounds.

STEP 3 of 3 $\frac{\text{2.2 lb}}{\text{1 kg}} \times \frac{\text{66 lb}}{\text{(X)}} = \textbf{[2.2 lb × U : 66 × 1] = [66 ÷ 2.2] = 30 kg}$

Cross–multiply the numbers in the equation to determine the unknown amount. 66 pounds equals 30 kilograms.

P7. Calculation Formulas: Other Methods

Let's expand on the ratio conversion method by adding the ratio–proportion method and the formula method. Both of these methods allow the clinician to easily and accurately determine a dose or quantity to administer from the medication available. You can choose to use whichever method is easier for you.

These methods are used to determine the "unknown" or "X" amount in an equation.

Ratio–Proportion Method

$$\frac{\text{Dosage available (H)}}{\text{Volume available (V)}} = \frac{\text{Dose ordered (D)}}{\text{Amount to administer (X)}}$$

- Units of measure should always be stated in the same sequence. (mg/mL = mg/mL)
- Always state the known ratio first

Formula Method

$$\frac{\text{Dose ordered (D)}}{\text{Dosage available (H)}} \times \text{Volume available (V)} = \text{Amount to administer (X)}$$

P8. Calculation Formulas: Ratio-Proportion Method

Let's look at an example of the **Ratio–Proportion Method**:

Order: 0.5 mg of a medication
On hand: 2 mg/0.5 mL

Determine the proper amount to administer by clicking the box below to see each step.

Go

$$\frac{\text{Dosage available (H)}}{\text{Volume available (V)}} = \frac{\text{Dosage ordered (D)}}{\text{Amount to administer (X)}}$$

STEP 1 of 3

$$\frac{\textbf{2 mg}}{\textbf{0.5 mL}} = \frac{\textbf{0.5 mg}}{\text{Amount to administer (X)}}$$

Set up the method by plugging in the values.

STEP 2 of 3

$$\frac{\text{2 mg}}{\text{0.5 mL}} \times \frac{\textbf{0.5 mg}}{\text{X mL}} = \textbf{2(X) = 0.25}$$

Cross multiply to solve for X mL.

STEP 3 of 3	0.25 ÷ 2 = 0.125 mL = **Amount to be administered: 0.13 mL**

Calculate the answer out three decimal points: X = 0.125 mL.

Using appropriate rounding rules, the amount to administer is 0.13 mL.

P9. Calculation Formulas: Formula Method

Let's look at an example of the **Ratio–Proportion Method**:

Order: 24 mg of a medication
On hand: 16 mg/5 mL

Determine the proper amount to administer by clicking the box below to see each step.

Go	$\frac{\text{Dosage ordered (D)}}{\text{Dosage available (H)}} \times \text{Volume available (V)} = \text{Amount to administer (X)}$

STEP 1 of 2	$\frac{\textbf{24 mg}}{\textbf{16 mg}} \times \textbf{5 mL} = \text{Amount to administer (X mL)}$

Set up the method by plugging in the values.

STEP 2 of 2	24 mg ÷ 16 mg × 5 mL = **7.5 mL to be administered**

Divide and multiply to find the amount to administer: 7.5 mL.

P10. Practice Calculations: Practice

It is now time to practice a few calculations on your own. Complete the following sample problem using one of the calculation methods discussed in this course.

A 4–kilogram neonate is to receive gentamicin 8.5 mg IV every 12 hours. The medication concentration is 10 mg/mL. How many milliliters should be administered for each dose?

- o 0.85 mL
- o 1.7 mL
- o 1.2 mL
- o 2.4 mL

P11. Practice Calculations: Practice (cont.)

Complete the following sample problem using one of the calculation methods discussed in this course.

A cardiac patient in the PICU has an order for 15.4 mg of furosemide IV every 12 hours. The vial of furosemide. The medication concentration is 10 mg/mL. How many milliliters should be administered?

- o 2 mL
- o 1.2 mL
- o 0.5 mL
- o 1.5 mL

P12. Practice Calculations: Practice (cont.)

Amoxicillin 200 mg by mouth twice daily has been ordered for an infant with an ear infection. Amoxicillin suspension is available 125 mg/5 mL. How many milliliters of Amoxicillin should be administered?

- o 8 mL
- o 1.6 mL
- o 4 mL
- o 5 mL

P13. Safety Strategies: Review

Now that you have practiced some calculations, let's review simple strategies for preventing medication errors.

- Question orders that use trailing zeros (e.g., 2.0 mg instead of 2 mg) or naked decimals (e.g., .5 mg instead of 0.5 mg).
- Confirm orders that utilize problematic abbreviations, such as "U" for unit, "µg" instead of "mcg" or "microgram," "QD" instead of "daily" or "every day." Check your institution's policy for acceptable abbreviations. Follow The Joint Commission's "do not use" list of abbreviations.
- Clarify orders in which the medication name is abbreviated versus completely spelled out, such as MSO_4 instead of morphine sulfate.
- Perform independent double–checks for complex calculations.
- Check labels to confirm correct concentration.
- Remember, an error can occur at any point in the medication administration process – upon ordering, dispensing or administering the medication. Physicians, pharmacists, nurses and other clinical personnel should always ask questions when orders are unclear or when there is any doubt.
- Check with your educator for additional institution–specific safe calculation policies.
- When setting up your problem always label all the units, including X.
- Always consider if the answer you calculate is a reasonable amount to administer.
- Practice, practice, practice – the more calculations performed the easier and more accurate you will be.

P14. Medication Reconstitution- Examples

When reconstituting meds, remember to use the total volume to figure out how much medication to give the pateint.

The doctor orders 250 mg of Ancef IM q8h. The medication label reads 1 g Ancef in powder form. Reconstitute by adding 2.5 mL of sterile water for injection, for a total volume of 3 mL. The solution concentration will yield 330 mg/mL.

How many mL will you administer? _____

Kefzol is ordered 200 mg. On hand is a vial of Kefzol powder 500 mg. To prepare solution add 2 mL of sterile water for a total volume of 2.2 mL.

How many mL would you give? _____

P15. Safe Dosage: Calculations by Weight

Recommended safe dosages are usually reported as mg/kg/day or mg/kg/dose. It is imperative when calculating the safe dose that the clinician is aware of which of these two ranges is being used. Additionally, recommended doses are often given in ranges and it will be important to determine if the ordered dose falls within the recommended range.

Safe dose calculation for mg/kg/day

1. Determine weight in kilograms if not already available
2. Calculate the recommended daily dose
3. Divide the daily dose by the number of doses per day ordered (e.g., every six hours would be four doses per day)
4. Compare the calculated dose or range to the ordered dose to determine if the ordered dose is appropriate

Safe dose calculation for mg/kg/dose

1. Determine weight in kilograms if not already available
2. Calculate the recommended dose or range amount
3. Compare to the ordered dose

While the clinician administering the medication may not have been responsible for ordering the drug, it is still the primary responsibility of the clinician to verify that the dose is correct and safe prior to administering.

P16. Safe Dosage: Example One

A two–year–old patient presents to the emergency department with congestive heart failure related to a ventricular septal defect. The child weighs 24 pounds. The ED physician orders 15 mg furosemide IV every six hours.The recommended pediatric IV dosage of furosemide for infants and children is 2 to 8 mg/kg/day divided every 6 to12 hours.

STEP 1 of 4

Calculate the weight using the ratio conversion method previously learned.

2.2 lbs/1 kg : 24 lbs/X kg = 10.9 kg

STEP 2 of 4

Calculate minimum and maximum dose per day.

2 mg/kg/day = 2mg × 10.9 kg = 21.8 mg/day
8 mg/kg/day = 8 mg × 10.9 kg = 87.2 mg/day

STEP 3 of 4

Divide the daily dose by number of ordered doses per day.

21.8 mg/day ÷ 4 doses/day (every six hours) = 5.45 mg/dose
87.2 mg/kg/day ÷ 4 doses/day (every six hours) = 21.8 mg/dose

It is not necessary to do any rounding of the safe dose calculation as you are only using the number for confirmation of safe dose, not for actual administration of the dose.

STEP 4 of 4

Confirm the ordered dose is within the recommended dose range.

Recommended safe dosage range = 5.45 mg/dose to 21.8 mg/dose.

Ordered dose = 15 mg

P17. Safe Dosage: Example Two

A nine–year–old child requires sedation for a short radiology procedure. The child weighs 65 pounds. The radiologist orders 1 mg IV midazolam. The recommended IV dose for children six to 12 years of age for sedation prior to procedures is 0.025 mg to 0.05 mg/kg/dose.

STEP 1 of 3

Calculate the weight using the ratio conversion method previously learned.

2.2 lbs/1 kg : 65 lbs/X kg = 29.5 kg

STEP 2 of 3

Calculate minimum and maximum dose.

0.025 mg/kg/dose × 29.5 kg = 0.7375 mg/dose
0.05 mg/kg/dose × 29.5 kg = 1.475 mg/dose

STEP 3 of 3

Confirm the ordered dose is within the recommended dose range.

Recommended safe dosage range = 0.7375 mg/dose to 1.475 mg/dose.

Ordered dose = 1 mg

P18. Safe Dosage Practice: Practice Problem One

Now let's practice calculating and verifying safe dosages.

A ten–year–old patient requires IV antibiotics for osteomyelitis. The physician orders vancomycin 424 mg IV every 8 hours. The patient weighs 70 pounds. The recommended pediatric IV dose is 40 mg/kg/day. What is the maximum daily amount of vancomycin for this patient?

- o 1272 mg/day
- o 3816 mg/day
- o 6160 mg/day
- o 1400 mg/day

P19. Safe Dosage Practice: Practice Problem Two

What is the maximum dose amount of vancomycin for this patient?

- o 424 mg/dose
- o 400 mg/dose
- o 500 mg/dose
- o 350 mg/dose

P20. Safe Dosage Practice: Practice Problem Three

A two–year–old child receives ranitidine for GERD. The child weighs 11.5 kg. The ordered dose is 12 mg of ranitidine by mouth twice daily. The recommended oral dose of ranitidine for GERD in children from one month of age to 16 years is 2 to 4 mg/kg/day divided twice daily.

What is the maximum daily amount of oral ranitidine for this patient?

- o 25 mg/day
- o 23 mg/day
- o 44 mg/day
- o 46 mg/day

P21. Safe Dosage Practice: Practice Problem Four

What is the maximum dose amount of ranitidine for this patient?

- o 46 mg/dose
- o 23 mg/dose
- o 11.5 mg/dose
- o 15 mg/dose

P22. Safe Dosage Practice: Key Guidelines

The following guidelines are important to remember as you calculate recommended safe dosages.

- Confirm if the recommended dose is listed as per day or per dose.
- Remember the dosage references may list different dosage recommendations for different diagnoses or age groups.
- It is not necessary to round the calculated safe dosage amounts.
- Label all numbers in the calculations with appropriate units of measure.

Basic Medication Calculation

Answers to practice questions

P10. Practice Calculations: Practice

A 4–kilogram neonate is to receive gentamicin 8.5 mg IV every 12 hours. The medication concentration is 10 mg/mL. How many milliliters should be administered for each dose?

- (•) 0.85 mL
- ( ) 1.2 mL
- ( ) 1.7 mL
- ( ) 2.4 mL

Correct!

0.85 mL is the proper amount to administer.

P11. Practice Calculations: Practice (cont.)

A cardiac patient in the PICU has an order for 15.4 mg of furosemide IV every 12 hours. The vial of furosemide. The medication concentration is 10 mg/mL. How many milliliters should be administered?

- ( ) 2 mL
- ( ) 0.5 mL
- ( ) 1.2 mL
- (•) 1.5 mL

Correct!

1.5 mL is the proper amount to administer.

P12. Practice Calculations: Practice (cont.)

Amoxicillin 200 mg by mouth twice daily has been ordered for an infant with an ear infection. Amoxicillin suspension is available 125 mg/5 mL. How many milliliters of Amoxicillin should be administered?

- (•) 8 mL
- ( ) 4 mL
- ( ) 1.6 mL
- ( ) 5 mL

Correct!

8 mL is the proper amount to administer.

P14. Medication Reconstitution

The doctor orders 250 mg of Ancef IM q8h. The medication label reads 1 g Ancef in powder form. Reconstitute by adding 2.5 mL of sterile water for injection, for a total volume of 3 mL. The solution concentration will yield 330 mg/mL. How many mL will you administer? **__0.76ml_____**

Kefzol is ordered 200 mg. On hand is a vial of Kefzol powder 500 mg. To prepare solution add 2 mL of sterile water for a total volume of 2.2 mL. How many mL would you give? **___0.88ml_____**

P18. Safe Dosage Practice: Practice Problem One

A ten–year–old patient requires IV antibiotics for osteomyelitis. The physician orders vancomycin 424 mg IV every 8 hours. The patient weighs 70 pounds. The recommended pediatric IV dose is 40 mg/kg/day.

What is the maximum daily amount of vancomycin for this patient?

- (•) 1272 mg/day
- ( ) 3816 mg/day
- ( ) 6160 mg/day
- ( ) 1400 mg/day

Correct!

1272 mg/day is the safe dosage to administer.

P19. Safe Dosage Practice: Practice Problem Two

What is the maximum dose amount of vancomycin for this patient?

- (•) 424 mg/dose
- ( ) 500 mg/dose
- ( ) 400 mg/dose
- ( ) 350 mg/dose

Correct!

424 mg/dose is the safe dosage to administer.

P20. Safe Dosage Practice: Practice Problem Three

A two–year–old child receives ranitidine for GERD. The child weighs 11.5 kg. The ordered dose is 12 mg of ranitidine by mouth twice daily. The recommended oral dose of ranitidine for GERD in children from one month of age to 16 years is 2 to 4 mg/kg/day divided twice daily.

What is the maximum daily amount of oral ranitidine for this patient?

- ( ) 25 mg/day
- ( ) 44 mg/day
- ( ) 23 mg/day
- (•) 46 mg/day

Correct!

46 mg/day is the maximum daily amount to administer.

P21. Safe Dosage Practice: Practice Problem Four

What is the maximum dose amount of ranitidine for this patient?

- ( ) 46 mg/dose
- ( ) 11.5 mg/dose
- (•) 23 mg/dose
- ( ) 15 mg/dose

Correct!

23 mg/dose is the correct amount to administer.

Additional Practice Questions

1. You are to administer 42 mcg of IV digoxin. You have available 0.1 mg/mL. How many mL will you administer?

- 42 mL
- 4.2 mL
- 0.42 mL
- 2.1 mL

2. A 10-year-old child who weighs 40 kilograms is to receive 360 mcg of digoxin po twice a day. The digoxin elixir is available in a liquid concentration of 0.05 mg/mL. How many milliliters should be given for each dosage?

- .72 mL
- 7.2 mL
- .36 mL
- 3.6 mL