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Let's Crunch Some Numbers:
Calculations for a Pharmacy Technician

A presentation for HealthTrust Members
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Disclosures

- This program may contain the mention of drugs or brands presented in a case study or comparative format using evidence-based research. Such examples are intended for educational and informational purposes and should not be perceived as an endorsement of any particular supplier, brand or drug.

- The presenter has no financial relationship with any commercial interests pertinent to this presentation.

Learning Objectives

- Define key issues and negative outcomes that result from medication miscalculations
- Explain how to approach ratio, proportion, flow rate and percentage math problems involving one or multiple units of measurement
- Execute relevant and common pharmacy calculations needed for daily operations

Outline

- Overview of Miscalculations
- Systems of Measurement & Conversions
- Ratio and Proportion
- Reconstitution of Dry Powders
- Percentages
- Flow Rates

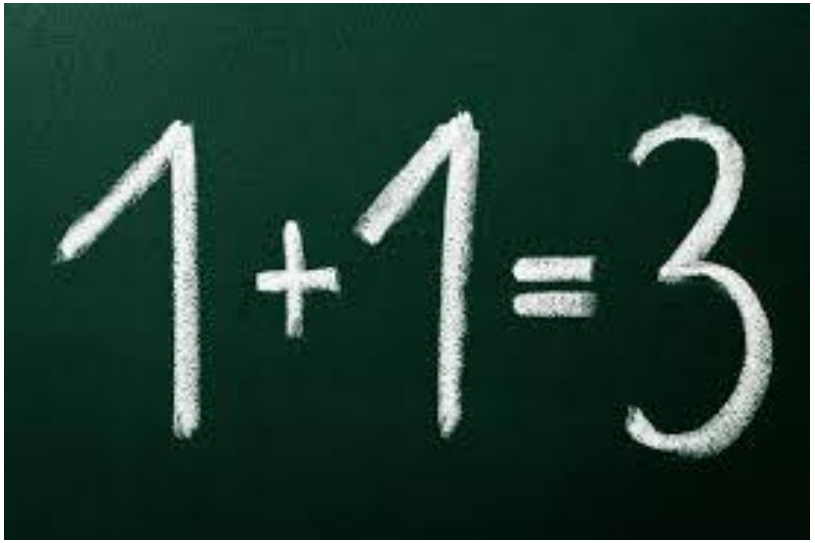
What is a Medication Error?

Medication errors (MEs) are defined as any ***preventable*** event that may cause or lead to inappropriate medication use or patient harm while the medication is ***under the control*** of the health care professional, patient, or consumer

Source: Mohamed Kamal Elden, et al. *Glob J Health Sci.* 2016 Aug; 8(8):243-251.

Calculations

- Calculations are intrinsically prone to error
  - Unfamiliar to the operator
  - Performed under pressure
  - Dosage/ dilution calculations



- Compounding errors are due to miscalculations that can result in extreme overdosing or under-dosing of a patient

Source: Lesar TS, et al. *JAMA* 1997; 277: 312–7.

How often do errors happen?

- More than one in six medication errors involve:
  - Miscalculation of dose
  - Wrong decimal point placement
  - Incorrect expression of unit of measurement
  - Incorrect medication administration rate

Source: Lesar TS, et al. *JAMA* 1997; 277: 312–7.

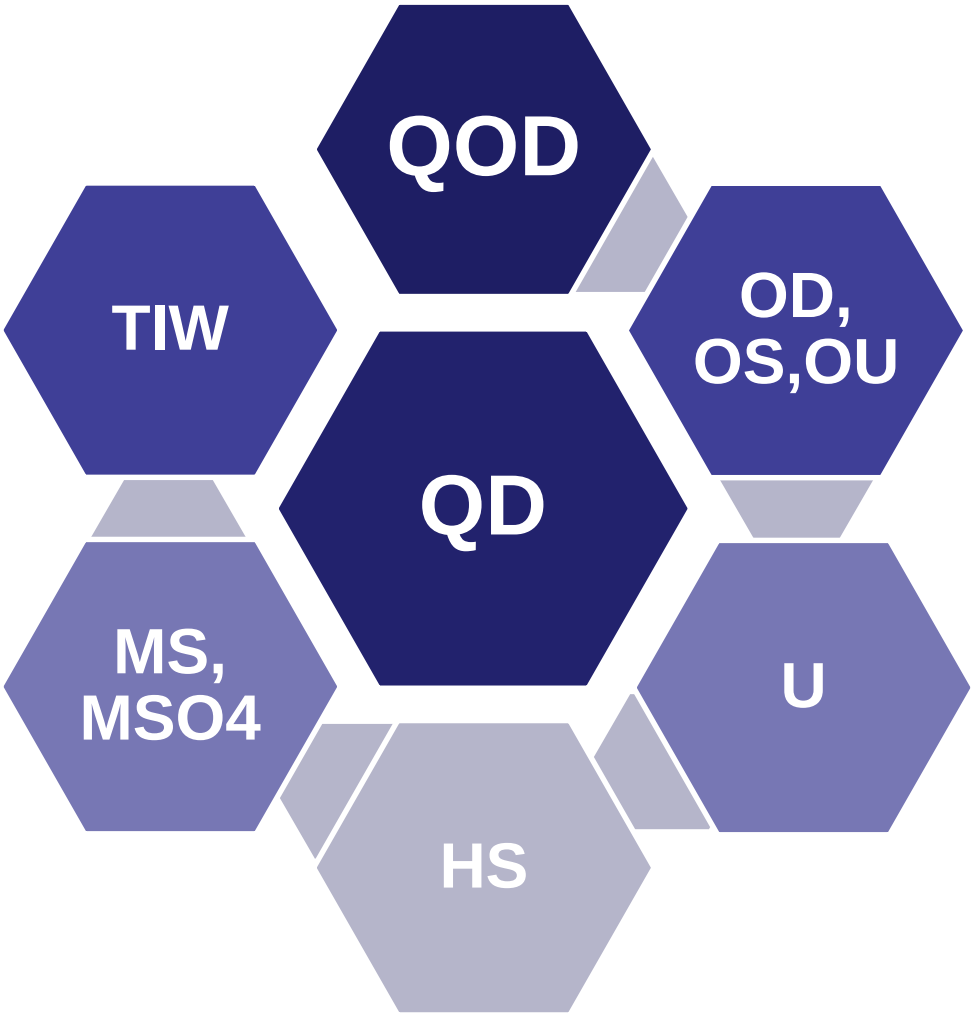
Impact of miscalculations

- Betsy Lehman's death at the Dana Farber Cancer Institute in 1994:
  - Boston Globe health writer was receiving her chemotherapy
  - Written medication order stated:
    - "Cyclophosphamide (Cytoxan®) 4 g/m^2 days 1-4"
    - Intended: 1 g/m^2 daily for each of four days
    - Interpreted: 4 g/m^2 daily for each of four days

- Miscalculation was not discovered until 3 months after Lehman's death

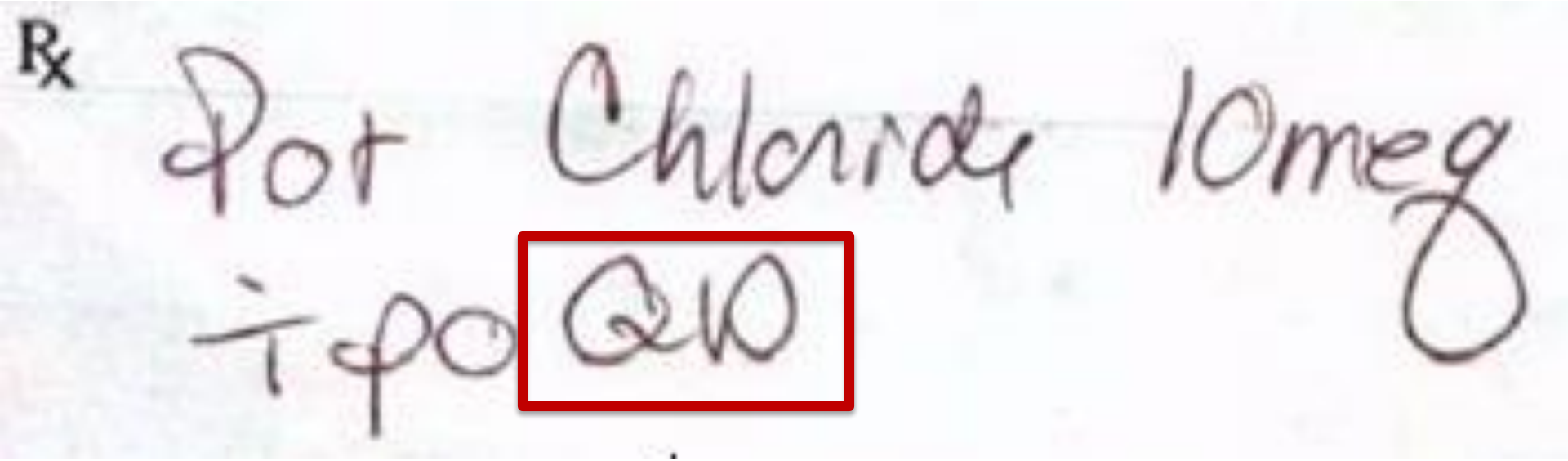
Source: Altman LK. *New York Times.* Mar 1995. Available at: www.nytimes.com. Accessed Jan 1 2019.

Error Prone Abbreviations



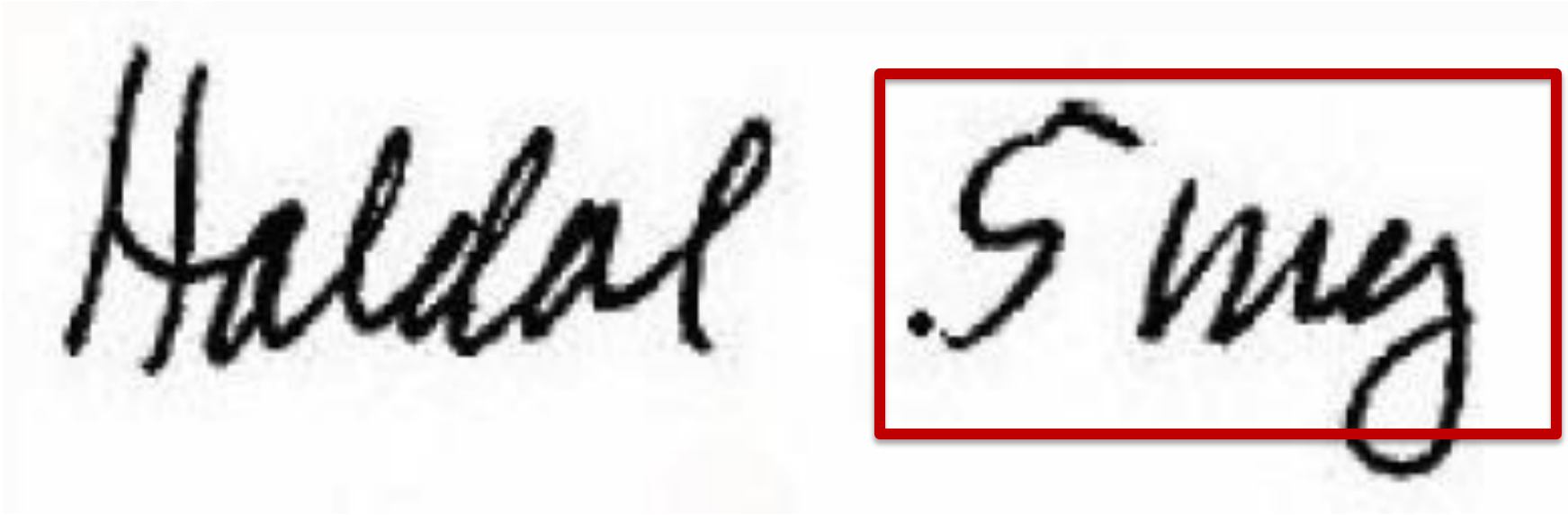
Source: Institute for Safe Medication Practices. List of Error-Prone Abbreviations. Oct 2017.

Error Prone Abbreviations



Four times daily vs. Once daily

Error Prone Abbreviations



Leading zeros = YES
5 mg vs. 0.5 mg

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Systems of Measurement & Conversions

Units of Measure

Length	*Weight*	*Volume*
• Meter • m	• Gram • g	• Liter • L

Source: Hopkins WA. Complete Math Review for the Pharmacy Technician. 3rd edition. Washington, DC: APhA Publications; 2010

Units of Measure

Prefix	Conversion	Numerical Value
Kilo-	one thousand	1,000
Deci-	one tenth	1/10
Centi-	one hundredth	1/100
Milli-	one thousandth	1/1,000
Micro-	one millionth	1/1,000,000

- Small unit → larger unit: number should ***decrease***
- Large unit → smaller unit: number should ***increase***

Source: Hopkins WA. Complete Math Review for the Pharmacy Technician. 3rd edition. Washington, DC: APhA Publications; 2010

Small vs. Large Units

Which is smaller?

- Gram vs. Milligram
  - Milligram
- Microgram vs. Milligram
  - Microgram
- Centimeter vs. Decimeter
  - Centimeter

Measurement Conversion

Small → large:

5,000 g = X kg

- Kilo = 1,000
- 1 kg = 1,000 g

1. $5{,}000\ \text{g} \times \frac{1\ \text{kg}}{1{,}000\ \text{g}} = X\ \text{kg}$

2. $\frac{5{,}000 * 1\text{kg}}{1{,}000} = \mathbf{5\ kg}$

Follow the units!

Measurement Conversion

Small → large:

5,000 g = X kg

- Kilo = 1,000
- 1 kg = 1,000 g

- 5,000 g = 5 kg
- 5,0 0 0. g = **5 kg**

Never use trailing zeros!

5.0 kg = NO

Measurement Conversion

Large→ Small:

0.02 kg = X mcg

- Micro = one millionth
- 1 g = 1,000,000 mcg
- 1 kg = 1,000,000,000 mcg

1. $0.02\ \text{kg} \times \frac{1{,}000\ \text{g}}{1\ \text{kg}} \times \frac{1{,}000\ \text{mg}}{1\ \text{g}} \times \frac{1{,}000\ \text{mcg}}{1\ \text{mg}}$

= **20,000,000 mcg**

Measurement Conversion

Large→ Small:

0.02 kg = X mcg

- Micro = one millionth
- 1 g = 1,000,000 mcg
- 1 kg = 1,000,000,000 mcg

- 0.02 kg = 20 g = 20,000,000 mcg
- 0. 0 2 0 0 0 0 0 0 0 kg = 20,000,000 mcg

Metric Notation Do's and Don'ts

- Always use appropriate leading zeros
  - 0.16 mg, **not** .16 mg
- Be mindful of subunits
  - 143 mcg = 0.143 mg, **not** 143 mg
    - ***Micro****grams are* ***smaller*** *than milligrams*
    - ***Milli****grams are* ***larger*** *than micrograms*
- Never use trailing zeros
  - 18 mL, **not** 18.0 mL

Source: Hopkins WA. Complete Math Review for the Pharmacy Technician. 3rd edition. Washington, DC: APhA Publications; 2010

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Ratio and Proportion

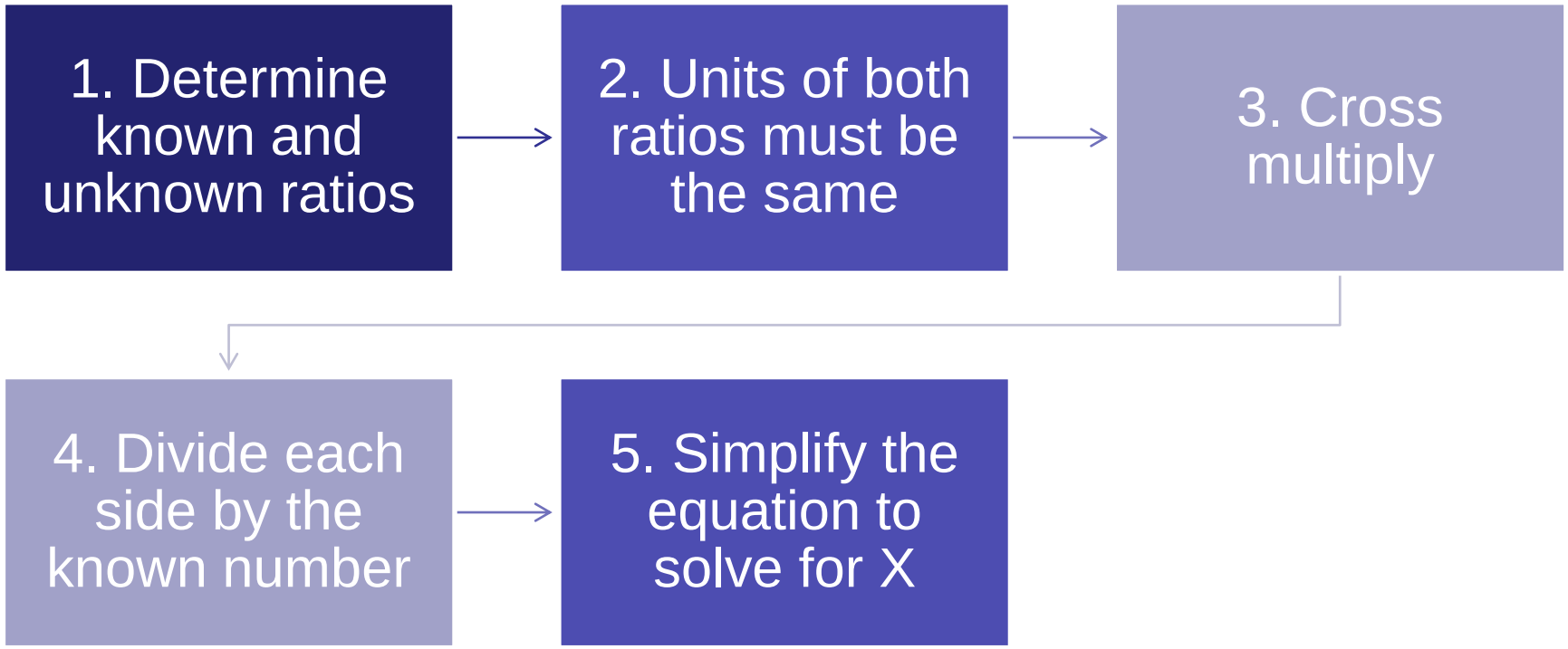
Overview

- **Ratio**: quantitative method of illustrating a relationship between two items
  - Can be expressed in the form of:
    - Fraction
    - Percentage
    - Decimal fraction

- **Proportion**: two ratios involving the same units can be combined to express equality
  - (A/B)=(C/D)

Source: Lacher BE. Pharmacy Technician Certification Review and Practice Exam. 3rd edition. Beaverton: ASHP Ringgold Inc;2011.

Ratio & Proportion Method



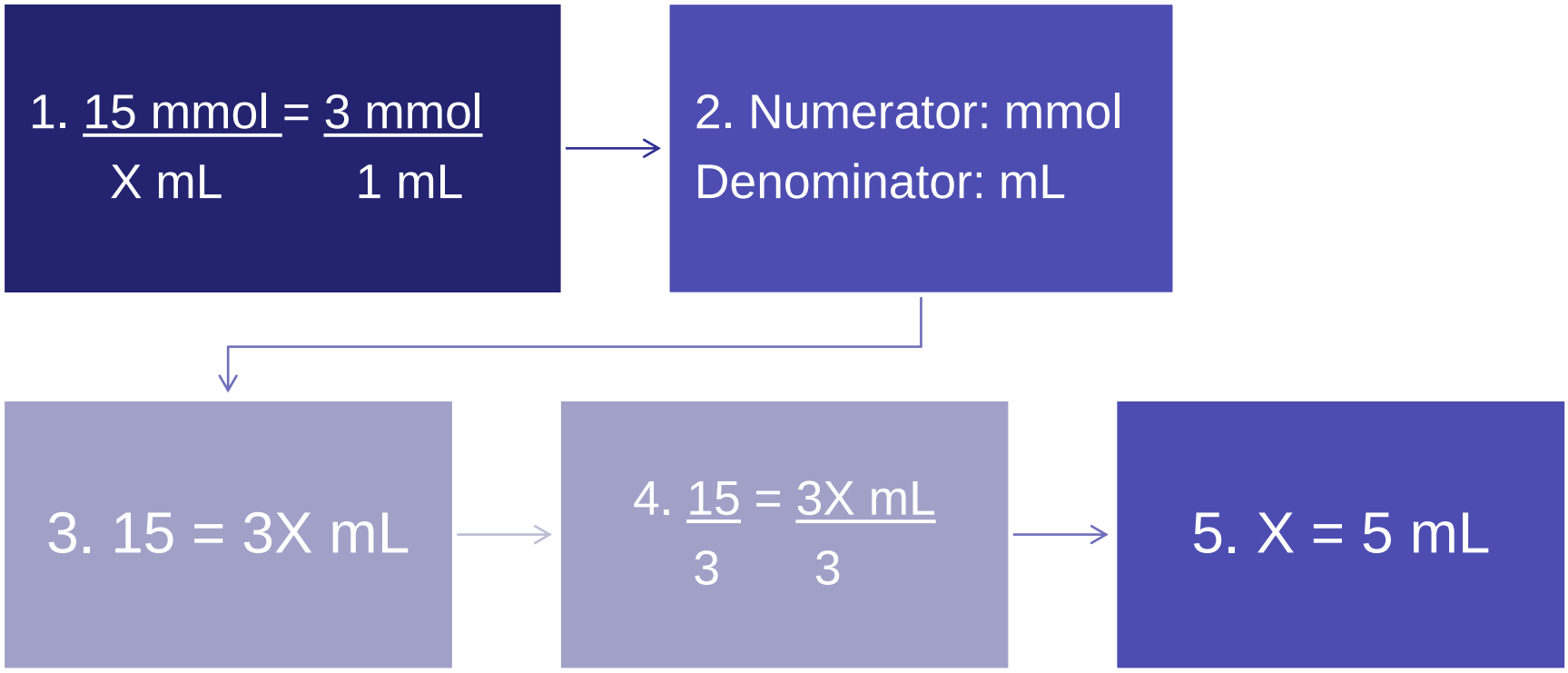
Source: Lacher BE. Pharmacy Technician Certification Review and Practice Exam. 3rd edition. Beaverton: ASHP Ringgold Inc;2011.

Ratio & Proportion Method Example

- Order: Potassium Phosphate 15 mmol, how many mLs need to be used?

Vial Strength = 3 mmol/mL

Ratio & Proportion Method

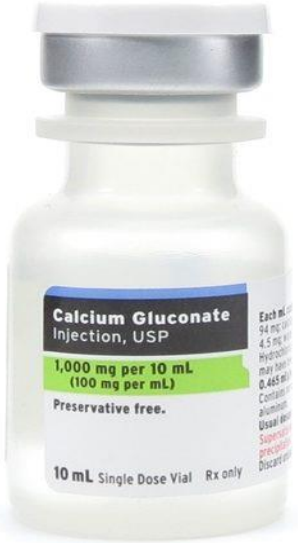


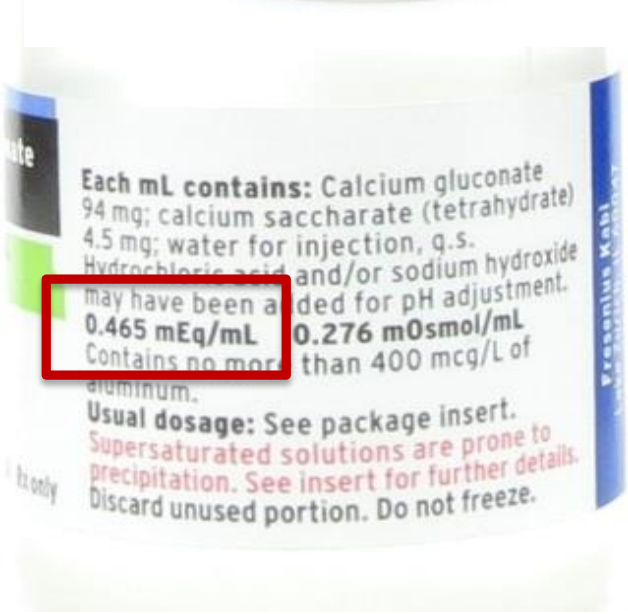
Calculation Example

- Order:
  - Calcium Gluconate 5 mEq
  - X mL
- Vial: 0.465 mEq/mL

- $\frac{0.465 \text{ mEq}}{1 \text{ mL}} = \frac{5 \text{ mEq}}{X \text{ mL}}$

  X = 10.75 mL





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Reconstitution of Dry Powders

Overview

- Reconstitution: dissolving a dry powder with an appropriate diluent

- Often required for medications that quickly lose potency after being prepared to a liquid dosage form

- It is important to use the diluents mentioned on the drug's package insert, labeling or package

Source: Hopkins WA. Complete Math Review for the Pharmacy Technician. 3rd edition. Washington, DC: APhA Publications; 2010

Reconstitution Example

SC receives an order for:

“Daptomycin 480 mg in 100 mL NS”

How many mLs of daptomycin should be injected into a 100 mL NS bag?

Reconstitution Example

2.6 Preparation and Administration of CUBICIN

There are two formulations of daptomycin that have differences concerning storage and reconstitution. Carefully follow the reconstitution and storage procedures in labeling.

Reconstitution of CUBICIN Vial

CUBICIN is supplied in single-dose vials, each containing 500 mg daptomycin as a sterile, lyophilized powder. The contents of a CUBICIN vial should be reconstituted, using aseptic technique, to 50 mg/mL as follows:

1. To minimize foaming, AVOID vigorous agitation or shaking of the vial during or after reconstitution.
2. Remove the polypropylene flip-off cap from the CUBICIN vial to expose the central portion of the rubber stopper.
3. Wipe the top of the rubber stopper with an alcohol swab or other antiseptic solution and allow to dry. After cleaning, do not touch the rubber stopper or allow it to touch any other surface.
4. Slowly transfer 10 mL of 0.9% sodium chloride injection through the center of the rubber stopper into the CUBICIN vial, pointing the transfer needle toward the wall of the vial. It is recommended that a beveled sterile transfer needle that is 21 gauge or smaller in diameter, or a needleless device is used, pointing the transfer needle toward the wall of the vial.
5. Ensure that all of the CUBICIN powder is wetted by gently rotating the vial.
    1. Allow the wetted product to stand undisturbed for 10 minutes.

1. Must reconstitute the vial with 10 mL of NS
2. $\frac{500 \text{ mg}}{10 \text{ mL}}$ = **50 mg/mL**

Source: Cubicin (daptomycin) [prescribing information]. Whitehouse Station, NJ: Merck Sharp & Dohme Corp; December 2018.

"Daptomycin 480 mg in 100 mL NS"

1. Determine known and unknown ratios:

$$\frac{480\ \text{mg}}{X\ \text{mL}} = \frac{50\ \text{mg}}{1\ \text{mL}}$$

2. Cross-multiply and simplify:

$$480 = 50X$$

X= 9.6 mL of daptomycin

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Percentages

Percentages – Fraction of 100

Weight in weight (w/w)	Weight in volume (w/v)	Volume in Volume (v/v)
• X grams/ 100 grams	• X grams/ 100 mL	• X mL/ 100 mL

** ***Remember:*** percentage strengths are always per 100 grams or 100 milliliters **

Source: Lacher BE. Pharmacy Technician Certification Review and Practice Exam. 3rd edition. Beaverton: ASHP Ringgold Inc;2011.

Diluents

NaCl

Normal saline (NS) = 0.9%

0.9 grams per 100 mL of water

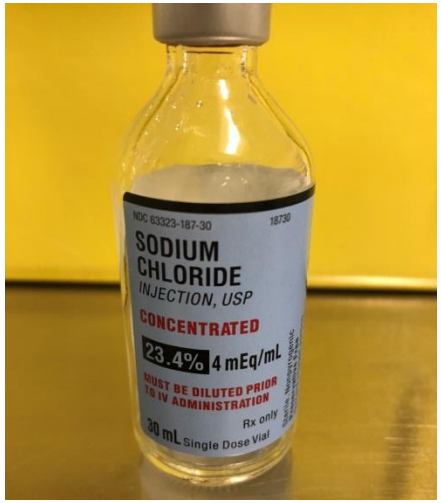
Dextrose

Dextrose (D5W) = 5%

5 grams per 100 mL per water

Source: Lacher BE. Pharmacy Technician Certification Review and Practice Exam. 3rd edition. Beaverton: ASHP Ringgold Inc;2011.

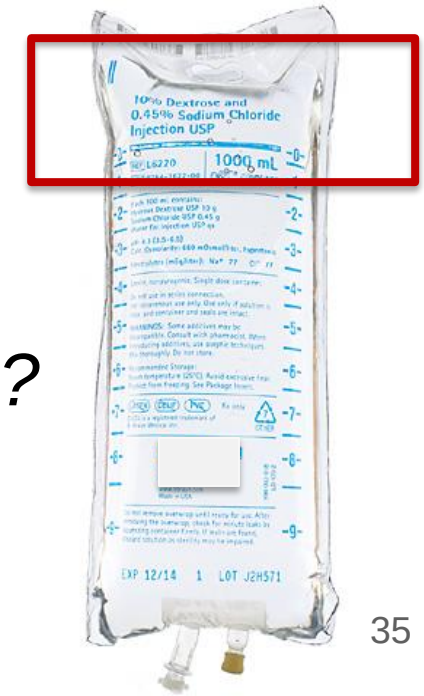
Diluent Example:



RJ needs to prepare an order for:

"Dextrose 10% / 0.9% NaCl 1,000 mL"

However, the IV room only has D10W, ½ NS bags. How many mLs of sodium chloride should RJ inject into the bag?



Question: *How many liters is 1,000 mL?*

1 L

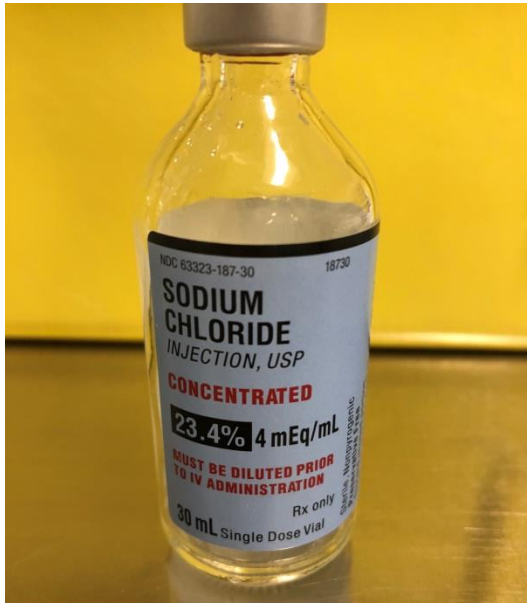
"Dextrose 10% / 0.9% NaCl 1,000 mL"

- ❑ Volume: 1,000 mL ✖
- ❑ Dextrose: 10% ✖
- ❑ NaCl:
  - Have 0.45% in 1000 mL
  - Need 0.9% in 1,000 mL

1. $\frac{0.45\text{ g}}{100\text{ mL}} = \frac{X\text{ g}}{1{,}000\text{ mL}}$ **X = 4.5 g**
2. $\frac{0.9\text{ g}}{100\text{ mL}} = \frac{X\text{ g}}{1{,}000\text{ mL}}$ **X = 9 g**
3. 9 - 4.5 = **4.5 g need to be injected**

"Dextrose 10% / 0.9% NaCl 1,000 mL"

- Need 4.5 g of NaCl
- Have 23.4% concentrated NaCl



1. **23.4%** = $\frac{23.4\ g}{100\ mL}$

2. $\frac{23.4\ g}{100\ mL} = \frac{4.5\ g}{X\ mL}$ **X = 19.2 mL**

Example:

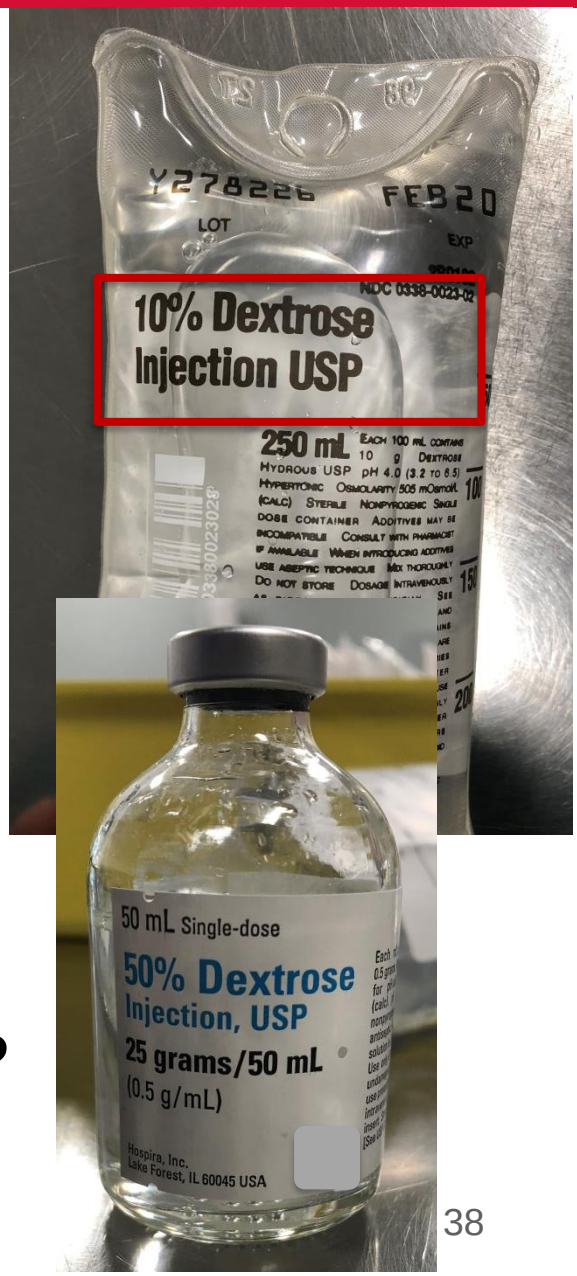
SM needs to prepare an order for:

“NICU Dextrose 12.5% 250 mL”

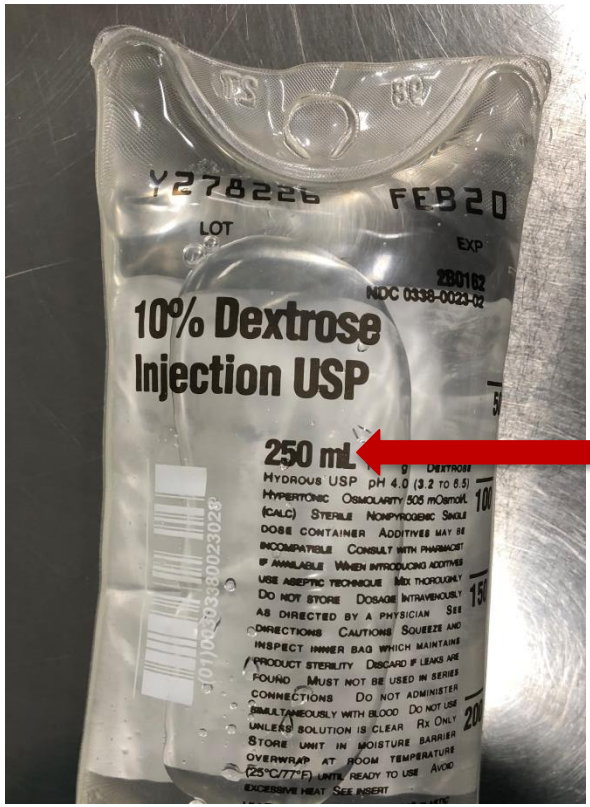
The IV room only has D10W 250 mL bags. How many mLs of dextrose should SM inject into the bag?

***Question**: How many grams of dextrose are in a D10W **100** mL bag?*

10 g



"Dextrose 12.5% 250 mL"



- ❑ Volume: 250 mL ✖
- ❑ Dextrose:
  - Have 10% in 250 mL
  - Need 12.5% in 250 mL

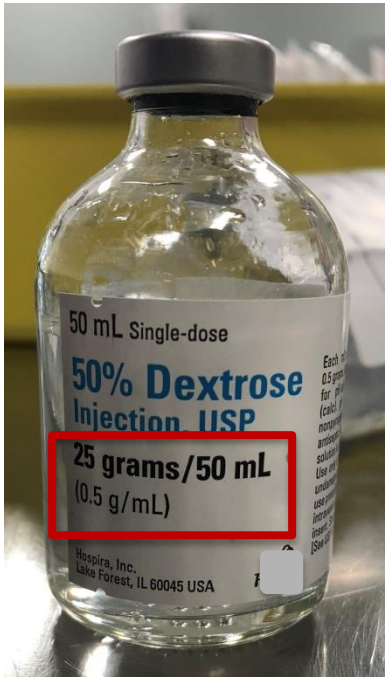
1. $\frac{10\text{ g}}{100\text{ mL}} = \frac{X\text{ g}}{250\text{ mL}}$ **X = 25 g**
2. $\frac{12.5\text{ g}}{100\text{ mL}} = \frac{X\text{ g}}{250\text{ mL}}$ **X = 31.25 g**
3. 31.25 - 25 = **6.25 g need to be injected**

"Dextrose 12.5% 250 mL"

- Need 6.25 g of dextrose
- Have 50% concentrated dextrose

1. $50\% = \frac{25\ g}{50\ mL} = 0.5g/\ mL$

2. $\frac{0.5\ g}{1\ mL} = \frac{6.25\ g}{X\ mL}$ **X = 12.5 mL**



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Flow Rates

Intravenous Rates

- Determined by physician's order, but knowing how long a bag will last can:
  - Better understand resupplying
  - Help prevent making mistakes

- Parenteral solutions are administered to the patient via:
  - Gravity
  - Flow into patient's vein
  - Electronic infusion pumps

Source: Hopkins WA. Complete Math Review for the Pharmacy Technician. 3rd edition. Washington, DC: APhA Publications; 2010

Rate Calculation

How many milliliters per minute would a patient receive if 500 mL of IV solution is being infused over a 4-hour period?

1. Convert hours to minutes:
   - (60 minutes/hour)*(4 hours) = 240 minutes
2. Set up proportion of equal ratios:
   - $\frac{500 \text{ mL}}{240 \text{ min}} = \frac{X \text{ mL}}{1 \text{ min}}$

X = 2.08 mL

Key Takeaways

- Pharmacy staff should aim to consistently perform diligent calculations
- Miniscule mistakes can result in catastrophic patient outcomes
- Always ask a pharmacist when unsure of how to perform a calculation or if questioning an order

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Thank you!

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