Southwest Wisconsin Technical College

Dimensional Analysis in Nursing

Dimensional Analysis Showcase

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Dimensional Analysis in Nursing

DIMENSIONAL ANALYSIS SHOWCASE

Overview
Welcome!

This document's purpose is to give new nursing students a sense of the power and flexibility that the dimensional analysis technique can provide when solving drug calculation problems.

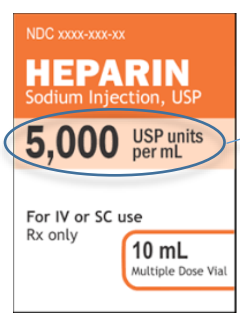
To accomplish this, I have assembled a dimensional analysis showcase featuring a wide sampling of problems that can be solved with the technique. No attempt at instruction is made in these examples; that comes later when you work through each of the modules in this textbook.

It is hoped that by scanning through these examples you will ultimately agree that learning the dimensional analysis technique is worth your time and energy.

Importance of Equivalencies
Even if you are just giving each example in the showcase a cursory glance, take special note of the equivalencies used in each and every solution. Equivalencies are things such as:

1 foot = 12 inches
2.2 pounds = 1 kilogram
1 milligram = 1000 micrograms

Some equivalencies are specific to a medicine and these are most often found on the product's label:



5,000 units = 1 milliliter

Equivalencies are the "fuel" that propel a dimensional analysis setup forward. Just as you cannot drive an automobile without gasoline (or a charged-up battery pack) you cannot solve a measurement conversion or drug computation problem without using at least one equivalency.

When you scan through the solution of any problem in the showcase, observe that *every single fraction* that follows a multiplication symbol (×) is made from an equivalency of one sort or another.

Dimensional Analysis Showcase

Exhibit 1-Basic Measurement Conversion

•Convert 202 pounds to kilograms (kg).

$$\frac{202\ \cancel{\text{pounds}}}{1} \times \frac{1\ \text{kg}}{2.2\ \cancel{\text{pounds}}} = \frac{202\ \text{kg}}{2.2} = \mathbf{91.8\ kg}$$

Note the equivalency; 1 kg = 2.2 pounds.

Exhibit 2-Using Multiple Steps to Solve a Measurement Conversion Problem

•Convert 2.5 fluid ounces to teaspoons.

$$\frac{2.5\ \cancel{\text{fluid ounces}}}{1} \times \frac{30\ \cancel{\text{mL}}}{1\ \cancel{\text{fluid ounce}}} \times \frac{1\ \text{teaspoons}}{5\ \cancel{\text{mL}}} = \frac{75\ \text{teaspoons}}{5} = \mathbf{15\ teaspoons}$$

Exhibit 3-Rates

• A typical walking pace is 3.0 miles per hour. Convert this pace to feet per minute.

$$\frac{3.0\ \cancel{\text{miles}}}{1\ \cancel{\text{hour}}} \times \frac{5280\ \text{ft}}{1\ \cancel{\text{mile}}} \times \frac{1\ \cancel{\text{hour}}}{60\ \text{minutes}} = \frac{15{,}840\ \text{ft}}{60\ \text{minutes}} = \mathbf{264\ ft/min\ \ or\ \ 264\ ft\ per\ min}$$

Exhibit 4-Metric to metric Measurement Conversion

•40 micrograms (mcg) = ________ milligrams (mg)

$$\frac{40\ \cancel{\text{mcg}}}{1} \times \frac{1\ mg}{1000\ \cancel{mcg}} = \frac{40\ mg}{1000} = 0.04\ mg$$

Exhibit 5-Basic Drug Calculation (tablets/capsules)

•Prescription: Potassium penicillin 600,000 units
Inventory: Potassium penicillin 400,000 units tablets
Quantity to give patient: ___________

$$\frac{600{,}000\ \cancel{units}}{1} \times \frac{1\ tablet}{400{,}000\ \cancel{units}} = \frac{600{,}000\ tablets}{400{,}000} = \mathbf{1.5}\ \boldsymbol{tablets}$$

Exhibit 6-Entry Level Drug Calculation Intermediate (tablets/capsules)

•Prescription: Azulfidine 2 g
Inventory: 500 mg tablets
Quantity to give patient: __________

$$\frac{2\ \cancel{\text{g}}}{1} \times \frac{1000\ \cancel{\text{mg}}}{1\ \cancel{\text{g}}} \times \frac{1\ \text{tablet}}{500\ \cancel{\text{mg}}} = \frac{2000\ \text{tablets}}{500} = \mathbf{4\ tablets}$$

Exhibit 7-Entry Level Drug Calculation Advanced (tablets/capsules)

•Prescription: Prescription: Ampicillin 1 g, BID
Inventory: Ampicillin 500 mg tablets
Determine: ________tablets per day

$$\frac{1\ \cancel{\text{g}}}{1\ \cancel{\text{dose}}} \times \frac{1000\ \cancel{\text{mg}}}{1\ \cancel{\text{g}}} \times \frac{1\ \text{tablet}}{500\ \cancel{\text{mg}}} \times \frac{2\ \cancel{\text{doses}}}{1\ \text{day}} = \frac{2000\ \text{tablet}}{500\ \text{day}} = \mathbf{4\ tablets/day}$$

Exhibit 8-Entry Level Drug Calculation (liquids-oral)

•Prescription: Dilantin 50 mg per dose
Inventory: Dilantin 125 mg/mL
Quantity to give patient: __________ per dose

$$\frac{50\ \cancel{mg}}{1} \times \frac{1\ mL}{125\ \cancel{mg}} = \frac{50\ mL}{125} = \mathbf{0.4\ mL}$$

Exhibit 9-Entry Level Drug Calculation Advanced (liquids-oral)

• Prescription: Lyrica 200 mg PO TID
Inventory: Lyrica 20 mg/mL
Determine *milliliters per day*: ________

$$\frac{200\ \cancel{mg}}{1\ \cancel{dose}} \times \frac{1\ mL}{20\ \cancel{mg}} \times \frac{3\ \cancel{doses}}{1\ day} = \frac{600\ mL}{20\ days} = \mathbf{30\ mL/day}$$

Exhibit 10-Flow Rate (IV pumps)

• Heparin sodium is to be infused at 1000 units per hour, IV.
Available is a heparin sodium solution with a concentration of 50,000 units per 500 mL.

The infusion pump setting should be ________ mL/hour.

$$\frac{1000\ \cancel{units}}{1\ hour} \times \frac{500\ mL}{50{,}000\ \cancel{units}} = \frac{500{,}000\ mL}{50{,}000\ hours} = \mathbf{10\ mL/hr}$$

Exhibit 11-Flow Rate (IV drip infusion)

•200 mL of aminophylline is to be delivered IV by drip infusion over the next 2 hours. The tubing drop factor is 15 drops per milliliter (15 gtts/mL). Determine the correct flow rate expressed in drops per minute (gtts/min).

$$\frac{200\ \cancel{mL}}{2\ \cancel{hours}} \times \frac{15\ gtts}{1\ \cancel{mL}} \times \frac{1\ \cancel{hour}}{60\ minutes} = \frac{3{,}000\ gtts}{120\ minutes} = \mathbf{25\ gtts\ per\ minute}$$

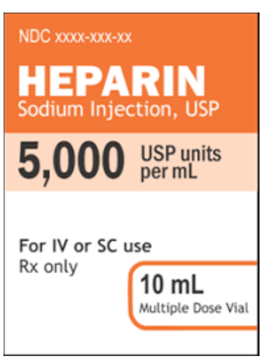
Exhibit 12-Entry Level Weight based Drug Calculation

•An order for Acyclovir is written for a 160 pound patient. Per CDC recommendations, this drug should be administered at 5 mg/kg/dose every 8 hours.

$$\frac{160\ \cancel{lb}}{1} \times \frac{1\ \cancel{kg}}{2.2\ \cancel{lb}} \times \frac{5\ mg}{1\ \cancel{kg} \cdot 1\ dose} = \frac{800\ mg}{2.2\ dose} = \mathbf{364\ mg\ per\ dose\ (nearest\ whole\ number)}$$

Exhibit 13-Working with Medicine Labels to Compute Drug Amount

• A patient is to receive Heparin in an initial dose of 10,000 units IV injection. How many milliliters (mL) of Heparin will the patient receive in this injection?



$$\frac{10{,}000\ \cancel{\text{units}}}{1} \times \frac{1\ \text{mL}}{5{,}000\ \cancel{\text{units}}} = \frac{10{,}000\ \text{units}}{5{,}000} = \mathbf{2\ mL}$$

Exhibit 14-Flow Rate Problems: time to completion

•A one liter solution of D5LR is to be infused by IV pump. The pump setting is 125 mL/hour. How long will it take to run out this supply of D5LR?

$$\frac{1\ \cancel{\text{L}}}{1} \times \frac{1000\ \cancel{\text{mL}}}{1\ \cancel{\text{L}}} \times \frac{1\ \text{hour}}{125\ \cancel{\text{mL}}} = \frac{1000\ \text{hours}}{125} = \mathbf{8\ hours}$$

Exhibit 15-Flow Rate Problems: quantity of fluid delivered

•How much fluid (expressed in mL) will a patient receive if an IV has just been started, delivering fluid at a rate of 80 mL/hour for 90 minutes?

$$\frac{90\ \cancel{\text{minutes}}}{1} \times \frac{1\ \cancel{\text{hour}}}{60\ \cancel{\text{minutes}}} \times \frac{80\ \text{mL}}{1\ \cancel{\text{hour}}} = \frac{7200\ mL}{60} = \mathbf{120\ mL}$$

Exhibit 16-Flow Rate Problems: quantity of drug (mass or weight) delivered

•Guidelines suggest that patients with a deep vein thrombosis, receive a maximum of 40,000 units of Heparin per day. A patient is ordered to receive Heparin with a concentration of 100 units/mL-D5% IV at a flow rate of 15 mL/hour.

(a) How many units of Heparin does this patient receive in one day?

$$\frac{15\ \cancel{\text{mL}}}{1\ \cancel{\text{hour}}} \times \frac{100\ \text{units}}{1\ \cancel{\text{mL}}} \times \frac{24\ \cancel{\text{hours}}}{1\ \text{day}} = \frac{36{,}000\ \text{units}}{1\ \text{day}} = \mathbf{36,000\ units\ per\ day}$$

(b) Based on the maximum dosage guidelines, is this a safe dose for the patient?

The maximum recommended dose of Heparin is 40,000 units/day. Since we computed that the amount received by the patient is only 36,000 units per day, this is considered a safe dose.

Exhibit 17-Diluting a Drug before Injection or Infusion

•The doctor's order is furosemide IV 40 mg.

Available is furosemide 10 mg/mL.

The drug reference information for furosemide indicates:
Direct IV: Concentration 4 mg/mL

How much diluent should be added to the medicine to achieve the required concentration?

Exhibit 17 (continued)-Diluting a Drug before Injection or Infusion

Step 1 Determine how many milliliters of furosemide are required based on the original concentration. Doctor's order is 40 mg and the initial drug concentration is 10 mg/mL.

$$\frac{40\ \cancel{mg}}{1} \times \frac{1\ mL}{10\ \cancel{mg}} = \frac{40\ mL}{10} = \boldsymbol{4\ mL}$$

Step 2 Now determine the milliliters of drug required *as if it really is available* at the required 4 mg/mL concentration.

$$\frac{40\ \cancel{mg}}{1} \times \frac{1\ mL}{4\ \cancel{mg}} = \frac{40\ mL}{4} = \boldsymbol{10\ mL}$$

Step 3 Subtract the two results to determine the diluent required:

10 mL – 4 mL = **6 mL** of diluent.

Summary: To administer the correct amount of medicine at the required concentration, measure-out 4 mL of furosemide from the available supply. Add 6 mL of diluent to reduce the concentration to 10 mL/mg.

Exhibit 18-Weight based Drug Calculation Advanced

•A 2.1 kg infant is prescribed Bacitracin 900 units/kg/day in three divided doses. Available is Bacitracin 5000 units/mL. How many mL will be given to the patient per dose?

$$\frac{2.1\ \cancel{\text{kg}}}{1} \times \frac{900\ \cancel{\text{units}}}{1\ \cancel{\text{kg}} \cdot 1\ \cancel{\text{day}}} \times \frac{1\ mL}{5{,}000\ \cancel{units}} \times \frac{1\ \cancel{day}}{3\ doses} = \frac{1{,}890\ mL}{15{,}000\ doses} = 0.126\ mL\ per\ dose^{*}$$

*Since this is a pediatric patient, you want to avoid rounding up. Our final answer to the nearest tenth is **0.1 mL per dose**.

Exhibit 19-Compute Drug Protocol

•A client with a weight of 32 kg is to receive 21.4 mL of Diphenhydramine oral solution every 8 hours. The Diphenhydramine label indicates the concentration is 12.5 mg/mL.

How many **milligrams per kilogram per day** is the patient receiving?

$$\frac{21.4\ \cancel{mL}}{32\ kg \cdot 8\ \cancel{hours}} \times \frac{12.5\ mg}{1\ \cancel{mL}} \times \frac{24\ \cancel{hours}}{1\ day} = \frac{6420\ mg}{256\ kg \cdot day} = \boldsymbol{25.1\ mg\ \textbf{per}\ kg\ \textbf{per}\ day}$$

Exhibit 20-Safe Dose Determination

•A 130 pound patient is to receive aminophylline at a rate of 20 mL/hour. The concentration of the drug used is 100 mg/100 mL. From a drug reference book, it is noted that 0.36 mg/kg/hour is the recommended safe maintenance dose for this drug.

(a) Determine the *safe flowrate* (in milliliters/hour) for this 130 pound patient using the guideline protocol of 0.36 mg/kg/hour.

$$\frac{130\ \cancel{\text{pounds}}}{1} \times \frac{1\ \cancel{\text{kg}}}{2.2\ \cancel{\text{pounds}}} \times \frac{0.36\ \cancel{\text{mg}}}{1\ \cancel{\text{kg}} \cdot 1\ \text{hour}} \times \frac{100\ \text{mL}}{100\ \cancel{\text{mg}}} = \frac{4{,}680\ \text{mL}}{220\ \text{hours}} = \mathbf{21.3\ mL\ per\ hour}$$

(b) Compare the answer in part (a) to determine if the prescribed flowrate of 20 mL/hour is safe.

Since the *actual* flowrate of 20 mL/hour is *less than* the recommended safe flowrate from part (a) we can confirm that this is <u>safe</u>.

Exhibit 21-Change Formula Concentration

•300 mL of baby formula is to be mixed with water to create a 2/3 strength solution.

a) How many milliliters of solution will you create?

$$\frac{300\ \cancel{mL\ formula}}{1} \times \frac{3\ mL\ solution}{2\ \cancel{mL\ formula}} = \boldsymbol{450\ mL\ of\ solution}$$

b) How many milliliters of water must be added to the original formula to make the required solution?

$$450\ mL\ of\ solution - 300\ mL\ formula = \boldsymbol{150\ mL\ of\ water}$$

Exhibit 22-Percent Concentration (w/w, w/v, v/v)

•Given 50 mL of 20%$^{v/v}$ acetic acid solution, your job is to dilute it with water in order to create a 15%$^{v/v}$ acetic acid solution.

a) How much solution will you have when you have met this goal?

$$\frac{50\ \cancel{\text{mL original solution}}}{1} \times \frac{20\ \cancel{mL\ acetic\ acid}}{100\ \cancel{mL\ original\ solution}} \times \frac{100\ mL\ final\ solution}{15\ \cancel{mL\ acetic\ acid}} =$$

$$= \frac{100000\ mL\ final\ solution}{1500}$$

$$= \boldsymbol{66.7\ ml\ \ final\ solution}\ (\boldsymbol{15}^{\%^{v/v}}\ \boldsymbol{acetic\ acid})$$

b) What quantity of water must be add to the original 20%$^{v/v}$ acetic acid?

66.7 mL – 50 mL = **15 mL of water required**.

Exhibit 23-Compute Volume of Fluid Lost Based on Weight Lost

•On admittance, a patient weighed 153 pound. Two days later, it is noted that his weight is 147 pounds. How many milliliters (mL) of water has this patient lost?

$$\frac{6\,\cancel{lb}}{1} \times \frac{1\,\cancel{kg}}{2.2\,\cancel{lb}} \times \frac{1\,\cancel{L}}{1\,\cancel{kg}} \times \frac{1000\,mL}{1\,\cancel{L}} = \frac{6000\,mL}{2.2} = \mathbf{2727.3\,mL}\ of\ water\ loss.$$