Pharmacy Calculations

Quick Quiz

1. You are at home and get a call from a friend of yours who is a mom. Her 15-month-old child is running a rectal temperature of 102°F and she is worried. You remember from class that you should recommend watching fevers under 38.5°C, treat fevers over 38.5°C, and refer children in to be seen when temperatures are over 40°C. Calculate the child's temperature in °C. What advice will you give this mother?

temperature:_____°C

Advice:_____watch fever _____treat fever _____take child to doctor

2. Despite or because of your advice, the mother decides to treat the child with some acetaminophen (trade name: Tylenol) elixir that she has at home. She says that the bottle reads "80mg/half-teaspoonful" and she thinks her child weighs about 25 lbs. She has an oral syringe that is marked off at 0.2 milliliter intervals and goes up to 10ml. You remember from class that the standard dose for acetaminophen elixir is 10mg/kg. How many milliliters of acetaminophen elixir will you recommend she give the child? (round to nearest 0.2ml, e.g. 1.0, 1.2, 1.4, 1.6, 1.8)

_____ml

3. Mom calls back. Her child is refusing the elixir, but she thinks that he might take a chewable tablet. She has some at home that are 80mg/tablet. How many tablets should she give her child? (The tablets are scored so can be broken in half easily)

_____ tablet(s)

4. While in hospital, a patient is receiving penicillin G 5 million units IV q6h (antibiotic), furosemide 40mg po qd (a diuretic), and K-Dur 20mEq po qd (a potassium supplement). Knowing that the penicillin G is being administered as the potassium salt, you check your references and note that there is 1.7mEq potassium in each million units of penicillin. How many mEq of potassium is this patient receiving daily?

_____mEq potassium

5. A 68 year-old female patient has been prescribed Bactrim DS, an antibiotic, for a urinary tract infection. The physician wrote the usual directions of "Bactrim DS i po BID" on the order. You remember that patients with a creatinine clearance of 30-50ml/minute should have their dosing frequency reduced to q24h, and that patients with a creatinine clearance below 30ml/minute should receive an alternative drug. The patient tells you she weighs 120 lbs. Her labs show her to have a serum creatinine of 1.2mg/dL. What is her calculated creatinine clearance? What will your recommendation (if any) be to the physician?

CrCl: _____ml/minute

recommendation:

_____continue therapy as prescribed

_____change directions to Bactrim DS i po q24h

_____use alternative antibiotic

General Rules for Calculations

1. Dimensional analysis is your friend.

Proportional calculations are useful for simple problems. For example:

> A 26-year old, 5'6" woman admitted to hospital with shock. This woman's current weight is 120 pounds, which is 10 pounds lower than her usual weight. Calculate her current and usual weight in kilograms.
>
> current weight: **130 lbs x 1kg/2.2 lbs = 59 kg**
> usual weight: **120 lbs x 1kg/2.2 lbs = 54.5 kg**

However, when you are dealing with more than one variable, you will have to do a series of proportional equations. The more separate equations you do, the higher the risk that you will make a mistake on one, and that mistake will be transferred along to the next calculation. Multivariable equations are best dealt with using dimensional analysis.

Dimensional analysis allows you to feel more confident that you have set up a multivariable equation correctly. The trick is to set the equations up so that when you finish canceling units on one side of the equation, the remaining units match the units on the other side of the "=" sign.

The steps are:
1. Write out the units you need to determine on the right-hand side of the paper. Leave a space to the left, then write an = sign. Here is the scenario:

> A 26-year old, 5'6" woman admitted to hospital with shock. This woman's current weight is 54.5 kg. The physician orders a dopamine drip to run at 5 mcg/kg/min. Your stock solution of dopamine is 40 mg/mL. You place 400mg of this stock solution in a 250 mL bag of D5W. At what infusion rate (in **mL/hr**) should the nurse program the pump to run?
>
> Step 1. = ml/hr

2. On the left-hand side of the equation, line up all of your available data, which in this case we call **dimensions**. It is imperative that you list the units alongside each number. Trying to decide which dimensions to use will be the biggest challenge of this step.

> A 26-year old, 5'6" woman admitted to hospital with shock. This woman's current weight is **54.5 kg**. The physician orders a dopamine drip to run at **5 mcg/kg/min**. Your stock solution of dopamine is 40 mg/mL. You place **400mg** of this stock solution in a **250 mL** bag of D5W. At what infusion rate (in mL/hr) should the nurse program the pump to run?
>
> Step 2. = ml/hr

Question: Other available dimensions in this scenario were 26 years, 5'6", and 40mg/ml (stock solution of dopamine. Why did you not use these data?

3. Invert dimensions where necessary such that the numerator units and denominator units on the right hand side of the equation have the corresponding units on the left side of the equation. Add conversion dimensions where needed so that you can cross out units (e.g., if you have L on one side of the equation and mL on the other side, you will need to add 1000 mL/L into the left-hand side of the equation. If you have more than one drug form or concentration, then you will need to label each concentration with the name of the drug in addition to identifying the units.

Step 3: $\mathbf{5\ \frac{mcg/kg}{min} \times 60\ \frac{min}{hr} \times 54.5\ kg \times \frac{250\ mL}{400\ mg} \times \frac{1\ mg}{1000\ mcg} = \frac{mL}{hr}}$

4. Cross out all units on the left-hand side of the equation that will cancel out, to ensure that the units left on the left-hand side of the equation match the units on the right-hand side of the equation.

Step 3: $\mathbf{5\ \frac{mcg/kg}{min} \times 60\ \frac{min}{hr} \times 54.5\ kg \times \frac{250\ mL}{400\ mg} \times \frac{1\ mg}{1000\ mcg} = \frac{mL}{hr}}$

Then perform your calculation.

2. Use a dosing guide to check doses on all prescribed doses where the patient has a condition (e.g., kidney dysfunction, volume depletion, young age, old age) that might necessitate dose modification.

The physician wants to give ticarcillin/clavulanate and asks you for an appropriate dose. Dose recommendations for severe infections are 300 mg/kg/day given IV in 4 – 6 divided doses. Please design a dosing regimen for this patient. Round your dose recommendation to the nearest tenth of a gram. Use her current weight for your calculations.

Timentin® _____ g IV q _____ h

Please set up this equation below.

3. Use only validated equations and forms of equations.

One good example of this is confusion over dosing drugs for renal insufficiency. The most commonly-used equation is Cockroft-Gault, which estimates creatinine clearance (usually abbreviated either $CrCl_{est}$ or eCrCl). The original study used 249 male subjects between the ages of 18 and 92. None of the subjects were more than 130% of ideal body weight.

estimation of **creatinine clearance for adults up to 130% of IBW**:
use **Cockroft-Gault** equation: $\frac{(140 - age)(ABW \text{ in kg})}{(\text{sex factor})(SCr)} = CrCl \text{ in ml/min}$

- sex factor = 72 for men, 85 for women
- ABW = actual body weight
- Many clinicians use a SCr of 1.0 mg/dL if the patient is > age 65 and has a SCr < 1.0 mg/dL; this approach not validated
- If the drug dosing guideline is in mL/min/1.73m^2, then multiply C-G CrCl in mL/min by (1.73/pt's BSA)

Many pharmacists try to use either lean/ideal body weight or adjusted body weight in this equation. Such approaches have not been validated. For individuals over 130% of ideal body weight, the Salazar-Corcoran equation has been identified as slightly more accurate overall, although not necessarily in individual cases.

estimation of **creatinine clearance for adults > 130% of IBW**, in the acute care setting:
use **Salazar-Corcoran** equation:

Men: $\frac{[137 - age]\,[(0.285)(ABW) + (12.1)(ht^2)]}{(51)(S_{Cr})}$ Women: $\frac{[146\text{-}age]\,[(0.287)(ABW) + (9.74)(ht^2)]}{(60)(S_{Cr})}$

- ABW = actual body weight in kg height: in meters, not centimeters

Finally, a newer equation is the Levey or MDRD equation, which estimates glomerular filtration rate (GFR). There is about a 15% difference between CrCl and GFR. The MDRD equation was developed to stage patients with chronic kidney disease and has not been validated for drug dosing. Nonetheless, many physicians will try to use it for drug dosing.

Levey, from modification of diet in renal disease study [J Am Soc Nephrol 2000;11:155A (abstract)]

MDRD GFR (mL/min/1.73 m^2) = $186.3 \times SCr^{-1.154} \times age^{-0.203}$ x 1.212 (if patient black) x 0.742 (if patient female)

- where age = age in yrs and SCr = serum creatinine in mg/dL

On day 3 of therapy, her serum creatinine increases to 2.8 mg/dL. Guidelines for dosing of ticarcillin/clavulanate in patients with kidney impairment are:

CrCl (ml/min)	Dose
60	3.1 g IV q4h
30 - 60	2 g IV q4h
10 - 30	2 g IV q8h
< 10	2 g IV q12h

The patient is now back at her usual weight (130 lbs).

Which equation will you use? Why? Use this equation to calculate this patient's creatinine clearance and determine then what dose should be used.

Calculation Templates and Conversions

1 kg = 2.2 lbs

1 inch = 2.54 cm

°F = [(°C)(9/5)] + 32 °C = (°F – 32)(5/9)

1 tsp = 5 ml

IBW equation
Men: 50kg + [(2.3)(#inches > 5ft)]
Women: 45kg + [(2.3)(#inches > 5ft)]

Cockroft-Gault equation for calculating creatinine clearance (for drug dosing)

$$CrCl = \frac{(140 - age)\ (ABW)}{(\text{gender factor})(S_{cr})}$$

Where
ABW is actual body weight in kg
gender factor is 72 for men and 85 for women
SCr is serum creatinine in mg/dL

Salazar-Corcoran equations (for individuals > 130% IBW)

Men: $\frac{[137 - age]\ [(0.285)(ABW) + (12.1)(ht^2)]}{(51)(S_{Cr})}$ Women: $\frac{[146\text{-}age]\ [(0.287)(ABW) + (9.74)(ht^2)]}{(60)(S_{Cr})}$

where:
weight is actual body weight in kg
height is in meters (not cm)
S_{Cr} is serum creatinine in mg/dL

Haycock-Schwartz body surface area (BSA) equation; validated in both children and adults
BSA in m^2 = (ht in cm)$^{0.3964}$ (wt in kg)$^{0.5378}$ (0.024265)

2008 Calculations Exam 1

Name: _____

For each problem below you will need to *show your work* as well as determine the answer to the problem.

1. The current way to determine if a person is overweight is to calculate their body mass index (BMI). This is done using the following equation:

$$\frac{\text{weight in kg}}{(\text{height in m})^2}$$

Under new guidelines, a patient with a BMI of 25 – 29.9 is considered overweight, and a patient with a BMI of ≥ 30 is considered obese. Please calculate the BMI for a 190-pound, 5'11' male patient and categorize his weight status.

BMI: _____; this patient is (circle 1): healthy overweight obese

2. A 26-pound child is to receive amoxicillin for an ear infection. The suggested dosing range for amoxicillin for an ear infection is 80-90 mg/kg/day, given in 2 divided doses. Amoxicillin comes in a 125mg/5 mL and a 250mg/5 mL oral suspension. Please design a dosing regimen for this child and write down the directions you would type on the label. Round to the nearest 1/2 teaspoonful.

You will dispense (circle one): 125mg/5 mL 250mg/5 mL

Give _____ teaspoonfuls every 12 hours for 10 days.

3. The physician decides to place a patient on an insulin drip at 1.5 units/hr. Your "standard" insulin drip concentration is 50 units in 250 mL NS, but the physician wants you to "double concentrate" the drip in order to limit the patient's daily fluids. How will you mix this drip and what infusion rate should the nurse set the pump to run at?

I will place _____ units of insulin in a (circle one): 50 mL 100 mL 250 mL bag of NS.

The nurse should program the pump to run at: _____ mL/hr

4. A child registers a rectal temperature of 39.2°C. What would this temperature be in °F?

_____°F

5. A 5'10" 170-pound male patient is prescribed dexamethasone 6mg/m^2/day, orally, on days 1 through 15 of a chemotherapy cycle. You carry dexamethasone tablets in your pharmacy in the following strengths: 0.5mg, 0.75mg, 1.5mg, and 4mg. You will want to give him enough tablets to last him for the *whole* cycle. Please identify the following information that you will place on the prescription label (note: the # refers to the total number of tablets that you will place in the prescription vial):

Dexamethasone _____ mg tablets, #_____

Directions: Take _____ tablets daily until all tablets are gone.

6. Famcyclovir is a drug that can be given to patients with herpes zoster (shingles) to help decrease duration of symptoms. You have the following information:

Famcyclovir dosage in renal impairment

CrCl (mL/min)	dosage regimen
≥60	500mg po q8h
40-59	500mg po q12h
20-39	500mg po q24h
<20	avoid use

Please calculate the creatinine clearance of a 140-pound, 5'7", 68-year-old female with shingles who has a serum creatinine of 1.4mg/dL, and recommend a dosing regimen.

_____mL/min

_____mg po q_____h

Extra credit questions for technicians!

7. A patient is prescribed:
ofloxacin 10mg/mL
5 mL
sig: i gtt ou BID
You have ofloxacin 3mg/mL (standard preparation) on your shelf. You also have ofloxacin for IV injection with a concentration of 400mg/5 mL of solution. How much of this concentrated solution will you add to your 3mg/mL preparation in order to make the final preparation specified in the prescription? (Hint: assume you will withdraw the same amount of 3mg/mL fluid from the eyedropper that you will add as stock solution.)

I will add _____mL of ofloxacin _____ mg/mL stock solution.

8. A patient has been taking 20mEq of potassium chloride daily in the form of K-Dur, which is affectionately referred to by many pharmacists as a "horse tablet". The patient has been experiencing difficulty in swallowing the tablet, so the physician wants you to dispense a liquid form of potassium. You have a potassium chloride 20% solution on your shelf. How many teaspoonfuls of this liquid will the patient need to take daily in order to equal her K-Dur dose? Round to the nearest half-teaspoonful.
(MW: K 39, Cl 35.5)

_____teaspoonful(s)

9. A 48-year-old, 5'9", 170-pound male patient with a serum creatinine of 1.1 has been prescribed vancomycin, an antibiotic. Population pharmacokinetic parameters state that the volume of distribution for vancomycin is 0.7 L/kg and that the clearance is (0.65)(CrCl). You remember from your notes that

$$\text{half-life} = \frac{(0.693)(V)}{Cl}$$

Please calculate this patient's expected vancomycin half-life.

_____ hrs

10. A physician has ordered a patient to receive 1 and 1/4 grain of aspirin daily. How many mg of aspirin should be in the product that the patient takes?

_____mg

Answer Key

First quiz

1. °C = (102° – 32)(5/9) = 38.9°C, so treat the fever

2. (10 mg/kg)(25 lb)(1 kg/2.2 lb)(0.5 tsp/80 mg)(5 ml/tsp) = 3.56 = 3.6 ml

3. (10 mg/kg)(25 lb)(1 kg/2.2 lb)(1 tab/80 mg) = 1.425 = 1.5 tabs

4. [(5 million units/dose)(4 doses/day)(1.7 mEq K/million units)] + 20 mEq/K-Dur tab = 54 mEq K/day

5. $\frac{(140 - 68)(120 \text{ lbs})(1 \text{ kg}/2.2 \text{ lbs})}{(1.2 \text{ mg/dL})(85)}$ = 38 ml/min, so will recommend 1 tablet daily

2008 calculations exam

1. $\frac{190 \text{ lb}}{1 \text{ kg}/2.2 \text{ lb}}$ = 86 kg (71 in)(2.54 cm/in) = 180 cm = 1.8 m

BMI: **26.5**; this patient is (circle 1): healthy **overweight** obese

$86\text{kg} / (1.8\text{m})^2 = 26.5$

2. You will dispense (circle one): 125mg/5 mL **250mg/5 mL**

Give **2** teaspoonfuls every 12 hours for 10 days.

$26 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{80\text{-}90 \text{ mg}}{\text{kg/day}} \times \frac{1 \text{ day}}{2 \text{ doses}} \times \frac{5 \text{ mL}}{250 \text{ mL}} \times \frac{1 \text{ tsp}}{5 \text{ mL}} = 1.89 - 2.1 \text{ tsp}$; 2 tsp within this range

3. (250 ml/100 units)(1.5 units/hr) = 3.75 mL/hr = 3.8 mL/hr

4. (39.2°C/ 5)(9) + 32 = 102.56° = 102.6°F

5. BSA in $m^2 = (178 \text{ cm})^{0.3964} (77 \text{ kg})^{0.5378} (0.024265) = 1.96 \text{ m}^2$

Another equation: BSA in $m^2 = \sqrt{\frac{(H)(W)}{3131}}$ H is in inches; W is in pounds; BSA = 1.95 m^2

$(1.96 \text{ m}^2)(6\text{mg/m}^2\text{/day}) = 11.76\text{mg/day} = 12$ mg/day, so 4mg x 3 tablets daily

6. $\frac{(140 - 68)(140 \text{ lb})(1 \text{ kg}/2.2 \text{ lb})}{(85)(1.4 \text{ mg/dL})}$ = 39 mL/min, so __500__mg po q__24__h

7. 400mg/5 mL = 80mg/mL
This problem is most easily solved using alligation:

80 — 7 — 7 parts = x mL — x = 0.45 mL
10 — 77 parts — 5 mL
3 — 70
77

I will add **0.45** mL of ofloxacin **80** mg/mL stock solution (after withdrawing the same amt from dropper bottle)

8. Here you need to know that 1 mEq = MW/valence
(20 mEq/dose)(74.5 mg/mEq)(100 mL/20,000mg) = 7.45 mL/dose = 1.5 teaspoonful(s)

9. This problem involves a few separate steps

ABW = (170 lb)(1kg/2.2 lb) = 77 kg

$$\text{CrCl} = \frac{(140-48)(77\text{ kg})}{(1.1)(72)} = 89\text{ mL/min}$$

$$\text{half-life} = \frac{(0.693)(0.7\text{L/kg})(77\text{ kg})}{(0.65)(89\text{ mL/min})(1\text{ L}/1000\text{ mL})} = 645\text{ min} \times \frac{1\text{hr}}{60\text{ min}} = 10.75\text{ hrs}$$

10. This problem merely requires knowing that there are about 65 mg/grain.

$$1.25\text{ grains} \times \frac{65\text{ mg}}{\text{grain}} = 81\text{ mg}$$