Famous last words, "This chapter should be easy."
--Sean Parsons

Back in chapter 9 you learned that there are three kinds of percentage strength that you will frequently use when doing dosage calculations:

weight/weight (w/w) – examples include ointments, creams, etc.
volume/volume (v/v) – a common example is an alcohol preparation or an oil in water preparation.
weight/volume (w/v) – this is the most common group and includes items such as solutions, suspensions, etc.

Another kind of percentage strength that you should acquire knowledge about is called:

milligram percent (mg%) - a measurement frequently used when looking at lab values for patients.

When these concepts are well understood you can:

● calculate the percentage strength of a mixture when you know know both the quantity of the active ingredient and the total mixture,
● determine how much of a mixture can be prepared from a given weight of ingredient when trying to prepare a compound with a specific percentage strength,
● determine the amount of an ingredient that is present in a mixture if you already know its percentage strength,
● determine whether a patient's lab values are within the appropriate range.

We should start off reviewing the first three kinds of percentage strength. You probably remember that:

w/w% is *typically* measured as g/100 g so a 1% hydrocortisone cream would mean that there is 1 gram of hydrocortisone in every 100 g of cream
v/v% is *typically* measured as mL/100 mL so a 70% isopropyl alcohol solution would mean that there are 70 milliliters of isopropyl alcohol in every 100 milliliters of solution.
w/v% is *always* measured as g/100 mL so a 0.9% sodium chloride solution would mean that there 0.9 grams of sodium chloride for every 100 milliliters of solution.

Weight/Weight (w/w)

A weight/weight percentage strength expresses the number of parts in 100 parts of a preparation . As mentioned above it is usually expressed as number of grams per 100 grams, but it could be expressed in

any unit of weight (grams, grains, ounces, pounds, etc.) as long as the units on the top and bottom match. Let's look at an example to help this make more sense.

Example

What would be the weight, expressed in grams, of zinc oxide (zinc oxide is the active ingredient) in 120 grams of a 20% zinc oxide ointment (the ointment is the total mixture)?

> QUESTION
> > How many grams of zinc oxide are in the ointment?
> DATA
> > 120 *g of ointment* $20\% = \dfrac{20\ g\ zinc\ oxide}{100\ g\ ointment}$
> MATHEMATICAL METHOD / FORMULA
> > Ratio Proportion (This can be done other ways, but this is the easiest method to explain thoroughly.)
> DO THE MATH
> > $$\dfrac{N}{120\ g\ ointment} = \dfrac{20\ g\ zinc\ oxide}{100\ g\ ointment}$$
> > $$N = \textbf{24 g zinc oxide}$$
> DOES THE ANSWER MAKE SENSE?
> > Yes

By using the ratio-proportion method for solving the problem, it largely lines itself up because the active ingredient goes on top and the total mixture belongs on the bottom. Also, remember that a percent is always out of 100.

Let's look at a couple of practice problems based on w/w percentage strength.

Practice Problems

1) What would be the percentage strength of a zinc oxide ointment if you prepared 90 grams of an ointment that contained 4.5 grams of zinc oxide? *(Hint: In this problem you have the weight of the active ingredient and the weight of the mixture, you need to find the percentage strength which would be out of 100 grams of mixture)*

2) If you had 2.5 grams of hydrocortisone powder on hand, how many grams of 0.5% hydrocortisone cream could you prepare?

Volume/Volume (v/v)

Volume/volume percentage strength problems are worked out in a similar manner to w/w percentage strength problems, except now the ingredients are liquid form. Typically it is expressed as number of milliliters per 100 milliliters, but it could be expressed in any unit of volume (liters, pints, fluid ounces, etc.) as long as the units on the top and bottom match. Look at the example problem below, and then complete the practice problem.

Example

How mL of isopropyl alcohol are in a 1 pint bottle of 70% isopropyl alcohol? Also, if the isopropyl alcohol solution is in sterile water for irrigation, how much water is in the solution?

> QUESTION
> > How many mL of isopropyl alcohol and how many mL of water are in the bottle?
> DATA
> > $1\,pint = 480\,mL\ of\ mixture$ $70\%\,isopropyl\ alcohol = \dfrac{70\,mL\ isopropyl\ alcohol}{100\,mL\ mixture}$
>
> MATHEMATICAL METHOD / FORMULA
> > Ratio Proportion (This can be done other ways, but this is the easiest method to explain thoroughly.)
> DO THE MATH
> > $$\dfrac{N}{480\,mL\ mixture} = \dfrac{70\,mL\ isopropyl\ alcohol}{100\,mL\ mixture}$$
> > $N = \textbf{336 mL isopropyl alcohol}$
>
> > $480\,mL - 336\ mL = \textbf{144 mL SWFI}$
> DOES THE ANSWER MAKE SENSE?
> > Yes

Practice Problems

1) How many liters of 2% lysol solution could be made with 80 mL of lysol and how many mL of SWFI would be required to make this preparation?

2) A pharmacy elixir recipe calls for a fluid ounce of 90% ethanol. How many milliliters of pure ethanol are going to be in this preparation?

Weight/Volume (w/v)

Weight/volume (w/v) percentage strengths are the most common percentages worked with in institutional pharmacy. The units in this type of problem are **always** grams of drug in 100 milliliters of solution (or suspension). Let's look at a practice problem.

Example

How many grams of sodium chloride are in a 500 mL bag of half-normal saline (0.45% sodium chloride)?

> QUESTION
> > How many g of sodium chloride are in the bag?
>
> DATA
> > 500 *mL of mixture* $0.45\% \, sodium \, chloride = \dfrac{0.45 \, g \, sodium \, chloride}{100 \, mL \, mixture}$
>
> MATHEMATICAL METHOD / FORMULA
> > Ratio Proportion
>
> DO THE MATH
> > $$\dfrac{N}{500 \, mL \, mixture} = \dfrac{0.45 \, g \, sodium \, chloride}{100 \, mL \, mixture}$$
> > $N = \textbf{2.25 g sodium chloride}$
>
> DOES THE ANSWER MAKE SENSE?
> > Yes

As w/v percentage strength problems are the ones we will be working with most frequently it is worth pointing out that our ratio proportions for w/v percentage strength problems always have grams on top and milliliters on the bottom. Let's look at some practice problems.

Practice Problems

1) A physician orders a TPN with 20 grams of dextrose. The pharmacy has a stock solution of 70% dextrose in water (D70W). How many milliliters of D70W are required to make the requested TPN?

2) An order for 1 liter of a 0.05% (w/v) solution is received in the pharmacy. In stock is 525 mg of the powdered drug. Is there enough drug to be able to fill this order?

1) 28.57 mL of D70W   2) Yes, there is enough drug on hand to fill the order.

476

Worksheet 19-1

Name:

Date:

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Solve the following problems.

1) You need to prepare 120 g of a 2% zinc oxide ointment. How many grams of zinc oxide will be needed to prepare this ointment?

2) How many liters of a 0.02% solution of cinnamon oil in alcohol could be made from 5 mL of cinnamon oil?

3) A patient is to be given 1 g of magnesium sulfate IM. The label on a 10 mL vial reads "50% solution of Mag Sulf." How many mL will you need?

4) You have 20 mL of 2% lidocaine on the shelf. The order calls for 100 mg. How many mL do you need to use?

5) You have in stock a 250 mL stock bottle of 23.4% concentrated sodium chloride injection.

   a) How many grams of sodium chloride are in the bottle?

   b) How many mg are in 1 mL?

6) Calcium gluconate is available as a 10% solution. You receive an order for 1.25 g of calcium gluconate. How many mL of the solution should be used?

7) You have 50 mg of chloramphenicol powder in the pharmacy. How many mL of a 1% ophthalmic solution will you be able to prepare?

8) Hydrocortisone topical cream is available as a 0.2% concentration in a 1 pound jar. How many milligrams of hydrocortisone are in the product?

9) How many mL of ethanol are in 35 ml of a 50% ethanol solution?

10) How many grams of amino acid are in a 500 mL bottle of 5.2% amino acid?

11) How many mg of potassium chloride are in 2 tablespoonfuls of 10% KCl solution?

12) How many 150 mg capsules of clindamycin are needed to prepare 2 fluid ounces of 1% clindamycin solution?

13) Devonex is a topical ointment available in a 0.005% concentration. How many milligrams of active ingredient would be in 45 grams of ointment?

14) An order for 500 mL of a 1.5% (w/v) solution is received in the pharmacy. In stock is 7 grams of the powdered drug. Is there enough drug to be able to fill this order?

15) A powdered drug comes in a vial containing 1.8 g. If the total volume after the diluent is injected is 6 mL, what is the percentage strength of this solution?

16) A patient order calls for a liter bottle of acetic acid irrigation solution 0.25% (v/v).

   a) How many milliliters of pure acetic acid is in a liter of 0.25% acetic acid?

   b) How many milliliters of pure acetic acid is in a 30 mL dose of 0.25% acetic acid?

17) If you dissolve 12.5 g of a drug in 500 mL of sterile water, what will be the percentage strength of the final solution (assuming that powder volume is negligible)?

18) Sulfatrim suspension is a combination product that contains 200 mg of sulfamethoxazole and 40 mg of trimethoprim in every teaspoon. What are the percentage strengths of each drug?

19) Sulfatrim suspension uses ethanol as an excipient. The suspension is approximately 0.5% ethanol. How many milliliters of alcohol would be present in a teaspoonful of this medication?

20) You receive an order to prepare 2 fluid ounces of a 0.025% solution. How many mg of powder will you need to prepare this solution?

Milligram Percent (mg%)

If you are working lab values, you will sometimes see another type of percentage strength referred to as a milligram percent (mg%). Milligram percents are not routinely used for dosing, but they are frequently used in reporting clinical laboratory test results. They are intended for reporting various chemicals that are present in the body in small quantities. Several examples are cholesterol, glucose, creatinine, and even some drugs.

You are already familiar with weight-in-volume percents, which were measured as g/100 mL. The only difference with milligram percent problems is that the numerator is in milligrams instead of grams. Also, instead of seeing the 100 mL in the denominator, you will see the letters dL, which stands for a "deciliter" and is the same as 100 mL. Sometimes, instead of being written as mg% you will see it written as mg/dL.

Let's look at an example problem below involving mg%.

Example

A patient in the ER was in a car accident, you receive the urine analysis and find that he had a blood alcohol content of 90 mg%. While individual states may set more stringent standards, the United States considers an individual legally intoxicated when their blood alcohol content is above 0.08%. Is the patient legally intoxicated based on federal standards?

$$\frac{90\,mg}{1} \times \frac{1\,g}{1000\,mg} = 0.09\,g$$

$$90\,mg\,\% = \frac{90\,mg}{100\,mL} = \frac{0.09\,g}{100\,mL} = \mathbf{0.09\,\%}$$

The patient **is** legally intoxicated.

Now, attempt a couple of practice problems prior to starting the next worksheet.

Practice Problems

Based on a patient with a reported serum glucose of 165 mg/dL answer the following questions.

1) What would her serum glucose be if it were recorded as a mg%?

2) What would her serum glucose be if it were recorded as a traditional weight/volume percentage strength?

Worksheet 19-2

Name:

Date:

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Solve the following problems.

1) A patient has a blood glucose of 130 mg/dL. What would the patients blood glucose be if you recorded it as a mg%?

2) A patient has a serum creatinine of 0.15% (w/v). Express this as a mg%.

3) An order calls for a pint of 2.5% suspension. How many 200 mg tablets will be required to compound this suspension?

4) A physician order 500 mcg of a medication. The drug is available in a concentration of 0.025%. How many milliliters of this 0.025% solution will be required to fill this order?

5) A 0.1% Protopic (tacrolimus) cream is temporarily unavailable from the manufacturer. How many 5 mg capsules of tacrolimus will you need to prepare 30 grams of this cream?

6) Pharmacies often use 70% isopropyl alcohol for wiping down items that need to maintain sterility. How many milliliters of isopropyl alcohol is in a pint of 70% isopropyl alcohol?

7) If a patient has a serum cholesterol level of 95 mg%, how many micrograms of cholesterol would be in 1 milliliter of serum?

8) If you dissolved 180 g of a drug in enough diluent to make a liter, what would be the resulting percentage strength?

9) The pharmacy has in stock a 50 mL vial of 25% mannitol injection. If an order request 4 g of mannitol, how many mL of solution will you need to withdraw from the vial?

10) How many mg of zinc sulfate are found in 8 oz. of a 0.02% solution?

11) How much of each ingredient must be weighed out to prepare the following ointment?

> Rx testosterone 2% and
> menthol 4.33% in hydrophilic petrolatum
> Disp: 90 g
> Sig: apply lightly q.i.d.

12) A patient is admitted to the hospital for a health condition unrelated to alcohol consumption. The physician decides to allow the patient to enjoy a 12 oz beer every evening. If the beer has an alcohol concentration of 5.9%, how much alcohol is this patient receiving every evening?

13) An order for 250 mL of a 2% (w/v) solution is received in the pharmacy. In stock is 5.5 grams of the powdered drug. Is there enough drug to be able to fill this order?

14) A child got into their parents' acetaminophen, and they aren't sure how much the child ingested. You checked a chart and saw that the blood serum for acetaminophen is not considered toxic till it reaches 15 mg%. If the child's acetaminophen level is high enough to be considered toxic the physician will want to start an acetylcysteine infusion to try and prevent permanent damage to the child's liver, but the drug has the potential of damaging his kidneys in the process. The lab results show his serum concentration of acetaminophen to be 100 mcg/mL. Has the child reached a toxic level?

484

15) Someone signs out 100 mg of cocaine for you to prepare a 0.4% ophthalmic solution. How many mL of this ophthalmic solution will you be able to prepare?

16) You have 250 mg of chloramphenicol powder in the pharmacy. How many mL of a 1% ophthalmic solution will you be able to prepare?

17) A 50 mL vial of sulfamethoxazole and trimethoprim injection contains a concentration of 80 mg of sulfamethoxazole and 16 mg of trimethoprim per mL. What are the percentage strengths of each of the drugs?

18) A vial of lyophilized powder with 2 g of ampicillin and 1 g of sulbactam is reconstituted to have a volume of 8 mL. What are the percentage strengths of each of the drugs?

19) An insulin resistant patient is admitted and given the following insulin sliding scale to follow:

   150-199 mg%: 2 unit bolus regular insulin
   200-249 mg%: 4 units bolus regular insulin
   250-299 mg%: 7 units bolus regular insulin
   300-349 mg%: 10 units bolus regular insulin
   Over 350 mg%: 12 units bolus regular insulin

   If the patient has a blood glucose reading of 260 mg/dL how many units of insulin should that patient receive?

20) What would be the percentage strength of a zinc oxide ointment if you prepared 60 grams of an ointment that contained 4.5 grams of zinc oxide?