How to Master Ratio Strength Calculations

RxCalculations

Ratio strength is one of the ways of expressing concentration and describes drug concentration in terms of a ratio. Here, concentration is defined in terms of one unit of solute contained in a total amount of solution or mixture. As a pharmacy student you should be proficient in ratio strength calculations.

In this blog post, I will show you how to master ratio strength calculations by providing a brief review of the different ways of expressing concentration, defining what ratio strength is and discussing how ratio strength should be interpreted.

I will also demonstrate how to convert percent strength to ratio strength and vice-versa, and show you how to calculate the ratio strength of a pharmaceutical preparation using three NAPLEX type example problems.

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Video Transcription

I'm going to show you how to master ratio strength calculations and we are starting right now.

Hello, this is Dr. Danquah and if this is your first time here and you would like to learn pharmaceutical calculations, tips, tricks and more then start by subscribing and clicking the bell so you don't miss anything.

So let's get right to it. This video is the first in a series on ratio strength calculations, so be sure to check the other videos when they do come out. But for this particular tutorial, what we're going to focus on is accomplishing four major things.

Learning Objectives

The first thing is to be able to define what ratio strength is. The second thing is to interpret the ratio strength as it pertains to weight-in-volume, volume-in-volume and weight-in-weight.

We also want to be able to convert percent strength to ratio strength and vice versa and the last thing we want to accomplish in this particular tutorial is to be able to calculate the ratio strength of a pharmaceutical preparation.

Four Common Ways of Expressing Concentration

But before we go ahead and dive deep into ratio strength, particularly, I just need to give some context. And that has to do with the ways in which we express concentration. So generally speaking, when you have a preparation, you're going to have a solute and a diluent.

And so the solute could be like the active pharmaceutical ingredient an API, and your diluent could be maybe a solvent like water, or a base like petrolatum. But the whole idea is at some point in time, you should be able to describe in terms of concentration, the amount of your solute in the total preparation, and that's where we have various ways of expressing concentration.

Now there are four major ones that are used very frequently. The first one is percentage concentration. And I do have an excellent video on percentage concentration. So I'll put a link in the description and the card will come up pretty shortly. And then also you have ratio strength, you have parts per million (ppm) and parts per billion (ppb).

Why Are There Different Ways of Expressing Concentration?

So the question becomes why are there different ways of expressing concentration? And the short answer to that has to do with the notion that pharmaceutical preparations typically come in different strengths and so you need an elegant way to describe how concentrated preparation is and you want to do it in such a way that you can easily convey that information to another professional so that they can either go ahead and compound that preparation or dispense it.

Ways of Expressing Concentration	Concentration of Preparation	Example (Strong Preparation)	Example (Weak Preparation)	Example (Very Dilute Preparation)
Percentage Concentration	Strong	2%	0.005%	0.0001%
Ratio Strength	Weak	1:50	1:20000	1:1,000,000
Parts per Million (PPM)	Very Dilute	20,000 ppm	50 ppm	1 ppm
Parts per Billion (PPB)	Extremely Dilute	20,000,000 ppb	50,000 ppb	1,000 ppb

So the next question that comes up is when do you use the different ways of expressing concentration?

So typically, what happens is if you have a fairly concentrated preparation, a fairly strong preparation, you will use percentage concentration because this lets you know the amount in grams out of 100 milliliters or hundred grams or whatever the units may be.

So as your solution gets more diluted, if you have a weak solution, for example, then you end up using the ratio strength because at that point in time using the percentage concentration approach becomes unwieldly. Okay, so you end up with so many zeros and the likelihood of making an error actually skyrockets.

Now if you have a very dilute preparation, then you end up using parts per million (ppm), which would be the amount in grams out of a million. Or if you have a really, really dilute preparation, you use parts per billion (ppb), so that will be the amount in grams out of a billion.

Okay, so let's look at a few examples just to illustrate that point. And then we can jump into the ratio strength calculations.

So the example of a strong preparation will be one that has maybe 2% concentration, so that's 2%. The same concentration expressed as a ratio strength to be 1:250. But if you're going to express that in ppm, that will be 20,000 ppm and then you have 20 million ppb. So as you can tell, it is more elegant to use 2% instead of 20 million ppb, okay?

Now if you had a weaker solution, such as 1:20,000, then if you're going to express that as a percentage concentration, that would be 0.005. And now you are beginning to have too many zeros and so the likelihood that you may miss one or you may put it down wrong just increases. And so it's much easier to put down 1:20,000 or perhaps 50 ppm, but definitely not 50,000 ppb.

And now, if you have a very dilute preparation, for example, 1 ppm or one part per million, then if you are going to express that as a percentage concentration, you have 0.001 or you have one is to 1 million as a ratio strength or 1000 ppb.

So clearly, depending on the concentration, one of these ways of expressing concentration is more suitable because it's easier to put down and there's less likelihood that you make an error in writing the concentration down on error in the compounder understanding what is written.

So, that was to give you a quick overview of the ways of expressing concentration. So that we have a better understanding of how ratio strength fits into the spectrum of the different ways in which you can express concentration of your preparations.

What is Ratio Strength?

But what exactly is ratio strength? Ratio strength describes the drug concentration in terms of a ratio. So, what that means is, you have one unit of solute contained in the total amount of preparation and so normally your ratio strength is written as one is to something. For example, you have 1:2,000 depending on whether you have a weight-in-weight, volume-in-volume or weight-in-volume scenario, you would interpret this accordingly.

Interpreting Ratio Strength

Okay, so for 1:2000 when you have a weight-in-volume situation that would mean that you have one gram of solute in 2000 milliliters of preparation. Then if you have a volume-in-volume scenario, the one would refer to one milliliter of solute in 2000 milliliters of preparation It could also be one liter of solute in 2000 liters of preparation, or one microliter of solute in 2000 microliters of preparation. So the units of volume for the solute and the preparation should be consistent. If you had the weight-in-weight scenario here is going to be one gram of your constituent or your solute in 2000 grams of mixture.

Now, it's important to understand that the ratio strength is always going to be one is to something. So if you had two grams of solute in 800 milliliters of preparation, what you don't want to do is to say 2:800, that will not be correct, rather it is going to be 1:400. So you always reduce the ratio in such a way that you have one unit of the solute to a certain quantity of your preparation.

So we know what the ratio strength is and we know how to interpret the information. The next thing we should be able to do is convert percentage strength to ratio strength. And if you need a review on what percentage strengths or percentage concentrations are, check out our previous video, I'll put a link to that in the description and I'll put it in the cards which should show pretty soon.

Example 1

All right, so here we have an example which says Express 0.02% as a ratio strength.

Now the first thing we should be able to do is put the 0.02% in terms of a ratio and that will be 0.02 grams in 100 ml. So that'll be 0.02 grams divided by 100 milliliters and now we need to set up a proportion.

So that should be equal to one gram over x milliliters because our ratio is going to be one is to something.

All right, so we solve for x and we have one gram times 100 milliliters divided by 0.02 and we have 5000 milliliters and so the ratio strength would actually be 1:5000. So that's how you want to convert percentage strength to ratio strength.

Express 0.02% as a ratio strength

$$\frac{0.02\ g}{100\ mL} = \frac{1\ g}{X mL}$$

$$X = \frac{1\ g\ x\ 100\ mL}{0.02\ g} = 5000\ \text{mL}$$

Hence, 0.02% is equivalent to **1:5000**

Example 2

So now that we can convert percentage strength to ratio strength, we should also be able to go in the other direction and convert ratio strength to percentage strength.

In this example, it says what is the percentage strength of a 1:500 zinc oxide ointment?

So here because you have an ointment, we know it is going to be on a weight by weight basis, alright. So we take the definition of ratio strength for the weight-in-weight scenario.

And that would be one gram of zinc oxide divided by 500 grams of preparation. So that would be the ratio. And now we set up a proportion. So for percentage strength, it's some quantity in grams out of 100 grams.

So that's why the proportion is set up that way. So we solve for x, x equals one gram times 100 grams divided by 500 grams. And so now that is equal to 0.2. And basically, that's our percentage strength. So the 1:500 is equivalent to 0.2%.

What is the percentage strength of a 1:500 zinc oxide ointment?

$$\frac{1\ g}{500\ g} = \frac{X g}{100\ g}$$

$$X = \frac{1\ g\ x\ 100\ g}{500\ g} = 0.2$$

Hence, 1:500 is equivalent to **0.2%**

Example 3

So the next thing we want to accomplish in this tutorial is to be able to calculate the ratio strength of a given pharmaceutical preparation.

And so in this example, it says an 80 mL solution contains 40 milligrams of drug. Express the concentration as a ratio of strength.

And so we need to bring to mind the interpretation of ratio strength. And if we did that, in this example, we need to have eventually one gram of drug to some quantity in milliliters of the total preparation.

What that will mean is a prudent thing to do would be to convert the 40 milligrams to grams. All right, so we start off with the idea that 1000 milligrams is one gram. And so how do we convert the 40 milligrams.

We have thousand milligrams divided by one gram and that should be equal to 40 milligrams divided by x grams. So we go ahead and solve for x, and x will be equal to 40 milligrams times one gram divided by 1000 grams and that gives us 0.04 grams.

So we go ahead and set up a ratio where you have 0.04 grams of drug divided by 80 milliliters of solution, okay, so 0.04 grams of drug divided by 80 milliliters of solution and that should be equal to one gram divided by y milliliters.

So the one gram represents the one unit of solute or one unit of drug, and we need to figure out what the total volume of the preparation will be accordingly.

So we solve for y, and y equals one gram times 80 milliliters divided by 0.04 grams, and that gives us 2000 milliliters. And so the ratio strength of this preparation is going to be 1:2000.

An 80 mL solution contains 40 mg of drug. Express the concentration as a ratio strength.

$$1000\ mg = 1\ g$$

$$\frac{1000\ mg}{1\ g} = \frac{40\ mg}{X\ g} \Rightarrow X = \frac{40\ mg\ x\ 1\ g}{1000\ mg} = 0.04\ g$$

$$\frac{0.04\ g}{80\ mL} = \frac{1\ g}{y\ mL}$$

$$y = \frac{1\ g\ x\ 80\ mL}{0.04\ g} = 2000\ mL$$

Hence, the answer is **1:2000**

So if you found this video useful, be sure to like it, share it and subscribe to the channel. And if you have any questions, put them in the comments or send me an email at and I will see you in the next video.

Do you have any questions or strategies on how to master ratio strength calculations? Share them in the comments box below.

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