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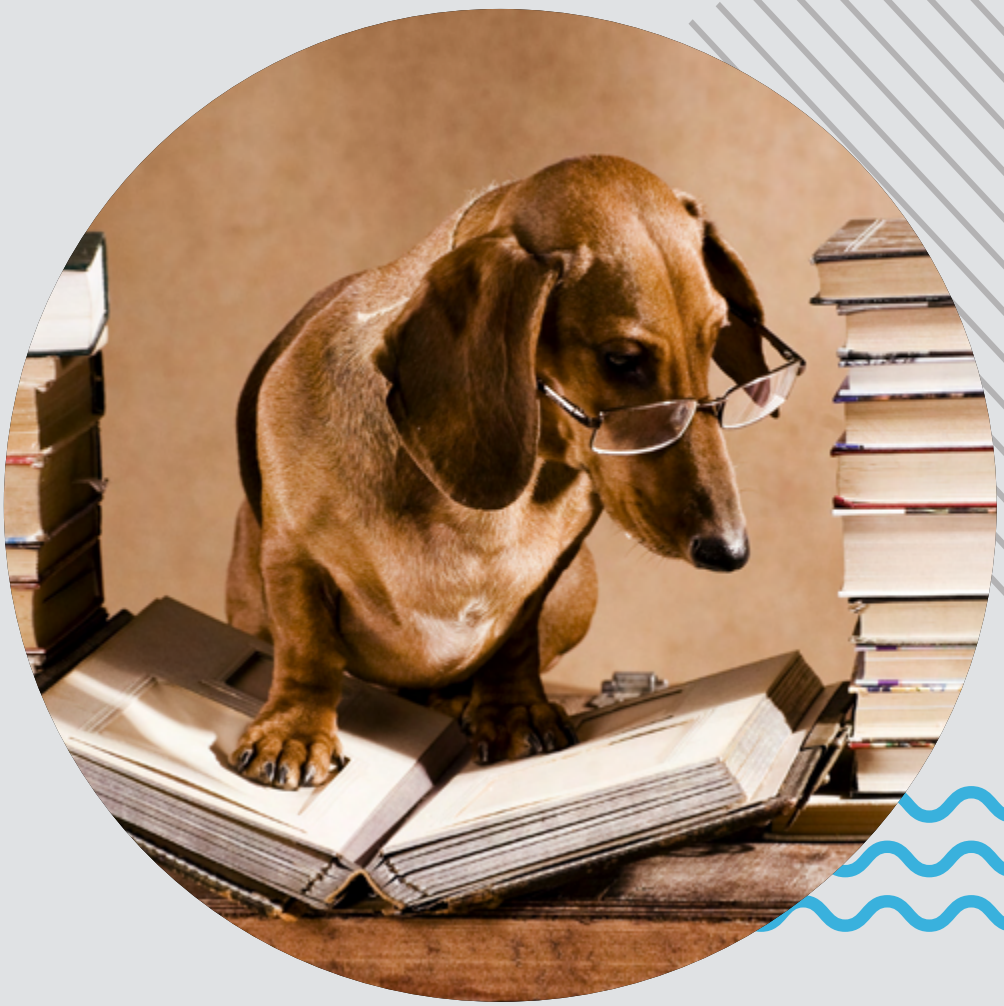
Medical Math for Veterinary Professionals

Whether you love math or hate it, it's likely to occupy a significant portion of your daily routine as a veterinarian. Much of what you do while on clinics and in future jobs will involve calculating drug doses, whether you are calculating an antibiotic dose for a skin infection or a propofol dose for a patient undergoing surgery.

While dosage calculations are typically relatively straightforward, other calculations in veterinary medicine may be more challenging. This is especially true for calculations that you may perform on an inconsistent basis, such as calculating caloric requirements for weight loss. Therefore, it's important to review these calculations and have resources available for assistance when needed.



Common Calculations in Veterinary Medicine

Calculate a Patient's Maintenance Fluid Rate

The normal maintenance fluid rate for small animal patients is 50-60 ml/kg/day. Intravenous fluid pumps, however, typically require you to enter a fluid rate in terms of milliliters per hour. In order to connect a patient to a fluid pump for the administration of maintenance fluids, you must determine how many mls of fluid the patient needs in a 24-hour period, then divide the daily fluid requirement by 24 (the number of hours in a day) to determine the hourly fluid rate.

If you wanted to create an equation to solve for ml/hr, that equation would look like this:

> Maintenance fluid rate (ml/hr) = [patient's weight (in kg) x 55 ml/kg/day] / [24 hrs/day]

In reality, however, it's probably easier to just think through this problem without writing out a full equation.

Example: A 25 kg dog requires maintenance fluid therapy. What ml/hr rate should be entered into the fluid pump?

First, calculate the patient's 24-hr requirement:

> (25 kg) x (55 ml/kg/day) = 1375 ml/day

There are 24 hours in a day, so this fact can be used to convert ml/day to ml/hr:

> (1375 ml/day) / (24 hrs/day) = 57 ml/hr

Therefore, you should enter a fluid rate of 57 ml/hr into the fluid pump.

Calculate a Patient's Replacement Fluid Rate

In a dehydrated patient, fluid therapy must take into account the patient's degree of dehydration, in addition to providing for the patient's maintenance fluid rate. Fluid deficits are typically corrected over a 24-hour period.

Example: The 25 kg dog in the example above is 8% dehydrated. What ml/hr fluid rate should be used for the first 24 hours of IV fluid therapy?

As calculated above, the dog's maintenance fluid rate is 1375 ml/day or 57 ml/hr. Next, calculate the quantity of fluids that must be given to correct dehydration.

> (25 kg) x (0.08 dehydration) = 2 kg water deficit

One kg of water is one L of water, therefore:

> 2k water deficit = 2L water deficit = 2000 ml water deficit

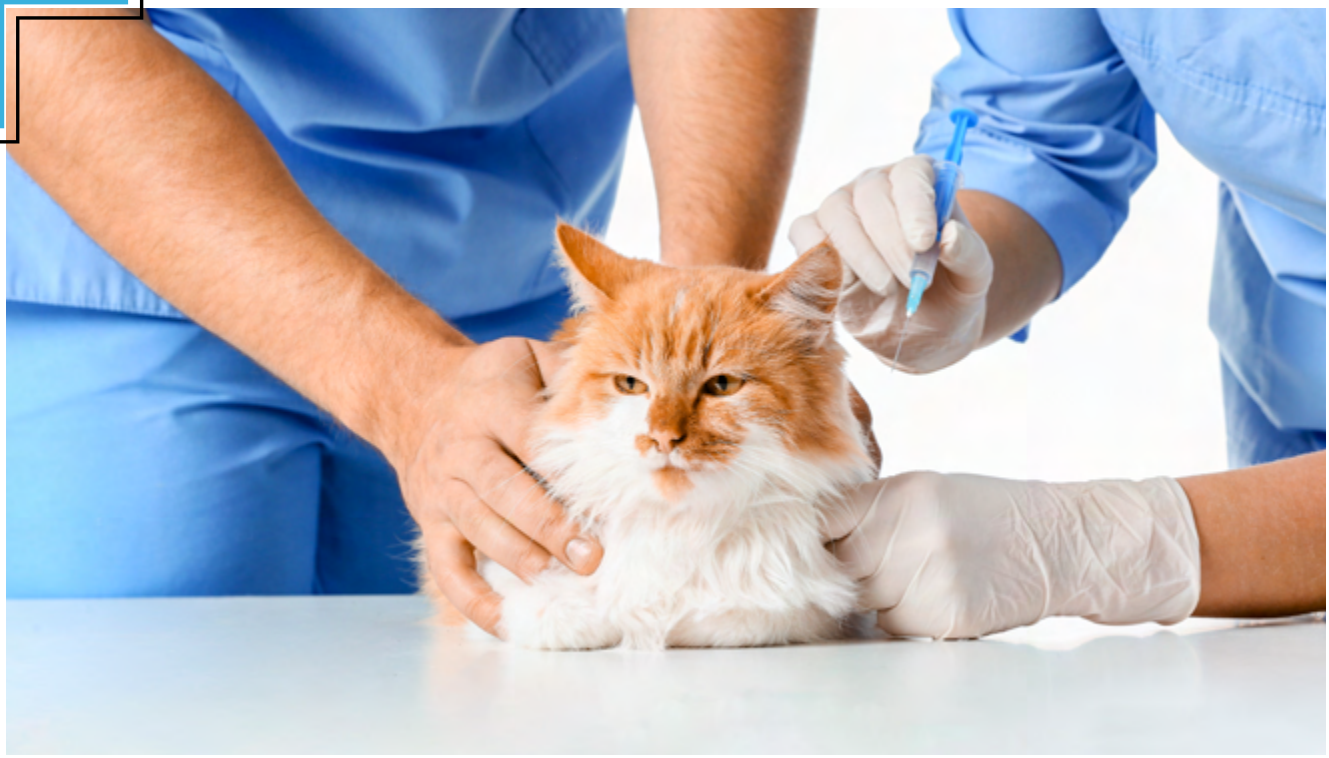
In order to obtain the fluid rate needed to correct dehydration, convert 2000 ml of water per day into ml/hr:

> (2000 ml) / (24 hrs/day) = 83 ml/hr

Finally, add the maintenance fluid rate and the rate needed to correct dehydration:

> 83 ml/hr + 57 ml/hr = 140 ml/hr

Therefore, a fluid rate of 140 ml/hr will ensure that the dog's maintenance requirements are met and that the dog's fluid deficit is corrected within the first 24 hours.



Dilute a Substance to Achieve a Desired Concentration

In many cases, dextrose or other substances must be added to IV fluids for a particular patient. The easiest equation to use for this type of calculation is the following:

$$C_1V_1 = C_2V_2$$

In this equation, C1 and V1 represent the starting concentration and volume, while C2 and V2 represent the final concentration and volume.

Example: A 3 kg hypoglycemic puppy requires a 2.5% dextrose solution for IV fluid administration. You have a 1L bag of LRS and a bottle of 50% dextrose. How much dextrose should you add to the fluid bag?

In this example, C1 is the original dextrose concentration (50%), V1 is the dextrose volume to be added, C2 is the desired dextrose concentration (0.025%), and V2 is the total volume of fluids.
Plugging the numbers that we know into the equation gives us:

(50%) x (ml dextrose) = (2.5%) x (1000 ml)

Dividing both sides by 50% to rearrange the equation gives:

ml dextrose = (2.5%) x (1000 ml) / (50%)
= 50 ml dextrose

The only tricky thing to remember in this calculation is that you want 50 ml of dextrose in a final volume of 1000 ml. Therefore, you can't add 50 ml of dextrose directly to the 1L LRS bag. First, remove 50 ml of LRS, then replace that 50 ml of LRS with dextrose. This

Calculate a Constant Rate Infusion

When calculating a CRI, it's important to think through the problem in a logical, stepwise fashion. If you know the rate at which you want the patient to receive a particular drug and you know how long the patient's fluid bag will last, you can determine how much of a particular drug should be added to the fluid bag in order to deliver the drug at your desired rate.

Example: A 10 kg dog requires a ketamine CRI at a dose of 0.5 mg/kg/hr. You would like to add the ketamine to a 1L bag of LRS, which you will administer at a maintenance rate of 23 ml/hr. How much ketamine (100 mg/ml) should you add to the fluid bag?

First, determine how much ketamine (in mg) the dog needs to receive every hour:

(0.5 mg/kg/hr) x (10 kg) = 5 mg/hr

Next, determine the volume of ketamine (in ml) the dog needs to receive every hour:

(5 mg/hr) / (100 mg/ml) = 0.05 ml/hr

Now, determine how many hours the dog's bag of IV fluids will last:

(1000 ml) / (23 ml/hr) = 43.5 hours

Finally, calculate how much ketamine needs to be added to the bag of IV fluids, in order to last the entire 43.5 hours?

(0.05 ml/hr) x (43.5 hrs) = 2.2 ml

Therefore, you should remove 2.2 ml from the bag of fluids and replace it with 2.2 ml ketamine, in order to ensure that the dog receives a 0.5 mg/kg/hr ketamine CRI.

Calculate Nutritional Requirements

Whether a pet is hospitalized or you are providing an owner with instructions for at-home feeding, there will be times that you need to calculate a pet's resting energy rate.

The first step to calculating nutritional requirements is to calculate the pet's resting energy requirement (RER), according to the following equation:

RER = 70 x (body weight in kg)0.75

The RER is then multiplied by 1.0-1.6, depending on the pet's reproductive status (altered pets < intact pets, lazy pets < active pets).

Example: A 10 kg spayed female dog presents for her annual wellness visit and you note that she has gained some weight since last year. She is not yet overweight, but you want to ensure that she does not gain additional weight. What is a good estimate of how many calories per day her owners should be feeding?

First, calculate the dog's RER:

RER = 70 x (10)0.75

= 70 x 5.6

= 394 kcal/day

Given that the dog is altered and is prone to gaining weight, the lower end of the multiplication factor range should be used. If the owner is instructed to feed RER x 1.0 to RER x 1.2, a range of 394-472 kcal should be recommended.

Convert a % Solution to mg/ml

This situation used to arise commonly, back when ivermectin was the recommended treatment for demodex and scabies. Fortunately, we now have newer drug options available, but you may still occasionally find yourself needing to convert a % (weight/volume) solution into a mg/ml solution.

> % weight/volume = (grams of solute) / 100 ml

Or, in plain English, the % w/v tells you how many grams of the drug are present in 100 ml.

Example: You are planning to dose a pet with injectable ivermectin, provided as a 1% solution. Convert the concentration from % (w/v) to mg/wml.

Using the equation above:

> 1% ivermectin = (1 gram ivermectin)/ (100 ml solution)

Next, convert grams to milligrams:

> = (1000 mg ivermectin)/(100 ml solution)

Finally, simplify the fraction by canceling zeroes:

> = (10 mg ivermectin)/(1 ml solution)

Therefore, 1% ivermectin is equivalent to 10 mg/ml ivermectin.

Tips for Medical Math

Knowing your math is essential, but it's also important to ensure that you can do these calculations quickly and accurately. Consider the following strategies to increase the speed and accuracy of your calculations.

1 Create or Download Spreadsheets for Common Calculations

The most common example of spreadsheet usage is emergency drugs. In many practices, a spreadsheet is used to calculate emergency drug doses for each hospitalized or anesthetized patient. Similar spreadsheets may also be used to calculate dosages of anesthetic drugs.

2 When In Doubt, Look It Up

Some calculations, like resting energy requirements, can be a challenge to memorize if you don't use them on a regular basis. Don't be afraid to look these equations up online!

3 Double-Check Your Calculations

A careless error, such as adding or dropping a zero, can mean the difference between dosing a pet appropriately and significantly overdosing a pet. Always double-check your calculations!

When possible, try to solve the problem two ways, ensuring that you get the same answer. In the example *"Calculate a patient's replacement fluid rate,"* for example, you could either calculate the replacement rate as an hourly rate and add the two ml/hr values together (as demonstrated in the example) or you could calculate the 24-hr replacement rate, add that to the 24-hr maintenance rate, and then divide the sum of the two numbers by 24 to get a ml/hr rate.

If you can calculate the problem in two different ways and arrive at the same answer, you can be confident in your math.

4 Work With Your Coworkers to Catch Mistakes

When accuracy is extremely important (for example, calculating the dosage of a drug with a narrow margin of safety), ask a coworker to also do the math and ensure that you both arrive at the same answer. Even if you consider yourself to be good at math, two heads are better than one!

About the Author

Cathy Barnette is a freelance veterinary writer and contributor to XPrep Learning Solutions. She is a graduate of the University of Florida College of Veterinary Medicine and spent 15 years working in small animal general practice before transitioning to a career in writing. Cathy is passionate about veterinary medicine and education; she enjoys working to provide valuable information to veterinarians, veterinary teams, and pet owners.