

Medical Math for Veterinary Technicians

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As Veterinary Technicians who administer the majority of drugs and fluids to hospitalized patients, it is very important for you to understand methods for calculating drug dosages and fluid rates to prevent both under and overdosing of medications to you animal patients. In busy practices, it is not uncommon for prescribed doses of drugs to be incorrect- commonly the consequence of a misplaced decimal point or changes in the concentration of drug/volume for the same medication. By understanding medical math, you will become invaluable to busy veterinarians who learn they can rely on you to double check dosages for drugs, fluids, & anesthesia and prevent any medication errors before they are made. Medical math may seem complicated initially, but once you work through the problems and practice a little, you will become a proficient at calculating drug dosages.

CONVERSIONS:

1 Liter = 10dL = 1000mL 0.001Kg = 1 gram = 1000mg = 1,000,000 μ g (mcg)

1 tsp = 5mL

1 tbsp = 15mL

1Kg = 2.2lbs

At 4° degrees Celsius, 1 cubic centimeter (cc) of water = 1mL = 1gm

1 ounce is approximately 28gm

Maintenance fluids:

- **Dog** – 66mL/kg/day (30mL/lb/day)
- **Cat** – 50-60mL/kg/day

Blood Volume:

- **Dog** – 90mL/kg
- **Cat** – 65mL/kg

STOICHIOMETRY:

- This means the conversion from one unit to another.
- Basically it is a matter of canceling out like units.

For calculating a volume:

If you need to give an animal 250mg of an antibiotic (ABx) , how many mL should you give if the concentration is 100mg/mL?

- To calculate, divide the amount you want to give (250mg) by the concentration

- (100mg/ml)
- $250\text{mg Abx} \div 100\text{mg Abx/mL solution} = 2.5\text{mL solution}$
 - **or to look at it another way:**
 - $250\text{mg ABx} \times 1\text{mL}/100\text{mg} = 2.5\text{ml}$

For making up solutions:

If you have 2000mg of KBr and you want to make a 250mg/mL solution, how many mL of diluent do you need to add?

- To Calculate, divide the amount of KBr (2000mg) by the intended concentration (250mg/ml) to get the volume
- $2000\text{mg KBr} \div 250\text{mg/ml KBr} = 8\text{mL solution}$
- **or to look at it another way:**
- $2000\text{mg KBr} \times 1\text{mL final solution}/250\text{mg KBr} = 8\text{mL solution}$

CALCULATING MAINTENANCE FLUIDS:

Calculate maintenance fluid rate for a 20kg dog using 66mL/kg/day (30mL/lb/day)

- $20\text{kg} \times 66\text{mL/kg/day} \times 1\text{day}/24\text{hours} = 55\text{mL/hour}$
- Step 1- multiple dog's weight (20kg) X maint rate 66ml/kg =
- Step 2- divide total fluids for day by 24 hours to get rate/hr

PERCENT SOLUTIONS:

% = gm/dL (i.e. a 5% solution means that 5gm of substance is in 1dL (100mL) of solution)

To convert 5% (gm/dl) to mg/mL: $5\text{gm/dL} \times 1000\text{mg/gm} \times 1\text{dL}/100\text{mL} = 50\text{mg/mL}$

- So a 5% solution = 5gm/dL = 50mg/mL

Problem: Make a 2.5% dextrose solution in a 500mL bag of saline. (Base stock of dextrose is 50%)

- **Step 1** – How much dextrose do you need?

$2.5\% = 2.5\text{gm/dL} \times 1000\text{mg/gm} \times 1\text{dL}/100\text{mL} = 25\text{mg dextrose/mL solution} \times 500\text{mL solution} =$

12500mg

- **Step 2** – How many mL of base stock do you need?

$$50\% = 50\text{gm/dL} \times 1000\text{mg/gm} \times 1\text{dL}/100\text{mL} = 500\text{mg/mL stock concentration}$$

$$12500\text{mg dextrose} \times 1\text{mL stock}/500\text{mg dextrose} = 25\text{mL stock solution}$$

This means to make a 2.5% dextrose solution in a 500mL bag, you need to add 25mL of 50% dextrose. (Technically you should first remove 25mL of saline out of the 500mL bag before adding the 25mL of dextrose so that your final solution is 500mL and not 525mL. If you don't, your solution will be slightly less than 2.5%)

INFUSIONS WITHOUT PUMPS:

If you have a 15drop/mL set, how many drops/second do you need to run an animal at 30mL/hr?

Step 1 – How many mL/sec?

$$30\text{mL/hr} \times 1\text{hr}/60\text{minutes} \times 1\text{minute}/60\text{seconds} = 0.0083\text{mL/sec}$$

Step 2 – How many drops/second?

$$0.0083\text{mL/sec} \times 15\text{drops/mL} = 0.125\text{drops/sec} = 1 \text{ drop every 8 seconds}$$

CONTINUOUS RATE INFUSIONS: (CRIs)

- Dosages tend to be given in either mg/kg/day or $\mu\text{g}/\text{kg}/\text{min}$ (micrograms)
- $1000 \mu\text{g} = 1 \text{ mg}$

CRI Problem #1.

If you have a vomiting 48kg dog and want to give him the high end dose of metoclopramide in a CRI, how many mL of metoclopramide should you add to a 1L bag of LRS to run the dog at 150mL/hr? (Dose of metoclopramide is 1-2mg/kg/day. 10mg/2mL stock solution.)

Step 1 – How many mg of metoclopramide do you need per hour?

$$48\text{kg} \times 2\text{mg/kg/day} = 96\text{mg/day} \times 1\text{day}/24\text{hours} = 4\text{mg/hr}$$

Step 2 – How many mg metoclopramide do you need per mL of LRS?

$$4\text{mg/hour} \times 1\text{hr}/150\text{mL} = 0.0267\text{mg metoclopramide/mL LRS}$$

Step 3 – How many mg metoclopramide per liter of LRS?

$$0.0267\text{mg/mL LRS} \times 1000\text{mL/L} = 26.7\text{mg metoclopramide}$$

Step 4 – How many mL of stock solution do you need?

$$26.7\text{mg metoclopramide/L LRS} \times 2\text{mL stock}/10\text{mg metoclopramide} = 5.33\text{mL stock /L LRS}$$

CRI Problem #2

If you have a 5kg cat who has a low blood pressure, how much dopamine should you add to a 250mL bag of saline to make a dopamine drip of $5\mu\text{g}/\text{kg}/\text{min}$ if you run the fluids at $5\text{mL}/\text{hr}$? Dopamine dose for blood pressure elevation is $2\text{-}10\mu\text{g}/\text{kg}/\text{min}$ (up to $15\mu\text{g}/\text{kg}/\text{min}$ for shorter duration). Stock solution is $200\text{mg}/5\text{mL}$.

Step 1 – How many μg of dopamine do you need per hour?

$$5\text{kg cat} \times 5\mu\text{g}/\text{kg}/\text{min} \times 60\text{min}/\text{hour} = 1500\mu\text{g}/\text{hr}$$

Step 2 – How many mg/mL of dopamine do you need?

$$1500\mu\text{g}/\text{hr} \times 1\text{mg}/1000\mu\text{g} \times 1\text{hr}/5\text{mL} = 0.3\text{mg dopamine}/\text{mL saline}$$

Step 3 – How many mg dopamine in a 250mL bag?

$$0.3\text{mg dopamine}/\text{mL saline} \times 250\text{mL saline} = 75\text{mg dopamine}$$

Step 4 – How many mL of stock solution do you need?

$$75\text{mg dopamine} \times 5\text{mL stock}/200\text{mg dopamine} = 1.875\text{mL stock solution in a 250mL bag}$$

To sum up: If you add 1.875mL of dopamine to a 250mL bag of saline, you get a dosage of $5\mu\text{g}/\text{kg}/\text{min}$ when run at $5\text{mL}/\text{hour}$ **for a 5kg cat**.

(Note: this also means that for this particular bag that every $X\text{mL}/\text{hr}$ you run the solution at $= X\mu\text{g}/\text{kg}/\text{min}$ **in a 5kg patient**. So if the blood pressure is still low and you want to increase the dopamine dose to $8\mu\text{g}/\text{kg}/\text{min}$, you don't have to recalculate the CRI. You can just increase your fluids to $8\text{mL}/\text{hr}$.)

A shortcut method for calculating CRIs.

- To do this, you would calculate an animal's 24 hour needs and add that to a 240mL bag of fluid.
- Take 10mL out of a 250mL bag to = 240ml. This way you could run the fluids at

10mL/hr.

CRI Problem #3 (using 24 hour rate method)

For example, you have a 30kg dog post-op from a splenectomy. Calculate a CRI of lidocaine for him, using a dose of 50µg/kg/min, to control his ventricular tachycardia. Your lidocaine is 2%.

Step 1 – How many mg per minute do you need?

$$30\text{kg} \times 50\mu\text{g}/\text{kg}/\text{min} = 1500\mu\text{g}/\text{min} \times 1\text{mg}/1000\mu\text{g} = 1.5\text{mg}/\text{min}$$

Step 2 – How many mg per day do you need?

$$1.5\text{mg}/\text{min} \times 60\text{min}/\text{hour} \times 24\text{hours}/\text{day} = 2160\text{mg}/\text{day}$$

Step 3 – How many mL of lidocaine should you add to the 240mL bag to run the bag at 10mL/hr?

$$2160\text{mg} \times 1\text{mL}/20\text{mg} = 108\text{mL}$$

- This sounds like a lot but you should remove a total of 118mL from a 250mL bag and add 108mL lidocaine (2%) in order to get a total of 240mL final solution. Then at 10mL/hr the dose is 50µg/kg/min. To titrate up or down, every 5mL/hr = 25µg/kg/min.

*****Quick dopamine/dobutamine cheat calculation.**

15 x mass of patient (in kg) = # of mg drug to add to a 250mL bag such that when you run that solution at 15mL/hr you are administering a dose of 15µg/kg/min. (This means that if you want a dose of 10µg/kg/min, change the rate to 10mL/hr.)

BLOOD TRANSFUSION CALCULATION:

Problem #1 - calculating blood transfusion

A 20kg dog presents to your clinic with a PCV=15%. How many mL of packed red cells (Assume 100% per volume even though it really is not.) do you need to raise the dog's hematocrit to 25%?

Step 1 – What is the dog's blood volume? (Formula in 'Conversions' section)

$$20\text{kg} \times 90\text{mL/kg} = 1800\text{mL blood volume}$$

Step 2 – What is the volume of existing red cells in the dog?

$$1800\text{mL} \times 15\%(0.15) = 270\text{mL}$$

Step 3 – What is the red cell volume desired?

$$1800\text{mL} \times 25\%(0.25) = 450\text{mL}$$

Step 4 – Required red cell mass. (Desired – Existing)

$$450\text{mL} - 270\text{mL} = 180\text{mL}$$

So if you assume that pRBC's have a hematocrit = 100% you need 180mL.

Problem #2 - calculating blood transfusion

A 4kg cat presents to your clinic with a PCV=11%. How many mL of whole blood (Assume PCV=50%) do you need to raise the cat's hematocrit to 20%?

Step 1 – What is the cat's blood volume? (Formula in 'Conversions' section)

$$4\text{kg} \times 65\text{mL/kg} = 260\text{mL}$$

Step 2 – What is the volume of existing red cells in the cat?

$$260\text{mL} \times 11\%(0.11) = 28.6\text{mL}$$

Step 3 – What is the red cell volume desired?

$$260\text{mL} \times 20\%(0.20) = 52\text{mL}$$

Step 4 – Required red cell mass. (Desired – Existing)

$$52\text{mL} - 28.6\text{mL} = 23.4\text{mL}$$

Step 5 - Required whole blood.

$$23.4\text{mL}/50\%(0.50) = 46.8\text{mL}$$

In other words, the cat needs 23.4mL of red cells but since whole blood is only ½ red cells you need twice as much, 46.8mL.

PRACTICE PROBLEMS:

- 1) You've been running a dog on LRS with 20mEq KCl/L at 50mL/hr for 6 hours.

(You started with a liter bag) Now, the doctor asks you to check blood glucose. BG=60 so he asks you to place the dog on a 5% dextrose drip in LRS. You don't want to throw the bag away, so how many mL of 50% dextrose do you need to add to turn the existing bag into a 5% solution?

- 2) Calculate a CRI of Reglan for a dog weighing 66lbs. (Use 2mg/kg/day and a rate of 75mL/hr)
- 3) Calculate a CRI of dopamine at 10 μ g/kg/min for a cat weighing 15.4lbs. Use a rate of 5mL/hr.
- 4) A 50kg dog presents with a PCV=12%. Calculate a pRBC transfusion (Assume 90%) needed to raise the hematocrit 10 points.

ANSWERS:

- 1) 70mL (Technically you should remove 70mL from existing bag before adding the dextrose)
- 2) 6.66mL of Reglan in a one Liter bag
- 3) 5.25mL of dopamine in a 250mL bag (Note every X mL/hr = 2X μ g/kg/min, so if you run the pump at 4mL/hr you are getting 8 μ g/kg/min for a 7kg cat.)
- 4) 500mL of pRBC's