Calculation of Dosages and Solutions: Ratio & Proportion

LEARNING OBJECTIVES

1. Use ratio and proportion to accurately solve a wide variety of dosage and solution problems.
2. Calculate oral, intramuscular, subcutaneous dosages using ratio and proportion and intravenous flow rates using a similar method of calculation.

INTRODUCTION

This course teaches the ratio and proportion method of calculating dosages. It provides the learner with an opportunity to use ratio and proportion calculations for a wide variety of oral, intramuscular, subcutaneous, and intravenous calculations as well as many practice calculations.

WHAT IS RATIO?

Ratio

Ratio is a relationship in terms of size, amount, or quantity of two or more things. They are pairs of numbers that are used to make comparisons between the numbers.

For example, the ratio of men compared to women included in a pharmacological research study may be 3 to 1. There are 3 times as many men in the study as there are women.

Ratios can be written in 3 different ways, as below:

- 1 to 4
- 1:4
- 1/4

Comparing Ratios

Write the ratios as fractions when you want to compare them. All ratios must be equal or they are not a ratio.

For example, the ratios 1/4 and 2/8 are equal. When you set up these ratios and criss cross multiple the numerators and denominators you end up with the same number, that is 8. These ratios are equal.

$$\frac{1}{4} = \frac{2}{8}$$

1 x 8 = 8 and

2 x 4 = 8

WHAT IS PROPORTION ?

Proportion

Proportion is the relationship of one part to another or to the whole in respect to size, size, amount or quantity. A proportion is an equation with a ratio on each side of the equal sign. Solving proportions involves criss cross multiplying and then finding out what the missing number is using division.

For example:

$$\frac{2}{8} = \frac{?}{24}$$

$$\frac{2 \times 24}{8} = \frac{48}{8} = 6$$

OR

$$\frac{\cancel{2} \times 24}{\cancel{8}\ 4} = \frac{24}{4} = 6$$

CALCULATING ORAL DOSAGES USING RATIO AND PROPORTION

The doctor orders: 250 mg of a medication

The label on the medication states: 1 tablet = 125 mg

How many tablets will you administer?

250 mg: **x** tabs :: 125 mg: 1 tab

OR

250 mg: **x** tabs = 125 mg: 1 tab

OR

$$\frac{250 \text{ mg}}{\mathbf{x} \text{ tabs}} = \frac{125 \text{ mg}}{1 \text{ tab}}$$

The immediately above setup allows us to more simply reduce numerators and denominators by dividing each by the same number and to more easily avoid errors as we criss cross multiply.

$$\frac{250 \text{ mg}}{\mathbf{x} \text{ tabs}} = \frac{125 \text{ mg}}{1 \text{ tab}} = 125\,\mathbf{x} = 250 =$$

$$\mathbf{x} = \frac{250}{125} = 2 \text{ tablets}$$

Doctor's order: tetracycline syrup 250 mg po

Medication label: tetracycline syrup 50 mg/mL

How many mL should you administer?

$$\frac{250 \text{ mg}}{\mathbf{x} \text{ mL}} = \frac{50 \text{ mg}}{1 \text{mL}} = 50\,\mathbf{x} = 250$$

$$\mathbf{x} = \frac{250}{50} = 5 \text{ mL}$$

Grab your pencil and paper and do these problems.

Practice Problem 1

Doctor's order: KCl 20 meq po

Medication label: KCl 15 meq/11.25 mL

How many mL would you administer?

Practice Problem 2

Doctor's order: Gantrisin 250 mg po

Medication label: Gantrisin 0.5 g/tab

How many tabs would you administer?

Practice Problem 3

Doctor's order: trimethoprim 5 mg/kg po. The patient weighs 80 kg.
Medication label: trimethoprim 160 mg/tab. The tabs are scored in half.

How many tabs would you administer?

Practice Problem 4

Doctor's order: nystatin 3 mg/kg po. The patient weighs 115 lb.

Medication label: nystatin 100 mg/tab

How many tabs would you administer?

Answers

1. 15 mL
2. ¼ tab
3. 2 ½ tabs
4. 1 ½ tabs

Practice Problem 1

$$\frac{20 \text{ meq}}{\mathbf{x} \text{ mL}} = \frac{15 \text{ meq}}{11.25 \text{ mL}} = 15\,\mathbf{x} = 20 \times 11.25$$

$$15\ \mathbf{x} = 225$$

$$\mathbf{x} = \frac{\cancel{225}^{45}}{\cancel{15}_{3}} = 15 \text{ mL}$$

Practice Problem 2

$$\frac{250 \text{ mg}}{\mathbf{x} \text{ g}} = \frac{1000 \text{ mg}}{1 \text{g}} = 1000\ \mathbf{x} = 250$$

$$\mathbf{x} = \frac{\cancel{250}^{1}}{\cancel{1000}_{4}} = 0.25 \text{ g}$$

This problem is a two step problem. Above we calculated the number of g for the 250 mg dose because the drug label is in g and not mg. Next we will calculate the dose to be administered in terms of g.

$$\frac{0.25 \text{ g}}{\mathbf{x} \text{ tabs}} = \frac{0.5 \text{ g}}{1 \text{ tab}} = 0.5\ \mathbf{x} = 0.25$$

$$\boldsymbol{x} = \frac{0.25}{0.5} = 0.5 \text{ or } ½ \text{ tab}$$

Practice Problem 3

$$\frac{80 \text{ kg}}{\mathbf{x} \text{ mg}} = \frac{1 \text{ kg}}{5 \text{ mg}} = \mathbf{x} = 80 \text{ X } 5 = 400 \text{ mg}$$

This problem is also a two step problem. Above we calculated the number of mg to be administered as per the patient's body weight. Next we will calculate the dose to be administered in terms of tablets as based on the patient's weight and the fact that the doctor has ordered 5 mg for each kg of body weight.

$$\frac{400 \text{ mg}}{} = \frac{160 \text{ mg}}{} = 160\ \mathbf{x} = 400$$

x tabs 1 tab

$$\mathbf{x} = \frac{400}{160} = 2\ ½ \text{ tablets}$$

Practice Problem 4

$\frac{115 \text{ lb}}{\mathbf{x} \text{ kg}} = \frac{2.2 \text{ lb}}{1 \text{ kg}}$ $2.2\ \mathbf{x} = 115$

$$\mathbf{x} = \frac{115}{2.2} = 52.27 \text{ kg}$$

This problem is a three step problem. Above we calculated the number of kg a patient weighs as based on the patient's body weight in pounds. The patient weighs 115 pounds or 52.27 kg. This can be rounded off to 52 kg.

Next we will calculate the dose to be administered in terms of mg as based on the patient's weight in kg.

$\frac{52 \text{ kg}}{\mathbf{x} \text{ mg}} = \frac{1 \text{ kg}}{3 \text{ mg}}$ $= \mathbf{x} = 156$ mg

Finally, we will calculate how many tablets will be administered in terms of body weight when each tablet has 100 mg.

$\frac{\mathbf{x} \text{ tabs}}{156 \text{ mg}} = \frac{1 \text{tab}}{100 \text{ mg}}$ $= 100\ \mathbf{x} = 156$

$$\mathbf{x} = \frac{156}{100} = 1.56 \text{ tabs rounded off to } 1\ ½ \text{ tabs}$$

CALCULATING INTRAMUSCULAR AND SUBCUTANEOUS DOSAGES USING RATIO AND PROPORTION

Sample Calculation 1

Doctor's order: meperidine 30 mg IM q4h prn for pain

Medication label: 50 mg/mL

How many mL or cc would you give?

$\frac{30\text{ mg}}{50\text{ mg}} = \frac{50}{\mathbf{x}} = 30\text{ mL}$

$$\mathbf{x} = \frac{30}{50} = 0.6\text{ mL}$$

Sample Calculation 2

Doctor's order: amikacin 5 mg/kg IM tid. The patient weighs 130 lb.

Medication label: amikacin 500 mg/2 mL

How many mL would you administer?

Again, there are multiple steps in this problem. First, we will calculate how many kg the patient weighs. Next, we will determine how many mg the patient will get in each tid dose. Lastly, we will calculate how may mL we will have to administer for the ordered number of mg.

$\frac{130\text{ lb}}{\mathbf{x}\text{ kg}} = \frac{2.2\text{ lb}}{1\text{kg}} = 2.2\,\mathbf{x} = 130$

$$\mathbf{x} = \frac{130}{2.2} = 65\text{ kg}$$

$\frac{5\text{ mg}}{1\text{ kg}} = \frac{\mathbf{x}\text{ mg}}{65\text{ kg}} = 1\ \mathbf{x} = 65\text{ X }5 = 325\text{ mg}$

$\frac{500\text{ mg}}{2\text{ mL}} = \frac{325\text{ mg}}{\mathbf{x}\text{ mL}} = 500\,\mathbf{x} = 325\text{ X }2$

$$\mathbf{x} = \frac{650}{500} = 1.3\text{ mL}$$

Sample Calculation 3

Doctor's order: heparin 3,000 Units subcutaneously

Medication label: 5,000 Units/mL

How many mL would you administer?

$$\frac{\mathbf{x}\ \text{mL}}{3{,}000\ \text{Units}} = \frac{1\ \text{mL}}{5{,}000\ \text{Units}} \quad 5{,}000\,\mathbf{x} = 3{,}000$$

$$\mathbf{x} = \frac{3{,}000}{5{,}000} = 0.6\ \text{mL}$$

Sample Calculation 4

Doctor's order: ticarcillin 600 mg IM

Medication label: ticarcillin reconstituted with 2 mL of sterile water to yield 1 g of ticarcillin in 2.6 mL of solution.

How many mL would you administer?

$$\frac{600\ \text{mg}}{\mathbf{x}\ \text{g}} = \frac{1{,}000\ \text{mg}}{1\ \text{g}} \quad 1{,}000\,\mathbf{x} = 600$$

$$\mathbf{x} = \frac{600}{1000} = 0.6\ \text{g}$$

$$\frac{0.6\ \text{g}}{\mathbf{x}\ \text{mL}} = \frac{1\ \text{g}}{2.6\ \text{mL}} \quad \mathbf{x} = 0.6 \times 2.6 = 1.56\ \text{m:}$$

Rounded Off to: 1.6 mL

Sample Calculation 5

Doctor's order: neomycin 30 mg/kg/day IM in three divided doses. The patient weighs 140 lb.

Medication label: neomycin 250 mg/mL

How many mL would you administer for each of the three doses?

$$\frac{140 \text{ lb}}{\mathbf{x} \text{ kg}} = \frac{2.2 \text{ lb}}{1 \text{ kg}} = 2.2\,\mathbf{x} = 140$$

$$\mathbf{x} = \frac{140}{2.2} = 63.63 \text{ or } 64 \text{ kg}$$

$$\frac{30 \text{ mg}}{1 \text{ kg}} = \frac{\mathbf{x} \text{ mg}}{64 \text{ kg}} = \mathbf{x} = 64 \text{ X } 30 = 1902 \text{ mg}$$

$$\frac{1902 \text{ mg}}{\mathbf{x} \text{ mL}} = \frac{250 \text{ mg}}{1 \text{ mL}} = 250\,\mathbf{x} = 1902$$

$$\mathbf{x} = \frac{1902}{250} = 7.6 \text{ mL}$$

Because the doctor ordered 30 mg/kg over one day in three divided doses, it is necessary to divide the **7.6** mL for the day by 3 to determine how many mL would be given in each of the doses:

7.6 divided by 3 is 2.5 mL per dose

Now try these intramuscular and subcutaneous dosage calculations:

Practice Problem 1

Doctor's order: heparin 3,000 Units subcutaneously
Medication label: 4,500 Units/ mL
How many mL would you administer?

Practice Problem 2

Doctor's order: cefuroxime 500 mg IM
Medication label: The addition of 3.2 mL of sterile water yields a suspension of 750 mg in 4.2 mL
How many mL would you administer?

Practice Problem 3

Doctor's order: cephalothin 400 mg IM
Medication label: The addition of 4 mL of sterile water yields 0.5 g in 2.2 mL of suspension.
How many mL would you administer?

Practice Problem 4

Doctor's order: neomycin 20 mg/kg/day IM in three divided doses. The patient weighs 120 lb.
Medication label: neomycin 250 mg/mL
How many mL would you administer for each of the three doses?

Practice Problem 5

Doctor's order: 450,000 Units of ampicillin
Medication label: 250,000 Units/mL
How many mL would you administer?

Now, check your answers. The answers are:

Answers

1. 0.7 mL
2. 2.8 mL
3. 1.8 mL
4. 1.4 mL
5. 1.8 mL

Here is how each of the problems is set up and solved:

Practice Problem 1

$$\frac{3{,}000 \text{ Units}}{\mathbf{x} \text{ mL}} = \frac{4{,}500 \text{ Units}}{1 \text{ mL}} = 4{,}500\,\mathbf{x} = 3{,}000$$

$$\mathbf{x} = \frac{3{,}000}{4{,}500} = 0.66 \text{ mL}$$

Rounded Off to: 0.7 mL

Practice Problem 2

$$\frac{500\text{ mg}}{\mathbf{x}\text{ mL}} = \frac{750\text{ mg}}{4.2\text{ mL}} = 750\,\mathbf{x} = 500 \text{ X } 4.2$$

$$\mathbf{x} = \frac{2100}{750} = 2.8\text{ mL}$$

Practice Problem 3

$$\frac{400\text{ mg}}{\mathbf{x}\text{ g}} = \frac{1{,}000\text{ mg}}{1\text{ g}} = 1000\,\mathbf{x} = 400$$

$$\mathbf{x} = \frac{400}{1000} = 0.4\text{ g}$$

$$\frac{0.4\text{ g}}{\mathbf{x}\text{ mL}} = \frac{0.5\text{ g}}{2.2\text{ mL}} = 0.5\,\mathbf{x} = 0.4 \text{ X } 2.2$$

$$\mathbf{x} = \frac{.88}{0.5} = 1.76\text{ mL}$$

Rounded Off to: 1.8 mL

Practice Problem 4

$$\frac{120\text{ lb}}{\mathbf{x}\text{ kg}} = \frac{2.2\text{ lb}}{1\text{ kg}} = 2.2\,\mathbf{x} = 120$$

$$\mathbf{x} = \frac{120}{2.2} = 54.5\text{ kg}$$

$$\frac{54.5\text{ kg}}{\mathbf{x}\text{ mg}} = \frac{1\text{ kg}}{20\text{ mg}} = \mathbf{x} = \frac{54.5 \text{ X } 20}{1} = 1090\text{ mg}$$

$$\frac{1090\text{ mg}}{\mathbf{x}\text{ mL}} = \frac{250\text{ mg}}{1\text{ mL}} = 250\,\mathbf{x} = 1090$$

$$\mathbf{x} = \frac{1090}{250} = 4.36 \text{ mL}$$

Because the doctor ordered 20 mg/kg over one day in three divided doses, it is necessary to divide the 4.36 mL for the day by 3 to determine how many mL would be given in each of the doses:

4.36 divided by 3 is 1.45 mL This is rounded off to 1.4 mL

Practice Problem 5

$$\frac{450{,}000 \text{ Units}}{\mathbf{x} \text{ mL}} = \frac{250{,}000 \text{ Units}}{5 \text{ mL}} = 250{,}000\ \mathbf{x} = 450{,}000$$

$$\mathbf{x} = \frac{450{,}000}{250{,}000} = 1.8 \text{ mL}$$

CALCULATING INTRAVENOUS RATES

The rule for calculating intravenous flow rates is as below.

$$\text{gtts/min} = \frac{\text{Total number of mL}}{\text{Total number of minutes}} \times \text{Drip or drop factor}$$

Sample Calculation 1

Doctor's order: 0.9% NaCl solution at 100 mL per hour

How many gtt per minute would you give if the tubing delivered 20 gtt/mL?

$$\mathbf{x} \text{ gtts per minute} = \frac{100}{60} \times 20 = \frac{2000}{60} = 33.3 \text{ gtt}$$

Rounded Off to: 33 gtt/min

Sample Calculation 2

Doctor's order: 1,000 mL of 5% D 0.45 normal saline solution to infuse over 4 hours

How many gtt per minute would you give if the tubing delivers 10 gtt/mL?

x gtts per minute = $\frac{1000}{240} \times 10 = \frac{10{,}000}{240} = 41.6$ gtt

Rounded off to 42 gtt per minute

Sample Calculation 3

Doctor's order: 30 mL/h of 5% D 0.45 normal saline solution

How many gtt per minute would you give if the tubing delivered 60 gtt/mL?

x gtts per minute = $\frac{30}{60} \times 60 = \frac{1800}{60} = 30$ gtt

Sample Calculation 4

Doctor's order: 25 mL/h of 5% D 0.45 normal saline solution

How many gtt per minute would you give if the tubing delivered 60 gtt/mL?

x gtts per minute = $\frac{25}{60} \times 60 = \frac{1{,}500}{60} = 25$gtt

Now, do these practice problems.

Practice Problem 1

Doctor’s order: 75 mL/h

How many gtt per minute would you give if the tubing delivered 60 gtt/mL?

Practice Problem 2

Doctor’s order: 125 mL/h

How many gtt per minute would you give if the tubing delivered 15 gtt/mL?

Practice Problem 3

Doctor’s order: 150 mL/h

How many gtt per minute would you give if the tubing delivered 20 gtt/mL?

Practice Problem 4

Doctor’s order: 80 mL/h

How many gtt per minute would you give if the tubing delivered 10 gtt/mL?

Practice Problem 5

Doctor’s order: 150 mL/h

How many gtt per minute would you give if the tubing delivered 15 gtt/mL?

Now, check your answers. The answers are:

Answers

1. 75 gtt
2. 31 gtt
3. 50 gtt
4. 13 gtt
5. 37 gtt

Here is how each of the problems is set up and solved:

Practice Problem 1

x gtts per minute = $\frac{75}{\cancel{60}} \times \cancel{60} = 75$ gtt

Practice Problem 2

x gtts per minute = $\frac{125}{\cancel{60}_{4}} \times \cancel{15}^{1} = 31.2$ or 31 gtt

Practice Problem 3

x gtts per minute = $\frac{150}{\cancel{60}_{3}} \times \cancel{20}^{1} = 50$ gtt

Practice Problem 4

x gtts per minute = $\frac{80}{\cancel{60}_{6}} \times \cancel{10} = 13.3$ or 13 gtt

Practice Problem 5 1

x gtts per minute = $\frac{150}{} \times \cancel{15} = 37.5$ or 37 gtt

SUMMARY

Ratio and proportion is useful way to calculate dosage and solution problems of all types. It is an orderly and systematic mathematical process that results in consistent accuracy, provided the equation is set up correctly and careless mathematical errors are avoided.

If you would like to learn the dimensional analysis method of calculations, take our course entitled *"Calculation of Dosages and Solutions: Dimensional Analysis".*