Southwest Wisconsin Technical College

Dimensional Analysis in Nursing

Module 2.1

DRUG CALCULATIONS – MISCELLANEOUS IV RELATED PROBLEMS

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Noteworthy

IV-related problems aren't always about flow rate.

You can determine; a) *how long* it will take for an IV to run, b) the *total amount of fluid infused*, and c) the *amount of drug* infused.

Pay attention to which piece of information you need to begin your computation. That is the key!!

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Dimensional Analysis in Nursing

Module 2.1

DRUG CALCULATIONS – MISCELLANEOUS IV RELATED PROBLEMS

Introduction

In this book, Modules 1.10 and 1.11 introduced you to problems where you had to compute flow rates involving either IV pump or IV drip infusion scenarios.

Other questions can arise from IV scenarios however. In most of these types of problems, the *flowrate is already known*. Your job is to compute something else.

For example;

(1) Determine the *total volume of liquid infused* over a certain period of time.
Refer to Examples 2.1.1 and 2.1.2.

(2) Determine *how long* it will take for a given supply to be infused.
Refer to Examples 2.1.3 and 2.1.4.

(3) Determine the *amount of drug* (mg for example) infused over a certain period of time. *This type of computation is often performed when checking to see if the prescription represents a "safe dose" for the patient.*
Refer to Examples 2.1.5, 2.1.6 and 2.1.7.

Example 2.1.1

How much fluid (expressed in mL) will a patient receive if an IV has just been started, delivering fluid at a rate of 80 mL/hour for 90 minutes?

Step 1 The amount of time that the IV will run is the starting point for these types of problems.

90 minutes will be written in the numerator of the initial fraction. After writing the multiplication symbol and a new fraction bar, write *minutes* in the denominator. This will guarantee that minutes gets cancelled-out.

$$\frac{90 \text{ minutes}}{1} \times \frac{\qquad}{\text{minutes}}$$

Goal: **mL**

Step 2 The flow rate of 80 mL/hour will allow you to eliminate the time unit of measure and introduce volume (*mL*). In order to use it, we'll first have to convert minutes to hours using **60 minutes = 1 hour**.

$$\frac{90 \cancel{\text{minutes}}}{1} \times \frac{1 \text{ hour}}{60 \cancel{\text{minutes}}}$$

Example 2.1.1 continued

Step 3 Now we can move from time to volume using the flowrate of 80 mL/hour. This is interpreted as the equivalency **80 mL = 1 hour**.

$$\frac{90 \text{ mi}\cancel{\text{nu}}\text{tes}}{1} \times \frac{1 \text{ h}\cancel{\text{ou}}\text{r}}{60 \text{ mi}\cancel{\text{nu}}\text{tes}} \times \frac{80 \text{ mL}}{1 \text{ h}\cancel{\text{ou}}\text{r}}$$

Step 4 The only unit of measure is *milliliters* (mL) which is the goal. Multiply the numerators, then the denominators. Divide to finish.

$$\frac{90 \text{ mi}\cancel{\text{nu}}\text{tes}}{1} \times \frac{1 \text{ h}\cancel{\text{ou}}\text{r}}{60 \text{ mi}\cancel{\text{nu}}\text{tes}} \times \frac{80 \text{ mL}}{1 \text{ h}\cancel{\text{ou}}\text{r}} = \frac{7200\, mL}{60} = \mathbf{120\ mL}$$

Example 2.1.2

How much fluid (expressed in mL) will a patient receive if a drip infusion IV has just been started, delivering fluid at a rate of 30 gtts/min for 2 hours? The tubing set drop factor is 10 gtts/mL.

Step 1 The amount of time that the IV will run is the starting point for these types of problems.

2 hours will be written in the numerator of the initial fraction. After writing the multiplication symbol and a new fraction bar, write *hours* in the denominator. This will guarantee that *hours* gets cancelled-out.

$$\frac{2 \text{ hours}}{1} \times \frac{\qquad}{\text{hours}}$$

Goal: **mL**

Step 2 The flow rate of 30 gtts/min will be helpful in terms of moving away from time and heading towards volume. Before we get there, we must first convert *2 hours* into *minutes*. Use the equivalency; **60 minutes = 1 hour**.

$$\frac{2 \text{ h}\cancel{\text{ou}}\text{rs}}{1} \times \frac{60 \text{ minutes}}{1 \text{ h}\cancel{\text{ou}}\text{r}}$$

Step 3 Now we can move from time (minutes) to volume (gtts) using the flowrate of 30 gtts/min. This is interpreted as the equivalency **30 gtts = 1 minute**.

$$\frac{2 \text{ h}\cancel{\text{ou}}\text{rs}}{1} \times \frac{60 \text{ mi}\cancel{\text{nu}}\text{tes}}{1 \text{ h}\cancel{\text{ou}}\text{r}} \times \frac{30 \text{ gtts}}{1 \text{ mi}\cancel{\text{nu}}\text{te}}$$

Step 4 We now have *drops* (gtts) but we really need *milliliters* (mL). Use the tubing set drop factor of 10 gtts/mL, interpreted as **10 gtts = 1 mL**.

$$\frac{2 \text{ h}\cancel{\text{ou}}\text{rs}}{1} \times \frac{60 \text{ mi}\cancel{\text{nu}}\text{tes}}{1 \text{ h}\cancel{\text{ou}}\text{r}} \times \frac{30 \text{ }\cancel{\text{gtts}}}{1 \text{ mi}\cancel{\text{nu}}\text{te}} \times \frac{1 \text{ mL}}{10 \text{ }\cancel{\text{gtts}}}$$

Example 2.1.2 continued

Step 5 The only unit of measure remaining is *milliliters* (mL). That's our goal, so finish by multiplying the numerators and then the denominators. Divide to finish.

$$\frac{2\ \cancel{\text{hours}}}{1} \times \frac{60\ \cancel{\text{minutes}}}{1\ \cancel{\text{hour}}} \times \frac{30\ \cancel{\text{gtts}}}{1\ \cancel{\text{minute}}} \times \frac{1\ \text{mL}}{10\ \cancel{\text{gtts}}} = \frac{3600\ \text{mL}}{10} = \mathbf{360\ mL}$$

Example 2.1.3

At 0400 (4:00 a.m.) a patient's supply of normal saline was approximately 300 mL. The infusion pump is set at 110 mL/hour. (a) How long will it take to exhaust the normal saline supply, and (b) at what time will this happen?

Step 1 The *quantity of fluid remaining* is always the starting point in these types of problems.

300 mL will be written in the numerator of the initial fraction. After writing the multiplication symbol and a new fraction bar, write *mL* in the denominator. This will guarantee that *mL*'s get cancelled-out.

$$\frac{300\ \text{mL}}{1} \times \frac{}{\text{mL}}$$

Goal: **hours**

Step 2 The flow rate of 110 mL/hour will allow you to transition from volume to time.

$$\frac{300\ \cancel{\text{mL}}}{1} \times \frac{1\ \text{hour}}{110\ \cancel{\text{mL}}}$$

Step 3 The goal of hours has been reached. Multiply the numerators, then the denominators. Divide to finish.

$$\frac{300\ \cancel{\text{mL}}}{1} \times \frac{1\ \text{hour}}{110\ \cancel{\text{mL}}} = \frac{300\ \text{hours}}{110} = \mathbf{2.727272\ldots\ hours} = \mathbf{2.7\ hours}\ (\text{nearest tenth})$$

Technically, you have an answer, **2.7 hours**, for part (a). Some nursing instructors might want you to break this down into *hours and minutes*. In other words, **2 hours and _______ minutes**.

In the result 2.7 hours, keep the whole amount, 2, to represent *hours*. Convert the decimal portion, 0.7 hours, into minutes. This is done in Step 4 below.

Step 4 Inspect the setup below to see how 0.7 hours was changed into minutes.

$$\frac{0.7\ \cancel{\text{hours}}}{1} \times \frac{60\ \text{minutes}}{1\ \cancel{\text{hour}}} = \frac{42\ \text{minutes}}{1} = \mathbf{42\ minutes}$$

The final answer for part (a) is **2 hours and 42 minutes**.

Step 5 Part (b) 0400 plus 2 hours 42 minutes = 0400 + 2 h 42 min = **0642 or 6:42 a.m.**

Example 2.1.4

A one-liter solution of D5LR is to be infused by IV pump. The pump setting is 125 mL/hour. How long will it take to run out this supply of D5LR?

Step 1 The *quantity of fluid available* is always the starting point in these types of problems.

1 liter will be written in the numerator of the initial fraction. After writing the multiplication symbol and a new fraction bar, write *liter* (L) in the denominator. This will guarantee that *liters* get cancelled-out.

$$\frac{1\text{ L}}{1} \times \frac{\phantom{1000\text{ mL}}}{\text{L}}$$

Goal: **hours**

Step 2 We would like to use the flow rate of 125 mL/hour but the amount of fluid is expressed in *liters*. So first, let's convert *liters* to *milliliters* using **1 L = 1000 mL**.

$$\frac{1\cancel{\text{ L}}}{1} \times \frac{1000\text{ mL}}{1\cancel{\text{ L}}}$$

Step 3 Now that *milliliters* has been introduced, you can use the flow rate of 125 mL/hour.

$$\frac{1\cancel{\text{ L}}}{1} \times \frac{1000\cancel{\text{ mL}}}{1\cancel{\text{ L}}} \times \frac{1\text{ hour}}{125\cancel{\text{ mL}}} = \frac{1000\text{ hours}}{125} = \mathbf{8\ hours}$$

Example 2.1.5

Aminophylline is infusing at 25 mL/hour. The drug is mixed 500 mg in 250 mL D5W. How many milligrams per hour is the patient receiving?

quantity of drug

The goal is to determine $\frac{\text{mg}}{\text{hour}}$.

time

Step 1 The flowrate of 25 mL/hour has the arrangement of *quantity of drug/time* so let's start with that. 25 mL will be written in the numerator and 1 hour in the denominator of the initial fraction.

$$\frac{25\text{ mL}}{1\text{ hour}}$$

Goal: $\frac{\text{mg}}{\text{hour}}$

Step 2 Let's use the drug concentration of 500 mg/250 mL to convert from *milliliters* (mL) to *milligrams* (*mg*).

$$\frac{25\cancel{\text{ mL}}}{1\text{ hour}} \times \frac{500\text{ mg}}{250\cancel{\text{ mL}}}$$

Step 3 *We now have the correct units of measure in the setup,* $\frac{\text{mg}}{\text{hour}}$.

$$\frac{25\cancel{\text{ mL}}}{1\text{ hour}} \times \frac{500\text{ mg}}{250\cancel{\text{ mL}}} = \mathbf{50\ mg\ per\ hour}$$

Example 2.1.6
500 mL of Aminophylline D5W is to be infused at 25 mL/hour. The concentration of the available drug is 105 mg/5 mL. How many milligrams of Aminophylline did the patient receive from this infusion?

The goal is to determine **mg**.

Step 1 The total amount of fluid to be infused, 500 mL, will be the starting point.

$$\frac{500\ \text{mL}}{1}$$

Goal: **mg**

Step 2 Let's use the drug concentration of 105 mg/5 mL to convert from *milliliters* (mL) to *milligrams* (*mg*).

$$\frac{500\ \cancel{\text{mL}}}{1} \times \frac{105\ \text{mg}}{5\ \cancel{\text{mL}}}$$

Step 3 *We now have the correct units of measure in the setup, **mg***.

$$\frac{500\ \cancel{\text{mL}}}{1} \times \frac{105\ \text{mg}}{5\ \cancel{\text{mL}}} = \frac{52{,}500\ mg}{5}\ \mathbf{10,500\ mg}$$

Example 2.1.7
Guidelines suggest that patients with a deep vein thrombosis, receive a maximum of 40,000 units of Heparin per day. A patient is ordered to receive Heparin with a concentration of 100 units/mL-D5% IV at a flow rate of 15 mL/hour.

(a) How many units of Heparin does this patient receive in one day?
(b) Based on the maximum dosage guidelines, is this a safe dose for the patient?

For part (a) the goal is to determine $\frac{\text{units}}{\text{day}}$.

quantity of drug

time

Step 1 The flowrate of 15 mL/hour has the arrangement of *quantity of drug/time* so let's start with that. 15 mL will be written in the numerator and 1 hour in the denominator of the initial fraction.

$$\frac{15\ \text{mL}}{1\ \text{hour}}$$

Goal: $\frac{units}{day}$

Step 2 Let's use the drug concentration of 100 units/mL to convert from *milliliters* (mL) to *units*. That takes care of half of our goal.

$$\frac{15\ \cancel{\text{mL}}}{1\ \text{hour}} \times \frac{100\ \text{units}}{1\ \cancel{\text{mL}}}$$

Example 2.1.7 continued

Step 3 *Hours* must be converted to *day* in order to fully achieve the goal of $\frac{\text{units}}{\text{day}}$.

Use **24 hours = 1 day**.

$$\frac{15\ \cancel{\text{mL}}}{1\ \cancel{\text{hour}}} \times \frac{100\ \text{units}}{1\ \cancel{\text{mL}}} \times \frac{24\ \cancel{\text{hours}}}{1\ \text{day}}$$

Step 4 Finish by multiplying the numerators then the denominators. Divide to finish.

$$\frac{15\ \cancel{\text{mL}}}{1\ \cancel{\text{hour}}} \times \frac{100\ \text{units}}{1\ \cancel{\text{mL}}} \times \frac{24\ \cancel{\text{hours}}}{1\ \text{day}} = \frac{36{,}000\ \text{units}}{1\ \text{day}} = \mathbf{36,000\ units\ per\ day}$$

So the answer to part (a) of this question is 36,000 units per day.

To answer part (b), we need to compare this to the maximum recommended dose of Heparin, which is 40,000 units/day. Since we computed that the amount received by the patient is only 36,000 units per day, this is considered a safe dose.

Summary

Clearly there are a variety of drug calculation problems involving flowrates. The key to solving these is knowing which piece of information represents the best starting point for your dimensional analysis setup.

In general, if you need to;

(1) Determine the *total volume of liquid infused* over a certain period of time, start your dimensional analysis with the amount of time (duration of the infusion).

(2) Determine *how long* it will take for a given supply to be infused, start your dimensional analysis setup with the amount of IV fluid that still remains.

(3) Determine an amount of drug infused over a certain amount of time (units/day, mg/hour, etc.), start your dimensional analysis setup with the flowrate.

(4) Determine the *total amount of drug infused when performing a single infusion (like Example 2.1.6)* start with the total amount of fluid to be infused.

Practice Problems

1.) An IV pump is programmed to infuse dextrose 5% at a rate of 75 mL/hour. How many milliliters will the patient receive in a 12 hour shift?

2.) A patient has been prescribed Dobutrex IV, to be infused at 30 mL/hour. Available is Dobutrex 500 mcg/mL-D5%.

(a) How many milliliters (mL) will be infused during an 8-hour shift?
(b) How many micrograms (mcg) of Dobutrex will the patient receive in this 8-hour time period?

3.) Saline solution is infused at a rate of 20 gtts/minute for 45 minutes. The tubing set has a drop factor of 20 gtts/mL. How many milliliters of saline solution will the patient receive?

4.) A patient has been started on a supply 250 mL normal saline. The IV pump is set for 75 mL/hour. How long will it take for the supply to run out? Express your answer in *hours and minutes* (for example, 3 hours 15 minutes).

5.) A drip infusion IV has been setup for a patient. 500 mL of dextrose 5% will be administered at a rate of 50 gtts/minute. The tubing set drop rate is 15 gtts/mL. How long, in *hours and minutes* will it take to use up this supply of dextrose 5%?

6.) 250 mL of Gentamicin 80 mg/100 mL – 0.9% is to be infused IV over 90 minutes. How many milligrams (mg) of Gentamicin will the patient receive?

7.) Heparin is available as 50,000 units/500 mL. If a patient is receiving this IV at a pump setting of 10 mL/hour, how many units is this patient receiving per hour?

8.) A patient is prescribed to receive corticotoprin by IV for 8 hours. The available concentration is 5 units/100 mL. If the IV pump setting is 65 mL/hour, how many units of corticotoprin will the patient receive per hour (nearest tenth)?

Solutions to Practice Problems

1.) An IV pump is programmed to infuse dextrose 5% at a rate of 75 mL/hour. How many milliliters will the patient receive in a 12 hour shift?

$$\frac{12\ \text{ho}\cancel{\text{urs}}}{1} \times \frac{75\ \text{mL}}{1\ \text{ho}\cancel{\text{ur}}} = \frac{900\ \text{mL}}{1} = \mathbf{900\ mL}$$

2.) A patient has been prescribed Dobutrex IV, to be infused at 30 mL/hour. Available is Dobutrex 500 mcg/mL-D5%.

(a) How many milliliters (mL) will be infused during an 8-hour shift?

$$\frac{8\ \text{ho}\cancel{\text{urs}}}{1} \times \frac{30\ \text{mL}}{1\ \text{ho}\cancel{\text{ur}}} = \frac{240\ \text{mL}}{1} = \mathbf{240\ mL}$$

(b) How many micrograms (mcg) of Dobutrex will the patient receive in this 8 hour time period?

$$\frac{8\ \text{ho}\cancel{\text{urs}}}{1} \times \frac{30\ \cancel{\text{mL}}}{1\ \text{ho}\cancel{\text{ur}}} \times \frac{500\ mcg}{1\ \cancel{mL}} = \frac{120{,}000\ \text{mcg}}{1} = \mathbf{120,000\ mcg}$$

3.) Saline solution is infused at a rate of 20 gtts/minute for 45 minutes. The tubing set has a drop factor of 20 gtts/mL. How many milliliters of saline solution will the patient receive?

$$\frac{45\ \cancel{\text{min.}}}{1} \times \frac{20\ \cancel{\text{gtts}}}{1\ \cancel{\text{min.}}} \times \frac{1\ \text{mL}}{20\ \cancel{\text{gtts}}} = \frac{900\ \text{mL}}{20} = \mathbf{45\ mL}$$

4.) A patient has been started on a supply 250 mL normal saline. The IV pump is set for 75 mL/hour. How long will it take for the supply to run out? Express your answer in *hours and minutes* (for example, 3 hours 15 minutes).

$$\frac{250\ \cancel{\text{mL}}}{1} \times \frac{1\ \text{hour}}{75\ \cancel{\text{mL}}} = \frac{250\ \text{mL}}{75} = \mathbf{3.333\ hours}$$

Need to convert 0.333 hours to minutes.

$$\frac{0.333\ \text{ho}\cancel{\text{urs}}}{1} \times \frac{60\ \text{minutes}}{1\ \text{ho}\cancel{\text{ur}}} = \frac{19.98\ \text{minutes}}{1} = \boldsymbol{20\ minutes\ (nearest\ whole\ minute)}$$

Final answer is **3 hours 20 minutes.**

5.) A drip infusion IV has been setup for a patient. 500 mL of dextrose 5% will be administered at a rate of 50 gtts/minute. The tubing set drop rate is 15 gtts/mL. How long, in *hours and minutes* will it take to use up this supply of dextrose 5%?

$$\frac{500\ \cancel{\text{mL}}}{1} \times \frac{15\ \cancel{\text{gtts}}}{1\ \cancel{\text{mL}}} \times \frac{1\ \cancel{\text{min.}}}{50\ \cancel{\text{gtts}}} \times \frac{1\ \text{hour}}{60\ \cancel{\text{min.}}} = \frac{7{,}500\ \text{hours}}{3{,}000} = \mathbf{2.\underline{5}\ hours}$$

Need to convert 0.5 hours to minutes.

$$\frac{0.5\ \cancel{\text{hours}}}{1} \times \frac{60\ \text{minutes}}{1\ \cancel{\text{hour}}} = \frac{30\ \text{minutes}}{1} = \boldsymbol{30\ minutes}$$

Final answer is **2 hours 30 minutes.**

6.) 250 mL of Gentamicin 80 mg/100 mL – 0.9% is to be infused IV over 90 minutes. How many milligrams (mg) of Gentamicin will the patient receive?

$$\frac{250\ \cancel{\text{mL}}}{1} \times \frac{80\ \text{mg}}{100\ \cancel{\text{mL}}} = \frac{20{,}000\ \text{mg}}{100} = \mathbf{200\ mg}$$

<u>NOTE:</u> In this problem, we do not have to start with flowrate because we know the *total amount* of Gentamicin (in milliliters) the patient will receive.

7.) Heparin is available as 50,000 units/500 mL. If a patient is receiving this IV at a pump setting of 10 mL/hour, how many units is this patient receiving per hour?

$$\frac{10\ \cancel{\text{mL}}}{1\ \text{hour}} \times \frac{50{,}000\ \text{units}}{500\ \cancel{\text{mL}}} = \frac{500{,}000\ \text{units}}{500\ \text{hours}} = \mathbf{1{,}000\ units\ per\ hour}$$

8.) A patient is prescribed to receive corticotoprin by IV for 8 hours. The available concentration is 5 units/100 mL. If the IV pump setting is 65 mL/hour, how many units of corticotoprin will the patient receive per hour (nearest tenth)?

$$\frac{65\ \cancel{\text{mL}}}{1\ \text{hour}} \times \frac{5\ \text{units}}{100\ \cancel{\text{mL}}} = \frac{325\ \text{units}}{100\ \text{hours}} = \mathbf{3.3\ units\ per\ hour}$$