Southwest Wisconsin Technical College

Dimensional Analysis in Nursing

Module 1.11

DRUG CALCULATIONS – FLOW RATE (IV DRIP INFUSION)

- **Table of Contents**

Noteworthy

- IV drip infusion flow rates *must* be communicated as $\frac{drops}{minute}$.
- In order to end up with a flow rate, you need to **start** with a flow rate*.

*Or something *close*...see problems 1.11.3, and 1.11.4

Pete Esser
Knox Learning Center Mathematics Instructor
Contact: pesser@swtc.edu

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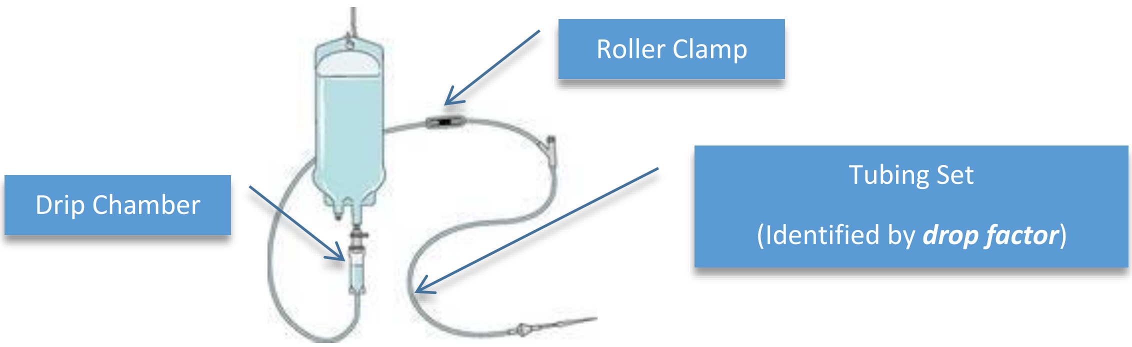
DRUG CALCULATIONS – FLOW RATE (IV DRIP INFUSION)

Introduction

In this module you will work with situations where liquid-based medicines or nutrients are delivered intravenously to a patient over a period of time.

Drip Infusion

The device most often used to do this job is called an infusion pump, however there are situations where **drip infusion** is used. Drip infusion relies on gravity instead of an electronic device to deliver a steady, predictable flow of medicine.



Tubing Sets

Various IV tubing sets are available and they are identified by their **drop factor**.

The drop factor communicates how many drops per milliliter (gtts/mL) you should expect when that particular tubing is selected. For example, *macro* IV **tubing sets** are available in 10, 15, or 20 gtts/mL sizes. *Micro* IV tubing sets are 60 gtts/mL.

The drop factor must be known in order for you to solve flow rate problems involving traditional IVs (drip infusion).

Flow Rate

The goal in any flow rate problem involving drip infusion is to determine **drops per minute**.

Regulating the correct drops per minute is accomplished by the use of a plastic **roller clamp**. The number of drops per minute can be determine by counting the drops occurring in the **drip chamber**. [See the illustration above.]

Abbreviations

From the discussion above you likely noted that *gtts* is the abbreviation for drops, while *gtt* is the abbreviation for drop. The abbreviation *gtt* comes from the Latin word "guttae" which means *drop*.

<u>Example 1.11.1</u>

200 mL of aminophylline is to be delivered IV by drip infusion over the next 2 hours. The tubing drop factor is 15 drops per milliliter (15 gtts/mL). **Determine the correct flow rate expressed in drops per minute (gtts/min).**

Your *goal* is to determine drops per minute: **Goal:** $\frac{\text{gtts}}{\text{min}}$

Step 1 You are looking to compute a flow rate. Flow rates are always in the arrangement of *volume* over *time* (volume/time). You will need to start this problem with information as close as possible to the flow rate goal of *drops per minute*.

We will use 200 mL for the volume, and 2 hours for the time.

volume

$$\frac{200\text{ mL}}{2\text{ hours}}$$

time

Goal: $\frac{\text{gtts}}{\text{min}}$

Step 2 Part of our goal is to have *drops*, not *milliliters*. The information that lets us make that change is the **drop factor** of 15 gtts/mL, which can be thought of as this equivalency; 15 gtts = 1 mL

After writing a multiplication symbol and a fraction bar, we'll put 1 mL in the denominator to force *milliliters* to cancel. 15 gtts will go in the numerator.

$$\frac{200\text{ }\cancel{\text{mL}}}{2\text{ hours}} \times \frac{15\text{ gtts}}{1\text{ }\cancel{\text{mL}}}$$

Goal: $\frac{\text{gtts}}{\text{min}}$

Step 3 The other part of our goal is to have *minutes*. Use the equivalency of 1 hour = 60 minutes. *1 hour* will go in the next numerator in order to cancel out *hours*.

$$\frac{200\text{ }\cancel{\text{mL}}}{2\text{ }\cancel{\text{hours}}} \times \frac{15\text{ gtts}}{1\text{ }\cancel{\text{mL}}} \times \frac{1\text{ }\cancel{\text{hour}}}{60\text{ minutes}}$$

Goal: $\frac{\text{gtts}}{\text{min}}$

Step 4 We now have the correct units of measure in the correct location; *gtts* in the numerator and *minutes* in the denominator. Multiply the numerators together, then the denominators. Divide to finish. The final answer should be expressed to the <u>nearest whole number</u>.

$$\frac{200\text{ }\cancel{\text{mL}}}{2\text{ }\cancel{\text{hours}}} \times \frac{15\text{ gtts}}{1\text{ }\cancel{\text{mL}}} \times \frac{1\text{ }\cancel{\text{hour}}}{60\text{ minutes}} = \frac{3{,}000\text{ gtts}}{120\text{ minutes}} = \mathbf{25\text{ gtts per minute}}$$

<u>Example 1.11.2</u>

100 mL of dopamine is to be infused IV drip infusion over the next 90 minutes. The tubing drop factor is 20 drops per milliliter (20 gtts/mL). **Determine the correct flow rate expressed in drops per minute (gtts/min).**

Your *goal* is to determine drops per minute: **Goal:** $\frac{\text{gtts}}{\text{min}}$

Step 1 Flow rates are always in the arrangement of *volume* over *time* (volume/time). You will need to start this problem with information as close as possible to the flow rate goal of *drops per minute*.

We will use 100 mL for the volume, and 90 minutes for the time.

volume

$$\frac{100\text{ mL}}{90\text{ min}}$$

time

Goal: $\frac{\text{gtts}}{\text{min}}$

Step 2 Let's use the drop factor of 20 gtts/mL (20 gtts = 1 mL) to convert *milliliters* to *drops*.

$$\frac{100\ \cancel{\text{mL}}}{90\text{ min}} \times \frac{20\text{ gtts}}{1\ \cancel{\text{mL}}}$$

Goal: $\frac{\text{gtts}}{\text{min}}$

Step 3 We now have the correct units of measure to communicate the drip infusion flow rate; *gtts* and *minutes*. Multiply the numerators, then denominators. Divide to finish, expressing your answer to the <u>nearest whole number</u>.

$$\frac{100\ \cancel{\text{mL}}}{90\text{ min}} \times \frac{20\text{ gtts}}{1\ \cancel{\text{mL}}} = \frac{2{,}000\text{ gtts}}{90\text{ minutes}} = \mathbf{22\ gtts\ per\ minute}$$

Example 1.11.3

Heparin is to be infused at a rate of 1,500 units per hour continuously by IV drip infusion. Available is Heparin 5,000 units/250 mL. The tubing drop factor is 10 drops per milliliter (10 gtts/mL). **Determine the correct flow rate expressed in drops per minute (gtts/min).**

Your *goal* is to determine drops per minute: **Goal:** $\frac{\text{gtts}}{\text{min}}$

Step 1 You will need to start this problem with information as close as possible to the flow rate goal of *drops per minute*.

We are given an initial rate of 1,500 units per hour. Let's start with that.

quantity

time

$$\frac{1{,}500 \text{ units}}{1 \text{ hour}}$$

Goal: $\frac{\text{gtts}}{\text{min}}$

Step 2 We need to replace *units* with *gtts*. Before we can use the drop factor of 10 gtts/mL, we first need to convert *units* to *milliliters*. We'll use the drug concentration of 5,000 units/250 mL to accomplish this.

$$\frac{1{,}500 \text{ }\cancel{\text{units}}}{1 \text{ hour}} \times \frac{250 \text{ mL}}{5{,}000 \text{ }\cancel{\text{units}}}$$

Goal: $\frac{\text{gtts}}{\text{min}}$

Step 3 Now we can use the drop factor of 10 gtts/mL convert *milliliters* to *gtts*.

Goal: $\frac{\text{gtts}}{\text{min}}$

$$\frac{1{,}500 \text{ }\cancel{\text{units}}}{1 \text{ hour}} \times \frac{250 \text{ }\cancel{\text{mL}}}{5{,}000 \text{ }\cancel{\text{units}}} \times \frac{10 \text{ gtts}}{1 \text{ }\cancel{\text{mL}}}$$

Step 4 The other part of our goal is to have *minutes*. Use the equivalency of 1 hour = 60 minutes.

$$\frac{1{,}500 \text{ }\cancel{\text{units}}}{1 \text{ }\cancel{\text{hour}}} \times \frac{250 \text{ }\cancel{\text{mL}}}{5{,}000 \text{ }\cancel{\text{units}}} \times \frac{10 \text{ gtts}}{1 \text{ }\cancel{\text{mL}}} \times \frac{1 \text{ }\cancel{\text{hour}}}{60 \text{ minutes}}$$

Goal: $\frac{\text{gtts}}{\text{min}}$

Step 5 Finish by multiplying the numerators together, then the denominators. Divide to finish. Your answer should be expressed to the nearest whole number.

$$\frac{1{,}500 \text{ }\cancel{\text{units}}}{1 \text{ }\cancel{\text{hour}}} \times \frac{250 \text{ }\cancel{\text{mL}}}{5{,}000 \text{ }\cancel{\text{units}}} \times \frac{10 \text{ gtts}}{1 \text{ }\cancel{\text{mL}}} \times \frac{1 \text{ }\cancel{\text{hour}}}{60 \text{ minutes}} = \frac{3{,}750{,}00 \text{ gtts}}{300{,}000 \text{ minutes}} = \textbf{13 gtts per min}$$

Example 1.11.4

500 mg of Vancomycin is to be infused IV drip infusion over 45 minutes. The tubing set has a drop factor of 20 gtts/mL. Available is a Vancomycin with a concentration of 750 mg/150 mL-D5%.

Determine the correct flow rate expressed in drops per minute (gtts/min).

$$\textbf{Goal: } \frac{\text{gtts}}{\text{min}}$$

Step 1 Since no initial volume is communicated, we will instead start with a *quantity* of drug and a time. The closest we can get to the goal of drops per minute (gtts/min) is to put *500 mg* in the numerator and *45 minutes* in the denominator.

quantity

time

$$\frac{500\text{ mg}}{45\text{ minutes}}$$

$$\textbf{Goal: } \frac{\text{gtts}}{\text{min}}$$

Step 2 – *Milligrams* will need to be replaced since *gtts* are required for the numerator. Before using the drop factor of 20 gtts/mL, we will first need to convert *milligrams* to *milliliters*. This can be accomplished by using the drug concentration of 750 mg/150 mL.

Note that *750 mg* must be written in the denominator so that *milligrams* cancel-out.

$$\frac{500\ \cancel{\text{mg}}}{45\text{ minutes}} \times \frac{150\text{ mL}}{750\ \cancel{\text{mg}}}$$

$$\textbf{Goal: } \frac{\text{gtts}}{\text{min}}$$

Step 3 – Now the drop factor of 20 gtts/mL can be used to convert *milliliters* to *drops*.

$$\frac{500\ \cancel{\text{mg}}}{45\text{ minutes}} \times \frac{150\ \cancel{\text{mL}}}{750\ \cancel{\text{mg}}} \times \frac{20\text{ gtts}}{1\ \cancel{\text{mL}}}$$

$$\textbf{Goal: } \frac{\text{gtts}}{\text{min}}$$

Step 4 – Since we now have the required units of measure (*gtts* and *minutes*), multiply the numerators together, and then the denominators. Finish by dividing numerator by denominator.

$$\frac{500\ \cancel{\text{mg}}}{45\text{ minutes}} \times \frac{150\ \cancel{\text{mL}}}{750\ \cancel{\text{mg}}} \times \frac{20\text{ gtts}}{1\ \cancel{\text{mL}}} = \frac{1{,}500{,}000\text{ gtts}}{33{,}750\text{ minutes}} = \textbf{44 drops per minute}$$

Practice Problems

Directions – For each problem, use dimensional analysis to determine the flow rate in drops per minute. Your answers should be include the appropriate units of measure and be rounded to the nearest whole number.

1.) 100 mL of dopamine IV drip infusion over the next 3 hours is ordered. The tubing set drop factor is 10 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is _________ gtts/min.

2.) A patient is ordered 250 mL of Aminophylline IV drip infusion over the next 6 hours. The tubing set drop factor is 20 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is _________ gtts/min.

3.) Doctor's orders are for 0.75 liters of NS IV drip infusion over 8 hours. The drop factor for the tubing set used is 15 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is _________ gtts/min.

4.) Doctor's orders are for 0.5 L of D5W IV over 4 hours. The drop factor is 10 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is _________ gtts/min.

5.) Order: 30 mL of Dobutrex IV drip infusion over the next 90 minutes. Tubing set available is a micro drip version which is 60 gtts/mL.

Goal: **gtts/min**

The correct drip infusion flow rate is _________ gtts/min.

6.) Order: 200 mg of Cisplatin IV drip infusion over 6 hours. Drop factor is 15 gtts/mL. Available is a Cisplatin with a concentration of 1 mg/mL.

Goal: **gtts/min**

The correct drip infusion flow rate is _________ gtts/min.

7.) Order: 300 mg of Gentamicin IV drip infusion over 3 hours. Drop factor is 20 gtts/mL. Available is Gentamicin 80 mg/100 mL-0.9%.

Goal: **gtts/min**

The correct drip infusion flow rate is _________ gtts/min.

8.) 500 mg of Gentamicin IV by drip infusion is to be infused over 90 minutes. Drop factor is 10 gtts/mL. Available is Gentamicin 100 mg/100 mL-0.9%.

Goal: **gtts/min**

The correct drip infusion flow rate is _________ gtts/min.

9.) Doctor's orders are for 45 mg of Dopamine per hour, continuous IV drip infusion. Available is Dopamine 800 mcg/mL – D5%. Drop factor is 10 gtts/mL.

Goal: **gtts/min**

The correct drip infusion flow rate is _________ gtts/min.

10.) Order: 2.0 g of Aminophylline IV by drip infusion to be infused over the next 4 hours. Available is Aminophylline 105 mg/5 mL. Drop factor is 60 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is __________ gtts/min.

Solutions to Practice Problems

1.) 100 mL of dopamine IV drip infusion over the next 3 hours is ordered. The tubing set drop factor is 10 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{100\ \text{mL}}{3\ \text{hours}} \times \frac{10\ \text{gtts}}{1\ \text{mL}} \times \frac{1\ \text{hour}}{60\ \text{minutes}} = \frac{1{,}000\ \text{gtts}}{180\ \text{minutes}} = \mathbf{6\ gtts\ per\ minute}$$

2.) A patient is ordered 250 mL of Aminophylline IV drip infusion over the next 6 hours. The tubing set drop factor is 20 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{250\ \text{mL}}{6\ \text{hours}} \times \frac{20\ \text{gtts}}{1\ \text{mL}} \times \frac{1\ \text{hour}}{60\ \text{minutes}} = \frac{5{,}000\ \text{gtts}}{360\ \text{minutes}} = \mathbf{14\ gtts\ per\ minute}$$

3.) Doctor's orders are for 0.75 liters of NS IV drip infusion over 8 hours. The drop factor for the tubing set used is 15 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{0.75\ \text{L}}{8\ \text{hours}} \times \frac{1000\ \text{mL}}{1\ \text{L}} \times \frac{15\ \text{gtts}}{1\ \text{mL}} \times \frac{1\ \text{hour}}{60\ \text{minutes}} = \frac{11{,}250\ \text{gtts}}{480\ \text{minutes}} = \mathbf{23\ gtts\ per\ minute}$$

4.) Doctor's orders are for 0.5 L of D5W IV over 4 hours. The drop factor is 10 gtts/mL.

Goal: **gtts/min**

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{0.5\ \cancel{L}}{4\ \cancel{hours}} \times \frac{1000\ \cancel{mL}}{1\ \cancel{L}} \times \frac{10\ gtts}{1\ \cancel{mL}} \times \frac{1\ \cancel{hour}}{60\ minutes} = \frac{5{,}000\ gtts}{240\ minutes} = \mathbf{21\ gtts\ per\ minute}$$

5.) Order: 30 mL of Dobutrex IV drip infusion over the next 90 minutes. Tubing set available is a micro drip version which is 60 gtts/mL.

Goal: **gtts/min**

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{30\ \cancel{mL}}{90\ minutes} \times \frac{60\ gtts}{1\ \cancel{mL}} = \frac{1{,}800\ gtts}{90\ minutes} = \mathbf{20\ gtts\ per\ minute}$$

6.) Order: 200 mg of Cisplatin IV drip infusion over 6 hours. Drop factor is 15 gtts/mL. Available is a Cisplatin with a concentration of 1 mg/mL.

Goal: **gtts/min**

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{200\ \cancel{mg}}{6\ \cancel{hours}} \times \frac{1\ \cancel{mL}}{1\ \cancel{mg}} \times \frac{15\ gtts}{1\ \cancel{mL}} \times \frac{1\ \cancel{hour}}{60\ minutes} = \frac{3{,}000\ gtts}{360\ minutes} = \mathbf{8\ gtts\ per\ minute}$$

7.) Order: 300 mg of Gentamicin IV drip infusion over 3 hours. Drop factor is 20 gtts/mL. Available is Gentamicin 80 mg/100 mL-0.9%.

Goal: **gtts/min**

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{300\ \cancel{mg}}{3\ \cancel{hours}} \times \frac{100\ \cancel{mL}}{80\ \cancel{mg}} \times \frac{20\ gtts}{1\ \cancel{mL}} \times \frac{1\ \cancel{hour}}{60\ minutes} = \frac{600{,}000\ gtts}{14{,}400\ minutes} = \mathbf{42\ gtts\ per\ minute}$$

8.) 500 mg of Gentamicin IV by drip infusion is to be infused over 90 minutes. Drop factor is 10 gtts/mL. Available is Gentamicin 100 mg/100 mL-0.9%.

Goal: gtts/min

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{500\ \text{mg}}{90\ \text{minutes}} \times \frac{100\ \text{mL}}{100\ \text{mg}} \times \frac{10\ \text{gtts}}{1\ \text{mL}} = \frac{500{,}000\ \text{gtts}}{9{,}000\ \text{minutes}} = \mathbf{56\ gtts\ per\ minute}$$

9.) Doctor's orders are for 45 mg of Dopamine per hour, continuous IV drip infusion. Available is Dopamine 800 mcg/mL – D5%. Drop factor is 10 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{45\ \text{mg}}{1\ \text{hour}} \times \frac{1000\ \text{mcg}}{1\ \text{mg}} \times \frac{1\ \text{mL}}{800\ \text{mcg}} \times \frac{10\ \text{gtts}}{1\ \text{mL}} \times \frac{1\ \text{hour}}{60\ \text{minutes}} = \frac{450{,}000\ \text{gtts}}{48{,}000\ \text{minutes}} = \mathbf{9\ gtts\ per\ minute}$$

10.) Order: 2.0 g of Aminophylline IV by drip infusion to be infused over the next 4 hours. Available is Aminophylline 105 mg/5 mL. Drop factor is 60 gtts/mL.

Goal: gtts/min

The correct drip infusion flow rate is __________ gtts/min.

$$\frac{2.0\ \text{g}}{4\ \text{hours}} \times \frac{1000\ \text{mg}}{1\ \text{g}} \times \frac{5\ \text{mL}}{105\ \text{mg}} \times \frac{60\ \text{gtts}}{1\ \text{mL}} \times \frac{1\ \text{hour}}{60\ \text{minutes}} = \frac{600{,}000\ \text{gtts}}{25{,}200\ \text{minutes}} = \mathbf{24\ gtts\ per\ minute}$$