Southwest Wisconsin Technical College

Dimensional Analysis in Nursing

Module 1.10

DRUG CALCULATIONS – FLOW RATE (INFUSION PUMPS)

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Noteworthy

- *Flow rates*
  Communicate the **volume** of fluid infused over a certain amount of **time**: $\frac{volume}{time}$.
- Units of measure for IV pump infusion: $\frac{mL}{hour}$.
- In order to end up with a flow rate, you need to **start** with a flow rate*.

*Or something *close*...see problems 1.10.3, 1.10.4, and 1.10.5

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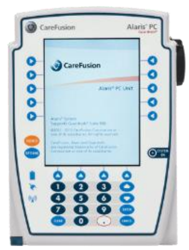
Dimensional Analysis in Nursing

Module 1.10

Drug Calculations – Flow Rate (Infusion Pumps)

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.

The device most often used to do this job is called an infusion pump.



The infusion pump controls the rate of delivery (flow rate) of the liquid. It is typically the responsibility of the nurse to accurately "program" the pump so that it dispenses the correct volume of liquid in the correct amount of time.

The goal in any flow rate problem involving infusion pumps is to determine **milliliters per hour**.

Once you have this information, you will be able to enter it via the infusion pump control panel.

Review
Since our topic area involves flow rates, please review Module 1.3 if you wish to review the general skills needed to solve rate problems.

Example 1.10.1
160 mL of aminophylline is to be infused IV over the next 8 hours. **Your job is to program the infusion pump, in *milliliters per hour* to carry out this order.**

Your *goal* is to determine milliliters per hour: **Goal:** $\frac{\text{mL}}{\text{hr}}$

Step 1 You want to start this problem with information as close as possible to the goal (mL/hr). Because you have *160 mL* and *8 hours* you can start with them in the order shown below.

Since you have the same units as the goal, divide to finish the problem.

volume → 160 mL
time → 8 hour

$$\frac{160\ \text{mL}}{8\ \text{hour}} = \mathbf{20\ mL\ per\ hour}$$

Goal: $\frac{\text{mL}}{\text{hr}}$

<u>Example 1.10.2</u>

75 mL of dopamine is to be infused IV over the next 90 minutes. **Your job is to program the infusion pump, in *<u>milliliters per hour</u>* to carry out this order.**

Your *goal* is to determine milliliters per hour: **Goal:** $\frac{\text{mL}}{\text{hr}}$

Step 1 Let's start by setting up with units of measure that are as close as possible to the goal. *75 mL* will be positioned in the numerator and *90 minutes* will be placed in the denominator.

volume → $\frac{75\text{ mL}}{90\text{ min}}$ ← time

Goal: $\frac{\text{mL}}{\text{hr}}$

Step 2 We already have the required units of measure (*milliliters*) in the numerator. However *minutes* must be changed to *hours*. Use **1 hour = 60 minutes**.

$$\frac{75\text{ mL}}{90\text{ }\cancel{\text{min}}} \times \frac{60\text{ }\cancel{\text{min}}}{1\text{ hour}}$$

In order to cancel-out "minutes", **60 min** must be in the numerator.

Goal: $\frac{\text{mL}}{\text{hr}}$

Step 3 We have achieved the required units of measure. *Milliliters* on top and *hours* on the bottom. Multiply the numerators, then the denominators. Divide to finish the problem.

$$\frac{75\text{ mL}}{90\text{ }\cancel{\text{min}}} \times \frac{60\text{ }\cancel{\text{min}}}{1\text{ hour}} = \frac{4500\text{ mL}}{90\text{ hours}} = \mathbf{50\text{ mL per hour}}$$

<u>**Example 1.10.3**</u>
Heparin sodium is to be infused at 1000 units per hour, IV.
Available is a heparin sodium solution with a concentration of 50,000 units per 500 mL.

The infusion pump setting should be _________ mL/hour.

Goal: $\frac{\text{mL}}{\text{hr}}$

Step 1 Begin with measurement information that is as close as possible to the goal. We will start with a *quantity* of medicine (*1000 units*) in the numerator and a *time* (*1 hour*) in the denominator.

quantity → $\frac{1000 \text{ units}}{1 \text{ hour}}$ ← time

Goal: $\frac{\text{mL}}{\text{hr}}$

Step 2 – The goal is to end up with *milliliters per hours*.

We already have *hours*, so we're halfway to meeting our goal.

Units need to be converted to *mL* however. We will use the available drug concentration of *50,000 units* per *500 mL* (**50,000 units = 500 mL**) to convert *units* to *milliliters.*
Note that *50,000 units* must be written in the denominator so that *units* cancel-out.

$$\frac{1000 \text{ units}}{1 \text{ hour}} \times \frac{500 \text{ mL}}{50{,}000 \text{ units}}$$

Note how this arrangement forces **units** to cancel-out.

Goal: $\frac{\text{mL}}{\text{hr}}$

Step 3 – The goal of achieving *milliliters per hour* has been accomplished because the only units of measure remaining are *mL* on top and *hours* on the bottom.

Multiply the numerators together, then multiply the denominators. Finish by dividing numerator by denominator.

$$\frac{1000 \text{ units}}{1 \text{ hour}} \times \frac{500 \text{ mL}}{50{,}000 \text{ units}} = \frac{500{,}000 \text{ mL}}{50{,}000 \text{ hours}} = \mathbf{10 \text{ mL/hr}}$$

<u>Example 1.10.4</u>

500 mg of Vancomycin is to be infused IV over 50 minutes.
Available is a Vancomycin with a concentration of 750 mg/150 mL-D5%.

The infusion pump setting should be _________ mL/hour.

$$\textbf{Goal: } \frac{\text{mL}}{\text{hr}}$$

Step 1 We need to start with a quantity of drug and a time. The closest we can get to the goal of mL/hr is to put *500 mg* in the numerator and *50 minutes* in the denominator.

quantity

time

$$\frac{500\text{ mg}}{50\text{ minutes}}$$

$$\textbf{Goal: } \frac{\text{mL}}{\text{hr}}$$

Step 2 – Note that <u>both</u> units of measure will need to be converted. Since you can only pursue one unit of measure at a time, let's convert *mg* to *mL*. To do this, use the concentration of the drug which is, *750 mg/150 mL*. This will be treated as the equivalency **750 mg = 150 mL**.

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

$$\frac{500\text{ }\cancel{\text{mg}}}{50\text{ minutes}} \times \frac{150\text{ mL}}{750\text{ }\cancel{\text{mg}}}$$

$$\textbf{Goal: } \frac{\text{mL}}{\text{hr}}$$

Step 3 – Now let's convert *minutes* to *hours* by using **1 hour = 60 minutes**. Note that *60* minutes is positioned in the numerator to force *minutes* to cancel-out.

Since we now have the required units of measure (*mL* and *hours*), multiply the numerators together, and then the denominators. Finish by dividing numerator by denominator.

$$\frac{500\text{ }\cancel{\text{mg}}}{50\text{ }\cancel{\text{minutes}}} \times \frac{150\text{ mL}}{750\text{ }\cancel{\text{mg}}} \times \frac{60\text{ }\cancel{\text{minutes}}}{1\text{ hour}} = \frac{4{,}500{,}000\text{ mL}}{37{,}500\text{ hours}} = \mathbf{120\ mL/hr}$$

Example 1.10.5

Prescription: Infuse 500 mg of dopamine in 250 mL of D5W over 90 minutes.

The infusion pump setting should be _________ mL/hour.

$$\textbf{Goal: } \frac{\text{mL}}{\text{hr}}$$

This problem ***appears*** to be similar to Example 1.10.4, but it has one crucial difference.

The information; “500 mg of dopamine”, seems important, but we won’t use it in our computation.

This is because we are told the dopamine is mixed **into** the 250 mL of D5W. This assures us that the patient will get the correct amount of dopamine. Knowing this lets us shift our focus to the amount fluid to be infused; 250 mL.

Step 1 We can start our setup with a flow rate. This is a best-case scenario. We’ll put *250 mL* in the numerator and *90 minutes* in the denominator.

volume → numerator; time → denominator

$$\frac{250 \text{ mL}}{90 \text{ min}}$$

$$\textbf{Goal: } \frac{\text{mL}}{\text{hr}}$$

Step 2 – We already have mL which is one of the required units of measure. That means we only need to convert *minutes* to *hours*. We’ll do that with the equivalency **1 hour = 60 minutes**.

Note that 60 minutes must be written in the numerator so that *minutes* cancel-out.

$$\frac{250 \text{ mL}}{90 \text{ }\cancel{\text{min}}} \times \frac{60 \text{ }\cancel{\text{min}}}{1 \text{ hour}}$$

$$\textbf{Goal: } \frac{\text{mL}}{\text{hr}}$$

Step 3 – Since we now have the required units of measure (*mL* and *hours*), multiply the numerators together, and then the denominators. Finish by dividing numerator by denominator.

$$\frac{250 \text{ mL}}{90 \text{ }\cancel{\text{min}}} \times \frac{60 \text{ }\cancel{\text{min}}}{1 \text{ hour}} = \frac{15{,}000 \text{ mL}}{90 \text{ hours}} = \mathbf{166.7 \text{ mL per hour}}$$

$$\textbf{Goal: } \frac{\text{mL}}{\text{hr}}$$

Practice Problems

Directions – For each problem, use dimensional analysis to determine the flow rate in milliliters per hour. Your answers should include the appropriate units of measure.

1.) 80 mL of dopamine is to be infused IV over the next 4 hours.
The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: **mL/hour**

2.) 250 mL of Aminophylline is to be infused IV over the next 8 hours.
The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: **mL/hour**

3.) Doctor's orders are for 0.5 liters of NS IV over 8 hours.

The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: **mL/hour**

4.) Doctor's orders are for 0.25 L of D5W IV over 3 hours.

The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: **mL/hour**

5.) 27 mL of Dobutrex is to be infused IV over the next 90 minutes.
The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: **mL/hour**

6.) 150 mg of Cisplatin IV is to be infused over 6 hours
Available is a Cisplatin with a concentration of 1 mg/mL.

The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: **mL/hour**

7.) 400 mg of Gentamicin IV is in 500 mL NS. It is to be infused over 2 hours.

<u>Goal:</u> mL/hour

The infusion pump setting should be ________ mL/hour (nearest tenth).

8.) 500 mg of Gentamicin IV is to be infused over 90 minutes.
Available is Gentamicin 100 mg/100 mL-0.9%.

<u>Goal:</u> mL/hour

The infusion pump setting should be ________ mL/hour (nearest tenth).

9.) 48 mg of Dopamine per hour, IV, is to be delivered with continuous IV infusion.
Available is Dopamine 800 mcg/mL – D5%

<u>Goal:</u> mL/hour

The infusion pump setting should be ________ mL/hour (nearest tenth).

10.) 2.1 g of Aminophylline IV in 1 liter of D5W is to be infused over the next 5 hours.

<u>Goal:</u> mL/hour

The infusion pump setting should be ________ mL/hour (nearest tenth).

Solutions to Practice Problems

1.) 80 mL of dopamine is to be infused IV over the next 4 hours.
The infusion pump setting should be ________ mL/hour.

Goal: mL/hour

$$\frac{80\text{ mL}}{4\text{ hours}} = \mathbf{20\ mL\ per\ hour}$$

2.) 250 mL of Aminophylline is to be infused IV over the next 8 hours.
The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: mL/hour

$$\frac{250\text{ mL}}{8\text{ hours}} = \mathbf{31.3mL\ per\ hour}$$

3.) Doctor's orders are for 0.5 liters of NS IV over 8 hours.

The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: mL/hour

$$\frac{0.5\text{ L}}{8\text{ hours}} \times \frac{1000\text{ mL}}{1\text{ L}} = \frac{500\text{ mL}}{8\text{ hours}} = \mathbf{62.5\ mL\ per\ hour}$$

4.) Doctor's orders are for 0.25 L of D5W IV over 3 hours.

The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: mL/hour

$$\frac{0.25\text{ L}}{3\text{ hours}} \times \frac{1000\text{ mL}}{1\text{ L}} = \frac{250\text{ mL}}{3\text{ hours}} = \mathbf{83.3\ mL\ per\ hour}$$

5.) 27 mL of Dobutrex is to be infused IV over the next 90 minutes.
The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: mL/hour

$$\frac{27\text{ mL}}{90\text{ minutes}} \times \frac{60\text{ minutes}}{1\text{ hour}} = \frac{1620\text{ mL}}{90\text{ hours}} = \mathbf{18\ mL\ per\ hour}$$

6.) 150 mg of Cisplatin IV is to be infused over 6 hours
Available is a Cisplatin with a concentration of 1 mg/mL.

The infusion pump setting should be ________ mL/hour (nearest tenth).

Goal: mL/hour

$$\frac{150\text{ mg}}{6\text{ hours}} \times \frac{1\text{ mL}}{1\text{ mg}} = \frac{150\text{ mL}}{6\text{ hours}} = \mathbf{25\ mL\ per\ hour}$$

7.) 400 mg of Gentamicin IV is in 500 mL NS. It is to be infused over 2 hours. Available is Gentamicin 80 mg/100 mL-0.9%.

Goal: mL/hour

The infusion pump setting should be ________ mL/hour (nearest tenth).

$$\frac{500\text{ mL}}{2\text{ hours}} = \mathbf{250\ mL\ per\ hour}$$

8.) 500 mg of Gentamicin IV is to be infused over 90 minutes. Available is Gentamicin 100 mg/100 mL-0.9%.

Goal: mL/hour

The infusion pump setting should be ________ mL/hour (nearest tenth).

$$\frac{500\text{ mg}}{90\text{ minutes}} \times \frac{100\text{ mL}}{100\text{ mg}} \times \frac{60\text{ minutes}}{1\text{ hour}} = \frac{3{,}000{,}000\text{ mL}}{9{,}000\text{ hours}} = \mathbf{333.3\ mL\ per\ hour}$$

9.) 48 mg of Dopamine per hour, IV, is to be delivered with continuous IV infusion. Available is Dopamine 800 mcg/mL – D5%

Goal: mL/hour

The infusion pump setting should be ________ mL/hour (nearest tenth).

$$\frac{48\text{ mg}}{1\text{ hour}} \times \frac{1000\text{ mcg}}{1\text{ mg}} \times \frac{1\text{ mL}}{800\text{ mcg}} = \frac{48{,}000\text{ mL}}{800\text{ hours}} = \mathbf{60\ mL\ per\ hour}$$

10.) 2.1 g of Aminophylline IV in 1 liter of D5W is to be infused over the next 5 hours.

Goal: mL/hour

The infusion pump setting should be ________ mL/hour (nearest tenth).

$$\frac{1\text{ liter}}{5\text{ hours}} \times \frac{1000\text{ mL}}{1\text{ liter}} = \frac{1{,}000\text{ mL}}{5\text{ hours}} = \mathbf{200\ mL\ per\ hour}$$