Southwest Wisconsin Technical College

Dimensional Analysis in Nursing

Module 2.2

DRUG CALCULATIONS - DILUTING A PRESCRIBED DRUG TO A SPECIFIED CONCENTRATION

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Noteworthy

- On occasion, you will be required to *reduce the concentration* of an available drug before delivery to the patient.
- Your job is to determine the *amount of water* needed to dilute the medication.
- You will use a quick three-step procedure to compute the diluent (water) needed.

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Dimensional Analysis in Nursing

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DRUG CALCULATIONS - DILUTING A PRESCRIBED DRUG TO A SPECIFIED CONCENTRATION

Introduction

Sometimes when a drug is prescribed, you will find the concentration of the drug you have on-hand does not match the concentration required for delivery to your patient.

> Drug: **Naloxone**
> Concentration of available drug: **1 mg/mL**
> Required concentration for delivery to patient: **10 mcg/mL**

In this example, the concentration of the available drug (1 mg/mL) is *much higher* than the required concentration.

How do you fix that? To achieve the required lower concentration of 10 mcg/mL, you will need to **dilute** the measured-out drug.

Dilution is accomplished by mixing a specific amount of **diluent** (usually sterile water or 0.9% NaCl) to the drug that you have measured out. *This is what you will be required to compute* --- the correct amount of diluent needed to reduce the available drug's concentration to the required level.

When done correctly, you will have the correct amount of drug at the required concentration.

Computational Procedure

Follow the three-step process below to determine the amount of diluent needed to dilute a drug to a required concentration. Examples 2.2.1 and 2.2.2 walk you through this procedure.

Step 1) Use the doctor's order and the concentration of the *available drug* to determine the milliliters required to give the patient.

Step 2) Use the doctor's order and the *required concentration* to determine the milliliters required to give the patient.

Step 3) How much diluent do you need to reduce the concentration of the measured-out drug you have? This is found by subtracting;

Step 2) Answer – Step 1) Answer = Diluent Required

Example 2.2.1

The doctor's order is midazolam IV 3 mg for a 60 kg patient.
The dosage strength of the available medicine is 5 mg/ml.

The drug reference information for midazolam indicates:

Direct IV: Concentration 1 mg/mL

- *How much diluent* should be added to the medicine to achieve the required concentration?

Step 1 - Determine how many milliliters of midazolam are required based on the available drug.

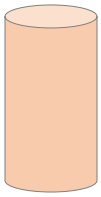
Doctor's order is 3 mg and the available drug concentration is 5 mg/mL.

$$\frac{3\ \cancel{\text{mg}}}{1} \times \frac{1\ \text{mL}}{5\ \cancel{\text{mg}}} = \frac{3\ \text{mL}}{5} = \mathbf{0.6\ mL}$$

If you measure-out this quantity, you have just guaranteed that the patient will get 3 mg of drug. The problem is that the concentration is too high (5 mg/mL versus 1 mg/mL).

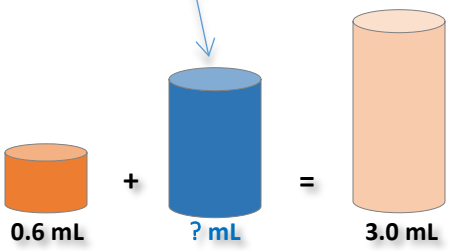
Step 2 - Now determine the milliliters of drug required *as if it really is available* at the required 1 mg/mL concentration. This step tells you where you need to be once the drug has been prepared correctly.

$$\frac{3\ \cancel{\text{mg}}}{1} \times \frac{1\ \text{mL}}{1\ \cancel{\text{mg}}} = \frac{3\ \text{mL}}{1} = \mathbf{3\ mL}$$



Step 3 The results for ***both*** Step 1 and Step 2 provide 3 mg of drug for the patient.

The question now is, "*How much diluent must be added to the measured-out volume of 0.6 mL to arrive at a final volume of 3 mL*?"



Step 3 (continued)

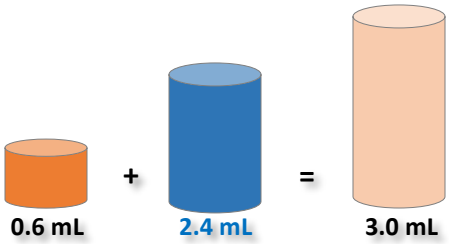
By *subtracting* the two volumes you computed in Step 1) and Step 2), you can determine the amount of diluent required to reduce the concentration to 1 mg/mL:

Step 2) Answer – Step 1) Answer = Diluent Required

3 mL – 0.6 mL = **2.4 mL** of diluent needed.

Summary: If you measure 0.6 mL of the available drug, *adding 2.4 mL of diluent** will reduce the concentration to 1 mg/mL.

*As noted earlier, sterile water or 0.9% NaCl are typical diluents.



Example 2.2.2

The doctor's order is naloxone IV 0.05 mg.
The dosage strength of the available medicine is 1 mg/mL.

The drug reference information for naloxone indicates:
Direct IV: Concentration 10 mcg/mL

- *How much diluent* should be added to the medicine to achieve the required concentration?

Step 1 Determine how many milliliters of naloxone are required based on the original concentration.
Doctor's order is 0.05 mg and the initial drug concentration is 1 mg/mL.

$$\frac{0.05\ \text{mg}}{1} \times \frac{1\ \text{mL}}{1\ \text{mg}} = \frac{0.05\ \text{mL}}{1} = \mathbf{0.05\ mL}$$

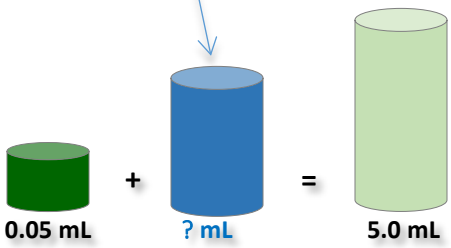
If you measure-out this quantity, you have just guaranteed that the patient will get 0.05 mg of drug. The problem is that the concentration is too high (1 mg/mL versus 10 mcg/mL).

Step 2 Now determine the milliliters of drug required *as if it really is available* at the required 10 mcg/mL concentration.

$$\frac{0.05\ \text{mg}}{1} \times \frac{1000\ \text{mcg}}{1\ \text{mg}} \times \frac{1\ \text{mL}}{10\text{mcg}} = \frac{50\ \text{mL}}{10} = \mathbf{5\ mL}$$

Step 3 The results for ***both*** Step 1 and Step 2 provide 0.05 mg of drug for the patient.

The question now is, "*How much diluent must be added to the measured-out volume of 0.05 mL to arrive at a final volume of 5 mL*?"

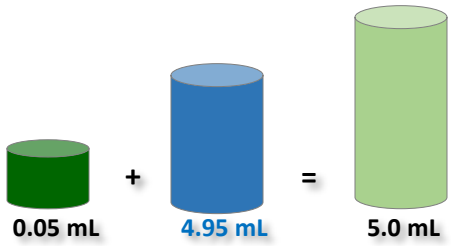


By subtracting the two volumes you computed in Step 1) and Step 2), you can determine the amount of diluent required to reduce the concentration to 10 mcg/mL:

Step 2) Answer – Step 1) Answer = Diluent Required

5 mL – 0.05 mL = **4.95 mL** of diluent needed.

Summary: If you measure 0.05 mL of this drug at the on-hand concentration of 1 mg/mL, *adding 4.95 mL of diluent* will lower the concentration to 10 mcg/mL.



Practice Problems

1.) The doctor's order is furosemide IV 40 mg.

Available is furosemide 10 mg/mL.

The drug reference information for furosemide indicates:
Direct IV: Concentration 4 mg/mL

- *How much diluent* should be added to the medicine to achieve the required concentration?

2.) The doctor's order is midazolam IV 2.4 mg for a 48 kg patient.

The dosage strength of the available medicine is 2 mg/ml.

The drug reference information for midazolam indicates:
Direct IV: Concentration 1 mg/mL

- *How much diluent* should be added to the medicine to achieve the required concentration?

3.) Doctor's order; pentazocine 60 mg IM or subcutaneously.

Available is pentazocine 30 mg/mL.

The drug reference information for pentazocine indicates IM injection concentration should be 10 mg/mL

- *How much diluent* should be added to the medicine to achieve the required concentration?

4.) 300 mg natalizumab once every 28 days is prescribed for a patient with a relapsing form of MS.

The concentration of the drug is initially 300 mg/15 mL.

You are required to dilute natalizumab down to a concentration of 2.6 mg/mL before administering to the patient by IV.

- *How much diluent* should be added to the medicine to achieve the required concentration?

5.) 1 g of magnesium sulfate is to be administered to a patient by IV.

As supplied, you have what is called a 50% solution of magnesium sulfate, which turns out to have a concentration of 1 g/2 mL.

You are required to dilute this down to a 20% solution which is 1 g/5 mL.

- *How much diluent* should be added to the medicine to achieve the required concentration?

Solutions to Practice Problems

1.) The doctor's order is furosemide IV 40 mg.

Available is furosemide 10 mg/mL.

The drug reference information for furosemide indicates:

Direct IV: Concentration 4 mg/mL

- *How much diluent* should be added to the medicine to achieve the required concentration?

Step 1 Determine how many milliliters of furosemide are required based on the original concentration.

Doctor's order is 40 mg and the initial drug concentration is 10 mg/mL.

$$\frac{40\ \text{mg}}{1} \times \frac{1\ \text{mL}}{10\ \text{mg}} = \frac{40\ \text{mL}}{10} = \mathbf{4\ mL}$$

Step 2 Now determine the milliliters of drug required *as if it really is available* at the required 4 mg/mL concentration.

$$\frac{40\ \text{mg}}{1} \times \frac{1\ \text{mL}}{4\ \text{mg}} = \frac{40\ \text{mL}}{4} = \mathbf{10\ mL}$$

Step 3 Subtract the two results to determine the diluent required:

10 mL – 4 mL = **6 mL** of diluent.

Summary: To administer the correct amount of medicine at the required concentration, measure-out 4 mL of furosemide from the available supply. Add 6 mL of diluent to reduce the concentration to 10 mL/mg.

2.) The doctor's order is midazolam IV 2.4 mg for a 48 kg patient.

The dosage strength of the available medicine is 2 mg/ml.

The drug reference information for midazolam indicates:

Direct IV: Concentration 1 mg/mL

- *How much diluent* should be added to the medicine to achieve the required concentration?

Step 1 Determine how many milliliters of midazolam are required based on the original concentration.

Doctor's order is 2.4 mg and the initial drug concentration is 2 mg/mL.

$$\frac{2.4\ \cancel{\text{mg}}}{1} \times \frac{1\ \text{mL}}{2\ \cancel{\text{mg}}} = \frac{2.4\ \text{mL}}{2} = \mathbf{1.2\ mL}$$

Step 2 Now determine the milliliters of drug required *as if it really is available* at the required 1 mg/mL concentration.

$$\frac{2.4\ \cancel{\text{mg}}}{1} \times \frac{1\ \text{mL}}{1\ \cancel{\text{mg}}} = \frac{2.4\ \text{mL}}{1} = \mathbf{2.4\ mL}$$

Step 3 Subtract the two results to determine the diluent required:

2.4 mL – 1.2 mL = **1.2 mL** of diluent.

Summary: To administer the correct amount of medicine at the required concentration, measure-out 1.2 mL of midazolam from the available supply. Add 1.2 mL of diluent to reduce the concentration to 1 mL/mg.

3.) Doctor's order; pentazocine 60 mg IM or subcutaneously.

Available is pentazocine 30 mg/mL.

The drug reference information for pentazocine indicates IM injection concentration should be 10 mg/mL.

- *How much diluent* should be added to the medicine to achieve the required concentration?

Step 1 Determine how many milliliters of pentazocine are required based on the original concentration. Doctor's order is 60 mg and the initial drug concentration is 30 mg/mL.

$$\frac{60\ \cancel{mg}}{1} \times \frac{1\ mL}{30\ \cancel{mg}} = \frac{60\ mL}{30} = \mathbf{2\ mL}$$

Step 2 Now determine the milliliters of drug required *as if it really is available* at the required 10 mg/mL concentration.

$$\frac{60\ \cancel{mg}}{1} \times \frac{1\ mL}{10\ \cancel{mg}} = \frac{60\ mL}{10} = \mathbf{6\ mL}$$

Step 3 Subtract the two results to determine the diluent required:

6 mL – 2 mL = **4 mL** of diluent.

Summary: To administer the correct amount of medicine at the required concentration, measure-out 2 mL of pentatzocine from the available supply. Add 4 mL of diluent to reduce the concentration to 10 mL/mg.

4.) 300 mg natalizumab once every 28 days is prescribed for a patient with a relapsing form of MS.

The concentration of the drug is initially 300 mg/15 mL.

You are required to dilute natalizumab down to a concentration of 2.6 mg/mL before administering to the patient by IV.

- *How much diluent* should be added to the medicine to achieve the required concentration?

Step 1 Determine how many milliliters of natalizumab are required based on the original concentration. Doctor's order is 300 mg and the initial drug concentration is 300 mg/15mL.

$$\frac{300\ \cancel{mg}}{1} \times \frac{15\ mL}{300\ \cancel{mg}} = \frac{4500\ mL}{300} = \mathbf{15\ mL}$$

Step 2 Now determine the milliliters of drug required *as if it really is available* at the required 2.6 mg/mL concentration.

$$\frac{300\ \cancel{mg}}{1} \times \frac{1\ mL}{2.6\ \cancel{mg}} = \frac{300\ mL}{2.6} = \mathbf{115\ mL}\ \text{(nearest whole amount)}$$

Step 3 Subtract the two results to determine the diluent required:

115 mL – 15 mL = **100 mL** of diluent.

Summary: To administer the correct amount of medicine at the required concentration, measure-out 15 mL of natalizumab from the available supply. Add 100 mL of diluent to reduce the concentration to 2.6 mL/mg.

5.) 1 g of magnesium sulfate is to be administered to a patient by IV.

As supplied, you have what is called a 50% solution of magnesium sulfate, which turns out to have a concentration of 1 g/2 mL.

You are required to dilute this down to a 20% solution which is 1 g/5 mL.

- *How much diluent* should be added to the medicine to achieve the required concentration?

Step 1 Determine how many milliliters of magnesium sulfate are required based on the original concentration. Doctor's order is 1 g and the initial drug concentration is 1 g/2 mL.

$$\frac{1\,\text{g}}{1} \times \frac{2\text{ mL}}{1\,\text{g}} = \frac{2\text{ mL}}{1} = \mathbf{2\ mL}$$

Step 2 Now determine the milliliters of drug required *as if it really is available* at the required 1 g/5 mL concentration.

$$\frac{1\,\text{g}}{1} \times \frac{5\text{ mL}}{1\,\text{g}} = \frac{5\text{ mL}}{1} = \mathbf{5\ mL}$$

Step 3 Subtract the two results to determine the diluent required:

5 mL – 2 mL = **3 mL** of diluent.

Summary: To administer the correct amount of medicine at the required concentration, measure-out 2 mL of magnesium sulfate from the available supply. Add 3 mL of diluent to reduce the concentration to 1 g/5 mL.