Chapter 18

Powder Volume Calculations

An oddity of understanding this chapter is that you'll realize that Bill Cosby lied when he said, "There's always room for JELL-O."

--Sean Parsons

As we start this chapter we should take a moment and consider why some medications come in lyophilized (freeze-dried) powders. The reasons are fairly straight forward such as improved stability, longer expiration, and easier storage with concern to temperature requirements. There are some concepts we need to thoroughly address in this chapter such as:

- powder volume,
- diluent volume,
- total volume,
- final concentration, and
- how to obtain different concentrations.

As this chapter is obviously primarily focused on powder volume we should explore this concept. The volume or space that the powdered drug occupies after it is reconstituted is called powder volume. For some drugs, the powder volume is so small that it is considered negligible. Other drugs have substantial powder volume which needs to be taken into consideration when reconstituting.

A common comparison is that most people do not leave significant, if any, room for the sugar they add to their morning coffee. In this scenario we can say that powder volume is negligible. But an interesting experiment to do is to take two containers that can hold three liters of volume. In one container add enough gelatin mix to make three liters of gelatin. In the other container fill it with three liters of fluid. Then using a funnel add all the water from the one container to the other one with the gelatin. If you pour out all the fluid a significant amount of fluid will spill everywhere. In this case we can say that the gelatin mix has a significant amount of powder volume that we should have accounted for.

From this basic idea we can ascertain the following formula:

$$\text{Powder Volume} + \text{Diluent Added} = \text{Total Volume}$$

We should consider several different ways that we can find powder volume. Sometimes the package insert or vials will tell you. Other times you will be told how much to reconstitute it with and be given either the concentration or the total volume. From there you can find the powder volume by taking the total volume and subtracting the amount of diluent added.

Without wanting to over explain a simple concept, let's go to the next page and look at an example problem.

Example:

If 95 mL of sterile water for injection (SWFI) is added to a 10 g bulk powdered drug pharmacy container, the concentration obtained is 100 mg/mL. What is the powder volume of the drug?

QUESTION

What is the powder volume of the drug?

DATA

95 mL SWFI added (this is the diluent added)
10 g powdered drug (this is the weight of drug)
100 mg/mL (this is our final concentration)

FORMULA/METHOD

Powder Volume
+ Diluent Added
Total Volume

MATH

We know the diluent added is 95 mL, and since we have the weight of the drug in the vial and the final concentration after reconstitution we can find the total volume as follows:

$$\frac{\text{mL}}{100\,\text{mg}} \times \frac{1000\,\text{mg}}{1\,\text{g}} \times \frac{10\,\text{g}}{1} = 100\,\text{mL}$$ total volume, often referred to as final volume.

Powder Volume = ???
+ Diluent Added = 95 mL
Total Volume = 100 mL

$100\,\text{mL} - 95\,\text{mL} = \mathbf{5\,mL\ Powder\ Volume}$

DOES THE ANSWER MAKE SENSE

Yes

It is noteworthy focusing on how we obtained the total volume. The final concentration and the quantity of drug in the vial are both reflective of what will be in the vial immediately after reconstitution is complete and therefore are appropriate to use when determining the total volume in the vial after reconstitution.

Now, you should attempt some problems to ensure that the concepts are making sense thus far.

Practice Problems:

1) You want to prepare a 500 mg dose of ceftriaxone for IM injection. If you reconstitute it with 1.8 ml of 2% lidocaine you attain a concentration of 250 mg/ml. What is the powder volume of the drug?

2) A 20 million unit (MU) vial of penicillin g potassium has 8 mL of powder volume. *(Notice that this problem has already given you the powder volume)*

   a) How many mL will you reconstitute it with to attain a concentration of 500,000 unit/mL? *(Hint: You can use the concentration to determine the total volume, which will be necessary to determine the volume of diluent needed.)*

   b) How many mL of the reconstituted solution will you draw up for a 12 MU dose? *(Hint: This is similar to what you did in Chapter 15, so all you will need is the dose and the concentration to solve this.)*

1) 0.2 mL powder volume 2-a) 32 mL of diluent 2-b) 24 mL

One more concept to cover is the idea of changing the quantity of diluent used to reconstitute a preparation in order to obtain a different concentration. Let's look at an example problem to explain this scenario.

Example:

Ordinarily IVIG is reconstituted to a concentration of 50 mg/mL. To obtain this concentration a 5 g vial is reconstituted with 93 mL of diluent. What is the powder volume for a 5 g vial of IVIG? How much would you reconstitute it with if the patient was fluid restricted and the physician requested a concentration of 100 mg/mL?

To find the powder volume by doing the same steps as we have already done on previous problems. The first step is to determine what the total volume would be, and conveniently the problem already gave us a volume for diluent added if reconstituted to a concentration of 50 mg/mL.

$$\frac{\text{mL}}{50\,\text{mg}} \times \frac{1000\,\text{mg}}{1\,\text{g}} \times \frac{5\,\text{g}}{1} = 100\,\text{mL total volume}$$

Powder Volume = ???
\+ Diluent Added = 93 mL
Total Volume = 100 mL

100 mL – 93 mL = **7 mL powder volume**

Now that we've answered the first question about powder volume we can determine the amount of

diluent to add to obtain the desired concentration of 100 mg/mL. We will once again need to determine the total volume, but this time for our new concentration.

$$\frac{\text{mL}}{100\,\text{mg}} \times \frac{1000\,\text{mg}}{1\,\text{g}} \times \frac{5\,\text{g}}{1} = 50\,\text{mL total volume}$$

Powder Volume = 7 mL
\+ Diluent Added = ???
Total Volume = 50 mL

50 mL – 7 mL = **43 mL of diluent** to obtain the requested concentration.

Now, using the example problem as a template, solve the practice problem below.

Practice Problem:

A 1 g vial of vancomycin ordinarily is reconstituted with 19.5 mL of sterile water for injection (SWFI) to obtain a concentration of 50 mg/mL. What is the powder volume and how much should you reconstitute it with if you needed a concentration of 100 mg/mL?

The vial has 0.5 mL of powder volume and 9.5 mL of SWFI should be used to obtain a concentration of 100 mg/mL.

Worksheet 18-1

Name:

Date:

Solve the following powder volume problems.

1) If 192 mL of sterile water for injection (SWFI) is used to reconstitute a 20 g vial of cefazolin Na, the concentration obtained is 100 mg/mL. What is the powder volume of this drug?

2) Using another 20 g vial of cefazolin Na, how many mL of SWFI should be added to obtain a concentration of 200 mg/mL instead? *(Hint: The powder volume from the previous question is required to solve this.)*

3) A vial contains a combination drug of ampicillin/sulbactam. There is 1 g of ampicillin and 0.5 g of sulbactam in the vial. When the vial is reconstituted with 3.2 mL of sterile water you end up with a total volume of 4.0 mL.

   a) How many mL of powder volume are there?

   b) What is the concentration of each drug?

4) The label on a bottle of oral amoxicillin suspension states you are to add 39 mL of purified or distilled water to the bottle to obtain a suspension with a concentration of 150 mg/tsp. The total amount of active ingredient in the bottle is 2 g. What is the powder volume?

5) The directions for a vial containing 1 g of lyophilized ceftriaxone states that the addition of 3.6 mL of SWFI will yield a solution with a concentration of 250 mg/mL. What is the powder volume of the drug?

6) If you dissolve 5 MU of penicillin with 8 mL of SWFI and you know that this vial contains 2 mL of powder volume, what is the concentration of the drug in the solution?

7) A 4 g vial of a powdered drug is reconstituted with 4.9 mL of SWFI to obtain a concentration of 800 mg/mL.

   a) What is the powder volume of the drug?

   b) If 2.6 mL of the reconstituted solution is added to a 500 mL bag of D5W, how much medication is in the IV bag?

8) If a 20 MU vial of penicillin g potassium has a powder volume of 8 mL, what would be concentration obtained if each of the possible volumes of SWFI listed below were used to reconstitute the vial?

   a) 32 mL

   b) 42 mL

   c) 72 mL

   d) 92 mL

9) You add 4.3 mL of diluent to a 1 g vial and have a final volume of 5 mL.

   a) What is the powder volume?

b) What is the final concentration in mg/mL?

c) How many mL would you need to add to a 50 mL bag of NS if a dose of 250 mg were required.

10) A pharmacists asks you to prepare cefazolin eye drops. You will need to add 9.8 mL of NSS to a 500 mg vial of cefazolin which has 0.2 mL of powder volume according to the package insert. You will draw up 1 mL of the reconstituted solution and filter through a 0.5 micron filter into a sterile eye dropper. Then you will add 9 mL of NSS to the eye dropper (this will also need filtered). What is the final concentration of cefazolin in the eye dropper? *(Hint: You will first need to figure out the concentration of the solution in the vial before you can calculate the concentration in the eye dropper.)*

Worksheet 18-2

Name:

Date:

Solve the following powder volume problems.

1) If 95 mL of sterile water for injection (SWFI) is used to reconstitute a 10 g vial of vancomycin, the concentration obtained is 100 mg/mL. What is the powder volume of this drug?

2) Using another 10 g vial of vancomycin, how many mL of SWFI should be added to obtain a concentration of 200 mg/mL instead?

3) A bulk pharmacy vial contains 40.5 g of a combination drug of Zosyn (piperacillin/tazobactam). There are 36 g of piperacillin and 4.5 g of sulbactam in the vial. When the vial is reconstituted with 152 mL of sterile water you end up with a concentration of 225 mg/mL of piperacillin and tazobactam combined.

   a) What is the powder volume in the vial?

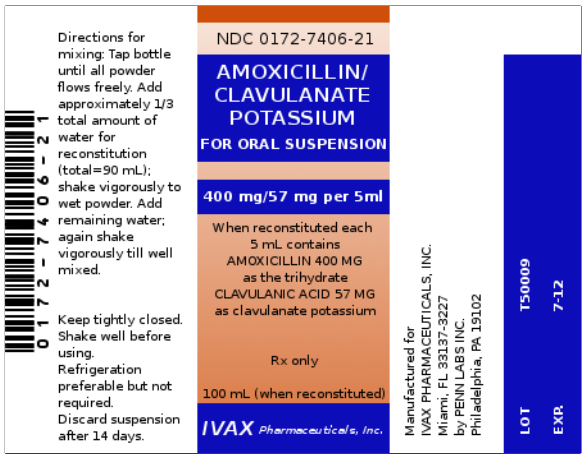
   b) What is the concentration (in mg/mL) of each active ingredient separately?

   c) If a physician ordered 4.5 g of Zosyn (piperacillin/tazobactam) in 100 mL of 0.45% sodium chloride, how many mL would you need to transfer from the bulk vial after reconstitution to the 100 mL minibag?

4) The package insert for a 1 g streptomycin vial instructs you to add 4.2 mL SWFI to obtain a concentration of 200 mg/mL. What is the powder volume for a 1 g vial of sreptomycin powder?

5) If you add 10 mL of SWFI to a 1 g vial of powdered drug that has a powder volume of 0.5 mL, what is the resulting concentration going to be in mg/mL?

6) Review the amoxicillin/clavulanate label below carefully:



a) What is the powder volume?

b) How many grams of amoxicillin are in the bottle?

c) How many grams of clavulanate are in the bottle?

7) The directions for a preparing a vial containing 1 g of lyophilized cefepime HCl for IM injection suggests the addition of 2.4 mL of 1% lidocaine HCl which will yield a solution with a concentration of 280 mg/mL.

a) What is the powder volume of the drug?

b) If a patient required only 500 mg to be given IM, how many mL would be needed to administer the desired dose?

8) An 8 g vial of a powdered drug is reconstituted with 19.6 mL of SWFI to obtain a concentration of 400 mg/mL.

a) What is the powder volume of the drug?

b) If a physician requests that 12 g of the reconstituted solution is to be added to a 500 mL bag of D5W, how many mL will you need to add to the IV bag?

9) If a 10 MU vial of medication has a powder volume of 4 mL, what would be concentration obtained if each of the possible volumes of SWFI listed below were used to reconstitute the vial?

a) 16 mL

b) 21 mL

c) 36 mL

d) 46 mL

10) A 6 g bulk vial of ceftazidime has a final volume of 30 mL when reconstituted with 26 mL.

a) What is the powder volume?

b) What is the concentration in mg/mL?

c) How many mL of the reconstituted solution would be required to fill an order for 2 g of ceftazidime?

11) A 3.2 g vial of Timentin (ticarcillin/clavulanic acid) has 2.2 mL of powder volume.

a) If you reconstitute it with 17.8 mL of SWFI, what is the cocnentration in mg/mL?

b) How many mL of the reconstituted solution will you need for a dose of 1.6 g of Timentin?

12) Ordinarily IVIG is reconstituted to a 5% (w/v) concentration and is available in vials of various quantities. For standard reconstitution a 2.5 g vial is reconstituted with 46.5 mL of diluent, a 5 g vial is reconstituted with 93 mL of diluent, and a 10 g vial is reconstituted with 186 mL of diluent.

a) What does 5% (w/v) mean?

b) How much powder volume is in each size of vial?

c) If a patient needed 27.5 g of IVIG how many of each size vial would be needed to fill this order? (I'm looking for the combination with the fewest possible vials that won't waste any drug.)

d) If the patient is fluid restricted and needs a 10% concentration of the drug instead, how many mL of diluent would you reconstitute each size vial with?

e) What would be the final volume of a 27.5 g solution at a 10% concentration?