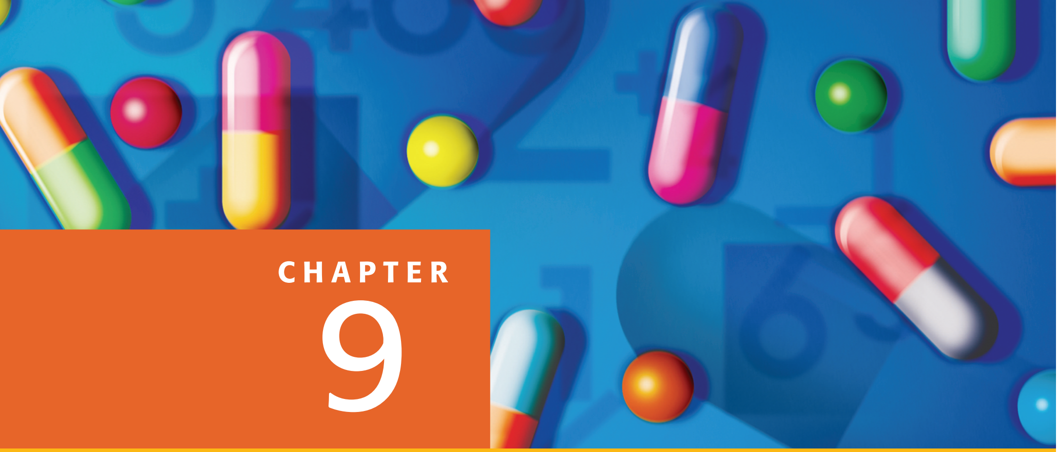


CHAPTER

9

Special Types of Intravenous Calculations

LEARNING OBJECTIVES

1. Amount of drug in a solution
2. Rules and calculations for special IV orders
3. Units/hr, mg/hr, g/hr, mL/hr, mg/min, milliunits/min, mcg/min, mcg/kg/min
4. Use of the body surface nomogram
5. Calculating metres squared for IV medications
6. Special types of calculation: heparin, insulin
7. Patient-controlled analgesia

In Chapter 8, we studied calculations for microdrip and macrodrip factors, the use of the infusion pump, and IVPB orders. In this chapter, we consider calculations for orders written in units, milliunits, milligrams, and micrograms; special types of calculations in relation to continuous heparin infusion and continuous insulin infusion; methods of calculating the safety of doses based on kilograms of body weight and body surface area (BSA); and the handling of orders for patient-controlled analgesia (PCA).

This chapter's dosage calculations are for medications mixed in IV fluids and delivered as continuous infusions. Administering these medications via infusion pumps ensures a correct rate and accuracy of dose (Fig. 9-1). Many infusion pumps can deliver rates less than 1 (e.g., 0.5 mL/hr, 0.25 mL/hr), and they also can be programmed with the amount of drug, amount of solution, patient's weight, and time unit (minutes or hours). Once the pump is set at an infusion rate, the pump calculates how much drug the patient is receiving. The nurse, however, still bears the responsibility for double-checking the calculation and entering the correct information on the infusion pump.

Because many of the medications that infuse via continuous infusions are very potent, small changes in the infusion rate can greatly affect the body's physiologic response. In particular, vasopressor drugs such as dopamine, epinephrine, dobutamine, and Levophed can affect the patient's blood pressure and heart rate, even in small doses. In many hospital settings, the pharmacy prepares medications and IV solutions.

Amount of Drug in a Solution

These calculations can be complicated. One helpful technique is reduction: Start with the entire amount of drug mixed in solution, and then reduce it to the amount of the drug in only 1 mL of solution. Here's an example:

Heparin is mixed 25,000 units in 500 mL D5W.

How much heparin is in 1 mL of fluid?

FIGURE 9-1

Infusion pump. (With permission from Evans-Smith, P. [2005]. *Taylor's clinical nursing skills.* Philadelphia: Lippincott Williams & Wilkins.)

Formula Method

$$\frac{25000 \text{ units}}{500 \text{ mL}} \times 1 \text{ mL} = \text{x}$$

$$50 \text{ units}$$

Proportion Expressed as Two Ratios

$$25000 \text{ units} : 500 \text{ mL} :: \text{x} : 1 \text{ mL}$$

Proportion Expressed as Two Fractions

$$\frac{25000 \text{ units}}{500 \text{ mL}} \times \frac{\text{x}}{1 \text{ mL}}$$

$$25000 = 500\text{x}$$

$$\frac{25000}{500} = \text{x}$$

$$50 \text{ units} = \text{x}$$

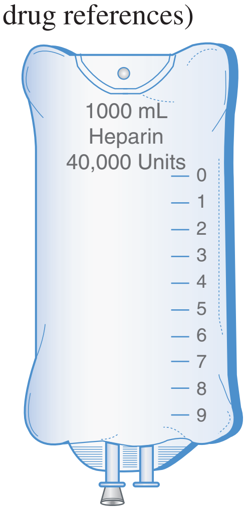
Here's a simple formula you can use to find concentration:

$$\frac{\text{Amount of Drug}}{\text{Amount of Fluid (mL)}} = \text{Amount of Drug in 1 mL}$$

Occasionally, the amount of medication to be added to an IV solution exceeds the capacity of the contained (bag/bottle) by approximately 10% or more (e.g., <10 mL in a 100-mL bag). If this occurs, an amount equal to the medication volume being added must first be removed using aseptic techniques (needle and syringe).

Medications Ordered in Units/hr or mg/hr

Sometimes patient medications are administered as continuous IVs. For these medications, solutions are standardized to decrease the possibility of error. Check the guidelines (institutional or drug references) to verify dose, dilution, and rate. If any doubts exist, consult with the prescribing physician or healthcare provider.



Units/hr—Rule and Calculation

The order will indicate the amount of drug to be added to the IV fluid and also the amount to administer.

Example

Order: heparin, infuse 800 units/hr

Available: heparin 40,000 units in 1000 mL D5W infusion pump

You know the solution and the amount to administer. Because you'll be using an infusion pump, the answer will be in mL/hr.

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{\overset{20}{\cancel{800}}\ \cancel{\text{units}}/\text{hr}}{\underset{1}{\cancel{40{,}000}}\ \cancel{\text{units}}} \times \cancel{1000}\ \text{mL} =$ 20 mL/hr on a pump Note that units cancel out and the answer is mL/hr.	1000 mL : 40000 units : : x mL : 800 units	$\frac{x\ \text{mL}}{800\ \text{units}} = \frac{1000\ \text{mL}}{40000\ \text{units}}$

$$40{,}000x = 800000$$

$$\frac{800000}{40000} = x$$

$$20\ \text{mL/hr} = x$$

How many hours will the IV run?

$$\frac{\text{Number mL}}{\text{Number mL/hr}}$$

$$\frac{1000\ \text{mL}}{20\ \text{mL/hr}} = 50\ \text{hours}$$

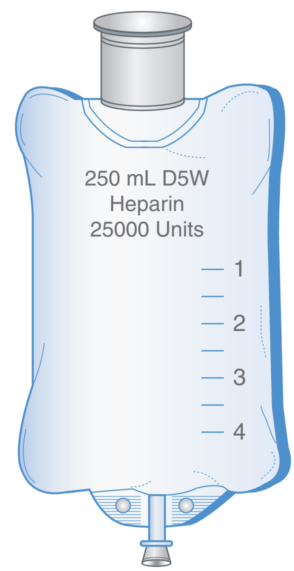
Note: Most hospitals require changing the IV fluids every 24 hours.

Example

Order: heparin sodium 1100 units/hr IV

Supply: infusion pump, standard solution of 25,000 units in 250 mL D5W

With an infusion pump, the answer will be in mL/hr.



Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{1100\ \cancel{\text{units}}/\text{hr}}{25{,}000\ \cancel{\text{units}}} \times 250\ \text{mL} =$ $= 11\ \text{mL/hr}$	250 mL : 25000 units : : x mL : 1100 units	$\frac{x\ \text{mL}}{1100\ \text{units}} = \frac{250\ \text{mL}}{25000\ \text{units}}$

$$\frac{275000}{25000} = x\ \text{mL}$$

$$11\ \text{mL/hr} = x$$

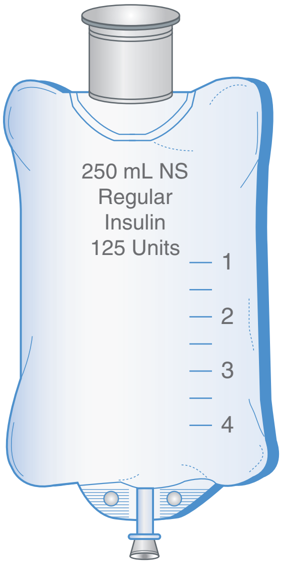
How many hours will the IV run?

$$\frac{\text{Number mL}}{\text{Number mL/hr}}$$

$$\frac{250\ \text{mL}}{11\ \text{mL/hr}} = 22.75 \text{ or } 23\ \text{hours}$$

Example Order: regular insulin 10 units/hr IV

Available: infusion pump, standard solution of 125 units regular insulin in 250 mL NS



Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{10 \cancel{\text{ units}}}{\cancel{125}_{1} \cancel{\text{ units}}} \times \overset{2}{\cancel{250}} \text{ mL}$ $= 20 \text{ mL/hr on a pump}$	$250 \text{ mL} : 125 \text{ units} :: x \text{ mL} : 10 \text{ units}$	$\frac{x \text{ mL}}{10} \times \frac{2500}{125}$

$$\frac{2500}{125 \text{ units}} = x \text{ mL}$$

$$20 \text{ mL/hr} = x$$

How many hours will the IV run?

$$\frac{\text{Number mL}}{\text{Number mL/hr}}$$

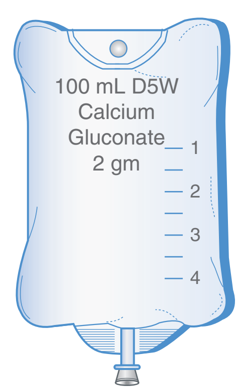
$$\frac{250 \text{ mL}}{20 \text{ mL/hr}} = 12.5 \text{ or approximately 13 hours}$$

mg/hr; g/hr—Rule and Calculation

The order will indicate the amount of drug added to the IV fluid and the amount to administer.

Example Order: calcium gluconate 2 g in 100 mL D5W; run 0.25 g/hr IV via infusion pump.

Because we know the solution and the amount of drug per hour, we can solve the problem and administer the drug in mL/hr per infusion pump. Round the final answer to the nearest whole number.



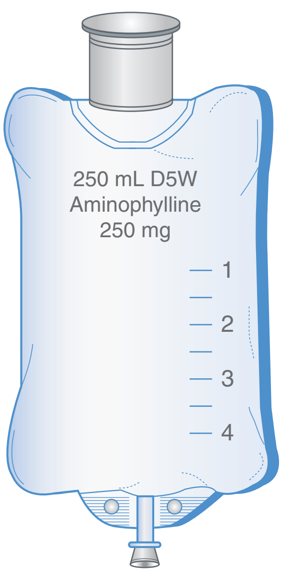
Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{0.25\,\cancel{g}/hr}{\overset{}{\underset{1}{\cancel{2}}}\,\cancel{g}} \times \overset{50}{\cancel{100}}\ mL = 12.5$ 13 mL/hr on a pump	$100\ mL : 2\ g :: x\ mL : 0.25\ g$	$\frac{x\ mL}{0.25\ g/hr} \times \frac{100\ mL}{2\ g}$ $\frac{25}{2} = x$ $12.5 \text{ or } 13\ mL/hr = x$

How many hours will the IV run?

$$\frac{\text{Number mL}}{\text{Number mL/hr}}$$

$$\frac{100\ mL}{13\ mL/hr} = 7.6 \text{ or approximately } 8 \text{ hours}$$

Example Order: aminophylline 250 mg in 250 mL D5W; run 65 mg/hr IV per infusion pump.



Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{65\ \cancel{mg}/hr}{\underset{1}{\cancel{250}}\ \cancel{mg}} \times \overset{1}{\cancel{250}}\ mL$ $= 65\ mL/hr$ on a pump	$250\ mL : 250\ mg :: x\ mL : 65\ mg$	$\frac{x\ mL}{65\ mg} \times \frac{250\ mL}{250\ mg}$ $\frac{65 \times \cancel{250}}{\cancel{250}} = x$ $65\ mL/hr = x$

How many hours will the IV run?

$$\frac{\text{Number mL}}{\text{Number mL/hr}}$$

$$\frac{250\ mL}{65\ mL/hr} = 3.8 \text{ or approximately } 4 \text{ hours}$$

SELF TEST 1 Infusion Rates

Solve the following problems. Answers appear at the end of this chapter.

1. Order: heparin sodium 800 units/hr IV
Supply: infusion pump, standard solution of 25,000 units in 250 mL D5W

a. What is the rate?
b. How many hours will the IV run?

2. Order: Zovirax (acyclovir) 500 mg in 100 mL D5W IV over 1 hr
Supply: pump, Zovirax (acyclovir) 500 mg in 100 mL
What is the rate?

3. Order: Amicar (aminocaproic acid) 24 g in 1,000 mL D5W over 24 hr IV
Supply: infusion pump, vials of Amicar (aminocaproic acid) labelled 5 g/20 mL
What is the rate?

4. Order: Cardizem (diltiazem) 125 mg in 100 mL D5W at 10 mg/hr IV
Supply: infusion pump, vial of Cardizem (diltiazem) labelled 5 mg/mL
What is the rate?

5. Order: Lasix (furosemide) 100 mg in 100 mL D5W; infuse 4 mg/hr
Supply: infusion pump, vial of Lasix (furosemide) labelled 10 mg/mL
What is the rate?

6. Order: regular insulin 15 units/hr IV
Supply: standard solution of 125 units in 250 mL NS, infusion pump

a. What is the drip rate?
b. How many hours will this IV run?

7. Order: nitroglycerin 50 mg in 250 mL D5W over 24 hr via pump
What is the drip rate?

8. Order: heparin 1200 units/hr IV
Supply: infusion pump, standard solution of 25,000 units in 500 mL D5W

a. What is the rate?
b. How many hours will the IV run?

9. Order: regular insulin 23 units/hr IV
Supply: infusion pump, standard solution of 250 units in 250 mL NS

a. What is the rate?
b. How many hours will the IV run?

10. Order: Streptase (streptokinase) 100,000 international units/hr for 24 hr IV
Supply: infusion pump, standard solution of 750,000 international units in 250 mL NS
What is the rate?

mg/min—Rule and Calculation

The order will indicate the amount of drug added to IV fluid and also the amount of drug to administer. These medications are administered through an IV infusion pump in mL/hr.

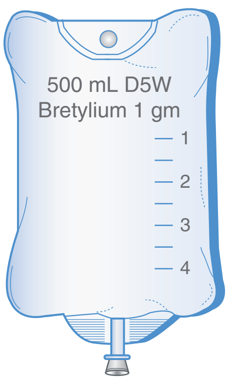
Example

Order: Bretylol (bretylium) 1 mg/min IV

Supply: infusion pump, standard solution of 1 g in 500 mL D5W (1000 mg in 500 mL)

The order calls for 1 mg/min. You need mL/hr for the pump.

Convert the order to mg/hr, by multiplying the drug amount by 60 (60 minutes =1 hour).
$1 \text{ mg/min} \times 60 = 60 \text{ mg/hr}$



Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{\overset{30}{\cancel{60}} \text{ mg/hr}}{\underset{1}{\underset{\cancel{2}}{\cancel{1000}}} \text{ mg}} \times \cancel{500} \text{ mL} = 30 \text{ mL/hr}$	$500 \text{ mL} : 1000 \text{ mg} :: x \text{ mL} : 60 \text{ mg}$	$\frac{x \text{ mL}}{60 \text{ mg}} \times \frac{500 \text{ mL}}{1000 \text{ mg}}$

$$\frac{30000}{1000} = x$$

$$30 \text{ mL/hr} = x$$

Set pump at 30 mL/hr.

How many hours will the IV run?

$$\frac{\text{Number mL}}{\text{Number mL/hr}}$$

$\frac{500\text{mL}}{30\text{mL/hr}} = 16.6$ or approximately 17 hours

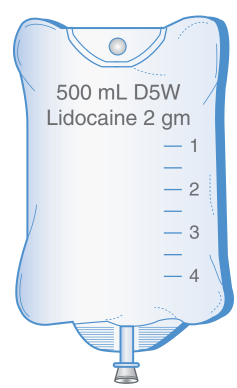
Example

Order: lidocaine 2 mg/min IV

Supply: infusion pump, standard solution of 2 g in 500 mL D5W (2000 mg in 500 mL)

The order calls for 2 mg/min. We need mL/hr for the pump.

Multiply $2 \text{ mg/min} \times 60 = 120 \text{ mg/hr}$



Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{\overset{30}{\cancel{120}}\text{ mg/hr}}{\underset{\underset{1}{\cancel{4}}}{\cancel{2000}}\text{ mg}} \times \cancel{500}\text{ mL} = 30\text{ mL/hr}$	$500\text{ mL} : 2000\text{mg} :: x\text{ mL} : 120\text{ mg}$	$\frac{x\text{ mL}}{120\text{ mg}} \times \frac{500\text{ mL}}{2000\text{ mg}}$

$$\frac{6000}{2000} = x$$

$$30\text{ mL/hr} = x$$

Set pump at 30 mL/hr.

How many hours will the IV run?

$$\frac{\text{Number mL}}{\text{Number mL/hr}}$$

$$\frac{500\text{ mL}}{30\text{mL/hr}} = 16.6 \text{ or approximately 17 hours}$$

SELF TEST 2 Infusion Rates for Drugs Ordered in mg/min

Solve the following problems. Answers appear at the end of the chapter.

1. Order: lidocaine 1 mg/min IV
   Supply: 2 g in 250 mL D5W, infusion pump
   a. What is the drip rate?
   b. How many hours will the IV run?
2. Order: Pronestyl (procainamide) 3 mg/min IV
   Supply: Pronestyl (procainamide) 1 g in 250 D5W, infusion pump
   a. What is the drip rate?
   b. How many hours will the IV run?
3. Order: Bretylol (bretylium) 2 mg/min IV
   Supply: Bretylol (bretylium) 1 g in 500 mL D5W, infusion pump
   a. What is the drip rate?
   b. How many hours will the IV run?
4. Order: Cordarone (amiodarone) 1 mg/min for 6 hr
   Supply: Cordarone (amiodarone) 450 mg in 250 mL D5W, infusion pump
   What is the drip rate?
5. Order: Pronestyl (procainamide) 1 mg/min IV
   Supply: Pronestyl (procainamide) 2 g in 500 mL D5W, infusion pump
   a. What is the drip rate?
   b. How many hours will the IV run?

Medications Ordered in mcg/min, mcg/kg/min, or milliunits/min

Intensive care units administer powerful drugs in extremely small amounts called micrograms (1 mg = 1000 mcg). The orders for these drugs often use the patient's weight as a determinant, because these drugs are so potent.

Example

Order: renal dose dopamine 2 mcg/kg/min

Order: titrate Levophed to maintain arterial mean pressure above 65 mm Hg and below 95 mm Hg

This section shows how to calculate doses in micrograms and in milliunits, and how to use kilograms in determining doses.

mcg/min—Rule and Calculation

Drugs ordered in mcg/min are standardized solutions that may be pre-packaged by the drug manufacturer. They are administered using infusion pumps that deliver medication in mL/hr.

To calculate drugs ordered in mcg/min, first determine how much of the drug is in 1 mL of solution (see beginning of this chapter). If the drug is supplied in mg, convert it to mcg; then divide that amount by 60 to get mcg/min. The final number tells you how much of the drug is in 1 mL of fluid. You can then use one of the three methods to solve for the infusion rate, on the basis of the ordered dosage.

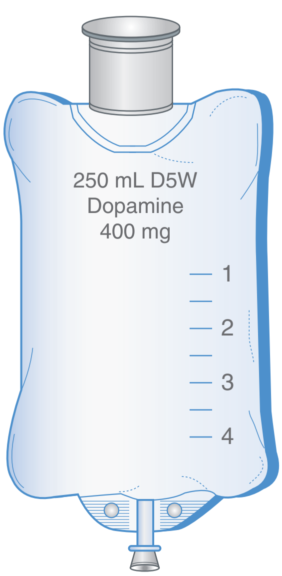
Solving mcg/min requires four steps:

1. Reduce the numbers in the standard solution to mg/mL.
2. Change mg to mcg.
3. Divide by 60 to get mcg/min.
4. Use either the formula, the ratio, or the proportion method to solve for mL/hr.

Example

Order: Intropin (dopamine) 400 mcg/min IV

Supply: Infusion pump, standard solution 400 mg in 250 mL D5W



Step 1. Reduce the numbers in the standard solution.

$$\frac{400 \text{ mg}}{250 \text{ mL}} = 1.6 \text{ mg in } 1 \text{ mL}$$

Step 2. Change mg to mcg.

$$1.6 \text{ mg x } 1000 = 1600 \text{ mcg/mL}$$

Step 3. Divide by 60 to get mcg/min.

$$\frac{1600 \text{ mcg}}{60 \text{ min}} = 26.67 \text{ mcg/min}$$

(round to hundredths)

Step 4. Solve for mL/hr (round to nearest whole number).

Formula Method

$$\frac{400 \text{ mcg/min}}{26.67 \text{ mcg/min}} \times 1 \text{ mL} = 15 \text{ mL/hr}$$

Proportion Expressed as Two Ratios

$$1 \text{ mL} : 26.67 \text{ mcg/min} :: x \text{ mL} : 400 \text{ mcg/min}$$

Proportion Expressed as Two Fractions

$$\frac{1 \text{ mL}}{26.67 \text{ mcg/min}} \times \frac{x \text{ mL}}{400 \text{ mcg/min}}$$

$$400 = 26.67x$$

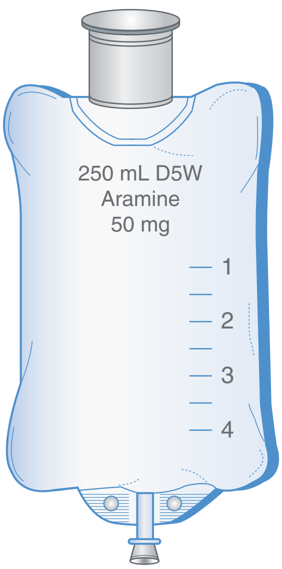
$$\frac{400}{26.67} = 15 \text{ mL/hr} = x$$

Set the pump: total number mL = 250; mL/hr = 15

Example

Order: Aramine (metaraminol) 60 mcg/min IV

Supply: infusion pump, standard solution 50 mg in 250 mL D5W



Step 1. Reduce the numbers in the standard solution.

$$\frac{50 \text{ mg}}{250 \text{ mL}} = 0.2 \text{ mg/mL}$$

Step 2. Change mg to mcg.

0.2 mg = 200 mcg/1 mL

Step 3. Divide by 60 to get mcg/min.

3.33 mcg/min

(Round to hundredths.)

Step 4. Solve. Round to the nearest whole number.

Formula Method

$$\frac{60 \text{ mcg/min}}{3.33 \text{ mcg/min}} \times 1 \text{ mL} = 18 \text{ mL/hr}$$

Proportion Expressed as Two Ratios

$$1 \text{ mL} : 3.33 \text{ mcg/min} :: x \text{ mL} : 60 \text{ mcg/min}$$

Proportion Expressed as Two Fractions

$$\frac{1 \text{ mL}}{3.33 \text{ mcg/min}} \times \frac{x}{60 \text{ mcg/min}}$$

$$60 = 3.33x$$

$$\frac{60}{3.33} = 18 \text{ mL/hr} = x$$

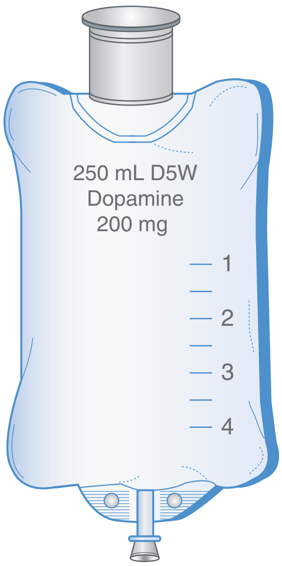
Set the pump: total number mL = 250; mL/hr = 18

mcg/kg/min—Rule and Calculation

Example

Order: Intropin (dopamine) 2 mcg/kg/min

Supply: infusion pump, standard solution 200 mg in 250 mL D5W; client weighs 80 kg



Note that this order is somewhat different. You are to give 2 mcg/kg body weight.

$$\begin{array}{r} 80\text{ kg} \\ \times\ 2\text{ mcg} \\ \hline 160\text{ mcg} \end{array}$$ The order now is 160 mcg/min.

1. Reduce the numbers in the standard solution.

   $$\frac{200\text{ mg}}{250\text{ mL}} = 0.8\text{ mg/mL}$$

2. Change mg to mcg.

   $0.8 = 800$ mcg/mL

3. Divide by 60 to get mcg/min.

   $$\frac{800}{60} = 13.33$$

   (Round to hundredths.)

4. Solve. Round to the nearest whole number.

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{160\text{ mcg/min}}{13.33\text{ mcg/min}} \times 1\text{ mL} = 12\text{ mL}$	1 mL:13.33 mcg/min::x mL:160 mcg/min	$\frac{x\text{ mL}}{160\text{ mcg/min}} \times \frac{1\text{ mL}}{13.33\text{ mcg/min}}$

$$160 = 13.33x$$

$$\frac{160}{13.33} = 12\text{ mL} = x$$

Set the pump: total number mL = 250; mL/hr = 12 mL/hr

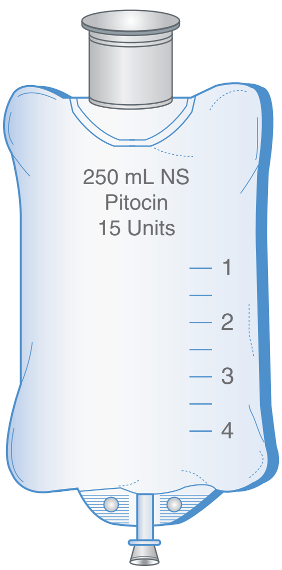
Milliunits/min—Rule and Calculation

In obstetrics, a Pitocin (oxytocin) drip can initiate labour. The standard solution of Pitocin is prepared by adding 10 units of oxytocin to 1000 mL of 0.9% sodium chloride. The initial dose should be 0.5 to 1 milliunits/min. At 30- to 60-minute intervals, the dose can be gradually increased in increments of 1 to 2 milliunits/min until the desired contraction pattern has been established. Always follow hospital or institutional policy. Because 1 unit = 1000 milliunits (mU), you solve these problems in the same way as mcg/min.

Example

Order: Pitocin (oxytocin) drip commence at 1 mU/min

Supply: infusion pump, standard solution 10 units Pitocin in 1000 mL NS



1. Reduce the number in the standard solution.

   $\frac{10\text{ units}}{1000\text{ mL}} = 0.01\text{units/mL}$

2. Change units of Pitocin to milliunits.

   1 unit = 1000 milliunits

   0.01 x 1000 = 10 milliunits/mL

3. Divide by 60 to get milliunits/min.

   $\frac{10}{60} = 0.167$ milliunits/min

4. Solve. Round to the nearest whole number.

Formula Method

$$\frac{1\ \text{milliunits/min}}{0.167\ \text{milliunit/min}} \times 1\ \text{mL} = 2\ \text{mL/hr}$$

Proportion Expressed as Two Ratios

$$1\ \text{mL} : 0.167\ \text{milliunit/min} :: x\ \text{mL} : 1\ \text{milliunit/min}$$

Proportion Expressed as Two Fractions

$$\frac{1\ \text{mL}}{0.167\ \text{milliunit}} \times \frac{x}{1\ \text{milliunit}}$$

$$\frac{\text{mL} \times 1\ \text{milliunit/min}}{0.167\ \text{milliunit/min}} = x$$

$$\frac{1\ \text{mL}}{0.167} = 5.98 = x$$

Set pump at 6 mL/hr
(1 milliunit/min = 6 mL/hr)

Example

Order: Increase Pitocin q30-60 min by 1-milliunit/min increments until labour is established.

1 milliunit = 6 mL/hr; therefore, increase the IV rate 6 mL/hr q30min until labour is established.

Infusion **Rates for Drugs Ordered in mcg/min, mcg/kg/min, milliunits/min**

Calculate the number of mL to infuse and the rate of infusion. Answers appear at the end of the chapter.

1. Order: Intropin (dopamine) double strength, 800 mcg/min IV
   Supply: standard solution 800 mg in 250 mL D5W, infusion pump
2. Order: Levophed (norepinephrine), 12 mcg/min IV
   Supply: standard solution of 4 mg in 250 mL D5W, infusion pump
3. Order: Dobutrex (dobutamine) 5 mcg/kg/min IV
   Supply: patient weight, 100 kg; standard solution of 1 g in 250 mL D5W, infusion pump
4. Order: Dobutrex (dobutamine) 7 mcg/kg/min IV
   Supply: patient weight, 70 kg; standard solution of 500 mg in 250 mL D5W, infusion pump
5. Order: nitroglycerin 10 mcg/min IV
   Supply: standard solution of 50 mg in 250 mL D5W, infusion pump
6. Order: Pitocin drip (oxytocin) 0.5 milliunit/min IV
   Supply: infusion pump, standard solution 10 units in 1000 mL NS
7. Order: Isuprel (isoproterenol) titrated at 4 mcg/min IV
   Supply: infusion pump, solution 2 mg in 250 mL D5W
8. Order: Brevibloc (esmolol) 50 mcg/kg/min IV
   Supply: infusion pump, 2.5 g in 250 mL D5W; weight, 58 kg
9. Order: Nipride (nitroprusside) 2 mcg/kg/min IV
   Supply: patient weight, 80 kg; nipride 50 mg in 250 mL D5W, infusion pump
10. Order: Inocor (amrinone) 200 mcg/min
    Supply: Inocor (amrinone) 0.1 g in 100 mL NS, infusion pump

Body Surface Nomogram

Antineoplastic drugs used in cancer chemotherapy have a narrow therapeutic range. Calculation of these drugs is based on BSA in square metres—a method considered more precise than mg/kg/body weight. BSA is the measured or calculated area of the body.

There are several mathematical formulas to calculate body surface area. One often used is:

$$\sqrt{\frac{weight(kg) \times height(cm)}{3600}} = \text{BSA}$$

Average BSA:

"Normal" BSA: 1.7 m^2

Average BSA for men: 1.9 m^2

Average BSA for women: 1.6 m^2

You can estimate BSA by using a three-column chart called a nomogram (Fig. 9-2). Mark the patient's height in the first column and the patient's weight in the third column. Then draw a line between these two marks. The point at which the line intersects the middle column indicates estimated body surface in metres squared. You'll use a different BSA chart for children, because of differences in growth (see Chapter 10).

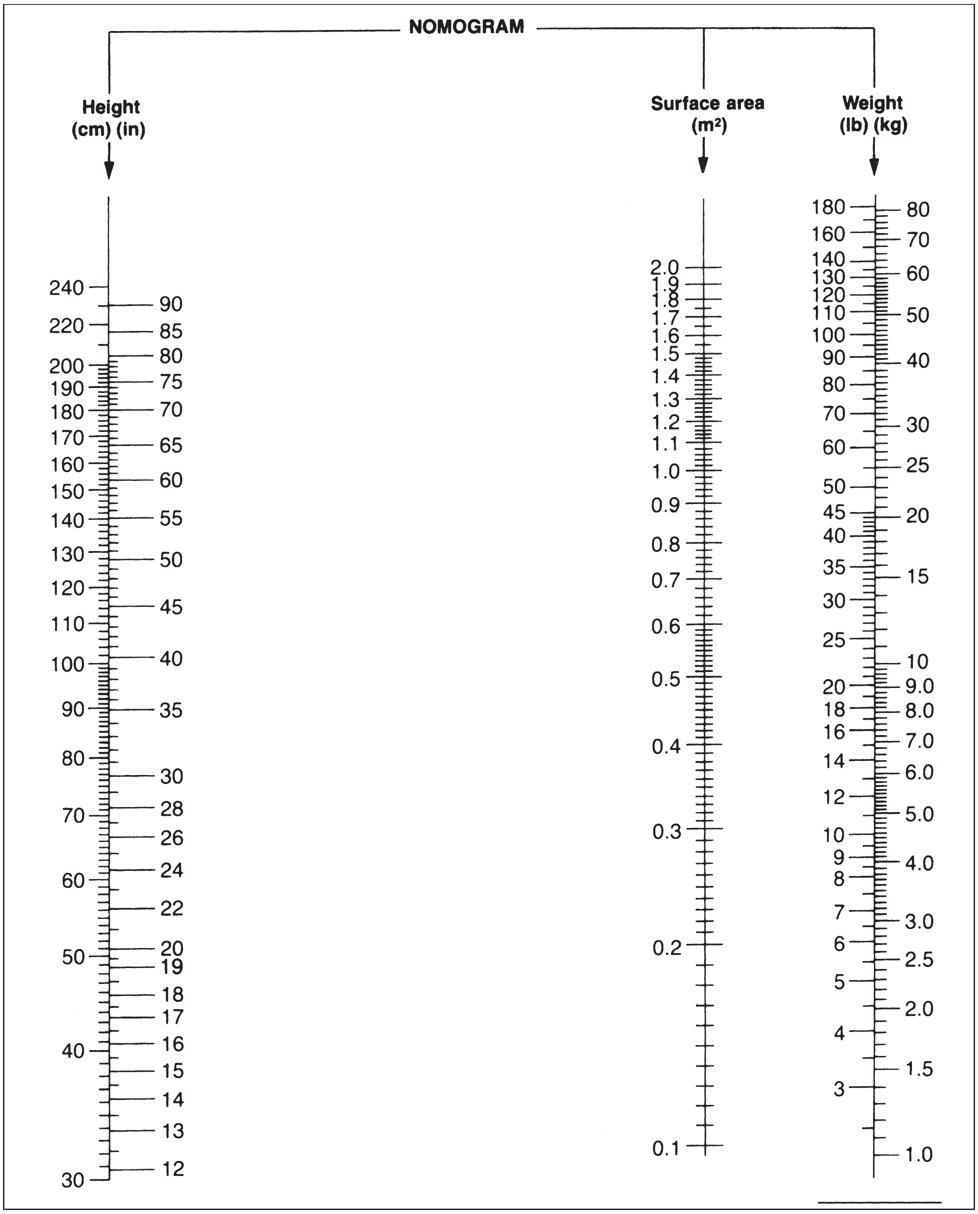


FIGURE 9-2

Body surface area (BSA) is critical when calculating dosages for pediatric patients or for drugs that are extremely potent and need to be given in precise amounts. The nomogram shown here lets you plot the patient's height and weight to determine the BSA. Here's how it works:

1. Locate the patient's height in the left column of the nomogram and the weight in the right column.
2. Use a ruler to draw a straight line connecting the two points. The point where the line intersects the surface area column indicates the patient's BSA in square metres.

DIAGNOSIS: ANAL CANCER PROTOCOL NAME/NUMBER:

PATIENT'S HEIGHT: 188 cm WEIGHT: 84 Kg or BSA: 2.1 m^2

VENOUS ACCESS: DEEP ☐ PERIPHERAL ☒

everyday

DRUG	PROTOCOL DOSAGE	PATIENTS DOSAGE	ROUTE AND DILUENT	FREQUENCY AND / OR DOSAGE	# OF DAYS
1. MITOMYCIN	12 mg/m²	24 mg	IVP × 1 m 9/08		
2. 5FU	1000 mg/m²	2000 mg	in 1000 mL of NS as a continuous infusion everyday × 4 days on 9/08, 9/09, 9/10, 9/11		
3.					

FIGURE 9-3

Portion of doctor's order form for chemotherapy. The doctor or healthcare provider writes the patient's height and weight and calculates the BSA as 2.1 m^2. The protocol dosage is the guide used to determine the patient's dose. For mitomycin, the protocol is 12 $mg/m^2 \times 2\ m^2 = 24$ mg. For 5FU, the protocol dose is 1000 $mg/m^2 \times 2\ m^2 = 2000$ mg.

The oncologist, a physician who specializes in treating cancer, lists the patient's height, weight, and BSA; gives the protocol (drug requirement based on BSA in m^2); and then gives the order.

Figure 9-3 shows a partial order sheet for chemotherapy. Both the pharmacist and the nurse validate the order before preparation.

To determine BSA in m^2, you can use a special calculator, obtained from companies manufacturing antineoplastics. Many websites also calculate BSA; see, for example, www.manuelsweb.com/bsa.htm www.users.med.cornell.edu/~spon/picu/calc/bsacalc.htm

m^2—Rule and Calculation

Oncology drugs are prepared by a pharmacist or specially trained technician who is gowned, gloved, and masked and works under a laminar flow hood; these precautions protect the pharmacist or technician and also ensure sterility. When the medication reaches the unit, the nurse bears two responsibilities: checking the doses for accuracy before administration and using an infusion pump for IV orders.

Example

H, 183 cm; W, 79 kg; BSA, 2.0 m^2

Order: Platinol (cisplatin) 160 mg (80 mg/m^2) IV in 1 L NS with 2 mg magnesium sulfate over 2 hr

1. Check the BSA using the nomogram in Figure 9-2. It is correct. Protocol calls for 80 mg/m^2; 160 mg is correct.
2. The IV is prepared by the pharmacy. Determine the rate of infusion.
   1 L = 1000 mL

$$\frac{\text{Number mL}}{\text{Number hr}} = \text{mL/hr} \qquad \frac{\overset{500}{\cancel{1000}}}{\underset{1}{\cancel{2}}} = 500\ \text{mL/hr}$$

Set the pump: total number mL, 1000; mL/hr, 500

SELF TEST 4 Use of Nomogram

Solve the following problems. Answers appear at the end of this chapter. Use the nomogram in Figure 9-2 to double-check the BSA.

1. H, 183 cm; W, 75 kg; BSA, 1.96 m^2
   Order: Doxil (doxorubicin) 39 mg (20 mg/m^2) in D5W 250 mL to infuse over ½ hr
   a. Is dose correct?
   b. How should the pump be set?
2. H, 165 cm; W, 70 kg; BSA, 1.77 m^2
   Order: Lomustine (CCNU) 230 mg po (130 mg/m^2) once q6wk
   a. Is dose correct?
   b. Lomustine (CCNU) comes in tabs of 100 mg and 10 mg. What is the dose?
3. H, 187 cm; W, 77 kg; BSA, 2.0 m^2
   Order: Cerubidine (daunorubicin) 80 mg (40 mg/m^2) in D5W over 1 hr IV
   Supply: IV bag labelled 80 mg in 80 mL D5W; infuse in rapidly flowing IV
   a. Is dose correct?
   b. How should the pump be set? (See IVPB administration in Chapter 8.)
4. H, 170 cm; W, 85 kg; BSA, 2.0 m^2
   Order: Vepesid (etoposide) 400 mg po every day × 3 (200 mg/m^2)
   Supply: capsules of 50 mg
   a. Is dose correct?
   b. How many capsules should be poured?
5. H, 160 cm; W, 54 kg; BSA, 1.6 m^2
   Order: Taxol (paclitaxel) 216 mg (135 mg/m^2) in D5W ½ L glass bottle over 3 hr
   a. Is dose correct?
   b. How should the pump be set?

Patient-Controlled Analgesia (PCA)

PCA, an IV method of pain control, allows a patient to self-administer a preset dose of pain medication. The physician or healthcare provider prescribes the narcotic dose and concentration, the basal rate, the lockout time, and the total maximum hourly dose (Fig. 9-4).

Basal rate is the amount of medication that is infused continuously each hour. *PCA dose* is the amount of medication infused when the patient activates the button control. *Lockout time* or *delay*—a feature that prevents overdosage—is the interval during which the patient cannot initiate another dose after giving a self-dose. *Total hourly dose* is the maximum amount of medication the patient can receive in an hour. The physician or healthcare provider writes all this information on an order form.

Figure 9-5 shows a narcotic PCA medication record. Morphine concentration is 1 mg/mL. The pharmacy dispenses a 100-mL NS bag with 100 mL morphine. The patient continuously receives 0.5 mg by infusion pump and can give 1 mg by pressing the PCA button. Eight minutes must elapse before another PCA dose can be delivered. Note that at 1200h, the nurse charted that the patient made three attempts but received only two injections. This indicates that 8 minutes had not elapsed before one of the attempts.

The nurse's responsibility is to assess the patient every hour, noting how the patient scores his or her pain, the number of PCA attempts, and the total hourly dose received, as well as the cumulative dose, the patient's level of consciousness, side effects, and respirations.

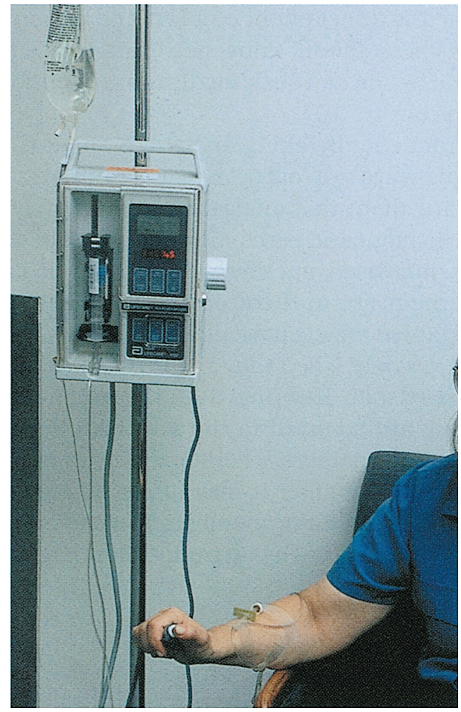


FIGURE 9-4

Patient-controlled analgesia allows the client to self-administer medication, as necessary, to control pain. (From Roach, S. S. [2004]. *Introductory clinical pharmacology* [7th ed.]. Philadelphia: Lippincott Williams & Wilkins, p. 173.)

AVERY MEDICAL CENTRE
Narcotic PCA
Medication Administration Record

Check appropriate order:
X Morphine 1 mg/1 mL:50 mL
___ Fentanyl. Concentration: ___ Volume: ___
___ Demerol 10 mg/1 mL:50 mL
___ Other: ______ Concentration ___ Volume: ___

Dose: 1 mg/mL
Lockout: 8 min
1 hour limit: 8 mg/mL
Basal 0.5 mg/hr

Infusion started by: ____________________ RN
(zero out prior shift volume with each new bag/syringe)
Settings confirmed by: ____________________ RN
Date/Time discoutinued: ____________________
Discontinued by: ____________________ RN
Total Amount Administered: ____________________
Waste returned to pharmacy: ____________________

Pharmacist: Witness: Witness:

Date	0600	0800	1000	1200	1400	1600
Number of attempts	3	2	2	3		
Number of injections	3	2	2	2		
Basal dose	0.5	0.5	0.5	0.5		
Total mL	3.5	4.5	4.5	2.5		
Cumulative mL	3.5	8	12.5	15		
Pain score	5	5	5	6		
Level of consciousness	1	1	1	1		
Respiratory rate (per minute)	16	20	16	22		
Nurse's initials	GP	GP	GP	GP		

Level of Consciousness: 1-alert, 2-drowsy, 3-sleeping, 4-confused, 5-difficult to arouse

Nurse's signature ______________ Initial ______
Nurse's signature ______________ Initial ______
Nurse's signature ______________ Initial ______
Nurse's signature ______________ Initial ______

FIGURE 9-5

Sample PCA medication record.

Heparin and Insulin Protocols

Many hospitals and other institutions now use protocols to give the nurse more autonomy in determining the rate and amount of drug the patient is receiving. These protocols are based on a parameter, usually a lab test ordered by healthcare provider. After receiving the lab test results, the nurse uses the protocol to determine the change (if any) in the dosage amount and when subsequent lab testing is to be done.

Two drugs used in protocols are heparin and insulin.

Heparin Protocol

Heparin, an anticoagulant, is titrated according to the results of the lab test, aPTT (activated partial thromboplastin time). Weight-based heparin protocol calculates the dose of heparin based on the patient's weight.

Sample heparin protocol:

Heparin drip: 25,000 units in 500 mL D5W

Bolus: 80 units/kg

Starting Dose: 18 units/kg/hr

Titrate according to the following chart:

aPTT (seconds)	<45 seconds	45-48 seconds	49-66 seconds	67-70 seconds	71-109 seconds	110-130 seconds	>130 seconds
Bolus	Bolus with 40 units/kg	Bolus with 40 units/kg	No bolus	No bolus	No bolus	No bolus	No bolus
Rate adjustment	Increase rate by 3 units/kg/hr	Increase rate by 2 units/kg/hr	Increase rate by 1 unit/kg/hr	No change	No change	Decrease rate by 1 unit/kg/hr	Stop infusion for 1 hour. Decrease rate by 2 units/kg/hr
Next lab	aPTT in 6 hours	aPTT in 6 hours	aPTT in 6 hours	aPTT next AM	aPTT next AM	aPTT in 6 hours	aPTT in 6 hours

Example

Example: patient weight is 70 kg.

1. Calculation for bolus dose: 80 units/kg.

   Multiply 80 units × 70 kg = 5600 units/kg

2. Infusion rate.

   First calculate what the dose will be

   Starting dose is 18 units/kg/hr

   Multiply 18 × 70 kg = 1260 units/kg

   Now use the calculation similar to that on p. 238

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{1260 \text{ units}}{25{,}000 \text{ units}} \times 500 \text{ mL} = 25.2 \text{ mL/hr}$	$500 \text{ mL} : 25000 \text{ units} :: x \text{ mL} : 1260 \text{ units}$	$\frac{500 \text{ mL}}{25000 \text{ units}} \times \frac{x \text{ mL}}{1260 \text{ units}}$

$$\frac{500 \times 1260}{25000} = x$$

$$25.2 \text{ mL/hr} = x$$

   Set the pump at 25 mL/hr.

3. The aPTT result 6 hours after the infusion started is 50. According to the table, increase the drip by 1 u/kg/hr.

   First, calculate the dose

   1 unit × 70 kg = 70 units/kg

   Then set up the same formula:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{70 \text{ units}}{25{,}000 \text{ units}} \times 500 \text{ mL} = 1.4 \text{ mL}$	$500 \text{ mL} : 25000 \text{ units} :: x \text{ mL} : 70 \text{ units}$	$\frac{500 \text{ mL}}{25000 \text{ units}} \times \frac{x \text{ mL}}{70 \text{ units}}$

$$500 \times 70 = 25000x$$

$$\frac{35000}{25000} = x$$

$$1.4 \text{ mL} = x$$

4. Increase the infusion rate by 1.4 mL.

   25.2 + 1.4 = 26.6 mL/hr. Set the pumps at 27 mL/hr

   Recheck the aPTT in 6 hours and titrate according to the result

SELF TEST 5

Use the chart on page 248 to solve the following problems. Use heparin 25,000 units in 500 mL as your IV solution. The patient's weight is 70 kg. Beginning infusion rate for each problem is 25.2 mL/hr. Answers appear at the end of the chapter.

1. The patient's aPTT is 45 seconds.

- **a.** Is there a bolus dose? If so, what is the dose?
- **b.** Is there a change in the infusion rate? Calculate the new infusion rate.

2. The patient's aPTT is 40 seconds.

- **a.** Is there a bolus dose? If so, what is the dose?
- **b.** Is there a change in the infusion rate? Calculate the new infusion rate.

3. The patient's aPTT is 110 seconds.

- **a.** Is there a bolus dose? If so, what is the dose?
- **b.** Is there a change in the infusion rate? Calculate the new infusion rate.

4. The patient's aPTT is 140 seconds.

- **a.** Is there a bolus dose? If so, what is the dose?
- **b.** Is there a change in the infusion rate? Calculate the new infusion rate.

Insulin Infusion Protocol

Intended only for use in intensive care settings, insulin infusions are initiated on adult patients with hyperglycemia. The rate of the infusion is titrated according to blood glucose measured hourly using a glucometer. Considerations made prior to the initiation of the infusion include absence of any neurologic injury and enteral or parenteral nutrition. Additionally, insulin infusion is not used in patients experiencing diabetic emergencies, such as diabetic ketoacidosis (DKA) or hyperglycemic hyperosmolar states. Insulin infusion protocols always contain actions to be taken if hypoglycemia occurs. For example, some protocols indicate that physician must be notified and 1 ampoule of D50W given IVP if blood glucose is less than 4.0 mmol/L. Always follow hospital or institutional policy. This section provides a partial example of an insulin infusion protocol.

Critical Care Insulin Infusion Protocal

GOAL: Maintain serum glucose between 4.5–8.0 mmol/L

1. Initiating an insulin infusion

Prepare an infusion of Humulin R insulin 50 units in 100 mL of 0.9% sodium chloride (concentration 0.5 units/mL). *NB – all doses are of Humulin R.*

Glucose Level	4.5–8.0 mmol/L	8.1–11.0 mmol/L	11.1–14.0 mmol/L	14.1-17.0 mmol/L	17.1-20.0 mmol/L	20 >mmol/L
Action	Monitor only	Start infusion 2 units/hr	2 units IVP Start infusion 2 units/hr	4 units IVP Start infusion 2 units/hr	8 units IVP Start infusion 2 units/hr	Call MD

2. Ongoing Infusion Titration

Check glucose q1h.

Glucose Level	Infusion rate 1–5 units/hr	Infusion rate 6–10 units/hr	Infusion rate 11–16 units/hr	Infusion rate > 16 units/hr
4.0–4.4 mmol/L	Discontinue infusion Recheck glucose in q30min x2 When glucose >6 restart infusion. Reduce rate by 1 unit/hr	Discontinue infusion Recheck glucose in q30min x3 When glucose >6 restart infusion. Reduce rate by 2 units/hr	Discontinue infusion Recheck glucose in q30min x4 When glucose >6 restart infusion. Reduce rate by 3 unit/hr	
4.5–8.0 mmol/L (Desired range)		Monitor and maintain glucose in desired range		
8.1–11.4 mmol/L	Increase infusion 1unit/hr	Increase infusion 2 units/hr	Increase infusion 3 units/hr	Call MD for new order
11.5–14.0 mmol/L	2 units IVP Increase infusion 1 unit/hr	2 units IVP Increase infusion 2 units/hr	2 units IVP Increase infusion 3 units/hr	
14.1–17.0 mmol/L	4 units IVP Increase infusion 1 unit/hr	4 units IVP Increase infusion 2 units/hr	4 units IVP Increase infusion 3 units/hr	
17.1–20.0 mmol/L	8 units IVP Increase infusion 1 unit/hr	8 units IVP Increase infusion 2 units/hr	8 units IVP Increase infusion 3 units/hr	
> 20.1 mmol/L		Call MD For New Order		

Example 1800h—Blood glucose is 12.2 mmol/L.

1. Initiation—give 2 units of Humulin R IVP.
2. Calculate the infusion rate to administer 2 units/hr.

Formula Method

$$\frac{2 \text{ units/hr}}{0.5 \text{ units}} \times 1 \text{ mL}$$

Proportion Expressed as Two Ratios

1 mL: 0.5 units :: x: 2 units/hr

Proportion Expressed as Two Fractions

$$\frac{1 \text{ mL}}{0.5 \text{ units}} \times \frac{x \text{ mL}}{2 \text{ units/hr}}$$

$$1 \text{ mL} \times 2 \text{ units/hr} = 0.5 \text{ units } 1 \text{ mL x } 2 \text{ units/hr}$$

$$\frac{1 \text{ mL} \times 2 \text{ units}}{0.5 \text{ units/hr}} = 1 \text{ mL x } 2 \text{ units}$$

$$4 \text{ mL/hr} = x$$

3. Initiation—refer to "Initiating an Insulin Infusion Protocol"

Locate blood glucose at top of table. Follow instructions.

Set pump at 4 mL/hr. Recheck blood glucose in 1 hour.
1900h—Blood glucose is 8.4 mmol/L

4. Titrate IV infusion—refer to "Ongoing Infusion Titration"

Find current infusion rate at top of table. Locate current glucose level on left of table. Follow instructions.
Increase infusion 1 unit/hr. (2 units/hr + 1 unit/hr = 3 units/hr)
Calculate the new infusion rate.

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{3 \text{ units/hr}}{0.5 \text{ units}} \times 1 \text{ mL}$	1 mL: 0.5 units :: x: 3 units/hr	$\frac{1 \text{ mL}}{0.5 \text{ units}} = \frac{x \text{ mL}}{3 \text{ units/hr}}$

$$1 \text{ mL} \times 3 \text{ units/hr} = 0.5 \text{ units } 1 \text{ mL x } 2 \text{ units/hr}$$
$$\frac{1 \text{ mL} \times 3 \text{ units}}{0.5 \text{ units/hr}} = 1 \text{ mL x } 2 \text{ units}$$
$$6 \text{ mL/hr} = x$$

Set IV pump at 6 mL/hr. Recheck blood glucose in 1 hour.

2000h—Blood glucose is 4.7 mmol/L

5. No change to infusion rate (6 mL/hr). Recheck blood glucose in 1 hour.

SELF TEST 6

Using Insulin Infusion Protocol above, complete the following calculations for your patient.

1. The insulin infusion is at 11 units/hr. Your patient's blood glucose is 11.4 mmol/L.

   a. Indicate action to be taken as per protocol.
   b. Calculate new infusion rate.

2. The insulin infusion is at 14 units/hr. Your patient's blood glucose is 4.3 mmol/L.

   Indicate action to be taken as per protocol.

3. Insulin infusion has been stopped for 60 minutes. Your patient's blood glucose is 6.3 mmol/L. The insulin infusion was at 14 units/hr.

   a. Indicate action to be taken as per protocol.
   b. Calculate new infusion rate.

SELF TEST 7 Infusion Problems

Solve these problems. Answers are given at the end of the chapter.

1. Order: start Normadyne (labetalol) 0.5 mg/min on pump
Supply: infusion pump, standard solution of 200 mg in 200 mL D5W
What is the pump setting?

2. Order: aminophylline 250 mg in 250 mL D5W at 75 mg/hr IV
Supply: infusion pump, vial of aminophylline labelled 250 mg/10 mL

a. How much drug is needed?
b. What is the pump setting?

3. Order: Bretylol (bretylium) 2 g in 500 mL D5W at 4 mg/min IV
Supply: infusion pump, standard solution of 2 g in 500 mL D5W
What is the pump setting?

4. Order: Zovirax (acyclovir) 400 mg in 100 mL D5W over 2 hr
Supply: infusion pump, 500-mg vials of Zovirax (acyclovir) with 10 mL diluent; makes 50 mg/mL

a. How much drug is needed?
b. What is the pump setting?

5. Order: Abbokinase (urokinase) 5,000 units/hr over 5 hr IV
Supply: infusion pump, vials of 5,000 units
Directions: Dissolve Abbokinase (urokinase) in 1 mL sterile water. Add to 250 mL D5W.

a. How much drug is needed?
b. What is the pump setting?

6. Order: magnesium sulfate 4 g in 100 mL D5W to infuse over 30 min IV
Supply: infusion pump, 50% solution of magnesium sulfate

a. How much drug is needed?
b. What is the pump setting?

7. Order: nitroglycerin 80 mcg/min IV
Supply: infusion pump, standard solution of 50 mg in 250 mL D5W
What is the pump setting?

8. Order: Dobutrex (dobutamine) 6 mcg/kg/min IV
Supply: infusion pump, solution 500 mg/250 mL D5W; weight, 82 kg
What is the pump setting?

9. Order: Pitocin (oxytocin) 2 milliunits/min IV
Supply: infusion pump, solution of 9 units in 150 mL NS
a. What is the pump setting?

10. H, 152.4 cm; W, 50 kg; BSA, 1.45 m^2
Order: Platinol (cisplatin) 116 mg (80 mg/m^2) in 1 L NS to infuse over 4 hr

a. Is dose correct?
b. How should the pump be set?

CRITICAL THINKING: TEST YOUR CLINICAL SAVVY

A 65-year-old patient with a 10-year history of congestive heart failure and type 1 diabetes is admitted to the ICU with chest pain of more than 24 hours. The patient is receiving heparin, insulin, calcium gluconate, and potassium chloride, all intravenously.

a. Why would an infusion pump be needed with these medications?
b. Why would medications that are based on body weight require the use of a pump? Why would medications based on BSA require an infusion pump?
c. Can any of these medications be regulated with standard roller clamp tubing? What would be the advantage? What would be the contraindication?
d. What other information would you need to calculate the drip rates of these medications?
e. Why would it be necessary to calculate how long each infusion will last?

Putting It Together

Mrs. R is a 79-year-old female with dyspnea without chest pain, fever, chills, or sweats. No evidence for bleeding. Admitted through the ER with BP 82/60, afebrile, sinus tachycardia at 110/min. She underwent emergency dialysis and developed worsening dyspnea and was transferred to the ICU. BP on admission to ICU was 70/30, tachypneic on 100% nonrebreather mask. No c/o chest discomfort or abdominal pain. Dyspnea worsened and patient became bradycardic and agonal respirations developed. A Code Blue was called and the patient was resuscitated after intubation. Spontaneous pulse and atrial fibrillation were noted.

Past Medical History: cardiomegaly, severe cardiomyopathy, chronic atrial fibrillation, unstable angina, hypertension, chronic kidney disease with hemodialysis, TIA in 3/07.

Allergies: calcium channel blockers

Current Vital Signs: pulse 150/min, blood pressure is 90/40, RR 18 via the ventilator. Afebrile. Weight: 90 kg

Medication Orders

Zosyn (piperacillin/tazobactam) *antibiotic* 0.75 G IV in 50 mL q8h
Protonix (pantoprazole) *antiulcer* 40 mg IV q12h. dilute in 10 mL NS and give slow IV push
Neo-Synephrine (phenylephrine) *vasopressor* drip 30 mg in 500 mL D5W
 100 mcg/min titrate for SBP > 90
Levophed (norepinephrine) *vasopressor* in 4 mg in 500 mL D5W
 Titrate SBP > 90 start at 0.5 mcg/min
½ NS 1000 mL at 150 mL/hr
Heparin (*anticoagulant*) 12 units/kg/hr. no loading dose. IV solution 25,000 units in 500 mL D5W
 Titrate to keep aPTT 49-70
Aspirin (*antiplatelet*) 81 mg po/N/G daily
Lanoxin (digoxin) *cardiac glycoside* 0.25 mg IV daily
Diprivan (propofol) *sedative* 10 mg/mL
 Titrate 5-50 mcg/kg/min for sedation

(continued)

Putting It Together

Calculations

1. Calculate how many mcg/mL of Neo-Synephrine.
2. Calculate the rate on the infusion pump of Neo-Synephrine 100 mcg/min.
3. Calculate how many mcg/mL of Levophed.
4. Calculate the rate on the infusion pump of Levophed 0.5 mcg/min.
5. Calculate the dose of heparin.
6. Calculate the rate on the infusion pump of the heparin dose. When is the next aPTT due?
7. Diprivan is mixed in 100 mL. How many mg are mixed to equal 10 mg/mL?
8. Calculate the rate on the infusion pump of Diprivan, using the range 5–50 mcg/kg/min.

Critical Thinking Questions

1. Do any of the patient's medical conditions warrant changes in the medication orders?
2. Why would two vasopressors be given together?
3. What is the reason for giving the patient Diprivan?
4. What medication may help atrial fibrillation yet be contraindicated in this patient?
5. What is a possible reason for the sinus tachycardia of 150/min?
6. What is the reason for giving a drug slow IV push, such as the Protonix?

Answers in Appendix B.

PROFICIENCY TEST 1 Special IV Calculations

Name: ______________________________

Solve these problems. Answers are given in Appendix A.

1. Order: regular insulin 15 units/hr IV
Supply: infusion pump, standard solution 125 units in 250 mL NS
What is the pump setting?

2. Order: heparin sodium 1500 units/hr IV
Supply: infusion pump, standard solution 25,000 units in 500 mL D5W IV
What is the pump setting?

3. Order: Bretylol (bretylium) 2 g in 500 mL D5W at 2 mg/min IV
Supply: infusion pump, standard solution of 2 g in 500 mL D5W
What is the pump setting?

4. Order: Cardizem (diltiazem) 125 mg in 100 mL D5W at 5 mg/hr IV
Supply: infusion pump, vial of Cardizem (diltiazem) labelled 5 mg/mL

a. What is the pump setting?
b. How much drug is needed?

5. Order: lidocaine 4 mg/min IV
Supply: infusion pump, standard solution of 2 g in 500 mL D5W
What is the pump setting?

6. Order: KCl 40 mEq/L at 10 mEq/hr IV
Supply: infusion pump, vial of KCl labelled 20 mEq/10 mL in D5W 1000 mL

a. How much KCl should be added?
b. What is the pump setting?

7. Order: Pronestyl (procainamide) 1 mg/min IV
Supply: infusion pump, standard solution of 2 g in 500 mL D5W
What is the pump setting?

8. Order: Fungizone (amphotericin) B 50 mg in 500 mL D5W over 6 hr IV
Supply: infusion pump, vial of 50 mg

a. How should the drug be added to the IV?
b. What is the pump setting?

9. Order: Pitressin (vasopressin) 18 units/hr IV, solution 200 units in 500 mL D5W
Supply: infusion pump, vial of Pitressin (vasopressin) labelled 20 units/mL

a. How much drug is needed?
b. What is the pump setting?

10. Order: Dobutrex (dobutamine) 250 mcg/min IV
Supply: infusion pump, solution of 500 mg in 500 mL D5W
What is the pump setting?

11. Order: renal dose Intropin (dopamine) 2.5 mcg/kg/min
Supply: infusion pump, solution 400 mg in 250 mL D5W; W, 60 kg
What is the pump setting?

(continued)

PROFICIENCY TEST 1 Special IV Calculations *(Continued)*

12. Order: Pitocin (oxytocin) 2 milliunits/min IV
Supply: infusion pump, solution of 5 units in 500 mL NS
What is the pump setting?

13. H, 160 cm; W, 65 kg; BSA, 1.7 m^2
Order: Ara-C 170 mg (100 mg/m^2) in 1 L D5W over 24 hr

a. Is dose correct?
b. How should the pump be set?

14. Order: Nipride (nitroprusside) 5 mcg/kg/min IV
Supply: patient wgt = 90 kg; Nipride (nitroprusside) 50 mg in 250 mL D5W, infusion pump
What is the pump setting?

15. Order: epinephrine 2 mcg/min
Supply: epinephrine 4 mg in 250 mL D5W, infusion pump
What is the pump setting?

16. Patient's aPTT is 45 seconds. Use the heparin protocol chart on page 248. Patient's weight is 90 kg. Heparin 25,000 units in 500 mL. Rate is currently 32 mL/hr.

a. Is there a bolus dose? If so, what is the dose?
b. Is there a change in the infusion rate? Calculate the new infusion rate.

17. Patient's aPTT is 40 seconds. Use the heparin protocol chart on page 248. Patient's weight is 90 kg. Heparin 25,000 units in 500 mL. Rate is currently 32 mL/hr.

a. Is there a bolus dose? If so, what is the dose?
b. Is there a change in the infusion rate? Calculate the new infusion rate.

18. Patient's aPTT is 110 seconds. Use the heparin protocol chart on page 248. Patient's weight is 90 kg. Heparin 25,000 units in 500 mL. Rate is currently 32 mL/hr.

a. Is there a bolus dose? If so, what is the dose?
b. Is there a change in the infusion rate? Calculate the new infusion rate.

19. Use regular insulin 50 units in 100 mL NS. Use the insulin protocol on p. 251 for changes.

Patient's blood glucose is 6.8 mmol/L. Repeat blood glucose in 1 hour is 7.1 mmol/L.

a. What is the infusion rate?
b. Is there a change in the rate? If so, what is the new rate?

Answers to Self Tests

Self Test 1 Infusion Rates

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
1. $\dfrac{\overset{8}{\cancel{800}}\ \cancel{\text{units}}/\text{hr}}{\underset{\underset{1}{\cancel{100}}}{\cancel{25{,}000}}\ \cancel{\text{units}}} \times \overset{1}{\cancel{250}}\ \text{mL}$ $= 8\ \text{mL/hr}$ on a pump	$250\ \text{mL} : 25000\ \text{units} :: x\ \text{mL} : 800\ \text{units}$	$\dfrac{x\ \text{mL}}{800\ \text{units}} \times \dfrac{250\ \text{mL}}{25000\ \text{units}}$

$$200000 = 25000x$$

$$\frac{200000}{25000} = x$$

$$8\ \text{mL/hr} = x$$

$$\frac{\text{number mL}}{\text{number mL/hr}}$$

$$\frac{250\ \text{mL}}{8\ \text{mL/hr}}$$

$$
\begin{array}{r}
31.2 \\
8\,\overline{)\,250.0} \\
\underline{24} \\
10 \\
\underline{8} \\
2.0
\end{array}
$$

approximately 31 hours; hospital policy states that IV bags be changed after 24 hours

2. Add 500 mg acyclovir to 100 mL D5W using a reconstitution device (see Chapter 8).

$$\frac{\text{number mL}}{\text{number hr}} = \text{mL/hr}$$

$\dfrac{100\ \text{mL}}{1\ \text{hr}}$ No math is necessary. Set the pump at 100 mL/hr.

3. a. Add amicar to IV.

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\dfrac{24\ \cancel{\text{g}}}{\cancel{5}\ \cancel{\text{g}}} \times \overset{4}{\cancel{20}}\ \text{mL} = 96\ \text{mL}$	$20\ \text{mL} : 5\ \text{g} :: x\ \text{mL} : 24\ \text{g}$	$\dfrac{x\ \text{mL}}{24\ \text{g}} \times \dfrac{20\ \text{mL (cc)}}{5\ \text{g}}$

$$24 \times 20 = 5x$$

$$\frac{480}{5} = x$$

$$96\ \text{mL} = x$$

(*Note:* Adding 96 mL to 1000 mL D5W = 1096 mL. This is too much fluid.)

Use five vials. Empty four completely.
Take 16 mL from the last vial.
20 mL × 4 vials = 80 mL + 16 mL = 96 mL
Remove 96 mL D5W from the IV bag before adding the amicar. This results in 1000 mL.

b. $\frac{\text{number mL}}{\text{number hr}} = \text{mL/hr}$

$$\frac{1000 \text{ mL}}{24 \text{ hr}} \qquad \begin{array}{r} 41.6 \\ \overline{)1000.0} \\ \underline{96} \\ 40 \\ \underline{24} \\ 16.0 \\ \underline{14.4} \end{array}$$

Set pump at 42 mL/hr.

4. a. Add diltiazem to IV.

Formula Method

$$\frac{\overset{25}{\cancel{125}}\text{ mg}}{\cancel{5}\text{ mg}} \times 1 \text{ mL} = 25 \text{ mL}$$

Proportion Expressed as Two Ratios

$$1 \text{ mL} : 5 \text{ mg} :: x \text{ mL} : 125 \text{ mg}$$

Proportion Expressed as Two Fractions

$$\frac{x \text{ mL}}{125 \text{ mg}} \times \frac{1 \text{ mL}}{5 \text{ mg}}$$

$$\frac{125}{5} = x$$

$$25 \text{ mL} = x$$

(*Note:* Adding 25 mL to 100 mL D5W = 125 mL. This is too much fluid. Remove 25 mL D5W from the IV bag before adding the diltiazem. This results in 100 mL.)

b. Add 25 mL to IV bag.

Formula Method

$$\frac{\overset{2}{\cancel{10}}\text{ mg}}{\underset{\underset{1}{\cancel{5}}}{\cancel{125}}\text{ mg}} \times \overset{4}{\cancel{100}} \text{ mL} = 8 \text{ mL/hr}$$

Proportion Expressed as Two Ratios

$$100 \text{ mL} : 125 \text{ mg} :: x \text{ mL} : 10 \text{ mg}$$

Proportion Expressed as Two Fractions

$$\frac{x \text{ mL}}{10 \text{ mg}} \times \frac{100 \text{ mL}}{125 \text{ mg}}$$

$$\frac{1000}{125} = x$$

$$8 \text{ mL/hr} = x$$

5. a. Add furosemide to IV.

Formula Method

$$\frac{\overset{10}{\cancel{100}}\text{ mg}}{\underset{1}{\cancel{10}}\text{ mg}} \times 1 \text{ mL} = 10 \text{ mL}$$

Proportion Expressed as Two Ratios

$$1 \text{ mL} : 10 \text{ mg} :: x \text{ mL} : 100 \text{ mg}$$

Proportion Expressed as Two Fractions

$$\frac{x \text{ mL}}{100 \text{ mg}} \times \frac{1 \text{ mL}}{10 \text{ mg}}$$

$$100 = 10x$$

$$10 \text{ mL} = x$$

(*Note:* Adding 10 mL to 100 mL D5W = 110 mL. This is too much fluid. Remove 10 mL D5W from the IV bag before adding the furosemide. This results in 100 mL.)

Add 10 mL to the IV bag.

b. Because the solution is 100 mg/100 mL (1:1) and the order reads 4 mg/hr, the pump should be set at 4 mL/hr.

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{4\ \cancel{\text{mg}}/\text{hr}}{\underset{1}{\cancel{100}}\ \cancel{\text{mg}}} \times \overset{1}{\cancel{100}}\ \text{mL} = 4\ \text{mL/hr}$	$100\ \text{mL} : 100\ \text{mg} :: x\ \text{mL} : 4\ \text{mg}$	$\frac{x\ \text{mL}}{4\ \text{mg}} \times \frac{100\ \text{mL}}{100\ \text{mg}}$

$$400 = 100x$$
$$4\ \text{mL/hr} = x$$

6. a.

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{15\ \text{units}}{125\ \text{units}} \times 250\ \text{mL}$ $0.12 \times 250\ \text{mL} = 30\ \text{mL/hr}$	$250\ \text{mL} : 125 :: x\ \text{mL} : 15\ \text{units}$	$\frac{x\ \text{mL}}{15\ \text{units}} \times \frac{250\ \text{mL}}{125}$

$$3750 = 125x$$
$$30\ \text{mL/hr} = x$$

b. The total volume of medication is 125 units and the client receives 15 units/hr.

$$\frac{125}{15} \qquad 15\overline{)125.00} = 8.33 = \text{approximately 8 hours}$$

```
   8.33
 )125.00
  120
  ---
    5.0
    4.5
    ---
     50
```

7. Nitroglycerin is prepared by the pharmacy as a standard solution of 50 mg in 250 mL/hr. We only need to calculate mL/hr.

Rule: $\frac{\text{number mL}}{\text{number hr}} = \text{mL/hr}$

$$\frac{250\ \text{mL}}{24\ \text{hr}} \qquad 24\overline{)250.0} = 10.4$$

```
   10.4
 )250.0
  24
  --
   10 0
    9 6
   ----
```

Set pump at 10 mL/hr.

8. a.

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{\cancel{1200}\ \cancel{\text{units}}}{\underset{5}{\cancel{25000}}\ \cancel{\text{units}}} \times \overset{1}{\cancel{500}}\ \text{mL} = 24\ \text{mL/hr}$	$500\ \text{mL} : 25{,}000\ \text{units} :: x\ \text{mL} : 1200\ \text{units}$	$\frac{x\ \text{mL}}{1200\ \text{units}} \times \frac{500\ \text{mL}}{25{,}000\ \text{units}}$

$$600000 = 25{,}000x$$
$$\frac{600000}{25000} = x$$
$$24\ \text{mL/hr} = x$$

b. Rule: $\frac{\text{number mL}}{\text{number mL/hr}}$

$\frac{500 \text{ mL}}{24 \text{ mL/hr}} = 20.8$ or approximately 21 hours

9. a.

Formula Method

$\frac{23 \cancel{\text{units}}/\text{hr}}{\cancel{250} \cancel{\text{units}}} \times \cancel{250} \text{ mL} = 23 \text{ mL/hr}$

Proportion Expressed as Two Ratios

$250 \text{ mL} : 250 \text{ units} :: x \text{ mL} : 23 \text{ units}$

Proportion Expressed as Two Fractions

$\frac{x \text{ mL}}{23 \text{ units}} = \frac{250 \text{ mL}}{250 \text{ units}}$

$23 \text{ mL/hr} = x$

b. Rule: $\frac{\text{number mL}}{\text{number mL/hr}}$

$\frac{250 \text{ mL}}{23 \text{ mL/hr}} = 10.8$ or approximately 11 hours

10.

Formula Method

$\frac{100\,\cancel{000} \text{ units}}{750\,\cancel{000} \text{ units}} \times 250 \text{ mL} = 33 \text{ mL/hr}$

Proportion Expressed as Two Ratios

$250 \text{ mL} : 750000 \text{ units} :: x \text{ mL} : 100000 \text{ units}$

Proportion Expressed as Two Fractions

$\frac{x \text{ mL}}{100000 \text{ units}} = \frac{250 \text{ mL}}{750000 \text{ units}}$

$\frac{2500}{75} = x$

$33 \text{ mL/hr} = x$

Self Test 2 Infusion Rates for Drugs Ordered in mg/min

1. a. Order: 1 mg/min = 60 mg/hr (1 mg/min × 60 minutes)

Solution: 2 g in 250 mL

2 g = 2000 mg

Formula Method

$\frac{60 \cancel{\text{mg}}/\text{hr}}{\underset{8}{\cancel{2000}} \cancel{\text{mg}}} \times \overset{1}{\cancel{250}} \text{ mL}$

$= 7.5 \text{ mL/hr}$ or 8 mL/hr

Proportion Expressed as Two Ratios

$250 \text{ mL} : 2000 \text{ mg} :: x \text{ mL} : 60 \text{ mg}$

Proportion Expressed as Two Fractions

$\frac{x \text{ mL}}{60 \text{ mg}} = \frac{250 \text{ mL}}{2000 \text{ mg}}$

$75000 = 2000\,x$

$7.5 \text{ mL} = x$

Set pump at 8 mL/hr.

b. $\frac{\text{number mL}}{\text{number mL/hr}}$

$\frac{250 \text{ mL}}{8 \text{ mL/hr}} = 31.25$ or approximately 31 hours; hospital policy requires that IV bags be changed every 24 hours

2. a. Order: 3 mg/min = 180 mg/hr (3 mg/min × 60 minutes)

Solution: 1 g in 250 mL

1 g = 1000 mg

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{180\ \cancel{\text{mg}}/\text{hr}}{\underset{4}{\cancel{1000}}\ \cancel{\text{mg}}} \times \cancel{250}\ \text{mL} = 45\ \text{mL/hr}$	250 mL : 1000 mg : : x mL : 180 mg	$\frac{x\ \text{mL}}{180\ \text{mg}} \times \frac{250\ \text{mL}}{1000\ \text{mg}}$

$45000 = 1000\ x$

$45 = x$

Set pump at 45 mL/hr.

b. $\frac{\text{number mL}}{\text{number mL/hr}}$

$\frac{250\ \text{mL}}{45\ \text{mL/hr}} = 5.5$ or approximately 6 hours

$\frac{12\ \cancel{\text{mcg/min}}}{0.27\ \cancel{\text{mcg/min}}} \times 1\ \text{mL} = 44\ \text{mL/hr}$

1 mL : 0.27 mcg/min : : x mL : 12 mcg/min

$\frac{1\ \text{mL}}{0.27} = \frac{x\ \text{mL}}{12\ \text{mcg/min}}$

$12 = 0.27x$

$\frac{12}{0.27} = x$

$44\ \text{mL/hr} = x$

3. a. Order: 2 mg/min = 120 mg/hr (2 mg/min × 60 minutes)

Solution: 1 g in 500 mL

1 g = 1000 mg

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{120\ \cancel{\text{mg}}/\text{hr}}{\underset{2}{\cancel{1000}}\ \cancel{\text{mg}}} \times \overset{1}{\cancel{500}}\ \text{mL} = 60\ \text{mL/hr}$	500 mL : 1000 mg : : x mL : 120 mg	$\frac{x\ \text{mL}}{120\ \text{mg}} \times \frac{500\ \text{mL}}{1000\ \text{mg}}$

$60000 = 1000\ x$

$60\ \text{mL/hr} = x$

Set pump at 60 mL/hr.

b. $\frac{\text{number mL}}{\text{number mL/hr}}$

$\frac{500\ \text{mL}}{60\ \text{mL/hr}} = 8.3$ or approximately 8 hours

4. Order: 1 mg/min = 60 mg/hr (1 mg/min × 60 minutes)

Solution: 450 mg in 250 mL

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{60\ \cancel{\text{mg}}/\text{hr}}{\underset{9}{\cancel{450}}\ \cancel{\text{mg}}} \times \overset{5}{\cancel{250}}\ \text{mL} = 33.33$ or 33 mL/hr	250 mL : 450 mg : : x mL : 60 mg	$\frac{x\ \text{mL}}{60\ \text{mg}} \times \frac{25\cancel{0}\ \text{mL}}{45\cancel{0}\ \text{mg}}$

$1500 = 45x$

$\frac{1500}{45} = x$

$33.33 = x$

Set the pump at 33 mL/hr. Run for 6 hours.

5. a. Order: 1 mg/min = 60 mg/hr (1 mg/min × 60 minutes)

Solution: 2 g in 500 mL

2 g = 2000 mg

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{60 \cancel{\text{mg}}/\text{hr}}{\underset{4}{\cancel{2000}} \cancel{\text{mg}}} \times \overset{1}{\cancel{500}} \text{ mL} =$ 15 mL/hr	500 mL : 2000 mg : : x mL : 60 mg	$\frac{\text{x mL}}{\text{60 mg}} \times \frac{\text{500 mL}}{\text{2000 mg}}$

30000 = 2000x

15 mL/hr = x

Set the pump at 15 mL/hr.

b. $\frac{\text{number mL}}{\text{number mL/hr}}$

$\frac{\text{500 mL}}{\text{15 mL/hr}}$ = 33.3 or approximately 33 hours; hospital policy requires that IV bags be changed every 24 hours

Self Test 3 Infusion Rates for Drugs Ordered in mcg/min, mcg/kg/min, milliunits/min

1. Order: 800 mcg/min

Standard solution: 800 mg in 250 mL D5W

Step 1. $\frac{\text{800 mg}}{\text{250 mL}}$ = 3.2 mg/mL

Step 2. 3.2 mg = 3200 mcg/mL

Step 3. $\frac{3200}{60}$ = 53.33 mcg/min

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{\text{800 mcg/min}}{\text{53.33 mcg/min}} \times 1 \text{ mL}$ = 15 mL/hr	1 mL : 53.33 mcg/min : : x mL : 800 mcg/min	$\frac{\text{1 mL}}{53.33} \times \frac{\text{x mL}}{\text{800 mcg/min}}$

800 = 53.33x

$\frac{800}{53.33} = \text{x}$

15 mL/hr = x

Set the pump: total number mL = 250 (standard solution); mL/hr = 15

2. Order: 12 mcg/min

Standard solution: 4 mg in 250 mL D5W

Step 1. $\frac{4 \text{ mg}}{250 \text{ mL}} = 0.016 \text{ mg/mL}$

Step 2. 0.016 mg = 16 mcg/mL

Step 3. $\frac{16 \text{ mcg}}{60 \text{ min}} = 0.27 \text{ mcg/min}$

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{12 \cancel{\text{mcg}}/\text{min}}{0.27 \cancel{\text{mcg}}/\text{min}} \times 1 \text{ mL} = 44 \text{ mL/hr}$	1 mL : 0.27 mcg/min : : x mL : 12 mcg/min	$\frac{1 \text{ mL}}{0.27} \times \frac{x \text{ mL}}{12 \text{ mcg/min}}$

$$12 = 0.27x$$

$$\frac{12}{0.27} = x$$

$$44 \text{ mL/hr} = x$$

Set the pump: total number mL = 250; mL/hr = 44

3. Order: 5 mcg/kg/min

Weight, 100 kg

Standard solution: 1 g in 250 mL

To obtain the order in mcg:

multiply 100 kg × 5 mcg/kg/min

100 kg
× 5 mcg/kg/min
500 mcg/min (order)

Step 1. 1 g = 1000 mg

$\frac{1000 \text{ mg}}{250 \text{ mL}} = 4 \text{ mg/mL}$

Step 2. 4 mg = 4000 mcg/mL

Step 3. $\frac{4000}{60} = 66.67 \text{ mcg/min}$

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{500 \cancel{mcg}/min}{66.67 \cancel{mcg}/min} \times 1\ mL = 7.49$ or 8 mL/hr	1 mL : 66.67 mcg/min : : x mL : 500 mcg/min	$\frac{1\ mL}{66.67} \times \frac{x\ mL}{500\ mcg/min}$

$$500 = 66.67x$$

$$\frac{500}{66.67} = x$$

$$7.5 \text{ or } 8 = x$$

Set the pump: total # mL = 250 (standard solution); mL/hr = 7.5 or 8 mL

4. Order: 7 mcg/kg/min

Standard solution: 500 mg in 250 mL D5W

Patient's wgt, 70 kg

The patient weighs
$$\begin{array}{r} 70\ kg \\ \times 7\ mcg/kg/min \\ \hline 490\ mcg/min \end{array}$$

Step 1. $\frac{500\ mg}{250\ mL} = 2\ mg/mL$

Step 2. $2 \times 1000 = 2000\ mcg/mL$

Step 3. $\frac{2000}{60} = 33.33\ mcg/min$

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{490 \cancel{mcg}/min}{33.33 \cancel{mcg/mL}/min} \times 1\ mL = x$ x = 14.7 or 15 mL/hr	1 mL : 33.33 mcg/min : : x mL : 490 mcg/min	$\frac{1\ mL}{33.33} \times \frac{x\ mL}{490\ mcg/min}$

$$490 = 33.33x$$

$$\frac{490}{33.33} = x$$

$$14.7 \text{ or } 15\ mL/hr = x$$

Set the pump: total number mL = 250 (standard solution); mL/hr = 15

5. Order: 10 mcg/min

Standard solution: 50 mg in 250 mL

Step 1. $\frac{50\ mg}{250\ mL} = 0.2\ mg/mL$

Step 2. $0.2 \times 1000 = 200\ mcg/mL$

Step 3. $\frac{200\ mcg}{60\ mL} = 3.33\ mcg/min$

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{10\ \cancel{\text{mcg/min}}}{3.33\ \cancel{\text{mcg/min}}} \times 1\text{ mL} = x$ $x = 3\text{ mL/hr}$	1 mL : 3.33 mcg/min : : x mL : 10 mcg/min	$\frac{1\text{ mL}}{3.33} \times \frac{x\text{ mL}}{10\text{ mcg/min}}$

$10 = 3.33x$

$\frac{10}{3.33} = 3.33$

Set the pump: total number mL = 250; mL/hr = 3

3 mL/hr = x

6. Order: 0.5 milliunit/min

Standard solution: 10 units in 1000 mL NS

Step 1. $\frac{10\text{ units}}{1000\text{ mL}} = 0.01$ units/mL

Step 2. 1 unit = 1000 milliunits

0.01 units = 10 milliunits

Step 3. $\frac{10}{60} = 0.167$ milliunit/min

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{0.5\text{ milliunit/min}}{0.167\text{ milliunit/min}} \times 1\text{ mL}$	1 mL : 0.167 milliunit :: × 10.5 milliunit	$\frac{1\text{ mL}}{0.167\text{ milliunit/min}} = \frac{x}{0.5\text{ milliunit/min}}$

$\frac{0.5\text{ mL}}{0.167} = 2.99 = x$

Set pump at 3 mL/hr

7. Order: 4 mcg/min

Solution: 2 mg in 250 mL

Step 1. $\frac{2\text{ mg}}{250\text{ mL}} = 0.008$ mg/mL

Step 2. $0.008 \times 1000 = 8$ mcg/mL

Step 3. $\frac{8\text{ mcg}}{60\text{ mL}} = 0.133$ mcg/min

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{4\ \cancel{\text{mcg/min}}}{0.133\ \cancel{\text{mcg/min}}} \times 1\text{ mL} = x$ $x = 30\text{ mL/hr}$	1 mL : 0.133 mcg/min : : x mL : 4 mcg/min	$\frac{1\text{ mL}}{0.133} \times \frac{x\text{ mL}}{4\text{ mcg/min}}$

$4 = 0.133x$

$\frac{4}{0.133} = x$

Set the pump: total number mL = 250; mL/hr = 30

30 mL = x

8. Order: 50 mcg/kg/min

Solution: 2.5 g in 250 mL

Weight: 58 kg

$$58 \text{ kg} \times 50 \text{ mcg} = 2900 \text{ mcg (order)}$$

Step 1. $2.5 \text{ g} = 2500 \text{ mg}$

$\frac{2500 \text{ mg}}{250 \text{ mL}} = 10 \text{ mg/mL}$

Step 2. $10 \times 1{,}000 = 10{,}000 \text{ mcg/mL}$

Step 3. $\frac{10000}{60} = 166.67 \text{ mcg/min}$

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{2900 \text{ mcg/min}}{166.67 \text{ mcg/min}} \times 1 \text{ mL} = 17 \text{ mL/hr}$	$1 \text{ mL} : 166.67 \text{ mcg/min} :: x \text{ mL} : 2900 \text{ mcg/min}$	$\frac{1 \text{ mL}}{166.67} \times \frac{x \text{ mL}}{2900 \text{ mcg/min}}$

$$2900 = 166.67x$$

$$\frac{2900}{166.67} = x$$

$$17 \text{ mL} = x$$

Set the pump: total number mL = 250; mL/hr = 17

9. Order: 2 mcg/kg/min

Solution: 50 mg in 250 mL

Weight: 80 kg

$$80 \text{ kg} \times 2 \text{ mcg} = 160 \text{ mcg (order)}$$

Step 1. $\frac{50 \text{ mg}}{250 \text{ mL}} = 0.2 \text{ mg/mL}$

Step 2. $0.2 \text{ mg} = 200 \text{ mcg}$

$0.2 = 200 \text{ mcg/mL}$

Step 3. $\frac{200 \text{ mg}}{60 \text{ mL}} = 3.33 \text{ mcg/mL}$

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{160 \cancel{\text{mcg/min}}}{3.33 \cancel{\text{mcg/min}}} \times 1 \text{ mL} = x$ $x = 48$	$1 \text{ mL} : 3.33 \text{ mcg/min} :: x \text{ mL} : 160 \text{ mcg/min}$	$\frac{1 \text{ mL}}{3.33} \times \frac{x \text{ mL}}{160 \text{ mcg/min}}$

$$160 = 3.33x$$

$$\frac{160}{3.33} = x$$

$$48 = x$$

Set the pump: total number mL = 250; mL/hr = 48

10. Order: 200 mcg/min

Solution: 0.1 g in 100 mL

100 mg in 100 mL

Step 1. $\frac{100\text{ mg}}{100\text{ mL}} = 1\text{ mg/mL}$

Step 2. 1 mg = 1000 mcg

1000 mcg/1 mL

Step 3. $\frac{1000\text{ mg}}{60} = 16.67\text{ mcg/min}$

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{200\ \cancel{\text{mcg/min}}}{16.67\ \cancel{\text{mcg/min}}} \times 1\text{ mL} = x$ $x = 11.99$ or 12 mL/hr	1 mL : 16.67 : : x mL : 200 mcg/min	$\frac{1\text{ mL}}{16.67} \times \frac{x\text{ mL}}{200\text{ mcg/min}}$

$200 = 16.67x$

$\frac{200}{16.67} = x$

$12 = x$

Set the pump: total number mL = 100; mL/hr = 12

Self Test 4 Use of Nomogram

1. a. Dose is correct; 20 mg/m² × 1.96 = 39 mg

b. Order calls for 250 mL over ½ hour, but pump is set in mL/hr. Double 250 mL.

Setting: total number mL = 250; mL/hr = 500.

The pump will deliver 250 mL in ½ hour.

2. a. Correct; 130 mg/m² × 1.77 = 230 mg

b. Pour two 100-mg tabs and three 10-mg tabs.

3. a. Correct; 40 mg/m² × 2 = 80 mg

b. Rapidly flowing IV is the primary line. Set the secondary pump: total number mL, 80; mL/hr, 80 (see Chapter 8 for IVPB).

4. a. Correct; 200 mg/m² × 2 = 400 mg

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{\overset{8}{\cancel{400}}\text{ mg}}{\cancel{50}\text{ mg}} \times 1\text{ capsule} = 8\text{ capsules}$	1 capsule : 50 mg : : x capsules : 400 mg	$\frac{x\text{ capsule}}{400\text{ mg}} \times \frac{1\text{ capsule}}{50\text{ mg}}$

$400 = 50x$

8 capsules = x

5. a. Correct; 135 mg/m² × 1.6 = 216 mg

b. ½ L = 500 mL over 3 hr; $\frac{500}{3}$ $\;\frac{166.6}{\overline{)500}} = 167$

Set the pump: total number mL = 500; mL/hr = 167

Self Test 5

1. a. Bolus with 40 units/kg
$40 \times 70 = 2800$ units

b. increase rate by 2 units/kg per hour
$2 \times 70 = 140$ units

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{140 \text{ units}}{25000 \text{ units}} \times 500 \text{ mL} = x$ $x = 2.8$ mL	500 mL : 25000 units : : x mL : 140 units	$\frac{500 \text{ mL}}{25000 \text{ units}} \times \frac{x \text{ mL}}{140 \text{ units}}$

$$\frac{500 \times 140}{25000} = x$$

$$2.8 \text{ mL} = x$$

Increase rate by 2.8 mL

$25.2 + 2.8 = 28$ mL/hr

2. a. Bolus with 40 units/kg
$40 \times 70 = 2800$ units

b. Increase rate by 3 units/kg/hr
$3 \times 70 = 210$ units

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{210 \text{ units}}{25000 \text{ units}} \times 250 \text{ mL} = x$ $x = 4.2$ mL	500 mL : 25000 units : : x mL : 210 units	$\frac{500 \text{ mL}}{25000 \text{ units}} \times \frac{x \text{ mL}}{210 \text{ units}}$

$$\frac{500 \times 210}{25000} = x$$

$$4.2 \text{ mL} = x$$

Increase rate by 4.2 mL

$25.2 + 4.2 = 29.4$ mL/hr

3. a. No bolus

b. Decrease rate by 1 unit/kg/hr
$1 \times 70 = 70$ units

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{70 \text{ units}}{25000 \text{ units}} \times 500 \text{ mL} = x$ $x = 1.4$ mL	500 mL : 25000 units : : x mL : 70 units	$\frac{500 \text{ mL}}{25000 \text{ units}} \times \frac{x \text{ mL}}{70 \text{ units}}$

$$\frac{70 \times 500}{25000} = x$$

$$1.4 \text{ mL} = x$$

Decrease drip by 1.4 mL

$25.2 - 1.4 = 23.8$ mL/hr

4. a. No bolus

b. Stop infusion for 1 hour
Decrease rate by 2 units/kg/hr
$2 \times 70 = 140$ units

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{140 \text{ units}}{25000 \text{ units}} \times 500 \text{ mL} = x$ $x = 2.8$ mL	500 mL : 25000 units : : x mL : 140 units	$\frac{500 \text{ mL}}{25000 \text{ units}} \times \frac{x \text{ mL}}{140 \text{ units}}$

$$\frac{500 \times 140}{25000} = x$$

$$2.8 \text{ mL} = x$$

Decrease rate by 2.8 mL

$25.2 - 2.8 = 22.4$ mL/hr

Self Test 6 Answer

1. a. Increase infusion 3 units/hr.

11 units/hr + 3 units/hr = 14 units/hr

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{14 \text{ units/hr}}{0.5 \text{ units}} \times 1 \text{ mL}$	1 mL : 0.5 units :: x 14 units/hr $1 \text{ mL} \times 14 \text{ units/hr} = 0.5 \text{ units } x$	$\frac{1 \text{ mL}}{0.5 \text{ units}} \times \frac{x \text{ mL}}{14 \text{ units/hr}}$

$$\frac{1 \text{ mL} \times 14 \text{ units}}{0.5 \text{ units/hr}} = x$$

$$28 \text{ mL/hr} = x$$

b. Set IV Pump at 28 mL/hr. Recheck blood glucose in 1 hour.

2. Discontinue (stop) infusion. Recheck glucose in q30min x 4.

3. a. Restart infusion. Reduce rate by 3 units/hr (14 units – 3 units = 11 units).

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{11 \text{ units/hr}}{0.5 \text{ units}} \times 1 \text{ mL}$	1 mL : 0.5 units :: x 11 units/hr	$\frac{1 \text{ mL}}{10.5 \text{ units}} \times \frac{x \text{ mL}}{11 \text{ units/hr}}$

$$\frac{1 \text{ mL} \times 11 \text{ units}}{0.5 \text{ units/hr}} = x$$

$$22 \text{ mL/hr} = x$$

b. Set IV pump at 22 mL/hr. Recheck blood glucose in 30 minutes.

Self Test 7 Infusion Problems

1. A pump is needed. This is set in mL/hr. The order calls for 0.5 mg/min. Because there are 60 minutes in an hour, multiply 0.5 mg × 60 = 30 mg/hr. The standard solution is 200 mg in 200 mL. This is a 1:1 solution, so 30 mg/hr = 30 mL/hr. You can also solve using the three methods:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\dfrac{30\text{ mg/hr}}{\underset{1}{\cancel{200}}\text{ mg}} \times \overset{1}{\cancel{200}}\text{ mL} = 30\text{ mL/hr}$	$200\text{ mL} : 200\text{ mg} :: x\text{ mL} : 30\text{ mg}$	$\dfrac{x\text{ mL}}{30\text{ mg/hr}} \times \dfrac{200\text{ mL}}{200\text{ mg}}$ $200 \times 30 = 200x$ $30\text{ mL/hr} = x$

Total number mL = 200; mL/hr = 30

2. Aminophylline comes 250 mg/10 mL. Remove 10 mL from the IV bag and add 10 mL drug. Order is 75 mg/hr. You have 250 mg in 250 mL (a 1:1 solution); therefore, set the pump at 75 mL/hr. You can also solve using the three methods:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\dfrac{75\text{ mg/hr}}{\underset{1}{\cancel{250}}\text{ mg}} \times \overset{1}{\cancel{250}}\text{ mL} = 75\text{ mL/hr}$	$250\text{ mL} : 250\text{ mg} :: x\text{ mL} : 75\text{ mg}$	$\dfrac{x\text{ mL}}{75\text{ mg}} \times \dfrac{20\text{ mL}}{250\text{ mg}}$ $250 \times 74 = 250x$ $75 = x$

Total number mL = 250; mL/hr = 75

3. 2 g = 2000 mg

A pump is needed and is set in mL/hr. Order calls for 4 mg/min. There are 60 minutes in an hour: 60 × 4 = 240 mg/hr

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\dfrac{\overset{60}{\cancel{240}}\text{ mg/hr}}{\underset{\underset{1}{\cancel{4}}}{\cancel{2000}}\text{ mg}} \times \overset{1}{\cancel{500}}\text{ mL} = 60\text{ mL/hr}$	$500\text{ mL} : 2000\text{ mg} :: x\text{ mL} : 240\text{ mg}$	$\dfrac{x\text{ mL}}{240\text{ mg}} \times \dfrac{5\cancel{00}\text{ mL}}{20\cancel{00}\text{ mg}}$ $240 \times 5 = 20x$ $60 = x$

Total number mL = 500; mL/hr = 60

4. Add acyclovir. Calculate the amount:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\dfrac{\overset{8}{\cancel{400}}\text{ mg}}{\cancel{50}\text{ mg}} \times 1\text{ mL} = 8\text{ mL}$	$1\text{ mL} : 50\text{ mg} :: x\text{ mL} : 400\text{ mg}$	$\dfrac{x\text{ mL}}{400\text{ mg}} \times \dfrac{1\text{ mL}}{50\text{ mg}}$ $400 = 50x$ $8 = x$

Remove 8 mL fluid from the IV bag and add 8 mL of drug. 8 mL × 50 mg/mL = 400 mg. This is now 400 mg/100 mL.

$$\frac{\text{number mL}}{\text{number hr}} = \text{mL/hr}$$

$$\frac{\overset{50}{\cancel{100}\ \text{mL}}}{\underset{1}{\cancel{2}\ \text{hr}}} = 50\ \text{mL/hr on a pump}$$

Total number mL = 100; mL/hr = 50

5. 5000 units/hr × 5 hr = 25,000 units in 250 mL D5W. Need five vials. Dissolve each with 1 mL sterile water. 5 vials = 25,000 units in 5 mL. Add to 250 mL D5W.

Calculate the mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\dfrac{\cancel{5000\ \text{units/hr}}}{\underset{\underset{1}{\cancel{100}}}{\cancel{25{,}000\ \text{units}}}} \times \cancel{250}\ \text{mL}$ $= 50\ \text{mL/hr on a pump}$	250 mL : 25000 units : : x mL : 5000 units	$\dfrac{x\ \text{mL}}{5000\ \text{units}} = \dfrac{\overset{1}{\cancel{250}}\ \text{mL}}{\underset{100}{\cancel{25{,}000}}\ \text{units}}$

5000 = 100x

50 mL/hr = x

Total number mL = 250; mL/hr = 50

6. Logic: magnesium sulfate comes in a 50% solution; 50 g in 100 mL = 0.5 g in 1 mL

Calculate the mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\dfrac{4\ \text{g}}{0.5\ \text{g}} \times 1\ \text{mL} =$ $x = 8\ \text{mL}$	1 mL : 0.5 g : : x mL : 4 g	$\dfrac{x\ \text{mL}}{4\ \text{g}} = \dfrac{1\ \text{mL}}{0.5\ \text{g}}$

4 g = 0.5x

8 mL = x

Add 8 mL $MgSO_4$ to 100 mL D5W. Infuse over 30 minutes. The pump is set in mL/hr (60 minutes).

$$\frac{60\ \text{minutes}}{30\ \text{minutes}} = 2$$

Multiply 100 mL × 2 = 200 mL/hr

Total number mL = 100 mL

7. Order: 80 mcg/min

Supply: 50 mg in 250 mL

Step 1. $\dfrac{50\ \text{mg}}{250\ \text{mL}} = 0.2\ \text{mg/mL}$

Step 2. 0.2 × 1000 = 200 mcg/mL

Step 3. $\dfrac{200}{60} = 3.33\ \text{mcg/min}$

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{80\ \cancel{\text{mcg/min}}}{3.33\ \cancel{\text{mcg/min}}} \times 1\text{ mL} = x = 24$	$1\text{ mL} : 3.33\text{ mcg/min} :: x\text{ mL} : 80\text{ mcg/min}$	$\frac{1\text{ mL}}{3.33} \times \frac{x\text{ mL}}{80\text{ mcg/min}}$

$$80 = 3.33x$$

$$\frac{80}{3.33} = x$$

$$24 = x$$

Set pump: total number mL = 250; mL/hr = 24

8. Order: 6 mcg/kg/min

Solution: 500 mg/250 mL

wgt: 82 kg

a. 6 mcg/kg × 82 kg = 492 mcg

Step 1. $\frac{500\text{ mg}}{250\text{ mL}} = 2\text{ mg/mL}$

Step 2. $2 \times 1000 = 2000\text{ mcg/mL}$

Step 3. $\frac{2000}{60} = 33.33\text{ mcg/min}$

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{492\ \cancel{\text{mcg/min}}}{33.33\ \cancel{\text{mcg/min}}} \times 1\text{ mL} = 14.7\text{ or }15$ 15 mL/hr	$1\text{ mL} : 492\text{ mcg/min} :: x\text{ mL} : 33.33\text{ mcg/min}$	$\frac{1\text{ mL}}{33.33} \times \frac{x\text{ mL}}{492\text{ mcg/min}}$

$$492 = 33.33x$$

$$\frac{492}{33.33} = x$$

$$14.7\text{ or }15\text{ mL/hr} = x$$

Set pump: total number mL = 250; mL/hr = 15

9. Order: 2 milliunits/min

Supply: 9 units in 150 mL NS

Step 1. $\frac{9\text{ units}}{150\text{ mL}} = 0.06\text{ units/mL}$

Step 2. 1 unit = 1000 milliunits
$0.06 \times 1000 = 60$ milliunits/mL

Step 3. $\frac{60}{60} = 1$ milliunit/mL

Step 4. Solve for mL/hr:

Formula Method	Proportion Expressed as Two Ratios	Proportion Expressed as Two Fractions
$\frac{\cancel{2 \text{ milliunits/min}}}{\cancel{1 \text{ milliunit/min}}} \times 1 \text{ mL}$	1 mL : 1 milliunit : : x mL : 2 milliunits	$\frac{1 \text{ mL}}{1 \text{ milliunit}} \times \frac{x \text{ mL}}{2 \text{ milliunits}}$

$2 = x$

Set pump: total number mL = 150 mL; mL/hr = 2

10. a. Correct; $1.45 \text{ m}^2 \times 80 \text{ mg/m}^2$

b. 1 L = 1000 mL

$$\frac{\text{number mL}}{\text{number hr}} = \frac{\overset{250}{\cancel{1000}} \text{ mL}}{\underset{1}{\cancel{4}} \text{ hr}} = 250 \text{ mL/hr}$$

Set the pump: total number mL = 1000; mL/hr = 250