Module 9: IV Infusions & Injectable Medications

Contents

Objectives: Upon completion of this module, the student is expected to be able to…
1. Perform calculations IV infusions.
2. Perform calculations for IV additives.
3. Perform rate-of-flow calculations for IV fluids.

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Content adopted from Ashley Stull, PharmD

The following material is taken from Zatz (Chapter 10) and Ansel (Chapter 13).
Please refer to class syllabus for specific notations regarding chapters covered in part.

Common IV Infusion Solutions

Table 1. Common IV Infusion Solutions	
Solution	Abbreviation
0.9% Sodium Chloride	NS
0.45% Sodium Chloride	½NS
5% Dextrose in Water	D5W
10% Dextrose in Water	D10W
5% Dextrose in 0.9% Sodium Chloride	D5WNS
5% Dextrose in 0.45% Sodium Chloride	D5W½NS
Lactated Ringer's (0.86% Sodium Chloride, 0.03% Potassium Chloride, 0.033% Calcium Chloride)	LR
5% Dextrose in Lactated Ringer's	D5LR

Example Problem 1

How many grams each of dextrose and sodium chloride are used to prepare a 250-mL bag of D5½NS for IV infusion?

$$\frac{5\ g}{100\ mL} = \frac{x\ g}{250\ mL}$$

$$x = 12.5\ g\ dextrose$$

$$\frac{0.45\ g}{100\ mL} = \frac{x\ g}{250\ mL}$$

$$x = 1.125\ g\ sodium\ chloride$$

Example Problem 2

Compare (a) the number of drops and (b) the length of time, in minutes, required to deliver 50-mL of IV solutions when using a microdrip set (60 drops/mL) and a standard administration set (15 drops/mL) if in each case one drop is to be administered per second.

Microdrip: (a) 60 drops/mL × 50 mL = 3000 drops
             (b) 3000 drops ÷ 60 drops/min = 50 min

Standard: (a) 15 drops/mL × 50 mL = 750 drops
            (b) 750 drops ÷ 60 drops/min = 12.5 min

If solving via dimensional analysis:

$$50\ mL\ \times \frac{60\ drops}{1\ mL}\ \times \frac{1\ min}{60\ drops} = 50\ min$$

$$50\ mL\ \times \frac{15\ drops}{1\ mL}\ \times \frac{1\ min}{60\ drops} = 12.5\ min$$

IV Push (IVP) Drug Administration
·   Also called bolus dose
·   Concentration and rate of administration extremely important for safety

Example Problem 1

A physician orders enalaprilat (Vasotec IV) 2 mg IVP for a hypertensive patient. A pharmacist delivers several 1-mL injections, each containing 1.25 mg of enalaprilat. How many milliliters of the injection should be administered?

$$\frac{1.25\ mg}{1\ mL} = \frac{2\ mg}{x\ mL}$$
$$x = 1.6\ mL$$

Example Problem 2

A physician orders midazolam hydrochloride (Versed) 2 mg IVP. A pharmacist delivers a vial containing midazolam hydrochloride 5 mg/mL. How many milliliters should be administered?

$$\frac{5\ mg}{1\ mL} = \frac{2\ mg}{x\ mL}$$
$$x = 0.4\ mL$$

Example Problem 3

General guidelines in the treatment of severe diabetic ketoacidosis include an initial bolus dose of 0.1 to 0.4 unit of insulin per kilogram IVP, followed by an insulin drip. Calculate the bolus dosage range for a 200-lb patient.

$$200\ lb \div 2.2\ lb/kg = 90.9\ kg$$
$$90.9\ kg \times 0.1\ unit/kg = 9.09\ units$$
$$90.9\ kg \times 0.4\ unit/kg = 36.36\ units$$

Additives to IV Infusion Solutions

Example Problem 1

A medication order for a patient weighing 154 lb calls for 0.25 mg of amphotericin B per kilogram of body weight to be added to 500 mL of a 5% dextrose injection. If the amphotericin B is to be obtained from a constituted injection that contains 50 mg/10 mL, how many milliliters should be added to the dextrose injection?

Dosing by infusion varies by:
Drug concentration
Volume administered
Rate of flow (mL/min, mg/min)

$$154\ lb = 70\ kg$$
$$0.25\ mg/kg \times 70\ kg = 17.5\ mg$$
$$\frac{50\ mg}{10\ mL} = \frac{17.5\ mg}{x\ mL}$$
$$x = 3.5\ mL$$

An intravenous infusion is to contain 15 mEq of potassium ion and 20 mEq of sodium ion in 500 mL of D5W. Using potassium chloride injection containing 6 g/30 mL and 0.9% NaCl injection, how many milliliters of each should be used to supply the required ions?

15 mEq of K+ ion will be supplied by 15 mEq of KCl, and 20 mEq of Na+ ion will be supplied by 20 mEq of NaCl.

$$mg = \frac{mEq \times Z}{valence} = \frac{15 \times 74.5}{1} = 1117.5 \ mg \ KCl$$

$$\frac{6 \ g}{30 \ mL} = \frac{1.1175 \ g}{x \ mL}$$

$$x = 5.6 \ mL$$

$$mg = \frac{mEq \times Z}{valence} = \frac{20 \times 58.5}{1} = 1170 \ mg \ NaCl$$

$$\frac{0.9 \ g}{100 \ mL} = \frac{1.17 \ g}{x \ mL}$$

$$x = 130 \ mL$$

Rate-of-Flow Calculations

A medication calls for 1000 mL of D5W to be administered over an 8-hour period. Using an IV administration set that delivers 10 drops/mL, how many drops per minute should be delivered to the patient?

$$\frac{1000 \ \text{mL}}{(8 \times 60 \ \text{min})} = 2.08 \ \text{mL per minute}$$

$$\frac{2.08 \ \text{mL}}{\text{min}} \times \frac{10 \ \text{drops}}{\text{mL}} = 20.8 \approx 21 \ \text{drops per minute}$$

An IV infusion contains 10 mL of a 1:5000 solution of isoproterenol hydrochloride and 500 mL of D5W. At what flow rate should the infusion be administered to provide 5 μg of isoproterenol hydrochloride per minute, and what time interval will be necessary for the administration of the entire infusion?

$$\frac{1 \ g}{5000 \ mL} = \frac{x \ g}{10 \ mL}$$

$$x = 0.002 \ g = 2 \ mg = 2000 \ mcg \ in \ 510 \ mL$$

$$\frac{2000 \ mcg}{510 \ mL} = \frac{5 \ mcg}{x \ mL}$$

$$x = 1.275 \approx 1.28 \ mL \ per \ min$$

$$\frac{1.28 \ mL}{1 \ min} = \frac{510 \ mL}{x \ min}$$

$$x = 398 \ min$$

Practice Problems

1. How many grams each of sodium chloride and dextrose are present in a 1000-mL bag of 0.18% sodium chloride and 4% dextrose?

2. How many grams each of sodium chloride, potassium chloride, calcium chloride, and dextrose are contained in a 500 mL bag of D5LR?

3. A patient received 250 mL of an infusion at a rate of 40 mL/hr. What was the infusion time in hours?

4. A patient was administered 150 mL of D5W at a rate of 25 mL/hr. If the infusion was begun at 8 am, at what time was it completed?

5. A patient received 500 mL of D5W½NS at a rate of 15 drops/min. If the administration set used delivered 15 drops/mL, calculate the infusion time in hours.

6. A pediatric patient received 50 mL of an infusion at 10 drops/min with an administration set that delivered 60 drops/mL. Calculate the duration of the infusion in minutes.

7. A patient received a 500-mL whole blood transfusion at 9:13 pm at a rate of 30 drops per minute via an administration set that delivers 10 drops/mL. At what time was the transfusion completed?

8. Daptomycin (Cubicin) 4 mg/kg is recommended for administration over a 30 min period by IV infusion in NS. How many milliliters of a vial containing 500 mg of daptomycin in 5 mL should be added to a 100-mL bag of NS in treating a 165-lb patient?

9. An emergency syringe contains lidocaine 1 g/5 mL. How many milliliters should be used in preparing 250 mL of an infusion to contain 4 mg/mL of lidocaine in D5W?

10. A fluconazole injection contains 400 mg of fluconazole in 200 mL NS. Calculate the concentration of fluconazole in mg/mL.

11. IV immunoglobulin (IVIG) has been administered in the pretransplantation of organs at a rate of 0.08 mL/kg/min. Calculate the number of milliliters administered to a 70-kg patient if a 10% w/v solution is infused over a period of 4 hours.

12. A pharmacist prepared a "standard concentration" of a dopamine HCl solution to contain 400 mg/250 mL D5W. If the patient is 150 lb and requires a dose of 5 mcg/kg/min…

    a. Calculate the concentration of dopamine HCl in the infusion in mg/mL.

    b. Calculate the infusion flow rate in mL/hr.

13. A pharmacist receives a med order for 300,000 units of penicillin G potassium to be added to 500 mL of D5W. The directions on the 1,000,000-unit vial state that if 1.6 mL of solvent is added, the solution will measure 2 mL. How many milliliters of the solution should be added to the D5W in preparing the med order?

14. A physician orders 2 g of an antibiotic to be placed in 1000 mL of D5W. Using an injection that contains 300 mg of the antibiotic per 2 mL, how many milliliters should be added to the D5W in preparing the med order?

15. An IV infusion for a patient weighing 132 lb calls for 7.5 mg of amikacin sulfate per kilogram of body weight to be added to 250 mL of 5% dextrose injection. How many milliliters of an amikacin sulfate injection containing 500 mg per 2 mL should be used in preparing the infusion?

16. In preparing a solution of lidocaine in D5W, a pharmacist added a concentrated solution of lidocaine (1 g/5 mL) to 250 mL of D5W. What was the final concentration of lidocaine on a mg/mL basis?

17. In preparing an IV infusion containing sodium bicarbonate, 50 mL of a 7.5% sodium bicarbonate injection were added to 500 mL of D5W. How many milliequivalents of sodium were represented in the total infusion?

18. A potassium phosphate solution contains 0.9 g of potassium dihydrogen phosphate and 4.7 g of potassium monohydrogen phosphate in 30 mL. If 15 mL of this solution are added to a liter of D5W, how many milliequivalents of potassium phosphate will be represented in the infusion?

19. A physician orders 20 mg of ampicillin per kilogram of body weight to be administered intravenously in 500 mL of NS. How many milliliters of a solution containing the equivalent of 250 mg of ampicillin per milliliter should be used in filling the medication order for a 110-lb patient?

20. The biotechnology drug cetuximab (Erbutix), used in the treatment of colorectal cancer, has a loading dose of 400 mg/m^2 administered as an IV infusion over a 120-min period. Using an IV set that delivers 15 drops/mL, calculate…

    a. …the dose for a patient with a BSA of 1.6 m^2.

    b. …the rate of delivery in drops/min for 250 mL of an IV fluid containing the dose.

21. How many milliliters of an injection containing 1 g of drug in 4 mL should be used in filling a medication order requiring 275 mg of the drug to be added to 500 mL of D5W solution? If the solution is administered at the rate of 1.6 mL per minute, how many milligrams of the drug will the patient receive in 1 hour?

22. A physician orders a 2-g vial of a drug to be added to 500 mL of D5W. If the administration rate is 125 mL per hour, how many milligrams of the drug will a patient receive per minute?

23. A certain fluid measures 1 liter. If the solution is to be administered over a period of 6 hours and if the administration set is calibrated at 25 drops per mL, what rate (in drops/min) should the set be adjusted to administer the solution during the designated interval?

24. A physician orders 35 mg of amphotericin B and 25 units of heparin to be administered intravenously in 1000 mL of D5W over an 8-hour period to a hospitalized patient. In filling the med order, the available sources of the additives are a vial containing 50 mg of amphotericin B in 10 mL and a syringe containing 10 units of heparin per mL.

    a. How many milliliters of each additive should be used in filling the medication order?

b. How many milliliters of the IV fluid per minute should the patient receive to administer the fluid over the designated interval?

25. A solution containing 500,000 units of polymixin B sulfate in 10 mL of SWFI is added to 250 m of D5W. The infusion is to be administered over 2 hours. If the administration set calibrates 15 drops/mL, at what rate, in drops per minute, should the flow be adjusted to administer the infusion over the designated time period?

26. 500 mL of a 2% sterile solution of a drug are to be administered by intravenous infusion over a period of 4 hours. If the administration set calibrates 20 drops/mL, at what rate (in drops/min) should the flow be adjusted to administer the infusion over the desired time interval?

27. An 8-kg infant requires a continuous infusion of a drug to run at 1 mL/hr to deliver 4 mcg/kg/min. Calculate the milligrams of drug that must be added to a 100-mL IV infusion solution.

28. 500 mL of an IV solution contain 0.2% of succinylcholine chloride in NS. At what flow rate should the infusion be administered to provide 2.5 mg of succinylcholine chloride per minute?

29. A hospital pharmacist prepared thirty 100-mL epidural bags containing 0.125% of bupivacaine HCl and 1 µg/mL of fentanyl citrate in NS.

    a. How many 30-mL vials of 0.5% bupivacaine HCl were required?

    b. How many 20-mL vials of 50 µg/mL fentanyl citrate were required?

    c. How many 1-L bags of NS were required?

30. An IV fluid of 1000 mL of LR was started in a patient at 8 am and was scheduled to run for 12 hours. A 3 pm, 800 mL of the fluid remained in the bottle. At what rate of flow should the remaining fluid be regulated using an IV set that delivers 15 drops/mL to complete the fluid in the scheduled time?

31. If a physician orders 5 units of insulin to be added to a 1-liter IV solution of D5W to be administered over 8 hours …

    a. How many drops per minute should be administered using an IV set that delivers 15 drops/mL?

    b. How many units of insulin would be administered in each 30-min period?

32. A patient is to receive 3 µg/kg/min of nitroglycerin from a solution containing 100 mg of the drug in 500 mL of D5W. If the patient weighs 176 lb and the infusion set delivers 60 drops/mL…

    a. How many milligrams of nitroglycerin would be delivered per hour?

b. How many drops per minute would be delivered?

33. Determine the rate of infusion delivery, in drops per minute, based on 1.5 liters of fluid to be used over a period of 8 hours with an infusion set calibrated to deliver 16 drops/mL.

34. The drug alfentanil HCl is administered by infusion at the rate of 2 µg/kg/min for anesthesia induction. If a total of 0.35 mg of the drug is to be administered to a 110-lb patient, how long should the infusion run?

35. The recommended maintenance dose of aminophylline for children is 1.0 mg/kg/hr by injection. If 10 mL of a 25 mg/mL solution of aminophylline is added to a 100-mL bottle of dextrose injection, what should be the rate of delivery, in milliliters per hour, for a 40-lb child?

36. A patient is to receive an infusion of a drug at the rate of 5 mg/hr for 8 hours. The drug is available in 10-mL vials containing 8 mg of drug per milliliter. If a 250-mL bottle of D5W is used as the vehicle…

   a. How many milliliters of the drug solution should be added?

   b. What should be the flow rate in milliliters per minute?

37. A patient is receiving an IV drip of the following:
Sodium heparin	25,000 units
½ NS	500 mL

   a. How many milliliters per hour must be administered to achieve a rate of 1200 units of sodium heparin per hour?

   b. If the IV set delivers 15 drop/mL, how many drops per minute should be administered?

38. A 50-mL vial containing 1 mg/mL of the drug alteplase is added to 100 mL of D5W and administered intravenously with an infusion set that delivers 15 drops/mL. How many drops per minute should be given to administer 25 mg of the drug per hour?

39. If the loading dose of phenytoin in children is 20 mg/kg body weight to be infused at a rate of 0.5 mg/kg/min, over how many minutes should the dose be administered to a 32-lb child?

40. The following was ordered for a critical care patient: 2 L D5W½NS to run over 24 hours with a 2000 mL IV fluid daily limit. An IVPB antibiotic is ordered to run every 6 hours separately in 50 mL of D5W over 30 min. The drop factor is 60 drops per mL. Calculate the flow rate of the IVPB and the D5W½NS.

41. If a med order calls for a dobutamine drip, 5 µg/kg/min, for a patient weighing 232 lb what should be the drip rate (drop/min) if the 125-mL infusion bag contains 250 mg of dobutamine and a microdrip chamber is used that delivers 60 drops/mL?

42. At what rate, in drops per minute, should a dose of 20 µg/kg/min of dopamine be administered to a 65-kg patient using a solution containing dopamine, 1200 µg/mL, and a drip set that delivers 60 drop/mL?

43. A pharmacist places a total of 5 mg/mL of acyclovir sodium into a 250 mL IV bag of D5W for parenteral infusion into a pediatric patient. If the infusion is to run for 1 hour and the patient is to receive 500 mg/m2 BSA, what would be the rate of flow in milliliters per minute for a patient measuring 55 cm in height and weighing 10 kg?

44. Aminophylline is not to be administered in pediatric patients at a rate greater than 25 mg per minute to avoid excessive peak serum concentrations and possible circulatory failure. What should be the maximum rate (mL/min) for a solution containing 10 mg/mL of aminophylline in 100 mL of D5W?

45. An IV infusion contains 5 mg of Reclast (zoledronic acid) in 100 mL. If the infusion is to be administered in 15 minutes…

    a. How many milligrams of zoledronic acid must be administered per minute?

    b.   How many milliliters of infusion must be administered per minute?

    c.   Using a drip set that delivers 20 drops/mL, how many drops per minute must be infused?

46. Orencia (abatacept), used to treat rheumatoid arthritis, is available in vials, each containing 250 mg of powdered drug, intended to be reconstituted with SWFI. The dose of abatacept depends on a patient's weight: < 60 kg →500 mg, 60 to 100 kg → 750 mg, and > 100 kg → 1 g. The contents of the appropriate number of vials are added to a 100-mL infusion bag of NS after the corresponding volume of NS has been removed. The concentration of abatacept in an infusion for a 200-lb patient would be:

    a.   5.8 mg/mL
    b.   6.25 mg/mL
    c.   6.8 mg/mL
    d.   7.5 mg/mL

47. Torisel (temsirolimus), for use in advanced renal cell carcinoma, is prepared for infusion by adding 1.8 mL of special diluent to the drug vial resulting in 3 mL of injection containing 10 mg/mL of temsirolimus. The required quantity is then added to a 250 mL container of sodium chloride injection for infusion. The recommended dose is 25 mg infused over 30 to 60 minutes. The quantity of drug delivered, in mg/mL, and the rate of infusion in mL/min, for a 30-min infusion are:

    a.   0.099 mg/mL and 8.42 mL/min
    b.   0.099 mg/mL and 8.33 mL/min
    c.   1 mg/mL and 8.42 mL/min
    d.   1 mg/mL and 8.33 mL/min

48. Cardene IV (nicardipine HCl) is administered in the short-term treatment of hypertension by slow IV infusion at a concentration of 0.1 mg/mL. A 10-mL ampul containing 25 mg of nicardipine HCl should be added to what volume of D5W to achieve the desired concentration?

    a.   80 mL
    b.   100 mL
    c.   240 mL
    d.   250 mL