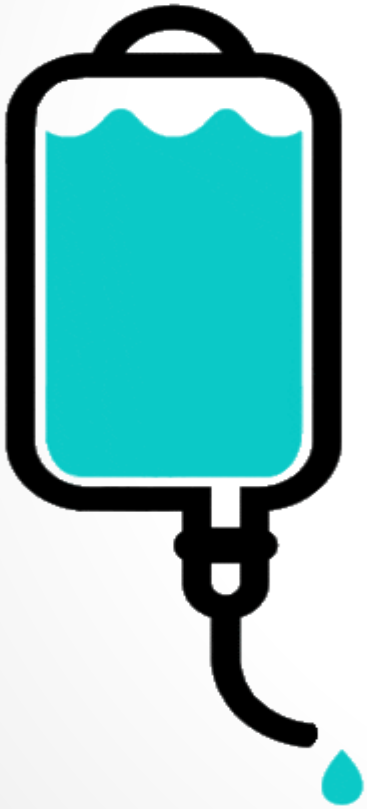
LECTURE 6:

Intravenous Infusions, Parenteral Admixtures, and Rate-of-Flow Calculations



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Objectives

Upon successful completion of this chapter, the student will be able to:

- ❑ Perform calculations for adult and pediatric intravenous infusions.
- ❑ Perform calculations for intravenous additives.
- ❑ Perform rate-of-flow calculations for intravenous fluids.
- ❑ Utilize correctly rate-of-flow tables and nomograms

1. To calculate Infusion time :

$$\text{Infusion time} = \frac{\textit{Volume of infusion in mL}}{\textit{Flow rate in mL/hr or mL/min}}$$

2. To calculate flow rate in drops/minute:

Rate of flow (drops/min) =

$$\frac{\textit{Volume infused (mL)} \times \textit{Drip set (drops/mL)}}{\textit{Time (minutes)}}$$

2. To calculate flow rate in mL/hour when based on dose4

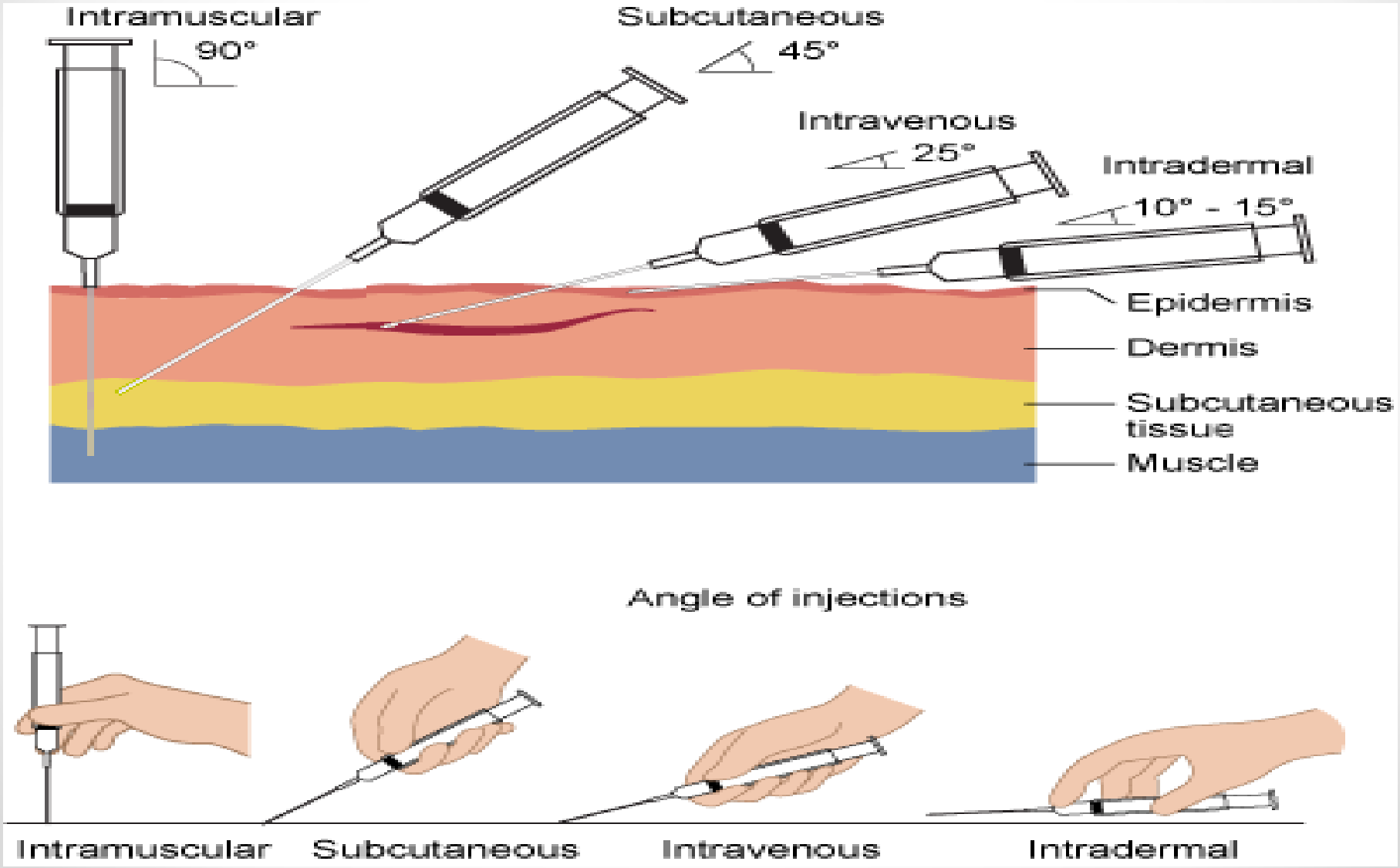
Infusion rate (mL/hr) =

$$\frac{\textit{Patient's weight (kg)}, \times \text{Dose (mcg, mg, or units/kg/min)} \times 60}{\textit{Drug concentration, infusion (mcg, mg, or units/mL)}}$$

Injections

- Injections are sterile pharmaceutical solutions or suspensions of a drug substance in an aqueous or nonaqueous vehicle.
- They are administered by needle into almost any part of the body, including
  - intra-articular → the joints
  - intrasynovial → joint fluid
  - Intraspinal → spinal column
  - intrathecal → spinal fluid
  - intra-arterial → arteries
  - intracardiac → the heart ((in an emergency)
- However, most injections are administered into a vein (intravenous, I.V), muscle (intramuscular, I.M), skin (intradermal, I.D, intracutaneous), or under the skin (subcutaneous).

Injections


Intramuscular
90°
Subcutaneous
45°
Intravenous
25°
Intradermal
10° - 15°
Epidermis
Dermis
Subcutaneous tissue
Muscle
Angle of injections
Intramuscular
Subcutaneous
Intravenous
Intradermal

Injections

Parenteral is defined as any medication route other than the alimentary canal القناة الهضمية and thus includes all routes of injection

Parental product are classified according to their volume into:

I. Small volume parental (SVP): from 1-10 ml, in ampuls or in prefilled disposable syringes for single-dose use. → used for rapid effect

II. Large volume parenteral (LVP): range from 100 to 1000 ml, in large volume plastic bags or glass containers given by slow I.V infusion and are used to:

→ supply the body with electrolytes and nutrients

→ Restore blood volume,

→ Prevent tissue dehydration:

→ Dilute toxic materials already present in body fluids.

Applicable dosage form

- solutions or suspensions
- dry powder for reconstitution to form a solution or suspension

Intravenous (IV)

- Intravenous (IV) infusions are sterile, aqueous preparations administered intravenously in relatively large volumes.

Uses:

- It used to restore blood volume and/or provide electrolytes, nutrients, or medications, and Prevent tissue dehydration
- Most IV infusions are administered to→
  - critical care, dehydrated, or malnourished patients سوء التغذية
  - patients prior to, during, and/or following surgery.

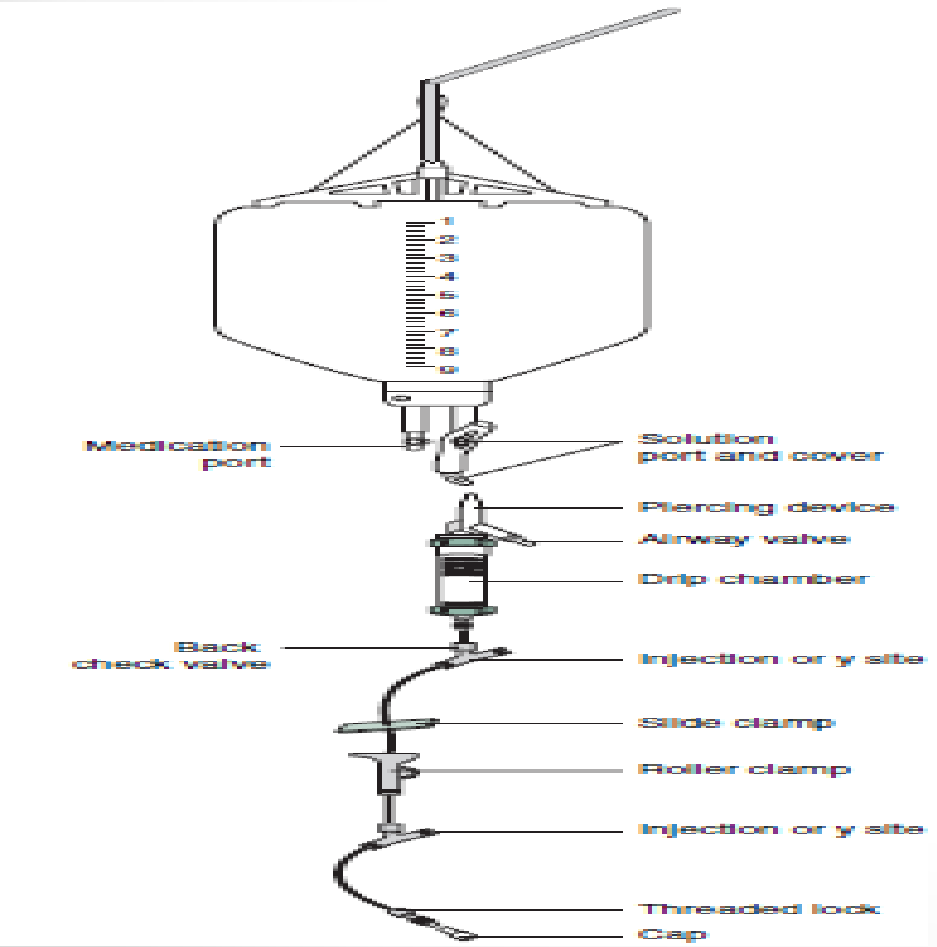
Dosage form

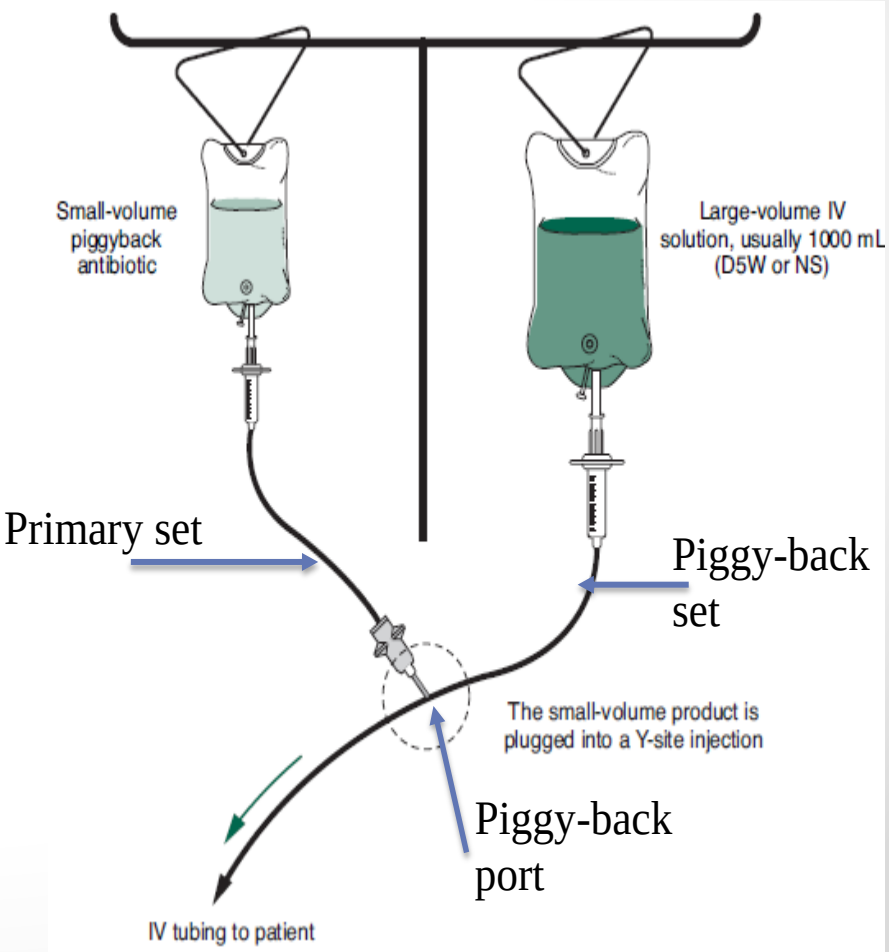
  - Most intravenous infusions are solutions;
  - however, some are very fine dispersions of nutrients or therapeutic agents, or blood and blood products.
- Although some IV solutions are isotonic or nearly isotonic with blood, isotonicity is not absolutely necessary because the volumes of fluid usually administered are rapidly diluted by the circulating blood.

Intravenous (IV)

Methods of administration of infusions drug.

- An administration set.
- Intravenous piggyback (IVPB)





Intravenous (IV)

- An administration set is attached to an intravenous bottle or bag to deliver the fluid into a patient's vein.
- the sets may be standard (macrodrip) or pediatric (microdrip).

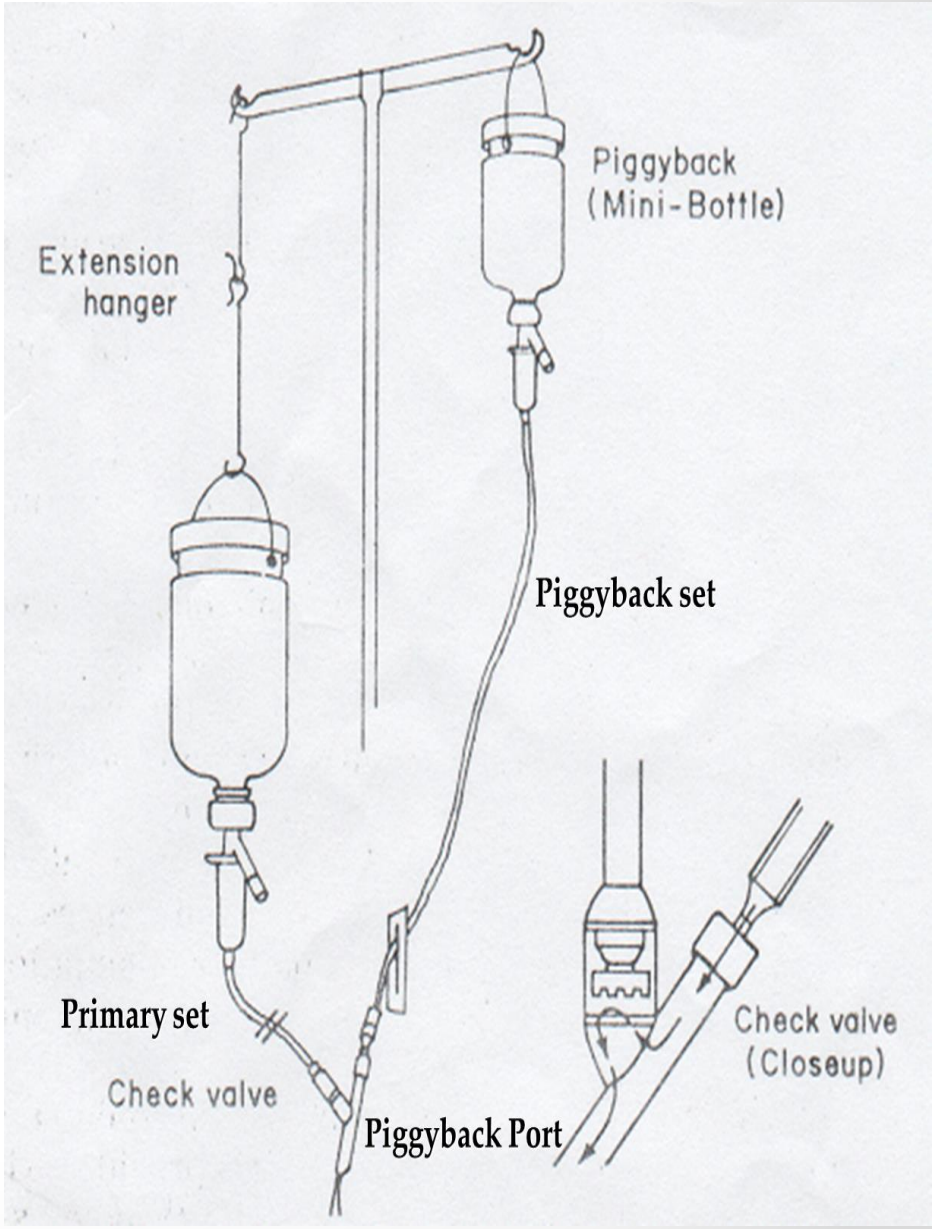
Drop factor is the number of drops needed to get 1ml of fluid.

- Depending on the particular set used, the drop factor can vary from
  - 10 to 15 drops/mL for standard sets
  - 60 drops/mL for microdrip sets.
- The drip rate معدل التنقيط for blood transfusion sets is usually 10 to 15 drops/ mL with infusions of 250 to 500 mL administered over a 2- to 4-hour period.
- The passage of an infusion solution into a patient's vein of entry may be assisted by
  - Ω gravity → the solution is hung on a stand well above the portal of entry (**above** the patient) → majority of infusion fluids
  - Ω by electronic volumetric infusion pumps.

Intravenous (IV)

Intravenous piggyback (IVPB) tubing is used to administer a small amount of medication along with the IV solution from two container into the patient vein through common tube.

- One solution generally is a LVP for continuous infusion (1ry solution).
- The other solution is an intermittent infusion as antibiotic (2nd or piggyback solution),



Intravenous (IV)

Types of Intravenous infusions

- It may be continuous or intermittent.

continuous infusions,

- carefully regulated large volumes of fluid (i.e., 250 to 1000 mL), with or without added drug, are run into a vein uninterrupted over a prolonged period

intermittent متقطع infusions

- It administered during scheduled periods.

→ Direct IV injection
→ Volume – Control Method
→ Piggyback Method

- **Direct IV injection (**IV push): The rapid infusion of small volumes (1-50 mL) of a medication into a vein and is usually conducted in 1-5 minutes

What are the most commonly used intravenous fluids?

- Aqueous solutions of dextrose, sodium chloride, and lactated Ringer's solution.

Intravenous (IV)

Some common intravenous Infusion solutions

SOLUTION[a]	ABBREVIATION
0.9% Sodium Chloride	NS (Normal Saline)
0.45% Sodium Chloride	½NS
5% Dextrose in Water	D5W or D_5W
10% Dextrose in Water	D10W or $D_{10}W$
5% Dextrose in 0.9% Sodium Chloride	D5NS or D_5NS
5% Dextrose in 0.45% Sodium Chloride	D5½NS or $D_5$1/2NS
Lactated Ringer's (0.86% Sodium Chloride 0.03% KCl, 0.033% Calcium Chloride)	LR
5% Dextrose in Lactated Ringer's	D5LR or D_5LR

- All solutions are prepared in Water for Injection, USP.
- These solutions may be administered as such or used as vehicles for therapeutic agents, nutrients, or other additives.

Example Calculations of Basic Intravenous Infusions

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

Answer

- From previous table, D5½NS is composed of 5% Dextrose in 0.45% Sodium Chloride

5g → 100ml

x → 250ml

- X= 12.5 g dextrose

0.45g → 100ml

X → 250ml

- X = 1.125 g sodium chloride

Example Calculations of Basic Intravenous Infusions

- 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, at 60 drops/mL, and a standard administration set, at 15 drops/mL, if in each case one drop is to be administered per second.

Answer

- Microdrip set:

(a) 60 (drops/mL) x 50 mL = 3000 drops

(b) 3000 drops / 60 (drops/minute) = 50 minutes.

- Standard set:

(a) (15 drops/mL) x 50 mL = 750 drops

(b) 750 drops 60 (drops/minute) = 12.5 minutes

Example Calculations of Basic Intravenous Infusions

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

Answer

1000 x 0.0018 = 1.8 g NaCl

1000 x 0.04 = 40 g dextrose

- *How many grams each of sodium chloride, potassium chloride, calcium chloride, and dextrose are contained in a 500- with Additives mL IV bag of D5LR?*

Answer

5% dextrose, 0.86% NaCl, 0.03% Kcl, 0.033% CaCl2.

0.05 x 500 = 25g

0.086 x 500 = 4.3g

0.0003 x 500 = 0.15g

0.00033 x 500 = 0.165g

Intravenous Push (IVP) Drug Administration

IV push (IVP), IV Stat, or a bolus dose.

- The rapid injection of intravenous medications, as in emergency or critical care situations and is usually conducted in less than a minute.
- For the most part, drugs administered by IV push are intended to quickly control
  - heart rate,
  - blood pressure,
  - cardiac output,
  - respiration,
  - other life-threatening conditions.
- IVP medications frequently are administered in less than one minute.
- The safe administration of a drug by IV push depends on precise calculations of dose and rate of administration.

Example Calculations of IV Push Drug Administration

- 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?

Answer

1.25 mg → 1 mL

2 mg → x

X = 1.6mL (1 mL from one syringe and 0.6 mL from another).

Example Calculations of IV Push Drug Administration

- *A physician orders midazolam hydrochloride (VERSED) 2 mg IV Stat. A pharmacist delivers a vial containing midazolam hydrochloride 5 mg/mL. How many milliliters should be administered?*

5 mg → 1 ml

2 mg → x x = 0.4mL

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

Answer

- 1kg = 2.2Ib so 200 lb / 2.2 lb/kg = 90.9 kg
- 90.9 kg x 0.1 unit/kg = 9.09 units
- 90.9 kg x 0.4 unit/kg = 36.36 units
- bolus dosage range for a 200-lb patient = 9.09-36.36

Intravenous Admixtures

- The preparation of intravenous admixtures involves the addition of one or more drugs to large volume sterile fluids such as sodium chloride injection, dextrose injection, lactated Ringer's injection, and others.
- The additives are generally in the form of small-volume sterile solutions packaged in ampules or vials.
- In any properly administered intravenous admixture program, all basic fluids, additives, and calculations must be carefully checked against the medication orders.

Example Calculations of Additives to Intravenous Infusion Solns

- 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 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?

Answer

- *1 kg = 2.2 lb.*
- *154 (lb.) / 2.2 (lb.) = 70 kg*
- *0.25 mg x 70 = 17.5 mg*

Constituted solution contains 50 mg/10 mL

- *50 (mg) → 10 (mL)*
- *17.5 (mg) → x*

x = 3.5 mL

Example Calculations of Additives to Intravenous Infusion Solns

- An intravenous infusion is to contain 15 mEq of K ion and 20 mEq of Na ion in 500 mL of 5% dextrose injection. Using KCl injection containing 6 g/30 mL and 0.9% NaCl injection, how many milliliters of each should be used to supply the required ions?

Answer

- 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
- 15 mEq of K ion = $\frac{mg}{74.5}$ = 1117.5 mg = 1.118 g

6 g → 30 ml

1.118 g → X so x = 5.59 mL

- 20 mEq of Na ion = $\frac{mg}{58.5}$ = 1117 mg = 1.170 g

0.9 g → 100 ml

1.170 g → X so x = 130 mL

Example Calculations of Additives to Intravenous Infusion Solns

- *A medication order for a child weighing 44 lb. calls for polymyxin B sulfate to be administered by the intravenous drip method in a dosage of 7500 units/kg of body weight in 500 mL of 5% dextrose injection. Using a vial containing 500,000 units of polymyxin B sulfate and sodium chloride injection as the solvent, explain how you would obtain the polymyxin B sulfate needed in preparing the infusion.*
  - 1 kg = 2.2 lb. → 44 / 2.2 = 20 kg
  - 7500 units x 20 = 150,000 units

Step 1. Dissolve contents of vial (500,000 units) in 10 mL of sodium chloride injection.

Step 2. Add 3 mL of constituted solution to 500 mL of 5% dextrose injection.

500000 units → 10ml

- x units → 1ml → x = 50000 units

Rate of Flow of Intravenous Fluids

- On medication orders, the physician specifies the rate of flow of intravenous fluids in mL / min, drops / min, amount of drug (as mg / hour), or, more frequently, as the approximate duration of time of administration of the total volume of the infusion.
- Pharmacists may be called on to perform or check rate-of-flow calculations using the following equation :

Rate of flow (drops/min)

$$= \frac{\{\text{Volume infusion (mL)} \times \text{Drip set (drops/mL)}\}}{\text{Time (minutes)}}$$

In common usage are → macro sets that deliver 10, 15, or 20 drops / mL

→ microdrip or minidrip sets that deliver 60 drops / Ml

- The drip rate (drops / min.) could be calculated according to the following:
- Drip rate (gtt. /min.) = flow rate (ml/h) × drop factor (gtt./ ml) × time conversion (h/60 minutes)

Rate of Flow of Intravenous Fluids

- A patient was prescribed to receive an IV infusion of D5W 1000ml to infuse over 8 Hrs. the IV tubing used was deliver 15 drops/ml, what is the correct drip rate?

Answer

- Drip rate (gtt. /min.) = flow rate (ml/h) × drop factor (gtt./ ml) × time conversion (h/60 minutes)

1000 ml → 8hrs

x → 1hr → X= 125ml

- Drip rate = 125ml/1hr × 15 gtt. /ml × 1hr/60mins = 31.25 drop/mint.

❑ The order is for 1800ml of saline solution to be infused in 12 hrs. the drop factor is 8gtt/ml. what drip rate should be used?

Answer

1800ml → 12 hrs

X → 1hr → X= 150 ml/hr

Drip rate (gtt/min) = 150 × (8 /60) = 20 drop/ min

Examples of Rate-of-Flow Calculations

A medication order 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?

Answer

Volume of fluid = 1000 mL 8 hours = 480 minutes

Rate of flow (drops/min)

$$= \frac{\{\text{Volume infusion (mL)} \times \text{Drip set (drops/mL)}\}}{\text{Time (minutes)}}$$

$$\text{Rate of flow (drops/min)} = \frac{1000 \times 10 \text{ drops/mL}}{480 \text{ min}} = 20.8 \text{ or } 21 \text{ drops /min}$$

Examples of Rate-of-Flow Calculations

- Ten (10) milliliters of 10% calcium gluconate injection and 10 mL of multivitamin infusion are mixed with 500 mL of a 5% dextrose injection. The infusion is to be administered over 5 hours. If the dropper in the venoclysis set calibrates 15 drops/mL, at what rate, in drops per minute, should the flow be adjusted to administer the infusion over the desired time interval?

Answer

- Total volume of infusion =10 mL+ 10 mL+ 500 ml = 520 mL
- 5hrs. = 300 min.
- Rate of flow (drops/minute)= $\frac{\text{Volume infusion (mL)} \times \text{Drip set (drops/mL)}}{\text{Time (minutes)}}$

Rate of flow (drops/minute) = $\frac{520 \text{ mL} \times 15}{300 \text{ minutes}}$ = 26 drops per minute

Examples of Rate-of-Flow Calculations

- *An intravenous infusion contains 10 mL of a 1:5000 solution of isoproterenol hydrochloride and 500 mL of a 5% dextrose injection. 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?*

Answer

1 → 5000

X → 10 → x = 0.002g = 2mg

- 10 mL of a 1: 5000 solution contain 2 mg
- 2 mg or 2000 microgram are contained in a volume of 510 mL

2000 → 510

5 → x x = 1.275 or 1.28 mL per minute

1.28 → 1

510 → x → x = 398 minutes or approx. 6.5 hours

Examples of Rate-of-Flow Calculations

- *If 10 mg of a drug are added to a 500-mL large-volume parenteral fluid: (a) what should be the rate of flow, in milliliters per hour, to deliver 1 mg of drug per hour? (b) If the infusion set delivers 15 drops/mL, what should be the rate of flow in drops per minute?*
- *(c) How many hours should the total infusion last?*

Answer

(a) rate of flow in mL/hour

10 → 500

1 → x → so X = 50 mL per hour

(b) rate of flow in drop/min → 15 drops/mL ×50 mL/hr = 750 drops / h

750 (drops) → 60 (minutes)

x (drops) → 1 (minute) → so X = 12.5 drops/minute

(c) hours of the total infusion last

- 50 (mL) → 1 (hour)

500 (mL) → x (hour) → so x =10 hours

- An order for a patient, with a 3-liter daily IV fluid limit, calls for 3 L of D5W with a 100-mL IVPB antibiotic to be run-in alone over a 1-hour period and administered every 6 hours. The administration set is calibrated to deliver 10 drops per milliliter. Calculate:
    a. The flow rate of the IVPB antibiotic;
    b. The total flow time for the IV antibiotic;
    c. The total volume for the IV antibiotic;
    d. The total flow time for the D5W;
    e. The total volume for the D5W;
    f. The flow rate for the D5W.

Answer

Questions ?