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Pharmacy department

Pharmaceutical calculation

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Intravenous infusions, *parenteral admixture*, rate-of-flow calculations

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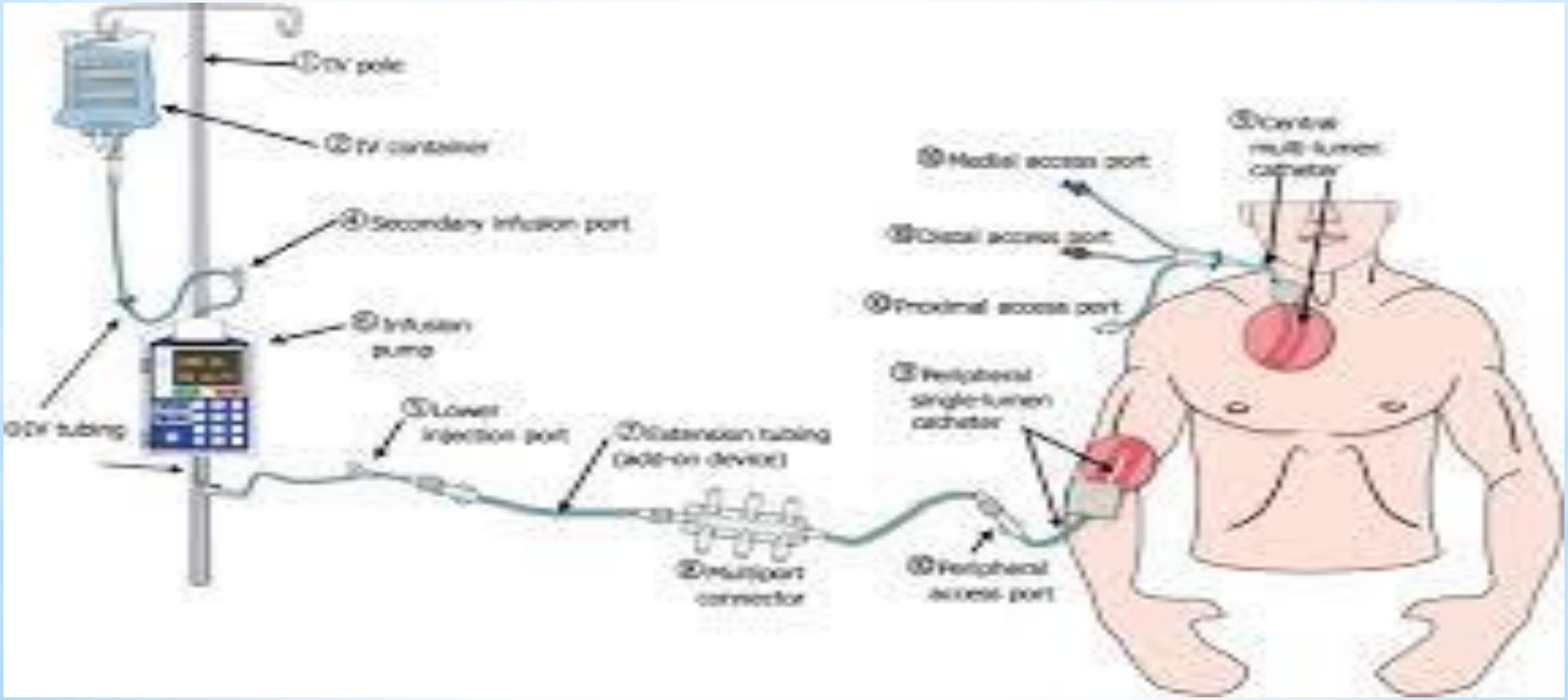


Injections

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 the joints (intra-articular), joint fluid (intrasynovial), spinal column (intraspinal), spinal fluid (intrathecal), arteries (intra arterial), and in an emergency, even the heart (intracardiac). However, most injections are administered into a vein (intravenous, I.V., IV), muscle (intramuscular, I.M., IM), skin (intradermal, I.D., ID, intracutaneous), or under the skin (subcutaneous, sub- Q, SQ, hypodermic).

Depending upon their use, injections are packaged in small volumes

- in **ampuls** or
- in prefilled **disposable syringes** for single-dose use;
- in **vials** and
- **pen-injectors** for single- or multiple-dose use;
- or in large volume **plastic bags** or **glass** containers for administration by slow intravenous Infusion.

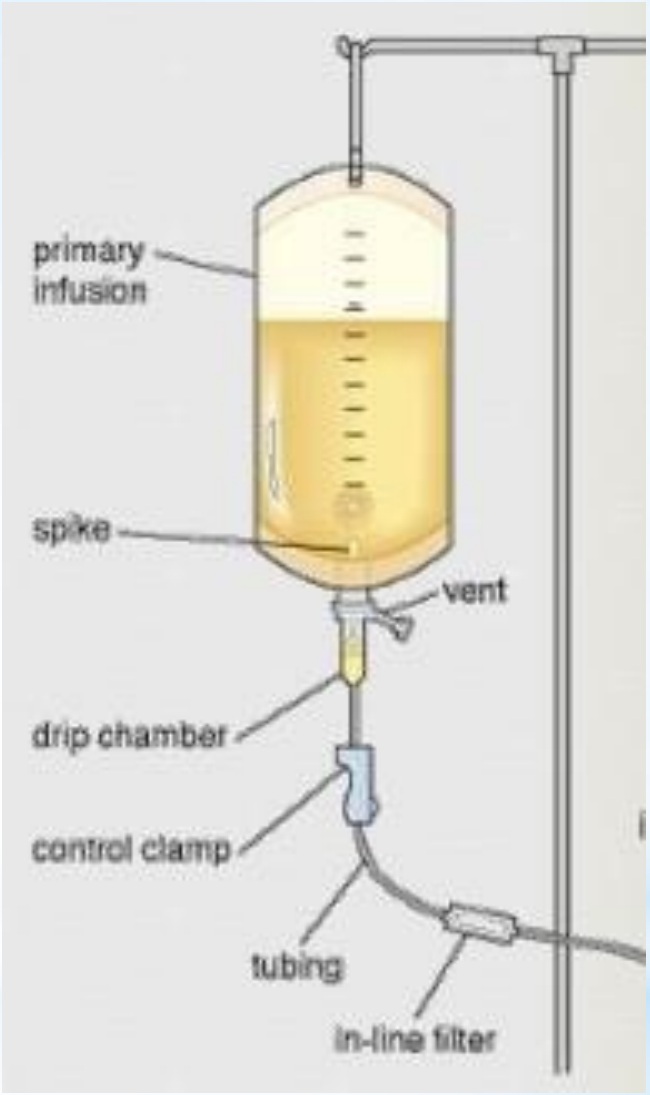
Some injections are available as prepared **solutions** or **suspensions** with their drug content labeled as, for example, “10 mg/mL.”

Others contain dry **powder for reconstitution** to form a solution or suspension by adding a specified volume of diluent prior to use and are labeled as, for example, “10 mg/vial.” Small-volume injections may be administered as such or they may be used as additives to large-volume parenteral fluids for intravenous infusion.

The term **parenteral** is defined as any medication route other than the alimentary canal and thus includes all routes of injection.

Intravenous (IV) infusions are sterile, aqueous preparations administered intravenously in relatively large volumes. They are used to extend blood volume and/or provide electrolytes, nutrients, or medications. Most intravenous infusions are administered to critical care, infirm, dehydrated, or malnourished patients, or to patients prior to, during, and/or following surgery. **Intravenous infusions** are widely employed in emergency care units, in hospitals and other patient care institutions, and in home care. Pharmacists participate in the preparation and administration of institutional as well as home intravenous infusion therapy.

Most intravenous infusions are **solutions**; however, some are very fine **dispersions** of nutrients or therapeutic agents, or blood and blood products. Although some intravenous 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. Commercially prepared infusions are available in glass or plastic bottles or collapsible plastic "bags" in volumes of 50 mL (a *minibag*), 100 mL, 250 mL, 500 mL, and 1000 mL. The smaller volumes find particular application in treating pediatric patients and adults who require relatively small volumes to be infused.


primary infusion
spike
vent
drip chamber
control clamp
tubing
in-line filter

Example Calculations of Basic Intravenous Infusions

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

250 mL × 0.05 (5% w/v) = 12.5 g dextrose, and
250 mL × 0.0045 (0.45% w/v) = 1.125 g sodium chloride, *answers.*

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 ampuls, vials, small-volume minibags for use as piggybacks, or sterile solids, some requiring constitution with a sterile solvent before transfer. Although a wide variety of drugs and drug combinations are used in preparing dilute infusions for intravenous therapy, some of the more common additives include electrolytes, antibiotics, vitamins, trace minerals, heparin, and, in some instances, insulin.

- *An intravenous infusion is to contain 15 mEq of potassium ion and 20 mEq of sodium ion in 500 mL of 5% dextrose injection. Using potassium chloride injection containing 6 g/30 mL and 0.9% sodium chloride 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

$$1 \text{ mEq of KCl} = 74.5 \text{ mg}$$
$$15 \text{ mEq of KCl} = 1117.5 \text{ mg or } 1.118 \text{ g}$$
$$\frac{6 \text{ (g)}}{1.118 \text{ (g)}} = \frac{30 \text{ (mL)}}{x \text{ (mL)}}$$
$$x = 5.59 \text{ or } 5.6 \text{ mL, } \textit{and}$$

$$1 \text{ mEq of NaCl} = 58.5 \text{ mg}$$
$$20 \text{ mEq of NaCl} = 1170 \text{ mg or } 1.170 \text{ g}$$
$$\frac{0.9 \text{ (g)}}{1.17 \text{ (g)}} = \frac{100 \text{ (mL)}}{x \text{ (mL)}}$$
$$x = 130 \text{ mL, } \textit{answers.}$$

Rate of flow of intravenous fluids

On medication orders, the physician specifies the rate of flow of intravenous fluids in milliliters per minute, drops per minute, amount of drug (as milligrams per 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. Oftentimes, the following equation finds use in rate-of-flow calculations:

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

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?*

$$\text{Volume of fluid} = 1000 \text{ mL}$$
$$8 \text{ hours} = 480 \text{ minutes}$$

$$\frac{1000 \text{ (mL)}}{480 \text{ (minutes)}} = 2.08 \text{ mL per minute}$$

$$2.08 \text{ mL/min} \times 10 \text{ (drops/mL)} = 20.8 \text{ or } 21 \text{ drops per minute, } \textit{answer.}$$

Or, solving by dimensional analysis:

$$\frac{10 \text{ drops}}{1 \text{ mL}} \times \frac{1000 \text{ mL}}{8 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 20.8, \text{ or } 21 \text{ drops per minute, } \textit{answer.}$$

- *An intravenous infusion contains 10 mL of a 15000 solution of isoproterenol hydrochloride and 500 mL of a 5% dextrose injection. At what flow rate should the infusion be administered to provide 5 g of isoproterenol hydrochloride per minute, and what time interval will be necessary for the administration of the entire infusion?*

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

$$\frac{2000\ (\mu g)}{5\ (\mu g)} = \frac{510\ (mL)}{x\ (mL)}$$

$$x = 1.275 \text{ or } 1.28 \text{ mL per minute, } \textit{and}$$

$$\frac{1.28\ (mL)}{510\ (mL)} = \frac{1\ (minute)}{x\ (minutes)}$$

$$x = 398 \text{ minutes or approx. } 6\tfrac{1}{2} \text{ hours, } \textit{answers.}$$

- *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?

$$\frac{10\ (\text{mg})}{1\ (\text{mg})} = \frac{500\ (\text{mL})}{x\ (\text{mL})}$$

$$x = 50\ \text{mL per hour, } \textit{answer.}$$

b) If the infusion set delivers 15 drops/mL, what should be the rate of flow in drops per minute?

$$15\ \text{drops/mL} \times 50\ \text{mL/hr} = 750\ \text{drops per hour}$$

$$\frac{750\ (\text{drops})}{x\ (\text{drops})} = \frac{60\ (\text{minutes})}{1\ (\text{minute})}$$

$$x = 12.5\ \text{drops/minute, } \textit{answer.}$$


Thank You