

Module 11

INTRAVENOUS THERAPY

INTRODUCTION

An intravenous infusion (IV) is the installation of a large amount of fluid and/or electrolytes, or nutrient substances into a vein. It is given to patients who require extra fluid or to those who cannot take fluids or nutrient substances orally. An IV is also a port for administration of medication. A physician is responsible for ordering the type of solution, the amount to be given, and the rate at which it is to be infused.

It is the responsibility of the nurse to carry out the physician's order by correctly and efficiently starting the IV and by regulating the desired flow rate. All nurses must guard against harmful complications by properly maintaining the infusion and frequently assessing the patient's response to therapy.

OBJECTIVES

Upon completion of this module, you should be able to:

- Discuss the causes of fluid and electrolyte imbalance.
- Identify the indications for administering intravenous (IV) fluids.
- Discuss the content of and reasons for administering nutrient solutions, electrolyte solutions, and blood volume expanders.
- List the equipment needed for starting an IV infusion.
- Differentiate between the types of intravenous solution containers.
- Differentiate between the type of administration sets/flow rate.
- Discuss the advantages and disadvantages of selected antiseptic solutions.
- Describe various IV needles and catheters.
- Select the appropriate equipment to begin an infusion.
- Properly assemble IV equipment before administering an infusion.
- Prepare a patient psychologically and physically for an IV administration.
- Identify various venipuncture sites in infants and adults.
- Discuss the role of the LPN in IV therapy.
- Apply appropriate techniques in performing a venipuncture.
- State appropriate procedure for addressing an IV site.
- Calculate drops per minute in regulating IV flow.
- Discuss the various types of IV infusion equipment.
- Identify clinical situations which require the use of volumetric infusion systems, mini-infuser systems, controller systems, and patient-controlled analgesia systems.
- Describe the infusion of primary and secondary lines using appropriate systems (volumetric, mini-infuser, or controller).
- Discuss the values associated with the utilization of PCA pumps.
- Begin to understand the procedure for programming the various pump systems used for maintaining an IV infusion.
- Monitor an IV pump infusion.
- State the frequency for changing fluid containers and tubing.
- Change a fluid container and tubing.

- Complete a routine assessment of an existing IV.
- Discuss complications which may occur with IV therapy.
- Discuss nursing actions implemented to correct complications occurring with IV therapy.
- Describe the method used to add medication to an IV bottle or bag and a volume control administration set.
- Describe the method of administering IV medication using additional bottles.
- Administer an IV medication using an IV push method.
- Describe the method for administering an IV medication if incompatibilities exist.
- Discontinue an IV infusion.
- State what should be charted regarding IV therapy.
- Compare and contrast all types of blood components relative to their therapeutic uses.
- Discuss the procedure for administering blood and blood components.
- Identify and describe the many types of transfusion reactions.
- Discuss the nursing interventions required for transfusion reactions.

Unit 1

Fluid and Electrolyte Overview

All bodily functions rely on the proper distribution of fluids and electrolytes between the intracellular and extracellular compartments. The balance of fluid and electrolytes is controlled by renal, hormonal, and metabolic functions.

Fluids

Water is the largest single component of the human body. Sixty percent of an adult's body weight consists of water. This fluid is distributed with 45 percent being intracellular and 15 percent being extracellular. The human maintains the fluid compartment by drinking fluids, taking in foods that contain fluid, or by IV administration. Fluid balance can be assessed by determining the volume of fluid intake as compared to the volume of fluid output. Fluid loss (output) occurs through urine, skin, lungs, and the gastrointestinal tract.

Electrolytes

Electrolytes are chemicals that, when dissolved, are positively (cations) and negatively (anion) charged ions. Commonly monitored electrolytes are sodium, potassium, and chloride. Electrolytes are constituents of both the intracellular and extracellular compartments. They serve many functions, including maintaining acid-base balance, neuromuscular excitability, blood clotting, and protein and cellular metabolism. The concentration of electrolytes in each compartment varies.

Imbalance of fluids and electrolytes

There is a variety of causes for a loss of fluid (dehydration) or electrolyte imbalances. Dehydration can be caused by:

- gastrointestinal losses such as vomiting, diarrhea, ileostomy, and gastric suction.
- urinary losses due to renal disease, diabetes, or diuretic administration.
- other factors such as burns, diaphoresis, hyperventilation, or a decrease in intake of fluids.

Electrolyte imbalances are often associated with the same conditions mentioned above. Loss or imbalance of electrolytes occurs because of conditions such as dehydration, vomiting, diarrhea, and excessive urination. When a person is experiencing a condition which lends itself to fluid and electrolyte imbalance, intravenous fluid therapy is ordered.

Unit 2 Indications for and Types of Intravenous Fluids

Indications for IV Therapy

Intravenous fluids are ordered for a variety of reasons. They maintain the daily requirements for fluid (for the patient who gets nothing by mouth [NPO] or who is nauseated and vomiting), replace lost fluid in the postoperative patient), provide large amounts of fluid rapidly (for the patient who has taken a drug overdose), and serve as a vehicle for medications, most commonly antibiotics.

Types of IV Fluids

Nutrient solutions contain some form of carbohydrate (e.g., dextrose, also referred to as glucose) and water. Water is supplied for fluid requirements and glucose for calories and energy. For example, one liter of 5 percent dextrose provides 200 calories. Common nutrient solutions are:

- 5 percent dextrose in water – D₅W.
- glucose in saline, which contains 3.3 percent glucose in 0.3 percent sodium chloride.
- 5 percent dextrose in half-strength saline (0.45 NaCl) – D₅, ½ NS.

Nutrient solutions are useful in preventing dehydration and ketosis, but do not provide sufficient calories to promote wound healing, weight gain, or normal growth in children. Ketosis is a condition in which ketone bodies accumulate in the blood. Ketone bodies are normally formed when fats are broken down, which is called the ketone stage, and then are broken down further (oxidized) into carbon dioxide and water. The presence of carbohydrates is essential for the latter process. Without carbohydrates the breakdown of fat is incomplete, i.e., it stops at the ketone stage, causing increasing levels of ketones in the blood stream. The result is a severe decrease in the blood pH called acidosis.

Electrolyte solutions

Electrolyte solutions are either saline (NaCl) or multiple electrolyte solutions containing varying amounts of specific cations and anions. Commonly used solutions are:

- normal saline (0.9 percent sodium chloride solution).
- Ringer's solution, which contains sodium (Na⁺), chloride (Cl⁻), potassium (K⁺), and calcium (Ca⁺⁺).
- lactated Ringer's solution which contains sodium, chloride, potassium, calcium, and lactate. Lactate is a salt of lactic acid that is metabolized in the liver to form bicarbonate (HCO₃⁻).

Normal saline solutions are frequently used as initial hydrating solutions. Multiple electrolyte solutions approximate the ionic profile of plasma and are used to prevent dehydration or to restore or correct fluid and electrolyte imbalances.

Blood volume expanders

Blood volume expanders are used to increase the volume of blood following a severe loss of blood (e.g., due to hemorrhage) or plasma (e.g., due to severe burns when large amounts of plasma shift from the bloodstream to the burn site). Common blood volume expanders are dextran, plasma, and human serum albumin.

Unit 2
Self-Test

1. Why are nutrient solutions used?
2. Normal saline and lactated ringers are known as _____ solutions.
3. Dextran, plasma, and albumin are classified as _____.

Unit 3

Preparing for Intravenous Therapy: General Information about Equipment

Intravenous therapy means different things to different people. For some it may be a means to rehydrate a patient; for others it may be a way to administer antibiotics to fight infection. Regardless of the reason for IV therapy, the procedure and equipment are basically the same. While the nurse must follow the specific policies and procedures of the institution, there are some general guidelines that can be adapted to the situation. In this unit, we will review general information regarding the following IV therapy equipment:

- Intravenous solution containers
- Administration sets/flow rates
- IV stands
- Antiseptic solution (alcohol/Betadine) to cleanse skin
- IV needles or catheters
- Tape and site dressing materials

IV Solution Containers

Intravenous solutions are supplied in glass bottles and plastic bags. In order for the solution to flow out of a bottle, some solution bottles have a tube inside that serves as an air vent so that as the solution runs out of the bottle it is replaced by air. Bottle containers without air vents require a vent on the administration set. Air vents usually have filters to remove any contamination from the air which enters the containers. Because the plastic bag will collapse as fluid is removed, no air vent is needed. This prevents non-sterile air from coming in contact with the IV fluid. Both bottles and bags come in sizes ranging from 50 to 1000 milliliters of solution per container.

Administration Sets/Flow Rates

The conventional administration set consists of plastic tubing with a plastic spike that is inserted into the fluid container. This spike must be kept sterile. Below the spike is a drip chamber, which allows the rate of fluid administration to be monitored by counting the drops falling into the chamber. A roller valve or screw clamp is used to control the rate. The syringe tip (male adapter end of the tubing) fits into the hub of the needle in the vein. Most sets have one or more soft rubber entry ports (Y-ports) that reseal after puncture by a needle. These are used to inject medications into the IV line. If any other part of the plastic is punctured with a needle, a leak will occur.

Administration Set

The administration sets are constructed so that the orifice in the drip chamber delivers a predictable number of drops for each milliliter of fluid. The most common sets are called macrodrip sets. These deliver 10 to 20 drops per ml. The sets do vary, so consult the manufacturer's package for a correct figure. Remember that this figure is correct for regular, water-type fluids; when very viscous fluids, such as those containing amino acids and fats, are given, the drops per ml may be fewer. (The figure is usually supplied with the product.) Most manufacturers also supply microdrip sets. These sets deliver 50-60 drops per ml and can be identified by the fine metal orifice in the drip chamber.

Blood administration sets are characterized by a larger lumen, which delivers fewer drops per ml, and a large built-in filter in the drip chamber, which removes any clots or precipitates in the blood.

Macro drip set delivers 10-20 drops/ml.
Center: Microdrip set delivers 60 drops/ml.
Right: Blood transfusion delivers 10 drops/ml.

Secondary sets are designed to allow more than one fluid container to be hung at the same time in one of three ways. The first method uses a tandem setup-the second container is attached to the first by the secondary set. The fluid container on the secondary set (farthest from the patient) empties first.

The second method is the piggyback setup. The secondary set is used to attach the second bottle to the primary set's tubing. Using the piggyback setup, either bottle can be made to run. To administer the solution in the secondary (piggyback) container, hang the secondary container on the IV stand, open the flow clamp on the piggyback line, and lower the primary container on to an extension hook. Note: It is important for the primary container to be hung lower than the secondary container. By doing so, the center of gravity is lowered in the primary container and the secondary solution is allowed to flow. When the secondary container is empty, the primary solution will resume administration. If the primary solution must be administered before completing the solution in the secondary container, simply close the flow clamp on the piggyback line and the primary container will resume administration.

Two containers can also be hung at the same time by using a Y-type administration set. When both arms of the Y are open, the container with the fluid at a higher level will empty first, and then the other container will empty. The Y-set can also be used to alternate solutions. If the tubing does not contain a special stop valve for the first emptying container, then the infusion must be monitored closely. The branch to the first emptying container must be turned off while there is still fluid in the tube. If air is allowed to enter one arm of the Y, it will be pulled into the fluid stream coming from the second bottle and could cause a significant air embolus.

Extension tubing is simply a length of IV tubing with a male adapter on one end and a female adapter on the other so that it can be attached to the main set to create longer tubing. Extension tubing is often added to allow a patient greater mobility.

IV Stands

An IV stand, or pole, is used for hanging the solution container. Some poles are already attached to the hospital bed. Others stand on the floor or hang from the ceiling. There are floor models with casters that can be pushed along when a patient is up and walking. The height of the rods is adjustable, and it is important to remember that the higher the solution container is suspended, the greater the force of the solution as it enters the patient and the faster the rate of flow.

Antiseptic Solutions

Having an IV always poses an infection risk to the patient. To reduce this possibility, the skin must be prepared to lower the number of infection-causing organisms. Unfortunately, the perfect agent for disinfecting the skin has not yet been found. Examples of antiseptic agents with the advantages and disadvantages of each are listed below.

Iodine: 2% solution or tinctured 2%

Advantages: relatively inexpensive; probably more effective than iodophors in killing bacteria, fungi, viruses, protozoa, and yeasts.

Disadvantages: could cause skin reaction; may burn or chap skin; may stain skin.

Special procedures: First be certain that the patient is not allergic to iodine. If not, scrub the skin with moderate friction using a circular motion, starting at the insertion site and moving outward. After allowing the skin to dry for 30-60 seconds, rinse the iodine off with 70% alcohol to prevent skin irritation.

Iodophors: providone – iodine (Betadine)

Advantages: less irritating than iodine solutions; does not stain skin as much as iodine.

Disadvantages: may cause allergic reaction; less effective than iodine solutions.

Special procedures: First be certain that the patient is not allergic to iodine. If not, apply in the same manner as iodine solutions but do not rinse off with alcohol. It is believed that the action of iodophors persists as long as the yellow color is visible.

Ethyl alcohol: 70% alcohol

Advantages: effective as fat solvent; may be used if patient is allergic to iodine.

Disadvantages: evaporates quickly; dries skin; not effective against viruses and spore-forming organisms.

Special procedures: Be sure to use ethyl alcohol and not isopropyl alcohol. Isopropyl alcohol can cause vasodilation and bleeding is more likely.

IV Needles and Catheters

The needle and catheter are among the most important of IV tools. The outside diameter of the needle shaft is called a gauge. The larger the gauge number, the smaller the diameter of the shaft. The inside diameter of the shaft is called the lumen.

IV Needle

The hub of an IV needle is the portion attached to the IV tubing or to a syringe. The bevel is the slanted edge at the end of the needle, with the tip being the longest portion of the slant and the heel being the shortest portion of the slant.

The winged-tip, or butterfly, needle comes in lengths of ½ inch to 1 ¼ inches, with diameters ranging from 25 gauge (G) to 17 G. The wings attached to the shaft are plastic or rubber, and the flexible tubing attached may be 3 to 12 inches long. Butterfly needles are usually used for infants or children, adults with small veins, or short-term therapy.

Intravenous Butterfly

The over-the-needle catheter consists of a needle with a catheter fitted around it. The catheter is from 1 ¼ to 5 ½ inches long and from 12G to 22G in diameter. The point of the needle extends beyond the tip of the catheter. After venipuncture, the needle is withdrawn and discarded, leaving just the catheter in the vein. The catheter is used for long-term therapy, delivery of viscous liquids like blood or hyperalimentation fluid, and for arterial monitoring.

An inside-the-needle catheter is used for delivery of drugs to central veins and central venous pressure monitoring, and is usually inserted by a physician. This consists of a catheter between 14G and 19G in diameter lying inside a needle of 1 ½ to 2 inches long. The catheter is from 8 to 36 inches long. The needle is removed from the skin once the catheter is in place.

Needles and Catheters

A: Over-the-Needle Catheter

B: Inside-the-Needle Catheter (intracatheter)

Tape and Site Dressing Materials

Policy on IV site dressing varies between agencies. It is important that the nurse be familiar with the procedure decided upon by the agency. Usually an occlusive dressing or a sterile 2 x 2 pad is used, with some sort of antiseptic ointment, and tape.

Unit 3
Self-Test

1. Macro drip sets deliver _____ drops/ml.
2. Micro drip sets deliver _____ drops/ml.
3. Blood transfusion sets deliver _____ drops/ml.
4. In the piggyback set-up, the primary IV should be higher or lower than the secondary IV.
5. Before using an iodophor solution on the patient's skin, the nurse should ask if the patient is allergic to _____.
6. Which type of alcohol is used as an antiseptic on the skin?
 - a. Ethyl alcohol
 - b. Isopropyl alcohol

Unit 4 Selecting and Assembling the IV Equipment

Selecting the IV Equipment

1. Check the physician's orders. Pay particular attention to the type of fluid and solution concentration, and to the infusion rate. Many abbreviations are used; some of the most common are:
 - 5 percent dextrose in water: D₅W
 - 5 percent dextrose in normal saline; D₅N/S
 - half-strength normal saline: ½ N/S
 - lactated Ringer's: LR

If you do not understand the orders, be sure to ask.

2. Wash your hands.
3. Select the ordered solution. Carefully check the order and the label to be certain that you have the correct solution. Also check the expiration date. Finally, check the clarity; any cloudiness or particulate matter could indicate that the solution is not suitable for use and should be returned to its source.
4. Select an infusion set, considering the amount of fluid to be administered and the rate. If a very slow rate is needed, a microdrip set will provide more accurate regulation. If medications are to be given, a set with multiple injection ports may be needed. For an infant or child, using a controlled-volume set (Buretrol or soluset) is usually routine. Using a controlled-volume set allows for more accurate delivery of IV solutions.
5. Attach a time label to the container. On the label write the approximate time the solution level should reach each mark on the container.
6. If there is a great deal of equipment around the patient, an extension tubing to lengthen the IV line may be needed. Make sure that an IV stand is available. Also, have an armboard available; you often do not know whether you will need an armboard until after the IV is in place. A tray is usually set up with equipment for starting the IV.

Assembling the IV Equipment

1. Open the package containing the tubing. Be sure to maintain the sterility of the connectors. If the connectors are covered with plastic caps, leave the plastic caps in place until you are ready to connect the tubing. Check the drop factor of the tubing.
2. Open the entry area of the fluid container according to the manufacturer's direction. There should be evidence that the container was sealed, which certified sterility. Be careful that you do not contaminate the entry port.

3. Follow the manufacturer's directions about cleaning the entry port with an alcohol swab. Most fluid containers are sealed so that the entry area is sterile and does not need to be cleaned.
4. Close the regulator on the tubing.
5. Insert the tubing into the fluid container through the correct entry port.
6. Invert the bottle with the tubing hanging down. It is convenient to be able to hang the bottle on a hook or stand at this time.
7. For a flexible plastic drip chamber, squeeze the chamber to fill it half full with fluid. A rigid drip chamber usually fills when the container is inverted.
8. Hold the end of the tubing over a basin or waste container. Open the regulator gradually and allow the tubing to fill. If the end of the tubing is tightly capped, that cap must be loosened to allow the tubing to fill. Replace the cap when the tubing is full. Be sure that all large bubbles are eliminated. Very tiny bubbles that do not together constitute a large bubble are not dangerous, so do not be alarmed if a small bubble is inadvertently administered.

Unit 4
Self-Test

1. In selecting an IV set for a child, you would mostly choose _____
2. You open a bag of IV fluid and note its appearance to be cloudy. You would
 - a. discard the bag in the trash
 - b. send the bag to its source – the pharmacy or central services
 - c. use the IV fluid – it's common to see some cloudiness

Unit 5

Preparing the Patient for IV Therapy

A few minutes before the infusion is to be started, the nurse should psychologically and physically prepare the patient. To some patients, the knowledge that they are about to receive intravenous fluids is threatening. Certain patients feel the procedure implies serious illness; others are frightened by the threat of pain, discomfort, and immobility. Previous experience can help make the patient less apprehensive, assuming the experience was a good one. For other patients, however, the memories of problems related to the IV make the impending experience truly frightening.

Explain the procedure to the patient and tell him or her why it has been ordered. Tell the patient that a venipuncture can cause discomfort for a few seconds, but there should be no discomfort while the solution is flowing. Provide any scheduled care prior to the IV to minimize movement of the affected limb during the procedure since moving the limb afterwards could dislodge the needle. Check the patient's gown to make sure that it can be removed over the IV apparatus if necessary. Some agencies provide special gowns which open over the shoulder and down the sleeve for easy removal. Patients often want to know how long the process will last. Some physicians' orders will specify the length of the infusion, e.g. 3000ml over 24 hours. It is best to keep the equipment out of the room until the nurse is ready to start the IV ("out of sight, out of mind").

Unit 5
Self-Test

What should the patient be told prior to initiating IV therapy?

Unit 6 Venipuncture Site Selection

When the tubing is set up, you are ready to start the IV. First select a venipuncture site. The site chosen will vary depending upon the patient's age, the infusion time, the type of solution used, and the condition of the veins. For infants, veins in the scalp may be used; for adults, veins in the arms are commonly used. The larger veins of the forearm, in contrast to the metacarpal veins of the hand, are used for infusions that need to be given rapidly, for solutions that are hypertonic, highly acidic or alkaline, or that contain irritating medications.

Infants

Because infants do not have large veins in the antecubital fossa, blood specimens for examination are usually taken from the external jugular vein and the femoral veins. If an infusion is to be maintained for a long period of time, veins in the temporal region of the scalp or sometimes the back of the hand or the dorsum of the foot are used.

Adults

The most convenient veins for venipuncture in the adult are the basilic median cubital veins in the crease of the elbow (antecubital space). These large superficial veins are frequently used by laboratory technicians to withdraw blood for examination. Unfortunately, use of these veins for prolonged infusions limits mobility for patients because splints are needed to stabilize the elbow joint. For prolonged therapy, veins on the back of the hand and on the forearm are preferred. The metacarpal, basilic, and cephalic veins are commonly used. These forearm sites are equipped with the natural splits of the ulna and radius, and allow the patient more arm movement for activities.

It is best to start low in the vein (in the hand or forearm). Then, if you are unsuccessful or if the IV comes out at a later time, you can choose a vein proximal to or higher than the first one. A site where there is bifurcation may be easier to enter if you can enter from below. Compare the length of the device you plan to use with the available vein. Given that you have a choice, it is preferable not to use the dominant hand or arm, and also better to change sides with subsequent IVs. Your choices are often limited by the diagnosis, the condition of the patient's veins, the presence of additional equipment.

Select the vein by looking, palpating, and attempting to distend any veins in the area. You want a clearly visible vein that can be palpated and that has a straight section for entry. If one is not visible, look for the faint outline of a blue vein under the skin to determine where to begin. When even an outline is not visible, you must begin to distend the veins to make them visible or palpable. To distend the veins, place a tourniquet a few inches above the area where you want to start the IV, and ask the patient to "pump" (opening and closing the fist). Generally, these maneuvers distend the vein, making it easier to locate and enter. If you are still unable to locate a vein, place the limb in a dependent position for a period of time or apply warm wet packs to the area. Veins that are not visible but are palpable can be used.

Some veins can be entered without using a tourniquet, a procedure that is advisable when a patient's veins are particularly fragile or rolling. The extra distention produced by a tourniquet can cause a vein to burst or roll even more.

If you have tried two times and are unable to enter a vein, it is best to get assistance. The procedure is uncomfortable for the patient and you do not want to use up all the available veins. If no member of the nursing staff can start the IV, it may be necessary to ask the anesthesia department for help (depending on the policies in your facility) or the physician to do a cutdown (surgical opening of a vein to start an IV).

Unit 6
Self-Test

1. IV sites commonly used for infants are:
2. For prolonged IV therapy in the adult, it is best to use the _____,
_____ and _____ veins.
3. Why is it preferable to start the IV low in the vein?

Unit 7 Performing the Venipuncture

In North Carolina, the role of the LPN in IV therapy is listed as a Category I function. Refer to Appendix “A” at the end of this unit for the role and responsibilities of LPNs regarding IV therapy.

Up to this point you have selected the needed IV equipment, assembled the equipment, prepared your patient psychologically and physically, and selected an appropriate site for inserting the IV. This unit covers the procedure for starting an IV.

1. **Wash your hands.** Starting an IV is a sterile procedure for which your hands must be clean. To protect yourself, put on clean gloves. **Note:** The latest Centers for Disease Control policy requires gloving whenever venipuncture is done.
2. **Position yourself.** In order to start an IV, you will find that it is equally important for you to be comfortable as it is for the patient. The position you choose in order to be comfortable for you may not be so orthodox as a chair at the bedside. Some nurses put the bed in high position and stand; others put the bed in low position and kneel on a towel, still others sit on the bed. Of course, the policy at your facility may somewhat limit your range of choices.
3. **Locate a vein in which to start the IV.** Examine both forearms and select a site to begin. Place a tourniquet a few inches above the area where you want to start, and ask the patient to open and close his or her fist. If the vein does not distend, you may have to place the limb in a dependent position or apply warm moist packs to the area.
4. **Clean the area thoroughly.** Start from the point at which you want to enter and move with a circular motion away from it, cleaning the skin thoroughly at and around the vein you have selected. If the area is especially hairy, shave or clip the hairs (some agencies prefer hair be only clipped with scissors) before you attempt to start the IV, both for aseptic reasons and to prevent the tape from pulling. Clean the area after it has been shaved or clipped. The antiseptic agent used for cleaning is usually indicated by unit or facility procedure. Try not to touch the area after it has been cleaned.
5. **Anesthetize the area if policy allows.** Use a local anesthetic to decrease the sensitivity of the skin and vein. Be sure to check whether the patient is allergic to local anesthetics.
6. **Insert the needle.** Using the thumb of the nondominant hand, gently retract the skin away from the site. Holding the needle at about a 45° angle, with the bevel up, pierce the skin immediately beside the vein you have selected. When the needle is through the skin decrease the angle until it is almost parallel with the skin, and enter the vein. When blood comes back into the tubing or syringe (depending on the device you use), insert the needle or catheter almost the full length of the needle. Follow the package instructions for the use of any other device.
7. **Release the tourniquet.** Holding the needle or other device steadily with your dominant hand, release the tourniquet with your other hand. Apply gentle pressure with index finger of nondominant hand 1 ¼ inches above site.

8. **Connect the tubing to the IV tube and initiate the flow.** Remove the protective cap from the IV tubing (maintaining sterile technique), connect it securely to the needle, and open the regulator to initiate the flow. This should be done quickly to prevent the patient's blood from clotting and clogging the needle.
9. **Tape the needle securely and dress the site.** This should be done according to unit or facility procedure. If you have no procedure, use the following:
 - a. Place a small amount of an antiseptic ointment (betadine is commonly used) at the needle site.
 - b. With ¼ inch adhesive tape (after checking for patient allergy), tape the needle in place using a chevron configuration.
 - c. Place a sterile 3 x 3 or 2 x 2 gauze square over the IV site.
 - d. Tape the needle and tubing in place, using paper tape (if available – it is usually less traumatic to the patient's skin), and make a loop near the point of entry. This helps prevent the weight of the tubing from pulling the needle out of place. A commercially produced firm plastic insert is available for this purpose.
 - e. Tape the armboard in place, if necessary.
 - f. Write the date, time, and your initials on the tape.
10. **Adjust the flow rate.** The physician will have ordered a specific amount of fluid to be administered over a certain period of time. In some facilities you will figure the flow rate yourself based on the number of drops per milliliter administered by the equipment you are using. In others, the rate will be figured by pharmacy personnel, but you still must figure again in the event the IV gets "ahead" or "behind." Many facilities stock narrow strips or paper calibrated according to the number of hours the IV is to run (time label); the nurse adds specific times appropriate for the individual.
11. **Dispose of the equipment.**
12. **Remove gloves.**
13. **Wash your hands.**
14. **Teach the patient how to protect the IV:**
 - a. Avoid sudden twisting or turning movements of the arm with the infusion.
 - b. Avoids stretching or placing tension on the tubing.
 - c. Try to keep the tubing from dangling below the bevel of the needle.
 - d. Notify the nurse if he or she notices a sudden change in the flow rate, the solution container becoming nearly empty, blood in the IV tubing, or discomfort at the IV site.

Nurses may need to show patients how to ambulate safely, if they are allowed to do so, with a portable IV pole.

15. **Chart the IV.** Usually a special form is used for this purpose. Include the time the IV was started, the type of fluid, any additives, where the IV was started, and by whom. When an IV is discontinued, include the time and the amount of fluid absorbed. A patient receiving an IV is usually on intake and output as well.

Unit 7
Self-Test

1. It is necessary for the nurse to wear gloves when performing venipuncture.

True_____

False_____

2. A sterile dressing should be placed over an IV insertion site.

True_____

False_____

3. What should the patient be told related to protecting the IV?

4. The patient with an IV should be on intake and output.

True_____

False_____

5. Under Category I, what functions may the LPN perform as part of implementing the pharmaceutical regimen prescribed by a physician or other person authorized to prescribe?

The Role of the LPN in I.V. Therapy

According to Board of Nursing Advisory Statements, the administration of I.V. fluids and medications via the central vascular route is within the scope of practice for the licensed practical nurse, and should only be performed after the facility has a written protocol and documentation of appropriate training and supervised clinical practice. The administration of I.V. fluids and medications via the peripheral vascular route by the licensed practical nurse, is considered general practice.

The LPN may perform the following as part of implementing the pharmaceutical regimen prescribed by a physician or other person authorized to prescribe:

- a. administration of I.V. fluids and medications via peripheral lines;
- b. venipuncture for insertion of a peripheral vascular access device;
- c. administration of I.V. fluids and medications via existing peripheral midline catheters. (Please note that the insertion of a peripheral midline catheter is limited to RN practice.)

The performance of I.V. therapy activities are functions of the licensed practical nurse provided there is continuous availability of an RN who is able to be on site when necessary. No licensee should be expected to perform or offer to perform services for which he/she is not competent. Consistent with Administrative Rule 21 NCAC 31.0224 (i) and (j), nurse managers/administrators are accountable for assessing capabilities of nursing personnel, validating their knowledge and skill and , as necessary, providing further learning opportunities to assure that the licensed nurse is capable of safely performing a nursing activity prior to the licensee being expected to perform that activity.

The decision as to what the level of the LPN's involvement in I.V. therapy will be is the responsibility of the employing agency. Protocols should clarify the specific aspects of I.V. therapy that may be assigned to the LPN, as well as the training and supervised clinical practice required of each LPN who will be participating in the administration of I.V. medications and fluids.

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Unit 8 Monitoring and Maintaining an IV Infusion

After the IV has been started, the nurse must continue to monitor and maintain the infusion. This unit will address regulating the flow rate, IV pumps, changing the fluid containers and tubing, and routine assessment. The unit will also assist you to become familiar with all types of available equipment for monitoring and maintaining an IV infusion.

Regulating Flow Rate

An important nursing function for an IV infusion is to regulate the flow rate of the solution. The physician usually describes in the IV order how long an infusion should last, e.g., 3000 ml over 24 hours. It is then a nursing responsibility to calculate the correct flow rate and regulate the infusion. Problems can result from incorrectly regulated infusions

Milliliters per hour

This calculation is made by dividing the total infusion volume by the total time in hours.

$$\text{Milliliters per hour} = \frac{\text{Total infusion volume}}{\text{Time of infusion in hours}}$$

Example: If the requirement is 1000 ml in 8 hours, the calculation is:

$$\frac{1000}{8} = 125 \text{ ml per hour}$$

Hourly checks are required by nursing personnel to ensure that the correct number of ml have infused. Some nurses put a strip of adhesive tape on the IV container with the exact times for the infusion or the amount to be infused hourly.

Drops per minute

The number of drops per minute (gtts/min) are calculated as follows: Multiply the milliliters per hour by the drip factor and divide by the number of minutes.

Example: IV to infuse at 125 cc/hr per IV set with drip factor of 15.

$$\frac{125 \times 15}{60} = \frac{1875}{60} = 31 \text{ gtts/min.}$$

The infusion rate can then be established by adjusting the clamp on the tubing and counting the drops in the drip chamber. Meters and similar devices are also available that can be set to regulate the flow. Some of these systems have alarms that are triggered when there is a change in the flow rate.

Types of Equipment

With the explosion of IV infusion technology and the increase in patient acuity levels, it is not uncommon to find patients on a general medical surgical unit who are receiving various types of IV therapy infusions. There is equipment available today that will infuse up to four primary and/or secondary infusions for one patient. Generally speaking, patients who are residing on a medical surgical unit should need infusion capabilities for controlling the flow of one primary and one secondary infusion. Persons requiring more than this level of care are usually in an intensive care unit.

IV Pumps

Many hospitals are now using infusion pumps to control the IV flow rate. The nurse sets the pump to deliver a set volume at a set rate. Since they pump against pressure gradients, a constant infusion rate and volume can be maintained even with fluctuations in the patient's venous pressure. Remember that the pump is only as effective as the nurse operating it. Do not expect the pump to be a substitute for nursing skills. You must still check the patient regularly for complications, such as infiltration or infection. The machine may not work properly all the time. Make sure you have easy access to the manufacturer's instructions and recommendations. You can avoid several common infusion pump problems by using this checklist:

1. Follow the manufacturer's instructions precisely when you insert the tubing. Remember, each model is a little different, so double-check procedures.
2. Take care to flush all air out of the tubing before connecting it to the patient. The danger of air embolism increases when the fluid is under pressure.
3. Double-check the flow rate. Do not assume you will get an accurate rate just by setting the control. Monitor the flow rate yourself over a specific time span; once you determine how accurate the delivery rate is, you can adjust the flow accordingly.

If your machine has a photoelectric drop sensor, position it properly. Align the top edge with the drip opening and make sure the drip chamber is one-half to one-third full. Otherwise the drop count will not be accurate.

4. Do not let droplets cling to the sides of the drip chamber or the drop count will be unreliable. Correct this problem by removing the drop sensor, clamping off the tubing below the chamber, and inverting the solution container and drip chamber. Repeat if necessary. Then replace the drop sensor, unclamp the tubing, and adjust the flow rate.
5. Avoid turning the pump on and off excessively. This can close the catheter.
6. Before you attach an IV filter or infuse blood, check the manufacturer's recommendations. Not all pumps are designed for these purposes.

Volumetric infusion pumps

As described earlier in this unit, IV fluids needing to be carefully controlled for the delivery of a specific volume over a designated time frame should be administered using a volumetric infusion system. The two types of volumetric infusion systems are the peristaltic and syringe/piston operated pumps.

The newer generation IV volumetric infusion systems will allow the nurse to infuse a primary and secondary line without having to disrupt the primary flow. A primary line is the line used to infuse the major large volume infusion orders, such as 1000 cc D5W, 1000 cc D5LR, 1000 cc NS to infuse over 24 hours at 125 cc/hour. The secondary line is used to infuse small volumes of fluid and/or medications, such as 50% Dextrose, 1 Gram Keflin, 1000 Mg. Ceftin.

Each brand of infusion equipment is operated slightly differently; therefore, it is imperative that you be informed about the types of equipment used in each facility. The principles of operation for infusing a primary and secondary infusion together are similar and are described in the next paragraph.

Basically, the primary infusion is always in place and intact. After hanging the secondary system and establishing the prescribed flow rate by making the necessary adjustments on the equipment key pads or thumb wheels, the primary infusion is stopped momentarily until the secondary infusion is complete. When complete, an alarm on the pump will sound notifying the nurse that the secondary infusion is completed. Automatically, the primary infusion will continue to flow at that rate until the nurse returns to reset the system for the primary infusion.

There are systems that can be programmed to stop the primary system, start the secondary infusion at a designated time, infuse the secondary infusion, and finally discontinue the secondary infusion, and finally discontinue the secondary system. At the same time that the secondary infusion is complete, the system restarts the primary system at the prescribed rate (not KVO).

Mini-infuser systems

Another popular infusion system for infusing a secondary solution/medication is a mini-infuser or syringe pump system. This particular syringe pump mini-infuser system is manufactured by Bard, and is used for all types of intermittent infusions. It is extremely accurate for the infusion of medications. Infusions may be performed with this system as follows:

- Primary intermittent infusions through heparin locks
- Piggyback infusions in combination with primary IV lines
- A delivery system for “IV push” medications

This system allows both the primary and secondary lines to infuse simultaneously. System benefits include:

- Syringe pump accuracy
- Constant rate of flow
- Reduced fluid volume
- Ease of operation

IV Controller

Controller systems can be used to monitor the flow rate of either primary or secondary infusions. The flow of the fluid, which is infusing, is achieved by gravity pressure. Accuracy of infusion is measured by rate of flow (drops per minute); therefore it is not as accurate as a volumetric infusion system. Controller systems are not recommended for use in situations which require exact volumes or dosages, such as IV therapy in renal failure of congestive heart failure or IV infusion of medications like Lidocaine or Apresoline.

PCA Pumps

Patient controlled analgesia (PCA) pumps were developed as a method of providing pain relief under the complete control of the patient. Doses of an IV non-narcotic or narcotic analgesia are administered in small controlled doses, which are accurately calculated so that no more than the prescribed dosage is administered within a designated time frame. The patient simply pushes the patient control button (PCB) each time a dose is desired. Even though the total dose may be administered after, for example, ten pushes of the PCB, the patient may reach the desired relief after six pushes. Additionally, the patient may push the PCB as many as 20 times; however, the final dose is administered after the tenth push.

Studies have shown that patients who are allowed to control the administration of pain medication use lesser doses of analgesia and require the analgesia over a shorter length of time. In many cases, hospitals have determined that patient length of stay has decreased by allowing patients to control analgesia administration. More and more, these systems are being used for chronic as well as acute pain control.

Changing the Fluid Container and Tubing

The Centers of Disease Control currently recommend that all IV tubings and dressings be changed every 48 hours to decrease the incidence of phlebitis at the site. Containers are changed every 24 hours. Following is the proper procedure for changing the tubing:

1. Check the orders.
2. Wash your hands.
3. Gather the necessary equipment:
 - Tape
 - Dressing material
 - A new fluid container (verify using three checks)
 - A new administration set
 - Clean gloves
4. Set up the equipment.
5. Check the patient's identity.
6. Hang the new container on the standard beside the current container.
7. Wearing gloves, remove the tape and dressing on the IV site to expose the hub of the needle. Be gentle and careful. Do not pull at the needle.

8. Examine the needle site for signs of swelling or inflammation.
9. When the hub is exposed, shut off the IV flow.
10. Hold the hub of the needle firmly and remove the tubing with a twisting motion.
11. Continue holding the hub of the needle with one hand while you remove the cap of the new tubing and insert it firmly into the hub with the other.
12. Immediately start the new infusion at a slow drip rate.
13. Redress the site according to your agency's procedure. If your agency has no procedure, use the following:
 - a. Clean the site with a water-soluble iodine pledget (Acudyne, Betadine).
 - b. Place a small amount of water-soluble iodine ointment on the needle site.
 - c. Tape the needle hub in place. Place the center of the tape strip, sticky side up, under the hub. Cross the tape ends over the top of the hub, creating a "V" or chevron. Secure the tape.
 - d. Place a sterile 2 x 2 gauze square over the needle.
 - e. Make an occlusive, or airtight, seal over the dressing with tape.
 - f. Write the date and time dressed directly on the tape to facilitate record-keeping. The date and time of starting the IV may also be recorded on the tape each time the dressing is changed. Initial the recording.
14. Regulate the IV to the ordered infusion rate. Be sure to label the IV bag and tubing with the patient's name and room number, date, time, and your initials or name.
15. Dispose of the used equipment.
16. Remove gloves; wash your hands.
17. Chart

Changing the container only

1. Wash your hands
2. Take the new fluid container to the bedside stand. Use the three checks to verify the fluid.
3. Check the patient's identity.
4. Remove the cover from the entry port and place the container on the bedside stand.
5. Turn off the IV flow.

6. Invert the old fluid container.
7. Remove the tubing connector, being sure not to touch the tubing end.
8. Insert the tubing into the new container.
9. Invert the new container and hang it on the IV stand.
10. Turn on the flow and regulate the rate. Label the IV bag with the patient's name and room number, date, time, and your initials or name.
11. Dispose of the old container.
12. Wash your hands.
13. Chart.

Routine Assessment

The nurse must make a systematic check of the entire infusion each time she or he is at the patient's bedside. Most IVs are checked hourly, or every 30 minutes in a pediatric or critical care setting. Review the entire system for obvious problems.

1. Check the container.
 - Note the date and time.
 - Is it the correct solution?
 - Which number bottle is it?
 - What time will it be finished?
2. Check the drip chamber.
 - Is it dripping?
 - Is there flow?
 - Is the rate correct?
3. Check the tubing over its entire length for kinks or obstructions.
4. Check the date and time on the tubing. If not dated, assume it needs to be changed.
5. Check the site for signs of phlebitis or infiltration:
 - Color.
 - Skin temperature.
 - Pain.
 - Swelling.

6. If an armboard is in use, remove it periodically to move the extremity or to examine for skin irritation or circulatory impairment. Then, replace.
7. Chart.

**Unit 8
Self-Test**

Calculate the following infusion rates:

1. 3000cc D5 LR to infuse over 24 hours.
IV set is macrodrip—10 drops/cc.

2. 1000cc D5 ½ NS to infuse over 12 hours.
Drip factor = 12 gtts/cc.

3. 75cc D5W to infuse over 30 minutes.
Drip factor = 15 drops/cc.

4. D5.2NS to infuse at 30cc/hr.
Drip factor = 60 gtts/cc.

5. 500cc D5 ½ NS with 20 m Eq KC1 per liter to infuse over 24 hours.
Drip factor = 60 gtts/cc.

6. The danger of air embolism is greater when the patient is on an IV infusion pump.

True _____
False _____

7. The IV infusion pump is 100% reliable to deliver the set amount of fluid.

True _____
False _____

8. Patients on PCA pumps usually require less narcotics than patients on “prn” pain medications.

9. IV tubing should be changed every _____ hours.

10. IV bags/bottles should be changed every _____ hours.

Unit 9

Complications of IV Infusions

The nurse needs to check the patient regularly for problems related to the infusion. Common complications are phlebitis, fluid infiltration, obstructions and circulatory overload.

Phlebitis

Phlebitis, an inflammation of the vein, can be present with or without a clot in the vein. When there is a clot, it is technically thrombophlebitis. In actual practice, the two terms are used interchangeably. Phlebitis is characterized by redness, warmth, pain, and swelling at the IV site. It seems to occur more rapidly when plastic rather than metal needles are used, when electrolytes (especially potassium) are in the solution, and when antibiotics are being administered through the IV. This is due to direct irritation of the vessel. Changing the dressing and tubing every 48 hours seems to decrease the incidence of phlebitis, which suggests that microorganisms also play a role in its development.

When phlebitis occurs, the best course of action is to discontinue the IV and use warm moist packs on the site to relieve the discomfort. When an IV is critical, or when there is just a small amount of fluid left, the IV may be continued at a slow rate. Observe carefully for any increase in redness or swelling.

Infiltration

Infiltration is caused by the leaking of IV fluid into the surrounding tissue. Pallor, swelling, coolness, pain at the site, and usually a diminished IV flow rate are all indications of infiltration. It occurs more frequently with metal needles that have become dislodged and have penetrated a vein wall. It also can occur around a plastic needle that has been in place for a period of time. An infiltrated IV must be discontinued.

Obstructions

Obstructions are indicated by a decrease in flow rate or the complete cessation of fluid flow. Obstructions can be caused by a clot forming over the needle lumen, particulate matter clogging the filters, the lumen of the needle being positioned against the wall of the vein, kinking or pressure on the tubing, or a position of the arm that occludes the vessel proximal to the IV site. Locate the source of the obstruction and correct it (See Table 1).

Circulatory overload

Circulatory overload occurs when the circulatory system contains more fluid than normal. A significant increase in the usual adult circulatory volume about six liters of blood, can cause circulatory overload, possibly resulting in pulmonary edema and cardiac failure. The clinical signs of cardiac failure are dyspnea, reduced urine output, edema, weak and rapid pulse, and shallow and rapid respiration. Pulmonary edema is recognized by dyspnea, cough, and frothy sputum. Careful monitoring of the patient's intake and output can help to prevent circulatory overload.

**Table 1
Complications of Intravenous Therapy**

<u>Complication</u>	<u>Assessment Data</u>	<u>Nursing Actions</u>
Infiltration of IV Solution	<ul style="list-style-type: none"> a. Infusion rate slows or stops completely. b. Swelling, hardness, and pain around the needle site. c. A feeling of coldness around the injection site. d. When the bottle is lowered below the level of the needle, blood fails to return into the tubing (into a reliable sign in presence of hypotension) e. Signs of tissue necrosis (with irritating solutions or vasoconstriction drugs). 	<ul style="list-style-type: none"> a. Immediately stops the infusion. b. Elevate the arm and apply warm towels to the swollen area to aid absorption and reduce discomfort c. If necessary, restart the infusion at another site.
Thrombophlebitis	<ul style="list-style-type: none"> a. Pain along the vein. b. Area of redness and swelling around the affected vein 	<ul style="list-style-type: none"> a. Stop infusion. b. If necessary, restart the infusion at another site. c. Apply warm moist compresses. d. Do not massage or rub the affected limb.
Pyrogenic Reaction	<ul style="list-style-type: none"> a. Symptoms generally appear 30 minutes after the injection is started. b. Temperature elevation and chills. c. Headache. d. Nausea and vomiting e. Circulatory collapse. 	<ul style="list-style-type: none"> a. Immediately stop infusion. b. Check vital signs. c. Notify physician. d. Save IV solution so that it can be examined for pathogens. e. Do not give any solution that is cloudy.
Speed Shock	<ul style="list-style-type: none"> a. Pounding headache. b. Hypertension with possible loss of consciousness. c. Rapid pulse. d. Apprehension. e. Chills. f. Dyspnea. 	<ul style="list-style-type: none"> a. Stop or slow infusion, depending upon the severity of the symptoms b. Check vital signs, neurologic and pulmonary functions. c. Notify physician.

<u>Complication</u>	<u>Assessment Data</u>	<u>Nursing Actions</u>
Air Embolism	The main problem here is sudden vascular collapse due to occlusion of vessel by embolism. As a result, tissues which are normally supplied with blood by the involved vessel will not receive adequate oxygen. Signs are cyanosis, low blood pressure, tachycardia, and a rise in venous pressure.	a. Check vital signs. b. Administer oxygen. c. To prevent this complication: <ul style="list-style-type: none"> • Make certain that air does not enter arterial or central venous catheters. Secure all IV connectors with adhesive tape. • Have the patient perform a Valsalva maneuver or place the patient's head below heart level while you are changing the tubing on the central venous lines.
Circulatory Overload	a. Weight gain b. Pitting edema c. Pulmonary edema. d. Ascites e. Distention of neck veins f. Apprehension g. Rales h. Dyspnea.	a. Notify physician b. Put the patient in semi-Fowler's position c. Administer oxygen. d. Administer diuretics. e. Restrict sodium. f. Weigh patient daily. g. Strict monitoring of IV h. Record and evaluate intake and output. i. Postural blood pressure and measurements.
Drug Reaction	a. Cardiac arrhythmias. b. Nausea c. Vomiting. d. Rashes. e. Renal failure f. Anaphylactic shock.	a. Slow or stop the infusion, depending upon the severity of the symptoms. b. Check the vital signs, neurologic and pulmonary functions. c. Notify physician.

Unit 9
Self-Test

1. What are the signs of phlebitis?
2. What are the signs of infiltration?
3. How can circulatory overload be prevented?
4. What are the signs of speed shock?

Unit 10

Intravenous Medications

Because IV medications directly enter the patient's bloodstream, they are appropriate when a rapid effect is required. (e.g., in a life-threatening situation such as cardiac arrest.) The IV route is also used when medications are too irritating to tissues to be given by other routes (e.g., Levophed for acute hypotension) or when an IV line is already established and you want to avoid the discomfort of other parenteral routes.

There are, however, potential hazards in giving IV medications: infections and rapid, severe reactions to the medication. To prevent infection, sterile procedures are used during all aspects of IV medication techniques. To safeguard against severe reactions, you must carefully assess the patient for early signs of a reaction such as:

- noisy respirations.
- changes in pulse rate.
- chills.
- nausea.
- headache.
- specific adverse effects of the particular medication.

If any of these signs occur, discontinue the medication and notify the physician or responsible nurse.

Intravenous medications are given in a variety of ways. This unit covers medications administered:

- into IV bottles or bags.
- into volume-controlled in-line administration sets.
- into additive sets (secondary or piggyback sets).
- by direct IV push (bolus), via venipuncture, a port in an established IV line, or an intermittent infusion set (Heparin lock or trap).

IV Bottle or Bag

Intravenous medications can be added to a new fluid container prior to hanging it or to a fluid container that is already attached and running. Electrolytes (e.g., potassium chloride) and vitamins (e.g., Solu-B) are commonly administered by this method.

Preliminary tasks

1. Determine from the physician's orders the specific medication and dosage.
2. Identify which infusions are to be used with the medication. For example, the medication may be ordered to infuse with 1000 ml of 5 percent dextrose and water rather than normal saline.
3. If more than one medication is to be added, determine the compatibility of the drugs and solutions being mixed. You may need to consult a pharmacist for this information. An incompatibility is an undesired chemical reaction between a drug and an infusion, or between two or more drugs.

Assembling the equipment

Perform a surgical hand wash prior to assembling the equipment to prevent the transfer of microorganisms to the equipment and to the patient. The following equipment is needed.

1. The correct solution container, if a new one is to be attached. Confirm its sterility, i.e., check the expiration date.
2. The physician's order or medication card.
3. The correct sterile medication. If the medication is in a powdered form, a diluent (e.g., sterile saline solution or water) will also be necessary.
4. Antiseptic swabs.
5. A sterile syringe of appropriate size (e.g., 5 or 10 ml) and a 1 to 1 1/2 inch, 20 or 21 gauge sterile needle.
6. A medication label to attach the IV solution container.

Preparing the medication

Prepare the medication from a vial or ampule according to the manufacturer's instructions. In some agencies a special filter needle is used to draw premixed liquid medications from multidose vials. The filter needle is then replaced by a regular needle to inject the medications into the solution container. The filter prevents any solid material from being drawn up.

Preparing the patient

Compare the name on the medication card to MAR with the patient's identification band. Explain to the patient what you plan to do and why. Normally, an IV medication is not uncomfortable for a patient.

Procedure

1. For a glass IV container, remove the metal cap and the rubber disc if the bottle is vented. Identify the injection port. For a plastic container, locate the separate, self-sealing, soft rubber injection port.
2. Clean the injection port with an antiseptic swab.
3. Remove the needle cover from the medication syringe and inject the medication into the port.
4. Remove the needle. For a glass container, cover the top immediately with either an antiseptic swab with the metal IV cap taped over it, or with the special sterile cap provided by the manufacturer.
5. Gently rotate the solution container to mix the drug with the solution.
6. Attach the medication label upside down to the fluid container. This makes the label easy to read when the container is hanging and infusing.

7. Spike and hang the container.

Volume-Control Administration Sets

Controlled-volume administration sets are commonly referred to as Buretrol, Soluset, Volutrol, or Pedictrol sets. They are small fluid containers, 100 to 150 ml in size, attached below the primary infusion container. The volume-control administration sets are most often used in pediatrics. They are also used to administer IV medications that do not remain stable for an extended length of time, to administer medications intermittently, and to dilute a drug.

Assembling the equipment

Perform a surgical hand wash prior to assembling the equipment to prevent transferring microorganisms to equipment and to the patient. The following equipment is needed:

- The correct solution container.
- A volume-control administration set.
- The physician's orders or medication card.
- The correct sterile medication.
- Antiseptic swabs.
- A sterile syringe of appropriate size (e.g., 5 or 10 ml) and a 1 ½ inch, 20 or 21 gauge sterile needle.
- A medication label to attach to the volume-control set.

The process of attaching and filling a volume-control set is similar to setting up a regular intravenous infusion, but differs in the priming procedure, i.e., the way in which the volume-control set is filled. The priming procedure also varies in accordance with the specific type of filter (membrane or floating valve) of the volume-control set. Assemble the equipment according to the manufacturer's instructions.

Preparing the medication

Prepare the medication from a vial or ampule. Check the agency's practice about whether a special filter needle is used when preparing the medication.

Preparing the patient

Compare the name on the medication card or MAR with the patient's identification band. Explain to the patient what you intend to do and why. Include in your explanation the fact that an IV medication is not normally uncomfortable.

Procedure

1. Ensure that there is sufficient fluid in the volume-control fluid chamber to dilute the medication. Check the directions from the drug manufacturer.
2. Close the inlet to the fluid chamber by adjusting the upper roller or slide clamp above the fluid chamber.

3. Clean the medication port on the volume-control fluid chamber with an antiseptic swab.
4. Insert the needle of the medication syringe into the port.
5. Inject the medication.
6. Regulate the flow.
7. Attach a medication label to the volume-control fluid chamber.

Additional Bottles

Additional fluid containers and sets are sometimes attached to a primary infusion set to administer IV medications, as was introduced and discussed in Unit 3. Examples of two medications commonly administered in this manner are the bronchodilator Aminophylline and the antibiotic Keflin.

There are two methods of attaching additional containers: the **piggyback set** and the **secondary set**. The piggyback set consists of a small IV bottle Z(minibottle) and a short tubing line that is connected to the upper Y-port (the piggyback port) of the primary line. Generally, a macrodrip system is used. The term piggyback refers to the positioning of the additive bottle, which is higher than the primary infusion bottle. Manufacturers provide an extension hook to position the primary bottle below the piggyback bottle. The piggyback set is used only for intermittent IV drug administration.

The secondary set system uses a microdrip or macrodrip bottle of any size and a long tubing line that is attached to the lower Y-port (secondary port) of the primary line. The primary and secondary bottles are positioned at the same height. This system is used to administer IV drugs intermittently or simultaneously with the primary IV solution, or to administer two types of IV solution through the same IV line.

Preliminary tasks

1. From the physician's order, determine the medication, dosage and how the additive set is to be attached.
2. Determine whether the medication is compatible with the primary infusion and with any other medications that are to be added.
3. If a secondary set is used, determine whether it is to run simultaneously with the primary infusion or is the primary infusion is to be clamped off at the time.

Assembling the equipment

Wash your hand before assembling the following equipment:

1. The appropriate additive set.
2. The physician's order or the medication card.
3. The correct sterile medication.
4. A sterile syringe and needle. Generally, a 20 gauge, 1 inch needle is used because longer needles can puncture the tubing and cause leakage of IV fluid.
5. A medication label.

Preparing the patient

Compare the patient's identification band with the medication card or MAR. Explain the procedure to the patient, including the fact that the administration of medications using a secondary or piggyback set should not cause the patient discomfort. Assist the patient to a comfortable position with appropriate support.

Procedure

1. Insert the medication into the secondary bottle.
2. If the medication is not compatible with the primary infusion, flush the primary line with a sterile saline solution before attaching the secondary set.
3. Wipe the port with an antiseptic swab.
4. Insert the needle of the secondary set into the port on the primary line and secure it with adhesive tape.
5. Open the clamp on the secondary line and regulate it in accordance with the recommended rate for the medication.
6. If a secondary set is used, clamp off the primary infusion, if necessary.
7. When the medication has infused, readjust the flow of the primary line at the correct rate.
8. Either retain the secondary line for subsequent use or detach it and dispose of the equipment.

IV Push

An IV push is the intravenous administration of a medication that cannot be diluted or that is needed in an emergency. Some drugs are also administered this way to achieve maximum effect. It is important to remember that the medication is administered rapidly with an IV push and this could be dangerous for the patient.

A IV push can be administered into the existing intravenous apparatus through an injection port and through an intermittent infusion set (Heparin lock) when the patient does not have an IV running but does have a Heparin lock in place. The Heparin lock is used primarily for patients who require regular intermittent IV medication but not the fluid volume of an IV infusion. The set usually consists of a butterfly needle attached to a plastic tube with a sealed injection tip. It is called a Heparin lock because small amounts of Heparin are injected into it to maintain its potency. The infusion set is generally inserted in a patient's arm or hand. **Note:** Some institutions are now using med-locks instead of Heparin locks for intermittent IV infusions. These are flushed with 1-2 ml of NaCl solution before and medication administration.

Assembling the equipment

1. Wash your hands using a surgical hand wash before gathering the following equipment:
2. The physician's order or medication card.
3. The correct sterile medication.
4. Antiseptic swabs.
5. A sterile syringe and sterile needle of the appropriate size for the volume of medication.
6. A syringe and needle with a Heparin solution if an intermittent infusion set is used. Check agency practice. Many agencies advocate using 100 units of Heparin per ml of saline solution.

IV push into an existing IV

1. Identify an injection port nearest the patient.
2. Clean the port with an antiseptic swab.
3. If the medication is not compatible with the primary infusion, flush the primary line with a sterile saline solution before giving the bolus.
4. Stop the IV flow by closing the clamp.
5. While holding the port steady, insert the needle in the port.
6. Draw back on the plunger to withdraw some blood. This ensures that the IV needle is in the vein.
7. Inject the medication at the correct rate (specific to each medication), withdraw the needle, reopen the clamp, and reestablish the IV infusion at the correct rate.

IV push into an intermittent infusion set

1. Swab the injection port with an antiseptic swab.
2. Insert the needle with the medication into the port.

3. Withdraw the plunger slightly. If blood does not return into the syringe, move the needle a little in case it is lodged against the wall of the vein. If blood still does not return in to the syringe, inject a little sterile saline and watch for any swelling or burning. If there is evidence that the fluid is flowing into the tissue, do not inject the medication.
4. When the set is in the vein, inject the medication into the set at the recommended rate specified for the medication.
5. Withdraw the needle. Clean the port again.
6. Insert the Heparin syringe and inject the Heparin slowly into the set. Some agencies instill saline before the Heparin, therefore, agency practice needs to be checked. After the injection of Heparin, the set is ready for the next infusion of medication. See Incompatible Medications below for information on what to do if a medication is incompatible with Heparin.

Incompatible Medications

If the drug you are to administer with the primary solution or with the Heparin used is incompatible for an intermittent infusion set, precautions must be taken. In general, follow these steps:

1. Prepare the medication to be administered as directed.
2. Prepare two syringes with normal saline.
3. Establish that the IV is in the vein (get blood return).
4. Use one syringe of normal saline to flush the IV tubing (insert needle at secondary port) or intermittent infusion set.
5. Administer medication.
6. Use the second syringe of normal saline to again flush the IV tubing or intermittent infusion set.
7. Restart the primary IV or inject Heparin if using the intermittent infusion set.

Unit 10
Self-Test

1. Prior to mixing any two drugs in the same IV solution, the nurse should check for _____.

2. Volume control sets are used:

3. When administering an IV medication by the “piggyback method,” should the medication solution be hung higher or lower than the primary IV?

4. Emergency medications are usually administered:
 - a. IV piggyback
 - b. IV push

5. In order to clear the IV line between two incompatible medications, the nurse should flush the line with _____.

Unit 11 **Discontinuing and IV**

Steps of Discontinuing an IV

1. Check the orders. It is very upsetting to patients and staff to have an IV discontinued by mistake.
2. Wash your hands.
3. Gather the necessary equipment: a 2 x 2 sterile gauze square and a band-aid type bandage.
4. Check the patient's identity.
5. Explain the procedure to the patient. Tell him/her that this should not cause discomfort.
6. Don clean gloves.
7. Carefully remove the tape and dressing.
8. Shut off the IV flow.
9. Hold the 2 x 2 gauze above the entry site. Be ready to exert pressure as soon as the needle is out, but do not exert pressure on the site while pulling the needle out. This compresses the vein wall between the needle and the swab and can damage the vein.
10. Remove the needle by pulling straight out in line with the vein. Check needle or catheter to be sure it is intact.
11. Immediately put pressure on the site.
12. Raise the patient's arm above his or her head for about one minute. Hold it there until the bleeding is controlled.
13. Put a bandage over the site.
14. Remove all the equipment. Be sure to note the volume of fluid remaining in the container in order to record intake accurately.
15. Remove gloves and wash your hands.
16. Chart, including intake, and note if needle or catheter is intact.

Charting

It is important to chart carefully after IV care and monitoring are done. The charting must include the exact time started and stopped, and the exact content in detail. Careful records of fluid quantities must be recorded often on the intake and output worksheet, to facilitate assessing the patient's fluid balance. The patient's response is also noted.

Some charts contain a separate sheet on which IVs are recorded, but the fluid quantities are still entered on the intake and output sheet. On other charts, IVs are recorded with medications and treatments. Many hospitals number each bottle sequentially to facilitate accuracy in administration and record-keeping. When complete tubing is changed or when the IV site is redressed, a notation is made. This can be on a separate flowsheet, on the IV sheet, or on the nurse's notes.

While an IV is in place, assessment data must be recorded, such as signs of infection and/or infiltration. Even if no problems are noted, evidence that assessment has been done is required. All items checked should be noted.

Unit 11

Self-Test

1. It is advisable for the nurse to wear gloves when discontinuing an IV.

True

False

2. The nurse should chart each IV dressing change in the patient's record.

True

False

Unit 12 Blood transfusions

INTRODUCITON

The case mix or various types of patients found in acute care settings has changed significantly over the last five years. Before, the majority of patients on general medical surgical units were moderately ill while 20 to 30 percent were either ambulatory patients who were admitted for diagnostic studies only or those who were seriously ill and needed total care. Today, the majority of all patients who are in hospitals are acutely or seriously ill, and there are no patients admitted just for diagnostic work-ups. Generally, the acuity level of patients has increased by at least 30 to 50 percent in some cases. This change has been brought about due to changes in the policies and procedures related to payment from all sources – Medicare, Medicaid, and private insurers.

Because patients in acute care facilities are sicker, the utilization of blood and blood components has increased significantly. Statistics tell us that over 90 percent of all persons in the United States will need the therapeutic benefits of some form of blood before the age of 75.

Blood and Blood Components

Whole Blood. Whole blood is used to treat massive hemorrhage or hypovolemic shock due to hemorrhage. Whenever possible, it is best to use other blood components rather than whole blood due to the ability to reduce the infusion volume.

Packed red cells. By utilizing the techniques of centrifuge or sedimentation, red cells are separated out of whole blood. Packed red cells are used to treat anemia as well as to treat patients pre-operatively and post-operatively. The major reason for using this product is to reduce the infusion volume. During the harvesting process, most of the plasma is removed which reduces the changed of transfusion reactions. Therefore, packed red cells are a safer blood product to use.

Platelets. Platelets are used to treat thrombocytopenia and hemorrhage. They are harvested by centrifuge and apheresis. To ensure that platelets are viable, they should be administered within 48 hours after processing.

Plasma. Plasma is used to replace the deficiencies in coagulation factors and to treat patients with severe liver disease. In order to preserve all coagulation factors, plasma is freshly frozen and stored frozen for up to one year.

Albmin. This product is used to expand the blood volume in patients with hypovolemic shock. During the preparation cycle, albumin is heated to 140°F for at least ten hours, which kills all viruses. Albumin is an extremely safe volume expander.

Granulocytes. Granulocytes are used to transfuse granulocytopenic patients (those who have severely deficient white cells).

Cryoprecipitate. This product is used to treat hemophilia A, DIC (disseminated intravascular coagulation), and uremic bleeding. It is a plasma derivative which provides factor VIII, factor XIII, fibronectin, and fibrinogen.

Each blood component product must be administered using appropriate administration sets. If a special administration set is not supplied with the component, read the applicable policy and procedure. If the procedure does not specifically address this matter, call the laboratory or Blood Bank to inquire. Many blood products should be filtered while others cannot be filtered because specific cells will be destroyed by the filtering process.

Administration of Blood and Blood Components

Each acute care facility will have a specific policy and procedure for detailing the exact administration of blood and blood components, so please read the policy and procedure carefully. However there are some very important points of emphasis which will be addressed in this section.

Prior to administering any blood or blood component, follow these steps:

- Compare the type and crossmatch results with the ABO and Rh factor reports. This is a vital step.
- Assess the blood or blood component for abnormal color or cloudiness which is indicative of hemolysis.
- Look closely for the presence of gas bubbles which may mean the beginning of bacterial growth.
- Check the blood donor number and the recipient number labels for accuracy.
- Confirm the patient's identify by asking the patient to state his/her full name and by checking the identification band.
- Take the patient's temperature, pulse, respiration, and blood pressure.
- Record all pertinent data.

Before administering any blood component, the type and crossmatch results, ABO and Rh factor reports, the patient's name and identification number should be verified by two licensed nurses. Most institutions require both individuals to sign the Blood Bank requisition which states that this information has been checked.

Once you are certain that everything has been fully confirmed and all data is recorded in the patient's chart, the transfusion may be started. All primary lines which will be used to infuse blood or blood components should be initially started with normal saline. The blood or blood component can easily be piggybacked with the normal saline. This serves two purposes: It allows the nurse to observe the infusion site initially to make certain that it is placed properly in the vein and patent, and it ensures that the normal saline will be in place for use should a transfusion reaction occur. It is very important to remain with the patient for at least 15 to 30 minutes, depending on the agency policy. Observe for circulatory overload and signs and symptoms of transfusion reaction. Vital signs should be monitored every 5 to 10 minutes, depending on policy during the specified observation period. Record all data collected.

Transfusion Complications

Any patient who receives a transfusion is subject to a transfusion reaction. Nursing responsibilities include close observation of patient responses to the transfusion and immediate nursing actions needed to control complications should they develop.

Allergic reaction. Signs and symptoms include hives, generalized itching, anaphylaxis.

Circulatory overload. Pulmonary edema will occur, and the following will be noted: dyspnea, cyanosis, anxiety, productive cough (pink-tinged), elevated central venous pressure (CVP).

Febrile reaction. This occurs due to bacteria in the blood and/or sensitivity to leukocytes or platelets. Within 30 minutes, fever and chills will be noted regardless of the cause. Shock follows immediately. Mortality is high for this complication; therefore, actions must be taken immediately.

Hemolytic reaction. This is the most serious reaction and is characterized by chills, headache, nausea, fever, low back pain, hypotension, hemoglobinuria, and vascular collapse. This type of reaction can be seen as early as 10 minutes into the infusion. Actions must be taken immediately.

Septic reaction. Blood contaminated with bacteria produces this reaction. All blood should be administered within four hours to prevent bacterial growth. With this reaction, chills occur rapidly followed by high fever, vomiting, diarrhea, and hypotension.

Nursing interventions

- Discontinue the infusion.
- Keep the line open with normal saline.
- Notify the physician.
- Save the blood or blood product bag and tubing to return to the Blood Bank for further studies.
- Draw blood work for hemoglobin, cultures, and typing studies.
- Collect a urine sample to test for hemoglobin.
- Notify the Blood Bank of the reaction.
- Be prepared to administer antibiotic therapy as ordered by the physician.
- Continue to monitor patient closely.

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Unit 12
Self-Test

1. For the patient with an abnormally low hemoglobin and hematocrit, it is preferable to administer

Whole blood.
Packed red cells.
Platelets.

2. The blood product that is freshly frozen and is good for one year after freezing is _____.

3. The patient with hemophilia would likely receive _____.

4. Prior to administering any blood product the nurse must check:

5. The nurse administering the blood product is the only one who needs to check the identifying information on the blood product.

True
False

6. What are types of blood reactions?

7. When the nurse suspects a transfusion reaction, her first action should be:

Module 11
Answers to Self-Tests

1. By comparing fluid intake to fluid output
 2. a. vomiting, diarrhea, ileostomy, gastric suction
b. renal disease, diabetes, diuretics
-
1. to prevent dehydration and treat ketosis
 2. electrolyte
 3. blood volume expanders
-
1. 10-20
 2. 60
 3. 10
 4. lower
 5. iodine
 6. a
-
1. a volume controlled set (Buretrol or soluset)
 2. b
-
1. Why it was ordered; there may be discomfort when the IV is started, but should not be uncomfortable while the solution is flowing; how long it will last.
-
1. Scalp, hands, and feet
 2. metacarpal, basilic, and cephalic
 3. Because you can move “up” the vein with subsequent venipunctures should the first one be unsuccessful, or if the IV comes out at a later time.
-
1. True
 2. True
 3. Avoid sudden, twisting movements of the arm with the infusion.
Avoid stretching or placing tension on the tubing.
Try to keep the tubing from dangling below the IV site.
Notify the nurse if he notices sudden change in flow rate, solution container becomes nearly empty, blood in IV tubing, or discomfort at IV site.
 4. True
 5. a. Administration of IV fluids and medications via peripheral lines.
b. Venipuncture for insertion of a peripheral access device.
 - d. Administration of fluids and medication via existing peripheral midline catheters.

Unit 8

1. $\frac{3000}{24} = 125 \text{ cc/hr}$

$$\frac{125 \times 10}{60} = 20.83 = 21 \text{ gtts/min.}$$

2. $\frac{1000}{12} = 83.3$

$$\frac{83 \times 12}{60} = 16.6 = 17 \text{ gtts/min.}$$

3. $\frac{75 \times 15}{30} = 37.5 = 38 \text{ gtts/min}$

4. $\frac{30 \times 60}{60} = \frac{1800}{60} = 30 \text{ gtts/min}$

5. $\frac{500}{24} = 20.8 = 21 \text{ cc/hr.}$

$$\frac{21 \times 60}{60} = \frac{1200}{60} = 21 \text{ gtts/min}$$

6. True

7. False

8. True

9. 48

10. 24

Unit 9

1. Redness, pain swelling, warmth.
2. Pallor, pain, swelling, coolness.
3. Careful monitoring of intake and output.
4. Pounding headache, high blood pressure, rapid pulse apprehension, chills, dyspnea.

Unit 10

1. Incompatibility
2. For pediatric patients.
To administer unstable meds.
To administer meds intermittently.
To dilute a drug.
3. Higher
4. B
5. normal

Unit 11

1. True
2. True

Unit 12

1. B
2. Plasma
3. cryoprecipitate
4. Type and crossmatch results with ABO and Rh factor reports.
Assess blood for abnormal color or cloudiness.
Assess blood for gas bubbles.
Check donor number and recipient labels for accuracy.
Confirm patient's identity with ID bracelet; ask patient to state his name.
Take TPR and BP.
5. False
6. Allergic.
Circulatory overload.
Febrile.
Hemolytic.
Septic.
7. To stop the infusion.