



30 Hour IV Certification
Study Guide
(Revised March, 2013)

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Hello, and welcome to the I.V. Therapy class. Clinical Solutions is proud to offer you a stress free environment to enhance your learning. Thank you for allowing us to provide for your educational needs.

I.V. therapy is a routine part of most patients' hospital stay. This program can be taken by RNs and LPNs. This course fulfills Florida State's 30- hour requirement for I.V. therapy training for LPNs. Included in this study packet is a copy of the Florida State statutes. This program is recognized by the Florida Board of Nursing, and complies with the requirements regarding the LPN performing I.V. therapy via a central line.

The program is comprised of two components: an 18 hour home study section and a 12 hour classroom section. You will receive 30 contact hours at the completion of the program. Remember, even though this program meets the state requirements, the facility where you work will have its' own policies and procedures that you must follow in regards to I.V. therapy.

The goal of this program is to combine a vibrant and interactive didactic presentation with plenty of hands on time for practical demonstration. The amount of material presented is most complex. For that reason, review of the Study Packet and completion of the Pre-test is mandatory prior to class. Your ability to comprehend the information and successfully complete the program is contingent on your compliance with the home study requirement. **YOU MUST BRING THE COMPLETED PRE-TEST ANSWER SHEET AND STUDY PACKET WITH YOU TO CLASS!** The answer sheets will be collected during registration. You will not be allowed to continue in the class if it is not completed. If this happens, you will be able to sign up for the next available class without additional cost.

Again, thank you for choosing Clinical Solutions. Before you leave, take a look at the additional training programs we offer. Remember, we offer many different training locations. In addition, we have the ability to bring the class to a location of your choosing with a minimum number of students required. When signing up for multiple classes, discounts are available.

CHAPTER 64B9-12
ADMINISTRATION OF INTRAVENOUS THERAPY BY LICENSED PRACTICAL NURSES

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64B9-12.001 Statement of Intent and Purpose.

(1) The “practice of practical nursing” as defined by Section 464.003(3)(b), Florida Statutes, includes the “administration of treatments and medication,” under direction, and holds the licensed practical nurse “responsible and accountable for making decisions . . . based upon the individual’s educational preparation and experience in nursing.” As medical science advances and the demands for health care in Florida grow, the scope of nursing practice, in general, and of the practice of practical nursing, in particular, is expanding. It has become necessary that the licensed practical nurse, when qualified by training and education and when approved by the institution at which the licensed practical nurse is employed, engage in the limited administration of intravenous therapy both to serve the public and to allow the professional nurse to better perform those acts requiring professional nursing specialized knowledge, judgment and skill.

(2) The purpose of this rule is to protect the public by ensuring the availability of intravenous therapy and its competent administration in the care of the ill, injured or the infirm. In keeping with the purpose, this rule authorizes the qualified licensed practical nurse to administer those aspects of intravenous therapy within the scope of practice of the licensed practical nurse, enumerates those aspects of intravenous therapy outside the scope of practice of the licensed practical nurse, and sets out the educational and/or competency verification necessary to administer, under direction, limited forms of intravenous therapy.

Specific Authority 464.006 FS. Law Implemented 464.003(3)(b) FS. History—New 1-16-91, Formerly 21O-21.001, 61F7-12.001, 59S-12.001.

64B9-12.002 Definitions.

(1) “Administration of Intravenous Therapy” is the therapeutic infusion and/or injection of substances through the venous peripheral system, consisting of activity which includes: observing, initiating, monitoring, discontinuing, maintaining, regulating, adjusting, documenting, planning, intervening and evaluating.

(2) “Under the direction of a registered professional nurse” means that the registered professional nurse has delegated intravenous therapy functions to a qualified licensed practical nurse. The registered professional nurse does not in all instances have to be on the premises in order for the licensed practical nurse to perform the delegated functions.

(3) “Direct supervision” means on the premises and immediately physically available.

Specific Authority 464.006 FS. Law Implemented 464.003(3)(b) FS. History—New 1-16-91, Formerly 21O-21.002, 61F7-12.002, 59S-12.002.

64B9-12.003 Aspects of Intravenous Therapy Outside the Scope of Practice of the LPN.

(1) Aspects of intravenous therapy which are outside the scope of practice of the licensed practical nurse unless under the direct supervision of the registered professional nurse or physician and which shall not be performed or initiated by licensed practical nurses without direct supervision include the following:

- (a) Initiation of blood and blood products;
- (b) Initiation or administration of cancer chemotherapy;
- (c) Initiation of plasma expanders;
- (d) Initiation or administration of investigational drugs;
- (e) Mixing IV solution;
- (f) IV pushes, except heparin flushes and saline flushes.

(2) Although this rule limits the scope of licensed practical nurse practice, it is appropriate for licensed practical nurses to care for patients receiving such therapy.

Specific Authority 456.013(2), 490.004(4) FS. Law Implemented 456.013(2) FS. History—New 1-16-91, Formerly 21O-21.003, 61F7-12.003, 59S-12.003, Amended 4-9-98.

64B9-12.004 Authority for the LPN to Administer Limited Forms of Intravenous Therapy.

(1) With the exception of those aspects of intravenous therapy deemed outside the scope of practice of the licensed practical nurse by Rule 64B9-12.003, F.A.C., above, and subject to the approval of the institution at which the licensed practical nurse is employed, any licensed practical nurse who meets the competency knowledge requirements of Rule 64B9-12.005, F.A.C., below, is authorized to administer intravenous therapy under the direction of a registered professional nurse.

(2) Individuals who have completed a Board approved prelicensure practical nursing education program, professional nursing students who qualify as graduate practical nurses, or licensed practical nurses who have not completed the specified course under Rule 64B9-12.005, F.A.C., may engage in a limited scope of intravenous therapy under the direction of a registered nurse, physician or dentist. This scope includes:

- (a) Perform calculation and adjust flow rate;
- (b) Observe and report subjective and objective signs of adverse reactions to IV administration;
- (c) Inspect insertion site, change dressing, and remove intravenous needle or catheter from peripheral veins.
- (d) Hanging bags or bottles of hydrating fluid.

Specific Authority 464.006 FS. Law Implemented 464.003(3)(b) FS. History—New 1-16-91, Formerly 21O-21.004, 61F7-12.004, 59S-12.004.

64B9-12.005 Competency and Knowledge Requirements Necessary to Qualify the LPN to Administer IV Therapy.

(1) Contents. The board endorses the Intravenous Therapy Course Guidelines issued by the Education Department of the National Federation of Licensed Practical Nurses, November, 1983. The intravenous therapy education must contain the following components:

(a) Policies and procedures of both the Nurse Practice Act and the employing agency in regard to intravenous therapy. This includes legalities of both the Licensed Practical Nurse role and the administration of safe care. Principles of charting are also included.

(b) Psychological preparation and support for the patient receiving IV therapy as well as the appropriate family members/ significant others.

(c) Site and function of the peripheral veins used for veinpuncture.

(d) Procedure for veinpuncture, including physical and psychological preparation, site selection, skin preparation, palpation of veins, and collection of equipment.

(e) Relationship between intravenous therapy and the body's homeostatic and regulatory functions, with attention to the clinical manifestations of fluid and electrolyte imbalance.

(f) Signs and symptoms of local and systemic complications in the delivery of fluids and medications and the preventive and treatment measures for these complications.

(g) Identification of various types of equipment used in administering intravenous therapy with content related to criteria for use of each and means of troubleshooting for malfunction.

(h) Formulas used to calculate fluid and drug administration rate.

(i) Methods of administering drugs intravenously and advantages and disadvantages of each.

(j) Principles of compatibility and incompatibility of drugs and solutions.

(k) Nursing management of the patient receiving drug therapy, including principles of chemotherapy, protocols, actions, and side effects.

(l) Nursing management of the patient receiving blood and blood components, following institutional protocol. Include indications and contraindications for use; identification of adverse reactions.

(m) Nursing management of the patient receiving parenteral nutrition, including principles of metabolism, potential complications, and physical and psychological measures to ensure the desired therapeutic effect.

(n) Principles of infection control in IV therapy, including aseptic technique and prevention and treatment of iatrogenic infection.

(o) Nursing management of special IV therapy procedures that are commonly used in the clinical setting, such as heparin lock, central lines, and arterial lines.

(p) Glossary of common terminology pertinent to IV fluid therapy.

(q) Performance check list by which to evaluate clinical application of knowledge and skills.

(2) Central Lines. The Board recognizes that through appropriate education and training, a Licensed Practical Nurse is capable of performing intravenous therapy via central lines under the direction of a registered professional nurse as defined in subsection 64B9-12.002(2), F.A.C. Appropriate education and training requires a minimum of four (4) hours of instruction. The requisite four (4) hours of instruction may be included as part of the thirty (30) hours required for intravenous therapy education specified in subsection (4) of this rule. The education and training required in this subsection shall include, at a minimum, didactic and clinical practicum instruction in the following areas:

(a) Central venous anatomy and physiology;

(b) CVL site assessment;

(c) CVL dressing and cap changes;

(d) CVL flushing;

- (e) CVL medication and fluid administration;
- (f) CVL blood drawing; and
- (g) CVL complications and remedial measures.

Upon completion of the intravenous therapy training via central lines, the Licensed Practical Nurse shall be assessed on both theoretical knowledge and practice, as well as clinical practice and competence. The clinical practice assessment must be witnessed by a Registered Nurse who shall file a proficiency statement regarding the Licensed Practical Nurse's ability to perform intravenous therapy via central lines. The proficiency statement shall be kept in the Licensed Practical Nurse's personnel file.

(3) Providers: The LPN/IV education must be sponsored by a provider of continuing education courses approved by the Board pursuant to Rule 64B9-5.005, F.A.C. To be qualified to teach any such course, the instructor must be a currently licensed registered nurse in good standing in this state, have teaching experience, and have professional nursing experience, including IV therapy. The provider will be responsible for issuing a certificate verifying completion of the requisite number of hours and course content.

(4) Educational Alternatives. The cognitive training shall include one or more of the following:

(a) Post-graduate Level Course. In recognition that the curriculum requirements mandated by subsection 64B9-2.006(3), F.A.C., for practical nursing programs are extensive and that every licensed practical nurse will not administer IV Therapy, the course necessary to qualify a licensed practical nurse to administer IV therapy shall be not less than a thirty (30) hour post-graduate level course teaching aspects of IV therapy containing the components enumerated in subsection 64B9-12.005(1), F.A.C.

(b) Credit for Previous Education. The continuing education provider may credit the licensed practical nurse for previous IV therapy education on a post-graduate level, providing each component of the course content of subsection 64B9-12.005(1), F.A.C., is tested by and competency demonstrated to the provider.

(c) Nontraditional Education. Continuing education providers may select nontraditional education alternatives for acquisition of cognitive content outlined in Rule 64B9-12.005, F.A.C. Such alternatives include:

1. Interactive videos;
2. Self study;

3. Other nontraditional education that may be submitted to the Board for consideration and possible approval. Any continuing education providers using nontraditional education must make provisions for demonstration of and verification of knowledge.

(5) Clinical Competence. The course must be followed by supervised clinical practice in intravenous therapy as needed to demonstrate clinical competence. Verification of clinical competence shall be the responsibility of each institution employing a licensed practical nurse based on institutional protocol. Such verification shall be given through a signed statement of a Florida licensed registered nurse.

Specific Authority 464.006 FS. Law Implemented 464.003(3)(b) FS. History—New 1-16-91, Formerly 21O-21.005, 61F7-12.005, Amended 7-15-96, Formerly 59S-12.005.

I.V. Therapy Certification

Schedule – Day 1

9:00 – 9:15	Welcome and Introductions
9:15 – 10:00	Introduction to I.V. Therapy <ul style="list-style-type: none">a. Safetyb. Resourcesc. Professional and Legal Standardsd. Video
10:40 – 10:50	Break
10:50 – 12:30	I.V. Therapy <ul style="list-style-type: none">a. Electrolyte Reviewb. Fluid Reviewc. Vascular System Reviewd. Considerations of Therapye. Hands on Vein Selection
12:30 – 1:20	Lunch
1:20 – 2:30	Steps of I.V. Insertion <ul style="list-style-type: none">a. Equipment Listb. Delivery Methodsc. Calculationsd. Establishing I.V. Accesse. Maintenancef. Discontinuing I.V.g. Terminology
2:30 – 2:40	Break
2:40 – 3:45	Hands on Practice
3:45 – 5:00	Complications of I.V. Therapy

Schedule – Day 2

9:00 – 9:30	Review Pre test
9:30 – 11:00	Advanced Vascular Access <ul style="list-style-type: none">a. Midline Cathetersb. P.I.C.C.c. Non-tunneled Cathetersd. Tunneled Catheterse. Implanted Portsf. Troubleshootingg. Maintenanceh. Sterile Dressing Changei. Complications
11:00 -11:10	Break
11:10 – 11:30	Hypodermoclysis
11:30 – 1:00	Additional Therapies <ul style="list-style-type: none">a. Transfusion Therapyb. Hyperalimentationc. Chemotherapy
1:00 – 1:45	Lunch
1:45 – 3:30	Practical Skill Station
3:30 – 3:40	Break
3:40 – 5:00	Written Exam <ul style="list-style-type: none">a. Exam Reviewb. Course Evaluation

PURPOSE:

The purpose of this class is to provide the healthcare professional with an understanding of all aspects of I.V. therapy including: fluid and electrolyte balance, information about the venous system, peripheral veins, common IV medical terminology, venipuncture; various means of access to deliver IV therapy, including different catheter types and their use, specific IV therapies, complications associated with IVs, different types of IV equipment, accurate administration of IV medications and solutions, caring for patients receiving IV therapy, blood and blood components, and parenteral nutrition.

OBJECTIVES:

At the conclusion of this course, the learner will be able to:

1. Detail the anatomy and physiology of the skin, venous and arterial systems.
2. Identify indications for I.V. therapy
3. Discuss osmosis and the effects of numerous intravenous fluids on the body.
4. Define a multitude of medical terms that are pertinent to intravenous therapy.
5. Describe the legal aspects of IV administration including competency and scope of practice.
6. Relate the procedures for venipuncture and starting and managing peripheral, midline, and central venous catheter lines.
7. Describe the purpose of and care of the patient with a peripheral IV, a midline catheter, and a central line.
8. Recognize and intervene appropriately when a complication or adverse reaction to intravenous therapy arises.
9. Review the various I.V. therapies including blood transfusions, parenteral nutrition, and chemotherapy.

INTRAVENOUS THERAPY

Introduction to IV therapy

I.V. therapy is the giving of liquid substances, primarily solutions of colloids, crystalloids, medications, and/or blood products directly into a vein. The word intravenous simply means, "within a vein." I.V. therapy is used to: keep the vein open (KVO), establish or maintain a fluid or electrolyte balance, administer continuous or intermittent medication, administer blood and/or blood products, administer anesthetics, correct or maintain nutritional status, administer diagnostic reagents, and monitor hemodynamic functions.

I.V. therapy has great benefits. It can be used to administer fluids, medications, nutrients, and other solutions when a patient cannot take oral substances. It also allows for more accurate dosing of medications. When giving a drug via the I.V. route, the entire amount of the drug reaches the bloodstream immediately and begins to act almost instantly. This is also the biggest risk of I.V. therapy especially if the wrong dose is administered or the patient has an immediate allergic reaction. Other risks include: bleeding, blood vessel damage, fluid overload, infiltration, infection, overdose, incompatibility, and allergic reaction to infused substances. It also affects a patient's activity level and ability to care for themselves. Lastly, I.V. therapy is more costly than other methods of medication delivery.

Common intravenous access methods in both hospital and pre-hospital settings include:

- Butterfly needle
- Hypodermoclysis
- Over the needle catheter (Jelco, Insyte)
- Midline catheter
- Peripherally Inserted Central Catheter (P.I.C.C.)
- Non-tunneled central venous catheter (Arrow, Cook)
- Tunneled central venous catheter (Broviac-Hickman, Groshong)
- Implanted port
- Intraosseous needle (I.O.)

Safety First

Bloodborne pathogens are the infectious microorganisms (viruses, bacteria, parasites) living in the blood stream. The Occupational Health and Safety Administration (OSHA) estimates that 5.6 million workers in health care and other facilities are at risk for exposure to bloodborne pathogens. As a health care worker you are at risk of exposure through a needlestick or other sharps injury and blood or fluid spatter/splash to the eyes, mouth, mucous membranes, nose, and open cuts or abrasions. Body fluids include:

- Blood
- Saliva
- Semen
- Vaginal secretions
- Cerebrospinal fluid
- Peritoneal fluid
- Pericardial fluid

- Pleural fluid
- Amniotic fluid

Although there are several bloodborne pathogens you could be exposed to in the workplace, the most significant are:

- Human Immunodeficiency Virus (H.I.V.)
- Hepatitis B (HBV)
- Hepatitis C (HCV)

H.I.V. attacks the body's immune system and may cause Acquired Immune Deficiency Syndrome (AIDS). Currently, there is no vaccine or cure for AIDS. H.I.V. is rarely transmitted via needle stick injury. Only .3%-4% of those who are exposed via this route will contract the disease. H.I.V. is a fragile virus that doesn't live long outside of the body. But precautions still must be taken when handling the body fluids of these patients.

Hepatitis B (HBV) infects roughly 8,700 healthcare workers every year. 6%-30% of healthcare workers who are exposed to HBV via a needlestick injury will develop the disease. The virus can live on dried surfaces for up to a week. The HBV vaccine is very effective.

Hepatitis C (HCV) is the most common bloodborne infection in the United States. More than 4 million people are infected with the virus and many aren't even aware of it. 3%-10% of those who are exposed to HCV via a needlestick injury or blood spatter to the eyes or an open wound will develop the disease. There is no vaccine against HCV.

OSHA has mandated bloodborne pathogen training for all U.S. workers who are at risk for exposure. It also mandates that employers provide personal protective equipment and HBV vaccine free of charge to all employees.

The best method of protecting yourself from bloodborne pathogens is to use standard precautions when providing care to your patients. You must treat ALL body fluids and substances as if they were infectious. You must wear the appropriate personal protective equipment with all patient contact.

PPE includes:

- Goggles
- Masks
- Impermeable gown
- Gloves

Handwashing is the beginning of infection control. It can prevent potentially fatal infections from spreading from patient to patient, from patient to health care worker and vice-versa. You must cleanse your hands before and after all patient contact. After applying soap, you must rub your hands together making a lather and continue rubbing for 15-20 seconds. To wash for the correct time, sing "Happy Birthday to You" twice! If soap and water are not available, you can use an alcohol based hand rub to clean your hands. These foam gels significantly reduce the number of germs on the skin and are fast acting. But be aware, they do not kill ALL germs, the most prominent being C-diff. In some community hospitals over the last two years, the rate of hospital acquired C-diff infections was 25% higher than MRSA infections.

All needles and other sharps (glass ampules, scalpels, etc.) must be disposed of in an approved sharps container. Sharps disposal containers should be:

- Functional – durable, closeable, leak/puncture resistant
- Accessible – close to where work is being done
- Visible – properly labeled and color coded
- Accommodating – conveniently located, easy to reach, and with an opening large enough for all needles and sharps

Never overfill a sharps container or you increase your chances of getting stuck accidentally. Fill only to the indicated line or $\frac{3}{4}$ of the container, whichever comes first. Tape, bloody gauze, dressings and IV tubing do not belong in the sharps container. These items must be disposed of in an appropriate RED biohazard bag or waste receptacle.

In November 2001 the Needlestick Safety Act was passed by Congress. This law mandates that all health care institutions use needles and other sharps that have engineering controls and design features to help prevent accidental needlestick or sharps injury. Even with these controls in place there are 600,000-800,000 sharps injuries every year.

The majority of needlestick injuries occur when healthcare workers:

- Dispose of needles
- Give injections
- Draw blood
- Recap needles
- Handle trash and dirty linens

This law also requires that healthcare institutions get input from those using the device. Be aware when new needles are being introduced on your unit. Evaluate the needle based on its' ease of activating the safety device, ease of use, and patient comfort. There are many different safety needles on the market. Become familiar with those used in your institution. Most safety devices will require you to activate the safety feature. These must be used properly, conscientiously, and every single time to prevent injury. Make sure you have read and understand your institutions policy regarding needlestick injury and prevention.

The federal government issues regulations and establishes policies related to I.V. therapy. It mandates adherence to standards of practice for health care facilities so that they are eligible to receive reimbursement under Medicare, Medicaid, and other programs. There are a number of regulatory agencies that dictate the standard of practice when it comes to administering intravenous therapy. These include:

- JCAHO (Joint Commission on Accreditation of Health Care Organizations)
- OSHA (The Occupational Health and Safety Administration)
- INS (Infusion Nurses Society)
- Board of Nursing
- CDC (Centers for Disease Control)
- Facility policy

Every health care facility has I.V. therapy policies. These policies are required to obtain accreditation from JCAHO. The INS has developed a set of standards that are commonly used by committees developing the facility policy. But remember, these policies can't go beyond what

the state's nurse practice act permits. This document defines the legal scope of nursing practice. The nurse practice act in many states does not address scope of practice issues regarding I.V. therapy by the RN. They do set out the guidelines regarding the LPN and I.V. therapy. Work to your license. Know what you are and are not allowed to do in regards to I.V. therapy. Any questions should be directed to the state board of nursing.

Administering I.V. therapy to patients is one of the most legally significant tasks nurses perform. Lawsuits arise for a variety of reasons:

- Wrong solution
- Wrong dose
- Wrong route
- Errors in infusion pump use
- Inappropriate placement of device
- Infiltration
- Dislodgment of I.V. equipment
- Failure to monitor for adverse reactions

Always adhere to the seven "rights" of giving medications to prevent lawsuits. They are:

1. Right drug
2. Right patient (using two identifiers)
3. Right time
4. Right dosage
5. Right route
6. Right reason
7. Right documentation

Failure to adhere to these principles of medication delivery can result in fines, loss of license, and even jail time.

Fluids, Electrolytes, and I.V. Therapy

Body fluids continually move from one compartment to another in an attempt to maintain homeostasis. Homeostasis is considered the steady state of the body by which the internal systems of the body maintain a balance. This natural state is maintained by adaptive responses that promote healthy functioning of the body.

One of the primary objectives of I.V. therapy is to maintain and/or restore the fluid and electrolyte balance in the body. Our bodies are composed largely of fluid. In fact, these fluids will account for about 60% of total body weight in an adult male, and 45%-50% in an adult woman. In infants, fluids account for about 80% of total body weight and will steadily decrease throughout childhood until it reaches adult percentages at around the age of 8. These fluids are composed of water and solutes. Solute are classified as either electrolytes or nonelectrolytes. The nonelectrolytes are solutes without an electrical charge and include: glucose, proteins, lipids, oxygen, carbon dioxide, and organic acids. The electrolytes will be discussed later.

Fluids help regulate the body's temperature, transport nutrients and gases throughout the body, and carry cellular waste products to excretion sites. The body fluids are distributed between two

major compartments – intracellular fluid (the fluid inside the cells) and extracellular (the fluid outside of the cells). The extracellular fluid occurs in two forms – interstitial fluid (surrounding each cell and lymph gland) and intravascular fluid (blood plasma). Part of the interstitial fluid is also made up of the cerebrospinal, pleural, peritoneal, or synovial fluids, and the secretions from the salivary glands, pancreas, liver, and sweat glands. The distribution of fluids between these two compartments is constant when the body is healthy. The heart, kidneys, liver, adrenal and pituitary glands, and nervous system all play a part in maintaining fluid balance in the body.

If there is fluid accumulation in a compartment other than the intracellular or extracellular space, it is referred to as third-space fluid shifting. This happens when a cellular membrane allows water and fluid to enter but not exit. For example, with severe burns, fluids will pool in the burn site, causing depletion of the fluids in the ICF and ECF. In pancreatitis fluids “leak out” into the peritoneal cavity also causing depletion in the ICF and ECF. Patients undergoing long and extensive surgeries will collect third-space fluids and will become intravascularly depleted despite the administration of large volumes of I.V. fluids and blood. Third-space fluid shifting can also occur due to acute bowel obstruction, ascites, and sepsis. These patients will experience tachycardia, hypotension, weight gain, low urine output, poor skin turgor, and hyponatremia.

Fluid balance is also affected by – fluid volume, distribution of fluids in the body, and the concentration of solutes in the fluid. Distribution of fluids depends on the hydrostatic and colloid osmotic pressures in the capillaries. Now, fluid volumes and concentration are regulated by the interaction of two hormones: ADH (antidiuretic hormone) and aldosterone. ADH is secreted when plasma osmolarity increases or circulating blood volume decreases and blood pressure drops. ADH restores blood volume by reducing diuresis and increasing water retention. Aldosterone is secreted when the serum sodium level is low, the potassium level is high, or the circulation volume of fluid decreases. It causes the kidneys to retain sodium and water.

Osmolarity is the concentration of a solution. Usually, the serum has the same osmolarity as other body fluids approximately 300 mOsm/L. If your patient has a serum osmolarity lower than this, they may have fluid overload. Whereas a higher serum osmolarity indicates the patient may be experiencing hemoconcentration of the fluid and dehydration.

Body fluids are in constant motion moving between the fluid compartments through membranes. Homeostasis (balance) is maintained when the solutes and fluids are distributed evenly on each side of the membrane. When there is an imbalance, these molecules will move between the compartments by various routes including:

- Diffusion – molecules move from areas of higher concentration to areas of lower concentration
- Active transport – requires energy for molecules to move from areas of lower concentration to areas of higher concentration. These molecules are moved by physiologic pumps – i.e. the sodium-potassium pump
- Passive transport – solutes are affected by the electrical potential across cell membranes
- Filtration – the movement of substances from an area of high hydrostatic pressure to an area of lower hydrostatic pressure
- Capillary filtration-forces fluid and solutes through capillary wall pores into the ISF
- Osmosis – fluids (water) flow passively from an area of higher water concentration to an area of lower concentration. The process stops when the solute concentrations on both

sides of the membrane are equal. Responds to osmolality changes because of osmotic and hydrostatic pressures

Fluids consist of water and solutes. The solutes that do not carry an electrical charge include: protein, glucose, lipids, and organic acids. Electrolytes are the electrically charged solutes of the body fluids and their role is to maintain the chemical balance of the body. Electrolytes are identified by their electrical charge. The cations, or positively charged electrolytes, are potassium, sodium, magnesium, and calcium. The anions, or negatively charged electrolytes, are chloride, phosphorus, and bicarbonate. The function of the electrolytes is to promote neuromuscular irritability, maintain osmolality, to regulate acid-base balance, and regulate the distribution of body fluids among the different fluid compartments. Electrolyte levels are regulated by various organs:

- Kidneys – through filtration, particles are removed from a solution
- Lungs and liver – part of renin-angiotensin-aldosterone system which regulates sodium, water balance, and blood pressure
- Heart – counteracts the renin-angiotensin-aldosterone system, causing sodium secretion
- Adrenal glands – secrete aldosterone, which influences sodium and potassium balance in the kidneys
- Hypothalamus and posterior pituitary gland – produces and excretes ADH which causes the body to retain water
- Parathyroid glands – secretes parathyroid hormone which draws calcium into the blood from the bones and moves phosphorus from the blood to the kidneys where it is excreted
- Thyroid gland – secretes calcitonin which is a hormone that lowers elevated calcium level by preventing calcium release from the bone
- G.I. tract – even though sodium, potassium, chloride, and water are lost in sweat, they are also absorbed here.

The following table shows the major electrolytes, the normal values, their principal functions, and the sign and symptoms of imbalance.

Electrolyte	Principal Functions	Signs/Symptoms of Imbalance
Sodium Major cation in ECF 135-145 mEq/L	Maintains ECF osmolarity Helps maintain BP Influences water distribution Helps regulate acid-base balance Aids nerve/muscle fiber impulse transmission	Hypernatremia: Irritability, thirst, fever, decreased urine output, flushed skin, hypertension Hyponatremia: Irritability, fatigue, muscle weakness, tachycardia, headache, hypotension, increased urine output
Potassium Major cation in ICF 3.5-5.0 mEq/L	Maintains fluid balance in cells Maintains cell osmolarity Contracts skeletal, cardiac, and smooth muscles Major role is acid-base balance Promotes cell growth	Hyperkalemia: muscle weakness, nausea, diarrhea, lethargy, bradycardia, hypotension, cardiac arrhythmias Hypokalemia: fatigue, weakness, leg cramps, weak/irregular pulse, hypotension, hyperglycemia, bradycardia, cardiac arrhythmias
Chloride Major anion in ECF 96-106 mEq/L	Maintains serum osmolarity Combines with other major cations to create important compounds - NaCl, HCl, KCl, CaCl	Hyperchloremia: stupor, rapid/deep breathing, muscle weakness Hypochloremia: increased muscle excitability, tetany, decreased respirations
Calcium 99% found in the bones and teeth 8.9-10.1 mg/dl	Enhances bone strength Maintains muscle tone Maintains cell membrane structure, function, permeability Enzyme co-factor for clotting Affects activation, excitation, and contraction of cardiac and skeletal muscles	Hypercalcemia: anorexia, nausea, fatigue, constipation, dehydration, headache, hypertension, cardiac arrhythmias Hypocalcemia: muscle spasms or cramping in calf muscles, tetany, positive Chvostek or Trousseau sign, hyperreflexia, laryngospasm, cardiac arrhythmias
Phosphorus Major anion in ICF 2.5-4.5 mg/dl	Maintains cell integrity Maintains bones/teeth Major role in acid-base balance as a urinary buffer Essential to muscle, red blood cell, and neurologic functions	Hyperphosphatemia: anorexia, nausea, tetany, tingling, cramps, nervousness, cardiac arrhythmias Hypophosphatemia: lethargy, stuttering/stammering, joint stiffness, memory loss, muscle pain
Magnesium Major cation in ICF 1.5-2.5 mg/dl	Active in carbohydrate and protein metabolism Facilitates sodium and potassium movement across all membranes Influences calcium levels Affects muscular irritability and contractions	Hypermagnesemia: muscle weakness, lethargy, nausea, hypotension, slow/weak pulse, bradycardia, decreased L.O.C. Hypomagnesemia: dizziness, confusion, leg cramps, nausea, difficulty swallowing, cardiac arrhythmias

	Causes of Imbalance	Treatment
Hypernatremia	High sodium intake, not drinking enough fluids, excessive fluid loss (fever, diarrhea), major burns, osmotic diuretics, diabetes insipidus	Diuretic therapy, hydration, treat underlying cause
Hyponatremia	Fluid overload (IV or PO), hyperglycemia, SIADH, heart failure, aggressive diuretic therapy, NG suctioning, vomiting/diarrhea, excessive sweating, giving hypotonic solutions	Treat underlying cause, administer hypertonic solutions (slowly), foods containing sodium
Hyperkalemia	Acidosis, renal failure, trauma, burns, crush injury, tumor lysis syndrome, hemolysis, hyponatremia	Loop diuretic, Kayexalate, IV Insulin, IV Sodium Bicarbonate, I.V. Calcium Gluconate, limit potassium containing foods, dialysis
Hypokalemia	Diarrhea, vomiting, severe diaphoresis, prolonged diuretic therapy, gastric suctioning, DKA, hepatic disease, metabolic and respiratory alkalosis	KCL infusion (slow), oral KCL supplement, foods high in potassium
Hyperchloremia	Diarrhea, hyperparathyroidism, respiratory alkalosis, hypernatremia	Treat underlying cause
Hypochloremia	Vomiting, diarrhea, sweating, prolonged fever, hyponatremia, respiratory acidosis	Treat underlying cause
Hypercalcemia	Hyperparathyroidism, excessive intake of vitamin D or calcium containing antacids, prolonged immobilization, malignancies	I.V. fluids/ followed by a loop diuretic, I.V. calcitonin, dialysis
Hypocalcemia	Malignancies, vitamin D deficiency, alkalosis, hypoparathyroidism, pancreatitis, medications (Phenobarbital, Dilantin, Lasix), hyperphosphatemia, hypomagnesemia, malnutrition	IV calcium gluconate (slow), vitamin D if chronic
Hyperphosphatemia	Acute/chronic renal failure, large intake of vitamin D, hypoparathyroidism, excessive use of laxatives or enemas containing phosphate, chemotherapy	Calcium supplements, calcium based phosphate binders (Tums), dialysis
Hypophosphatemia	Malabsorption, respiratory alkalosis, prolonged vomiting, long term alcohol abuse,	IV infusion of phosphate, foods high in phosphorus, oral supplements

	hyperparathyroidism, phosphate-binding antacids	
Hypermagnesemia	Renal failure, diabetes mellitus, DKA, ALL, AML, excessive amounts of magnesium containing antacids (Tums, Maalox, Mylanta) or laxatives (MOM), severe preeclampsia (receiving I.V. mg ++)	Dialysis (renal failure), loop diuretics, fluid bolus, IV calcium
Hypomagnesemia	Malabsorption (IBD, bowel resection, gastric bypass), alcoholic patient going through withdrawal, hypothyroidism, hypoparathyroidism, hypercalcemia, high-dose steroid use, sepsis, pancreatitis, some meds (Amphotericin B, Cisplatin, Cyclosporine, Tobramycin, Gentamicin)	IV replacement (slow), oral supplements

There are three basic types of fluids that are utilized for I.V. therapy. They are – isotonic, hypotonic, and hypertonic. Isotonic fluids have the same osmolality as the serum and other body fluids. It expands the intravascular compartment. It can be used to treat hypotension that is secondary to hypovolemia, or as maintenance fluids. Hypotonic fluids have a lower osmolality than the serum. When given they help hydrate the cells and can decrease the amount of fluid in the circulatory system. This is used when diuretic therapy dehydrates the cells, to lower serum sodium levels, in the treatment of diabetic ketoacidosis, and to treat hyperglycemic nonketotic syndrome. Hypertonic solutions have a higher osmolality than the serum. These fluids pull fluid from the interstitial and intracellular compartments back into the blood vessels. Can be used to treat hypovolemia, low serum sodium levels, or to help reduce risk of edema and low blood pressure in post op patients.

Isotonic fluids include:

- 2.5% dextrose/0.45% sodium chloride
- 0.9% sodium chloride
- 5% dextrose and water
- Normosol®³
- Plasmalyte® A
- Plasmalyte® R
- Isolyte®⁴ E · Ringer's
- Lactated Ringer's
- 2.5% dextrose in 1/2 lactated Ringer's
- 6% dextran and 0.9% sodium chloride
- 10% dextran and 0.9% sodium chloride

Hypotonic fluids include:

- 0.45% NS (Half-normal saline)
- 0.33% NS (One-third saline)
- D2.5W (Dextrose 2.5% in water)

Hypertonic fluids include:

- 5% dextrose/0.2% sodium chloride
- 5% dextrose/0.3% sodium chloride
- 5% dextrose/0.45% sodium chloride
- 5% dextrose/0.9% sodium chloride
- 10% dextrose/0.2% sodium chloride
- 10% dextrose/0.45% sodium chloride
- 10% dextrose/0.9% sodium chloride
- 3% sodium chloride
- 5% sodium chloride
- 10% dextrose and water
- 50% dextrose and water
- 5% dextrose in Ringer's
- 5% dextrose in lactated Ringer's
- 5% dextrose and 5% alcohol
- 5% sodium bicarbonate injection
- 10%, 15%, and 20% mannitol injection
- 6% dextran and 0.9% sodium chloride
- 10% dextran and 0.9% sodium chloride

The skin is the first barrier to a successful venipuncture. The skin acts as a barrier between the outside environment and internal organs. When the barrier is broken, the risk for infection increases. An infusion access device perforates the skin, interrupts the integrity of the barrier, and increases the risk for infection. Any infection in this tissue can spread throughout the body. Strict aseptic technique for venipuncture, care and maintenance of the site is mandatory.

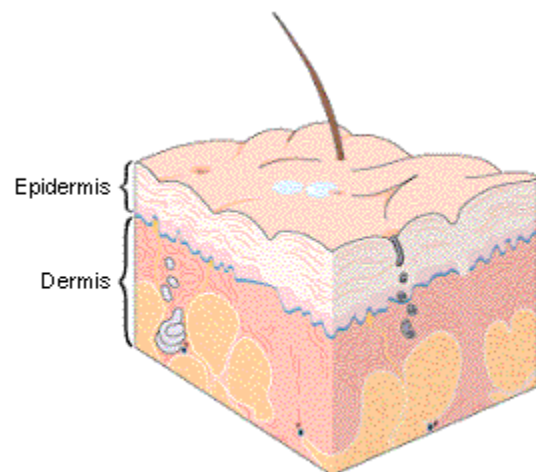
The skin serves multiple functions:

- Acts as a mechanical barrier to microorganisms
- Sensory and temperature regulation
- Aids in fluid and electrolyte balance

The skin consists of layers:

Epidermis: Composed of squamous cells that are less sensitive than underlying structures, the epidermis is the first line of defense against infection.

Dermis: Much thicker than the epidermis. This layer consists of blood vessels, hair follicles, sweat glands, sebaceous glands, collagen fibers, lymphatic vessels and nerves. The dermis reacts quickly to painful stimuli



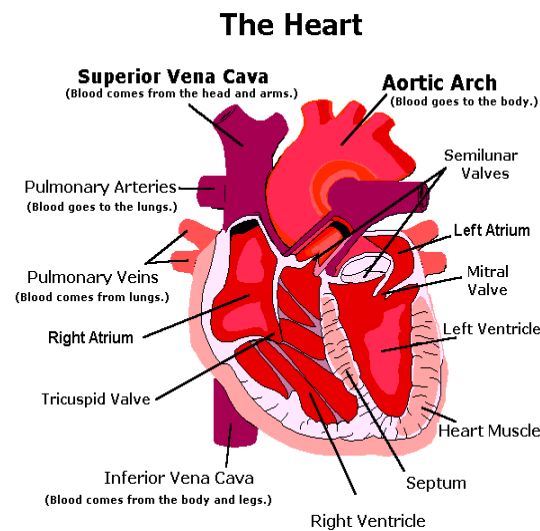
as well as to temperature changes and pressure sensation. This is the most painful layer during a venipuncture.

To help decrease pain during a venipuncture, penetrate these layers quickly!

The vascular system is made up of blood vessels, which include arteries, arterioles, capillaries and veins. These vessels vary in size and function.

- Arteries carry oxygenated blood away from the heart. The aorta is the largest artery, emanating from the heart. Arteries branch off the aorta. As they branch off the aorta, they decrease in size and become arterioles. Arterioles subdivide into capillaries.
- Capillaries provide nutrients to the tissue and take wastes away. Capillaries connect with venules, which are the smallest veins. The venules connect with larger veins, eventually leading to the vena cava, which is the largest vein and connects directly to the heart.
- Veins carry deoxygenated blood back to the heart. The deoxygenated venous blood is carried to the right atrium through the superior vena cava (SVC) and the inferior vena cava (IVC). The blood enters the right ventricle, exiting through the pulmonary artery to the lungs, where it is oxygenated and carried to the left atrium through the pulmonary veins.

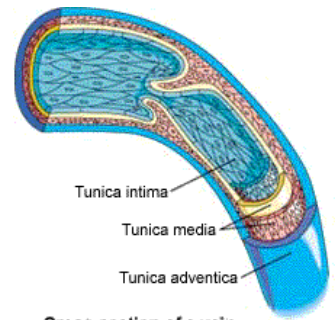
NOTE: The pulmonary artery carries deoxygenated blood and the pulmonary veins carry oxygenated blood; these are the only exceptions to the rule that an artery contains oxygenated and a vein deoxygenated blood.



The vein is the second barrier to successful venipuncture and consists of three layers:

- Tunica adventitia--outer coat, made of connective tissue, which is the support.
- Tunica media--muscle and elastic tissues which causes contraction and dilation.
- Tunica intima--endothelial lining of the vein; a single layer of smooth flat cells lying along the length of the vein, allowing for smooth blood flow; disruption of this layer exposes the basement membrane and the clotting process is immediately begun. Also, when solutions with extremes of osmolarity are infused, fluids shift into or out of these cells, which can cause the inflammatory process to occur. This can lead to phlebitis or thrombophlebitis.

Also in the tunica intima layer are the semi-lunar valves, which are directed toward the heart and prevent blood from flowing toward the extremities. Therefore, the direction of the IV needle should always be toward the heart with the flow of the circulation.



Cross-section of a vein.

Image modified by J. Williams, Baxter Healthcare Corporation
original image ©1994 by Techpool Studios Corp. USA

Systemic veins are in two sets: deep and superficial. Deep veins accompany the corresponding arteries and are called *venae comites* or *venae comitantes*. The superficial veins commence as a network of small veins just under the skin. Superficial veins in the hand and forearm are the ones most utilized for the initiation of IV therapy. However, upper arm veins can be and frequently are accessed as venipuncture sites.

Considerations of I.V. therapy

When selecting a vein to perform a venipuncture, consider the following factors:

- Cannula size – Select a cannula with the shortest length and diameter that accommodates the therapy being provided.
- Type of solution – Hypertonic solutions and various medications can be irritating to the vein. Consult with pharmacy regarding the properties of the medications or solutions being delivered. Do not administer continuous vesicant chemotherapy, parenteral nutrition exceeding 10% dextrose, or 5% albumin.
- Condition of vein – If the vein has recently been used, is bruised/red/swollen/red then do not use.
- Duration of therapy – Long-term therapy will require frequent venipunctures. When possible, alternate arms and always start distally.
- Patient age – Infants have fewer accessible sites than older children and adults. In toddlers, the feet and hands are the most accessible sites. In children, adolescents, teens, and adults the hands and the antecubital region offer the best sites. The elderly may have very fragile veins.
- Patient preference – Use nondominant side whenever possible. Ask the patient if they have ever had an I.V. before and which site they prefer.
- Patient activity – As much as possible, allow hands to be free, especially if the patient uses a walker, crutches, or wheelchair.

- Presence of disease or surgery – Avoid the affected side if a patient has burns or scars, has had a mastectomy, or is paralyzed.
- Presence of shunt or graft – NEVER use the arm that has a shunt or graft in place for hemodialysis

Selecting a vein

The most commonly used veins for placement of an I.V. include the metacarpal, cephalic, and basilic veins, including the accessory branches that merge with them. The superficial veins on the top of the hand and forearm are the best choice. The top of the hand is supplied with small, superficial veins that can be dilated easily. The forearm has long and straight veins with fairly large diameters. In the adult population, the saphenous vein on the inner aspect of the ankle and the veins of the dorsal foot network may be used as a last resort to establish I.V. access. In the pediatric population these veins are commonly used, but usually only if the child is not yet walking. Check your facility policy regarding the use of the foot for access. In infants younger than 6 months, scalp veins may be used.

All veins have valves. They are usually seen in long, straight arm veins, or in large well developed veins that have good tone. Look for veins that are straight and smooth for about 1 inch. Apply the tourniquet 2-6 inches above the intended site, just tight enough to distend the vein but not occlude arterial flow. Place the tourniquet under the patient's arm. Lift and stretch the tourniquet, crossing one end over the other, Tuck the top tail of the tourniquet under the bottom tail. Do not tie the tourniquet in a knot. Be careful not to pinch the skin or pull the patient's arm hair. Have the patient pump their fist. The tourniquet should be left in place for 1-2 minutes. If the vein doesn't distend, remove tourniquet and apply heat. Reapply tourniquet and gently tap on top of vein, rub the vein in one motion (proximal to distal), or lower patient's arm below their heart. Choose a firm vein that looks and feels round when palpated. When you compress the vein, it should rebound quickly. Remember, the most prominent veins are not always the best ones to use. Avoid areas of flexion like the wrist and elbow. When selecting an I.V. site, choose the distal veins first and work your way up the arm. Rotate the site per facility policy.

Listed below are the veins used for venipuncture:

Site	Advantages	Disadvantages
Digital veins Along lateral and dorsal portions of fingers	Used for short term therapy Used when other means aren't available	Uncomfortable for patient Requires splinting Large risk of infiltration Can't accommodate large volumes or fast I.V. rates Difficult to access
Metacarpal veins On dorsum of hand – formed by union of digital veins between the knuckles	Easily accessible Lie flat on back of hand so harder to dislodge In adults and large children, the bones of the hand act as a splint	Short catheter must be used so wrist movement is not limited Painful during insertion due to large number of nerve endings in hands Phlebitis likely at site
Accessory cephalic vein Along radial bone as a	Large vein Can use large-gauge	Difficult to position catheter flush with skin

continuation of metacarpal veins of thumb	catheters Doesn't impair mobility	Discomfort during movement due to location of catheter at bend of wrist Danger of radial nerve injury
Cephalic vein Along radial side of forearm and upper arm	Large vein Can use large-gauge catheters Doesn't impair mobility	Decreased movement due to the proximity of the catheter to the elbow May be difficult to stabilize the vein
Median antebrachial vein – Rising from palm and along ulnar side of forearm	Holds winged (Butterfly) catheters well Can be used when no other means are available Easily visualized	Painful insertion due to nerve endings in the area High risk of infiltration in this area Possible nerve damage due to infiltration
Basilic vein Along ulnar side of forearm and upper arm	Straight, strong vein Can use large-gauge catheters	Inconvenient position for patient during insertion Painful insertion due to nerve endings in the area Difficult to stabilize the vein
Antecubital veins In the antecubital fossa: median cephalic, median basilic, medial cubital)	Large veins Used for drawing blood Visible or palpable in children when other veins won't dilate Used in emergency situations Can be used when no other means are available	Difficult to splint elbow Veins may be sclerotic if blood has been drawn frequently from this site
Dorsal venous network Includes the saphenous vein and the dorsal venous arch in the foot	Suitable for infants and toddlers	Difficult to find vein if foot is edematous Limits mobility Increased risk of deep vein thrombosis
Scalp veins Includes the frontal, superficial temporal, and posterior auricular veins	Suitable for infants less than 6 months of age Usually visible and palpable in infants	Difficult to stabilize Requires clipping hair at site Increased infiltration risk due to vein fragility

I.V. Therapy

Before initiating I.V. therapy, verify orders. Check for allergies, medical history, current diagnosis, and care plan. Make sure the diagnosis fits the fluid or medication therapy ordered. A complete order for I.V. therapy should include the following:

- Type and amount of solution
- Any additives and their concentration (e.g. 10 mEq potassium chloride in 500 ml dextrose 5% in water)
- Rate and volume of infusion

- Duration of infusion

Also, verify the 7 “rights” of medication or fluid administration:

- Right patient
- Right drug
- Right dose
- Right route
- Right time
- Right reason
- Right documentation

Now, prepare your patient for the procedure. Remember, even though I.V. therapy is a routine procedure in the hospital setting, your patient may not view it in the same way, especially when they are ill, in a strange environment, and surrounded by strangers. To some, this procedure can be quite frightening. Every patient is different, and no one likes getting stuck with a needle. Using two identifiers, verify that you have the right patient. Explain the procedure you are about to do. You must get verbal consent before you start. To obtain consent, your patient must be awake, alert, and oriented times three. Ask the patient if they have ever had an I.V. before and any problems they may have had in the past. Ask them if they have a preference for where the catheter is to be placed. Again, your patient may be anxious regarding the procedure. This may cause vasoconstriction, making the venipuncture more difficult for you and more painful for the patient. A confident attitude and calm manner go a long way in helping your patient to relax. Topical anesthetics such as EMLA cream (Lidocaine/Prilocaine) and Cold Spray (Ethyl Chloride) or Lidocaine injected subcutaneously help mitigate the pain associated with venipuncture.

After preparing your patient, collect all supplies you will need for the procedure. This includes:

- Pad for the bed
- Fluid
- Infusion set
- Extension tubing or end cap
- Flush
- 2 catheters
- I.V. start kit (tourniquet, gauze, alcohol/chloroprep, transparent dressing, tape)
- Infusion device and arm board if necessary

Bring all supplies into the patients’ room. Wipe down the bedside table with antimicrobial soap, and then wash your hands.

Inspect the solution for the following:

- Correct solution
- Clarity
- Expiration date
- Volume
- Integrity of container
- Label

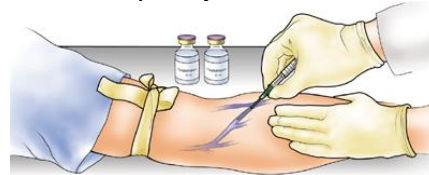
Remove infusion set from package, uncoil the tubing, and close the roller clamp. Remove the protective cover from the solution bag and the protective cover from the infusion set. While holding the insertion port of the bag firmly, insert the spike of the infusion set. Hang the bag on a pole. Squeeze the drip chamber until it is about half full. Open the roller clamp slowly and purge the tubing of all air. Keep the end of the infusion set sterile.

If using extension tubing or an end cap, flush them with saline making sure to keep the ends sterile. Open the I.V. start kit. Remove the tape and the tourniquet. Prepare the tape. Tear off a piece of tape approximately 2 inches long, and then tear it down the middle. Put the tape on the end of the cleaned table. Tear two more 2 inch pieces of tape and place them on the end of the table. Apply the tourniquet and determine the vein to be used. Remove tourniquet. If necessary, put on gloves and clip the hair over the insertion site to improve visibility. Do not shave the area as this can cause microabrasion of the skin which increases the chance of infection.

Position the patient and yourself. Place a pad or towel on the bed below the extremity you are using. Put on gloves. Using approved cleaning agent (alcohol, chloroprep, chlorhexidine), clean 2 inches around the insertion site and allow to dry completely. Apply tourniquet.

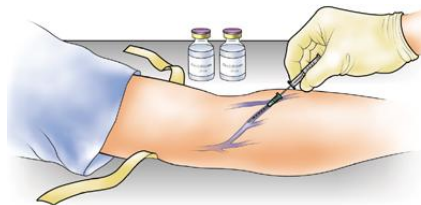
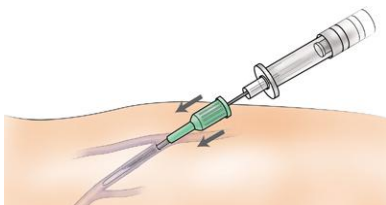


Using the thumb (or fingers) of your non dominant hand, hold the skin taut 1-2 inches below the insertion site. Grasp the catheter between the thumb and forefinger of your dominant hand. Tell the patient you are going to insert the catheter and to please hold still. Holding the catheter with the bevel up and at a 10-30 angle, pierce the skin quickly and advance the catheter slowly until

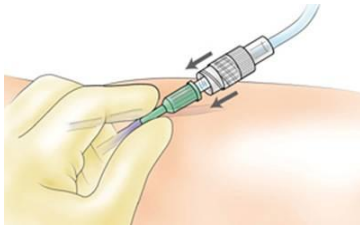


you see blood in the flashback chamber.

Next, decrease the angle slightly and using the forefinger of your dominant hand and advance the catheter forward (not the needle) until the hub is even with the skin. Do not force the catheter forward if you meet resistance. You are now holding the catheter between your thumb and middle finger. Using your non dominant hand, apply pressure 2 inches above insertion site. Remove needle from catheter and activate the safety feature using your dominant hand, then remove the tourniquet.



While still holding pressure, attach the end cap or extension tubing to the hub of the catheter aspirate to verify blood return, and then gently flush the catheter. Look for any swelling or leaking. Always maintain control of the catheter.



Cleanse the skin with a gauze pad and prepare to apply tape. There are several ways to tape an I.V. catheter in place. One is the chevron method which will be demonstrated in class, and the other is the U method which is seen below. After the tape is applied, cover insertion site with a transparent dressing.



After the transparent dressing is in place, tape tubing to the arm, making sure there are no loops or excessive tubing that the patient could catch on the bed rail or in their hand.



Once finished taping, fill out the label found in the start kit with the date, time, gauge of the catheter, and your initials. Place the label somewhere on the tape, avoiding the patients' skin and the area directly over the insertion site. Documenting what you did is the next step. Make sure you document:

- Date and time of the procedure
- Gauge and length of catheter
- Site used
- Number of attempts
- Note blood return was obtained and catheter flushed easily
- Type of solution and any additives
- Flow rate
- Any adverse reactions

- Note any patient teaching and understanding of information
- Your initials

Follow your facility's policy as to where this information needs to be documented.

Oftentimes, you may not see blood in the flashback chamber following the venipuncture. When this happens, do not remove the catheter right way. Slowly pull the catheter back, making sure the needle does not become separated from the catheter, watching for blood return. Change the angle and attempt to re-insert the catheter as described earlier. If still no blood return, remove catheter and look for another site. If at any time the catheter and the needle separate, NEVER attempt to rethread the needle back into the catheter. Most facilities allow you 2 attempts at I.V. access.

Inflammation and infection are two of the most common complications to peripheral I.V. therapy. Routine care measures help prevent any complications. Follow the facility guidelines for care of the I.V. Routine measures could include checking the insertion site every hour, every shift, with every medication delivered, or with every bag change and charting your findings. The transparent dressing should be changed if it becomes wet or soiled. Per the CDC guidelines, a peripheral I.V. should be changed every 96 hours. But, most facilities require that a peripheral I.V. should be changed every 72 hours. Limited venous access (pediatric and elderly population) will sometimes prevent you from changing sites this often. Alternatives for long-term therapy will need to be explored if this is the case. Facilities also require the tubing to be changed every 72 hours. This insures you are hanging clean tubing to a clean I.V. catheter. In some instances, tubing will be changed every 24 hours, e.g. secondary tubing or TPN tubing or every 12 hours, e.g. lipid tubing. The fluid bag must be changed every 24 hours. This helps avoid microbial growth. When connecting tubing to a y-port, remember to always clean the port with the cleaning agent approved by the facility. Be aware of the facility policy regarding care of the patient receiving I.V. therapy including daily lab work, strict I's and O's and/or daily weights.

Always check the order before discontinuing I.V. therapy. Check medication record to verify that all doses of medication have been given. If fluids are running, stop the infusion and close the roller clamp. Put on gloves. Keeping control of the catheter, peel tape towards the insertion site. Once tape is loosened, apply a sterile gauze over the site while pulling out the catheter. Maintain direct pressure over the site for about 2 minutes. After stasis is complete, apply a dressing over the site. Tell the patient to restrict activity for about 10 minutes. Document the procedure. Make sure to document:

- Date and time of removal
- Catheter length and integrity
- Condition of the site
- How the patient tolerated the procedure
- Any nursing interventions

There are many different ways to infuse fluids or medications through the I.V. You must become familiar with each of them to deliver the prescribed therapy to your patient.

- Continuous infusion: Maintains a constant therapeutic drug level or fluid infusion. It is given without interruption.
- Intermittent infusion: Drugs are administered over several minutes or hours. This method is used for example in fluid restricted patients.

- Bolus infusion: A large amount of fluid is infused rapidly
- Piggyback: Used to deliver drugs over a short period of time
- Saline/heparin lock: Used when a patient requires venous access, but not a continuous infusion.
- Push: A set amount of medication is delivered via a syringe over a set amount of time.

To administer intermittent (piggyback) therapy through a continuous I.V. line, a secondary administration set is used. Lower the primary fluid bag using the hanger that is enclosed in the secondary administration set package. Spike the medication bag using the secondary set and prime the tubing. Swab the y-port on the primary set with approved cleaning agent. Connect the secondary set to the y-port and open the roller clamp and set the drip rate. There is a check valve in the primary tubing that prevents fluid from the secondary tubing from flowing into the primary fluid bag.

If the patient has a saline or heparin lock in place, the injection (or end) cap may need to be changed if the number of punctures exceeds the manufacturer's guidelines, or it becomes contaminated. Follow the facility's policy regarding cap change. Some recommendations for changing include:

- The cap is removed from the end of the catheter
- Blood cannot be completely flushed from the cap after blood draw
- Signs of blood, precipitates, cracks, leaks, or other defects are noted
- The septum is no longer intact
- One week has passed without the cap being changed (e.g. with a central line).

If using a saline or heparin lock, become familiar with the steps necessary for using this type of device.

SASH Method (Heparin lock)

Saline – flush with saline

Administration – administer medication

Saline – flush with saline

Heparin – flush with heparin

SAS Method (Saline lock)

Saline – flush with saline

Administration – administer medication

Saline – flush with saline

The amounts of saline and heparin used in these methods will vary according to device and facility guidelines. Before flushing with saline, draw back on syringe to verify blood return. If no blood return, flush gently watching for any leaking or swelling. If resistance is met, do not exert pressure. Maintain positive pressure during and after each flush to prevent reflux of blood back into the injection cap. While flushing, clamp the tubing on the extension set. If you are using a positive pressure end cap, do not clamp the tubing on the extension set. Again, before accessing the injection cap whether to flush or to attach tubing, clean with approved agent per facility guidelines.

There are several infusion sets used for delivering I.V. fluids. These include: primary, secondary and volume-control sets. All three have drip chambers that may be vented or nonvented. Glass

containers will require an infusion set that is vented, whereas plastic ones don't. These infusion sets will deliver 10, 15, 20, or 60 drops per milliliter. The macrodrip system (10, 15, 20 gtt/ml) should be used when infusing 100 ml/hr or more. The microdrip system (60 gtt/ml) delivers a smaller amount of solution and is used for pediatric patients and adults who need small or closely regulated amounts of I.V. solution. A microdrip system may come already attached to a Buretro®, or will need to be attached to one. A Buretro® can hold up to 150 ml of fluid at any one time. When used in the pediatric population, no more than 2 hours of fluid are added to the Buretro® at a time. Check the facility policy regarding use of this device. The drop factor is found on the package the tubing comes in. The primary tubing may be anywhere from 70" to 110" in length. It can have multiple y-sites and a backcheck valve so that medication delivered via the y-site does not flow back into the main fluid. A secondary administration set is shorter in length and is used to deliver either another fluid or a medication. Some facilities will use a "dial a flow" device. The rate of flow is set via a dial that is located on the tubing.

Many times I.V. therapy is delivered via an infusion pump or a syringe pump. There are many different pumps on the market. Become familiar with those used in your facility.

If there are no pumps available for use, you will need to calculate the drip rate of the fluid to be delivered. The drip rate represents the number of drops infused per minute. *Here is the formula:

$$\frac{\text{Volume to be delivered} \times \text{drip factor}}{\text{Time (in minutes)}} = \text{Drip rate}$$

For example: The patient needs an infusion of D5W at 125 ml/hr. The infusion set delivers 15 gtt/ml. What is the drip rate?

$$\frac{125 \times 15}{60} = 31 \text{ gtt/min}$$

After you have the drip rate, count the number of drops going into the drip chamber for one minute. Adjust the flow with the roller clamp until the appropriate drip rate is reached. Remember, if after dividing, the results are 0.4 or less, round down to the nearest whole number. If the results are 0.5 or more, round up to the nearest whole number.

Flow rate represents the number of milliliters of fluid administered over 1 hour. Formula to use:

$$\frac{\text{Volume ordered}}{\text{Number of hours}} = \text{Flow rate}$$

For example: Infuse 3.5L of Normal Saline over the next 24 hours. What is the flow rate?

$$\frac{3500}{24} = 140 \text{ ml/hr}$$

To determine the dosage of a medication needed, use the following formula:

$$\frac{\text{Ordered dose} \times \text{Amount of ml per dose on hand}}{\text{Dose on hand}} = \text{Dose to be given}$$

For example: The order reads give Bumex 2 mg IVP. The vial contains Bumex 4 mg/ml. How many ml do you need?

$$\frac{2 \times 1}{4} = 0.5 \text{ ml}$$

If you have a patient receiving an infusion of a continuous medication, you will need two calculations to determine the unit dosage per hour: determine the amount of medication per ml and determine the infusion rate. To determine the amount of medication per ml, use this formula:

$$\frac{\text{Known amount of medication}}{\text{Volume of diluent}} = \text{Med/ml}$$

Next, determine the infusion rate using this formula:

$$\frac{\text{Dose per hour desired}}{\text{Concentration per ml}} = \text{Ml/hr}$$

For example: The physician orders a Heparin drip at 1,000 units/hr. You have available a 500 ml bag of D5W with 20,000 units of Heparin. How fast should the IV run to deliver the ordered dose?

$$\frac{20,000 \text{ units}}{500 \text{ ml}} = 40 \text{ units/ml}$$

THEN:

$$\frac{1000 \text{ units}}{40 \text{ units}} = 25 \text{ ml/hr}$$

Or you could use the previous formula to determine how many ml/hr will be needed to deliver the dose ordered.

Medications are most often classified and categorized according to their function or use. The classification of medications permits a quick identification of the similarities and differences of many medications within and outside of a particular classification or category. Most pharmacology resource books index and categorize medications according to one or more of these classification systems. Be aware that many of the medications also are divided into subcategories so there can be significant overlap of information. It is critical to utilize reliable printed resources whenever you administer medications to your patients.

Knowledge of how medications act on the body is also highly important. Such knowledge enables the nurse to critically think about and plan care related to how a medication can or

cannot be therapeutic for the patient; how it is absorbed, distributed, metabolized, and excreted. Medications can produce drug-drug, drug-food, drug-herb, drug-lifestyle, or drug-diagnostic test interactions. Such information helps the nurse to determine if the patient is experiencing an adverse reaction or side effect.

Nurses should also be knowledgeable about some of the most frequently occurring factors that affect how medications act on the body. Some of these factors include: the normal physiological changes associated with the aging process, the age-specific characteristics of neonates/infants/children, and the risks associated with giving medications to this population, and the presence of some chronic diseases such as hepatic and renal disease. These factors will impact nursing practice.

Medications chemically and therapeutically perform a role. Pharmacodynamics provides information about the metabolism and excretion of the drug which is affected by renal or hepatic dysfunction, as is the case with many medications. The pharmacokinetics of a medication provides information about the drug's half-life, onset, peak, and duration. Pharmacokinetics have implications for nurses administering medications.

All pharmacological agents have intended uses. Most intended uses result from the medication's direct action. Some uses are related to the side effects of a medication. For example, diphenhydramine (Benadryl) is an antihistamine, and is primarily intended to be used for allergic reactions. Diphenhydramine produces drowsiness as one of its common side effects, so it is also used for sedation and the promotion of sleep onset.

Dosages of medications will sometimes vary according to their intended use. Be sure to check for intended uses and correct dosages in reliable pharmacology resource books, such as the PDR or a current nursing drug handbook.

Certain medications should be used with caution or not at all among some populations. Some of the most frequent pharmacological precautions relate to the geriatric and pediatric populations as well as those with renal or hepatic disease, pregnancy, and lactation. Prior to the administration of a medication, nurses must be aware of its precautions and contraindications. If you are unsure if the medication is contraindicated for your patient, clarify the order with the doctor, or the person writing the order.

To mix medications in a solution for infusion, the drugs and the diluents must be compatible. To find out if what you are infusing is compatible, check a compatibility chart, the PDR or other drug reference book, or ask the pharmacist.

Generally, most I.V. drugs are compatible with the commonly used I.V. solutions. It makes sense that the more complex the solution, the greater the risk of incompatibility. Solutions containing some electrolytes (calcium), mannitol, bicarbonate, and nutritional additives prove to be the most commonly incompatible. There are three categories specific to drugs and diluents that are incompatible.

Physical incompatibility: Occurs most commonly with multiple additives. You will see a visible reaction: precipitation, haze, cloudiness, or gas bubbles. Some examples include – mixing Dilantin with any solution containing glucose, or the presence of calcium in a solution and mixing another medication with it.

Chemical incompatibility: The most common involves the reaction between acidic and alkaline drugs and solutions. Factors associated with chemical incompatibility include: drug concentration (the higher the concentration, the more likely for problems), pH of the solution (drugs and solutions should be similar), time (the longer two or more drugs are together, the more likely an incompatibility will occur), temperature (the higher the temperature of the additive, the higher the risk – prepare the admixture just before administration, or keep refrigerated), light (exposure to light affects the stability of certain drugs). Some examples include – mixing heparin solution with gentamicin, infusing amikacin and acyclovir together for more than 4 hours, not protecting amphotericin B or nitroprusside from light.

Therapeutic incompatibility: Can occur when two or more drugs are administered concurrently. For example, your patient has two different antibiotics ordered – chloramphenicol and penicillin. The chloramphenicol antagonizes the effects of penicillin, so the penicillin should be administered at least 1 hour before the other antibiotic.

There are several complications that can arise from I.V. therapy. Many factors can play a part in the development of complications such as miscalculation of fluid requirements, allergies, failure to maintain aseptic technique during insertion, failure to monitor site per guidelines, empty containers, etc. The following table lists not only systemic but local complications of I.V. therapy, and how to treat them.

Complications – signs and symptoms	Interventions
Local:	
Occlusion <ul style="list-style-type: none"> • Unable to flush the line • Rate of flow slows • Blood backed up in the line • Pain at insertion site 	<ul style="list-style-type: none"> • Attempt to flush line • Remove catheter and reinsert in a new site • Document findings, patient's condition, and any interventions
Vein irritation or spasm <ul style="list-style-type: none"> • Pain along vein • Pain during infusion • Blanched skin over vein • Skin red over vein during infusion • Developing signs of phlebitis • Rate slows down 	<ul style="list-style-type: none"> • Slow the infusion rate if possible • Apply warm soaks over the vein during infusion • Drugs may need to be diluted in more fluid if possible • Document findings, patient's condition, and any interventions
Hematoma <ul style="list-style-type: none"> • Tenderness at insertion site • Bruising around skin • Unable to flush line • Rate slows down 	<ul style="list-style-type: none"> • Remove the catheter • Apply pressure • Apply ice pack for 20 minutes • Recheck for continued bleeding • Document findings, patient's condition, and any interventions
Infiltration <ul style="list-style-type: none"> • Swelling at or around IV site 	<ul style="list-style-type: none"> • Remove the catheter • Warm compress for 20 minutes,

<ul style="list-style-type: none"> • Discomfort, pain, burning • Tight feeling • Decreased skin temperature • Blanching at the site • Absent backflow of blood • Slow or stopped flow rate 	<p>remove for 15 minutes, then reapply</p> <ul style="list-style-type: none"> • Elevate the extremity • Notify M.D. • Estimate how much fluid/med has infiltrated • Continue to assess the circulation-pulse, cap refill, numbness or tingling • Document findings, patient's condition, and any interventions
<p>Phlebitis</p> <ul style="list-style-type: none"> • Tenderness at tip of device and above • Redness at insertion site and along vein • Skin around vein is puffy • Vein feels hard or cord like on palpation • Elevated temperature more than 1 degree above baseline 	<ul style="list-style-type: none"> • Remove the catheter • Apply warm soaks to the affected area for 20 minutes, remove for 15 minutes, and then reapply • Notify MD • Document findings, patient's condition, and any interventions
<p>Thrombophlebitis</p> <ul style="list-style-type: none"> • Sluggish flow • Aching, burning sensation at site • Elevation in temperature more than 1 degree from baseline • Skin warm and red around IV site • Cording along the vein • Swelling and edema of the extremity 	<ul style="list-style-type: none"> • Remove the catheter • Notify MD • Apply cold compress initially for 20 minutes • Elevate the extremity • Apply warm compress for 20 minutes • Document findings, patient's condition, and any interventions
<p>Extravasation</p> <ul style="list-style-type: none"> • Slow rate • Infiltration • Swelling • Skin cool and taut • Redness and warmth • Tissue necrosis 	<ul style="list-style-type: none"> • STOP THE INFUSION • Notify MD • Remove catheter unless needed to instill antidote • Attempt to aspirate as much fluid as possible • Estimate amount of fluid infused • Elevate the extremity • Apply warm or cold compresses depending on what has been infused • Document findings, patient's condition, and any interventions
<p>Systemic:</p>	
<p>Overload</p>	<ul style="list-style-type: none"> • Raise head of bed to semi-Fowlers

<ul style="list-style-type: none"> • Discomfort • Restlessness • Weight gain • Positive fluid balance • Respiratory distress • Crackles • Edema • Pitting edema • Puffy eyelids • JVD • Increased BP • Low Hct 	<p>position as tolerated</p> <ul style="list-style-type: none"> • Slow infusion to 10-20 ml/hr • Administer oxygen if needed • Notify MD • Anticipate diuretic therapy • May need Morphine to help decrease pulmonary hypertension • Document findings, patient's condition, and any interventions
<p>Allergic reaction</p> <ul style="list-style-type: none"> • Itching • Tearing eyes and runny nose • Bronchospasm • Wheeze • Urticarial rash • Edema at I.V. site • Anaphylactic reaction (flushing, chills, anxiety, agitation, palpitations, paresthesia, wheezing, cough, seizures, cardiac arrest) 	<ul style="list-style-type: none"> • Stop infusion immediately • Infuse normal saline via new tubing at 10-20 ml/hr • Maintain airway • Give oxygen • Notify MD • Anticipate need for steroid, anti-inflammatory, and antipyretic medication delivery • Anticipate need for subcutaneous epinephrine delivery • Document findings, patient's condition, and any interventions
<p>Speed Shock</p> <ul style="list-style-type: none"> • Headache • Syncope • Flushed face • Tightness in chest • Irregular pulse • Low blood pressure • Anaphylactic shock 	<ul style="list-style-type: none"> • Stop infusion immediately • Notify MD • Give oxygen • Maintain airway • Infuse normal saline via new tubing at 10-20 ml/hr • Document findings, patient's condition, and any interventions
<p>Systemic infection (cellulitis)</p> <ul style="list-style-type: none"> • Fever and/or chills for no apparent reason • Malaise • Headache • Arm warm to touch 	<ul style="list-style-type: none"> • Notify MD • Remove the catheter • Prepare to culture the site, any drainage, or the device • Anticipate antibiotic therapy • Monitor vital signs • Document findings, patient's condition, and any interventions
<p>Catheter embolism (severed catheter)</p> <ul style="list-style-type: none"> • May have no symptoms • Leaking from catheter shaft • Low blood pressure • Weak, rapid pulse • Cyanosis • Changes in level of consciousness 	<ul style="list-style-type: none"> • If visible, attempt to remove the broken part of the catheter • Notify MD • Apply tourniquet above insertion site • Anticipate need for x-ray • Administer oxygen

	<ul style="list-style-type: none"> • Document findings, patient's condition, and any interventions
Air embolism <ul style="list-style-type: none"> • Respiratory distress • Unequal breath sounds • Wheeze, cough • Chest pain/Shoulder pain • Weak/thready pulses • Decreased blood pressure • Changes in level of consciousness 	<ul style="list-style-type: none"> • Stop infusion • Clamp the source of air intake • Place patient on left side with head down (Trendelenberg) • Give oxygen • Notify MD • Document findings, patient's condition, and any interventions

The INS has instituted grading scales for patients whose I.V. has infiltrated or have developed phlebitis. Be aware of your institutions' grading scale.

Infiltration scale:

Grade	Clinical Criteria
0	<ul style="list-style-type: none"> • No signs or symptoms
1+	<ul style="list-style-type: none"> • Skin blanched • Edema less than 1 inch in any direction • Cool to touch • With or without pain
2+	<ul style="list-style-type: none"> • Skin blanched • Edema 1" to 6" in any direction • Cool to touch • With or without pain
3+	<ul style="list-style-type: none"> • Skin blanched • Skin translucent • Gross edema more than 6" in any direction • Cool to touch • Mild to moderate pain • Possible numbness
4+	<ul style="list-style-type: none"> • Skin blanched • Skin translucent • Skin tight, leaking, discolored, bruised, swollen • Gross edema more than 6" in any direction • Deep, pitting tissue edema • Circulatory impairment • Moderate to severe pain • Infiltration of any amount of irritant, vesicant, or blood product

Phlebitis scale:

Grade	Clinical Criteria
0	<ul style="list-style-type: none"> • No signs or symptoms
1+	<ul style="list-style-type: none"> • Erythema at access site • With or without pain
2+	<ul style="list-style-type: none"> • Pain at access site • Erythema at access site • With or without edema
3+	<ul style="list-style-type: none"> • Pain at access site • Erythema at access site • With or without edema • Streak formation • Palpable venous cord
4+	<ul style="list-style-type: none"> • Pain at access site • Erythema at access site • With or without edema • Streak formation • Palpable venous cord greater than 1 inch in length • Purulent drainage

For your information, here is a partial list of vesicant medications. Consult your drug book or pharmacy before giving any medication:

- Antibiotics: Acyclovir, Cefotaxime, Doxycycline, Nafcillin, Penicillin, Piperacillin, Tetracycline, Unasyn, Vancomycin, Zosyn
- Electrolyte solutions: Calcium chloride, Calcium gluconate, Potassium, Sodium bicarbonate
- Vasopressors: Dopamine, Epinephrine, Levophed
- Chemotherapy drugs: Cisplatin, Daunorubicin, Doxorubicin, Vincristin
- Others: Amiodarone, Ativan, Dilantin, Phenergan, Digoxin, Mannitol, Milrinone, Nitroglycerin, TPN with dextrose concentration greater than 10%.

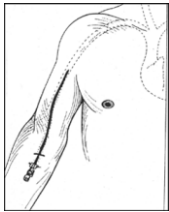
Midline Catheter

A midline catheter is between 3 and 8 inches long and is inserted within 1.5 inches above or below the antecubital fossa. The catheter tip ends in the peripheral vasculature below the axilla. A midline catheter is most frequently placed in one of the large veins of the upper arm. This allows for greater dilution of fluids and medications, and less vein irritation. This type of catheter is used when the duration of I.V. therapy will exceed 6 days. Fluids and medications delivered via the midline catheter should be as close to normal serum osmolality and pH to prevent vein wall irritation.

INS Standard 43 site selection, practice criteria for midline catheters states: “Therapies not appropriate for midline catheters include continuous vesicant chemotherapy, parenteral nutrition formulas exceeding 10% dextrose and/or 5% protein, solutions and/or medications with pH less than 5 or greater than 9, and solutions and/or medications with osmolarity greater than 500 mOsm/L”

Upper arm contractures, burns, scars and any vascular or musculoskeletal conditions may prevent successful insertion. This catheter may be used for therapy lasting up to 4 weeks. Use of the catheter longer than 4 weeks should be based on professional judgment in consideration of:

- Remaining length of therapy
- Peripheral venous status
- Condition of the vein in use
- Patient’s overall condition



Important nursing considerations include:

- No B/P measurements on the arm with the device
- Keep dressing dry
- Keep all sharp objects away from device
- Clean injection port thoroughly before use
- Flush port(s) per facility policy
- End cap change per facility policy
- Sterile dressing change every 7 days, if dressing becomes wet, soiled, or loose, or per facility policy

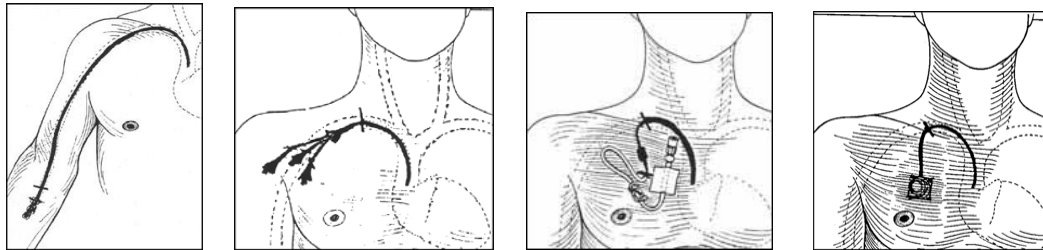
The signs and symptoms of complications from use of a midline catheter are the same as for a peripheral I.V., and the nursing interventions will be the same.

If allowed by your facility, discontinuing a midline catheter will require specific considerations. After putting on your gloves and stopping infusion if applicable, remove dressing and tape. Place sterile gauze over site, but do not apply pressure until catheter is out of the vein. Pull the catheter towards you, keeping it flush with the skin. If resistance is met, do not force. Use relaxation techniques with the patient – e.g. deep breathing. If unsuccessful, redress the catheter and apply a warm compress for 1-2 hours. If still unsuccessful, notify the doctor. Once catheter is out, apply pressure for 1-2 minutes to establish stasis. After stasis is achieved, apply sterile gauze and tape. Measure the catheter to make sure it has been removed in its entirety. Next, document procedure, including any interventions or per facility policy. Dressing should be kept in place for 24 hours.

Central Venous Therapy

The average adult body contains 5 L of blood. After delivering oxygen and nutrients throughout the body, the depleted blood flows from the capillaries to the veins, returning to the right side of the heart via the superior and inferior vena cava. The blood then flows from the right ventricle via the pulmonary arteries into the lungs where a fresh supply of oxygen is collected. From the lungs, the blood flows back into the left atrium via the pulmonary veins, down to the left ventricle. The blood is then pumped back into the body via the aorta.

When using central venous therapy, fluids and/or medications are infused via a central catheter directly into a major vein. The tip of this catheter lies either in the superior or inferior vena cava. Insertion sites include the large veins of the upper arm, the subclavian vein, the internal and external jugular veins, and the femoral vein. There are several types of central line catheters including: P.I.C.C. (peripherally inserted central catheter), nontunneled catheters, tunneled catheters, and implantable ports.



The indications for using central venous therapy include:

- Patient requiring multiple I.V. sites
- Lack of usable peripheral sites
- Requiring central venous pressure monitoring
- Requiring parenteral nutrition (more than 10% dextrose and/or 5% albumin)
- Requiring multiple incompatible medications
- Requiring multiple blood transfusions
- Requiring long-term infusion therapy
- Requiring temporary access site for dialysis
- Requiring multiple blood draws

Because blood flows very quickly around the central line tip, at approximately 2,000 ml per minute, fluids are rapidly diluted by the venous circulation. This allows infusion of highly concentrated caustic solutions or incompatible medications. The high flow rate also reduces the risk of thrombus formation.

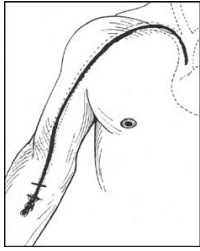
The complications of using a central line for therapy are similar to a peripheral I.V. In addition, there are several life-threatening complications which the following table will illustrate.

Complications – signs and symptoms	Interventions
Pneumothorax, hemothorax, chylothorax, hydrothorax <ul style="list-style-type: none"> • Chest pain • Dyspnea • Cyanosis 	<ul style="list-style-type: none"> • Confirm position of access device by x-ray • Assess for early signs of fluid infiltration (swelling in the neck, shoulder, arm, or chest areas)

<ul style="list-style-type: none"> • Crepitus • Decreased breath sounds on the affected side • Abnormal chest x-ray • Potential for low hemoglobin due to blood pooling (hemothorax) 	<ul style="list-style-type: none"> • Stop infusion and notify M.D. • Remove or assist with removal of device • Administer oxygen • Set up and assist with needle decompression, or chest tube insertion • Document findings, patient's condition, and any interventions
<p>Air embolism</p> <ul style="list-style-type: none"> • Respiratory distress • Unequal breath sounds • Weak pulses • Increased CVP • Decreased blood pressure • Change in level of consciousness 	<ul style="list-style-type: none"> • Purge all air from tubing and end caps before hookup • Clamp the catheter immediately • Cover the catheter exit site • Turn the patient on their left side with the head down • No Valsalva maneuver • Administer oxygen • Notify M.D. • Document findings, patient's condition, and any interventions
<p>Thrombus</p> <ul style="list-style-type: none"> • Edema or redness at insertion site • Swelling of face, neck, and arm • Pain along vein • Fever, malaise • Tachycardia 	<ul style="list-style-type: none"> • Notify M.D. • May need thrombolytic to dissolve the clot • Apply warm, wet compresses for 20 minutes • No venipuncture on the affected side • Document findings, patient's condition, and any interventions
<p>Local and/or systemic infection</p> <ul style="list-style-type: none"> • Redness, warmth, tenderness, or swelling at insertion/exit site • Possible purulent drainage • Local rash or pustules • Fever, chills, malaise • Nausea and/or vomiting 	<ul style="list-style-type: none"> • Monitor vital signs and temperature • Culture site and any drainage • Draw central and peripheral cultures • Assist with catheter removal • Culture tip of catheter once removed • Treat with antibiotics or antifungals • Document findings, patient's condition, and any interventions

Some of the disadvantages of using a central line include: requiring more time and skill to insert, costing more to maintain, and carrying a greater risk of infection. For these reasons, most facilities require a doctor's order stating that a central line is medically necessary before it can be inserted.

Peripherally Inserted Central Catheter



A PICC line is a single or multi lumen central venous catheter inserted via a peripheral vein with the tip lying in the superior vena cava. It is placed in one of the large veins of the upper arm. Upper arm contractures, burns, scars and any vascular or musculo-skeletal conditions may prevent successful insertion. A PICC should be considered for I.V. therapy lasting longer than 6 days and can be used for up to 1 year. Of the various central line devices, the PICC has the least risk of major complications.

In many states, nurse practice acts allow registered nurses who are trained and skilled in the proper technique to insert PICCs. The procedure may be done at the bedside or in the x-ray department.

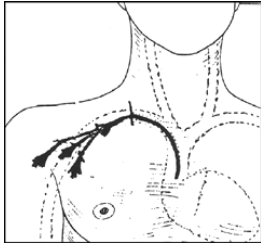
The advantages to using a PICC include:

- Provides long term access to central veins
- A single catheter may be used for entire course of therapy (up to 1 year)
- Provide a safe, reliable route for infusion of fluids and/or medications
- Provides a safe, reliable route for blood sampling
- Some PICCs have properties that minimize the risk of blood clots and phlebitis
- PICCs are cost-effective compared with other central line devices

Important nursing considerations include:

- No B/P measurements on the arm with the device
- **NEVER** use a TB or 3 ml syringe to administer medications or flush
- Only use 10 ml syringes
- Keep dressing dry
- Keep all sharp objects away from device
- Clean injection port thoroughly before use
- Flush port(s) per facility policy
- End cap change per facility policy
- Sterile dressing change every 7 days, if dressing becomes wet, soiled, or loose, or per facility policy

Nontunneled Catheter

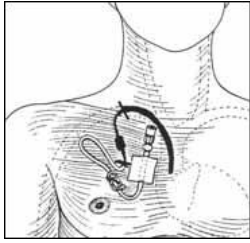


Nontunneled catheters can be used for all types of I.V. therapy and to draw blood. Because of the stiffness of the catheter, they are also used to measure central venous pressure. One of the advantages to using a nontunneled catheter is that it can be inserted at the bedside and it is easily removed. Some of the catheters you will see will be the Arrow and Cook catheters. They will come in various gauges and lengths to accommodate a large patient population. The catheters can be a single, double, or triple lumen. They are placed in the subclavian vein, internal/external jugular vein, or the femoral vein and then advanced into the superior vena cava. These catheters are designed for short term use. The optimal time for using these catheters is unknown. The rule of thumb suggests they be used for 3 days to 2 weeks depending on the insertion site. The subclavian vein is one of the most common insertion sites used for central venous therapy. Use of this site allows for the greatest patient mobility once inserted. This site also carries the least risk for development of infection. The internal jugular vein provides easy access, and in many instances it is the preferred site. However, its proximity to the common carotid artery can lead to serious complications. Placing a catheter here will also limit mobility and it can be difficult to keep the dressing in place. Using this site accounts for the second highest infection rate in central venous catheters. In the adult population, placement of a central venous catheter in the femoral vein is the standard of care in the emergency room when quick access is needed. Because catheters placed here account for the highest rate of infection, policies state they must be removed within 3 days.

Important nursing considerations include:

- Keep dressing dry
- Keep all sharp objects away from device
- Clean injection port thoroughly before use
- Flush port(s) per facility policy
- End cap change per facility policy
- Sterile dressing change every 7 days, if dressing becomes wet, soiled, or loose, or per facility policy
- Assess frequently for signs of infection
- Use the same lumen for the same task

Tunneled Catheter

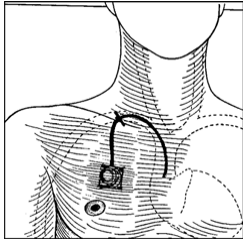


Tunneled catheters are designed for long-term use from months to years. These catheters have a cuff that encourages tissue growth within the tunnel. In about 7 to 10 days, the tissue anchors the catheter in place and keeps bacteria out of the venous circulation. Common catheters you will see include the Broviac, Hickman, Hickman-Broviac and Groshong catheters. They will come in various gauges and lengths and will be single, double, triple, or quadruple lumen. These catheters are placed in the operating room and there will be two surgical sites requiring dressings after insertion. Also, these catheters tear and kink easily so they must be handled carefully. A special consideration in the pediatric population is that if the catheter is used for years, growth may cause the catheter tip to move outside of the superior vena cava. An x-ray will confirm placement if there is any question.

Important nursing considerations include:

- When newly inserted, tape end of catheter to skin and pin tubing to the patient gown
- Keep dressing dry
- Keep all sharp objects away from device
- Handle catheters carefully
- Observe frequently for kinks, leaks, and tears
- Clean injection port thoroughly before use
- Flush port(s) per facility policy
- End cap change per facility policy
- Sterile dressing change every 7 days, if dressing becomes wet, soiled, or loose, or per facility policy
- Assess frequently for signs of infection
- Use the same lumen for the same task

Implanted Port



An implanted port functions like a long term central venous catheter, but it has no external parts. It is implanted in a pocket under the skin. The indwelling catheter is surgically tunneled under the skin until the tip lies in the superior vena cava. It can be threaded through the subclavian vein at the shoulder or through the jugular vein at the base of the neck. The implanted port poses less risk of infection as there is no exit site for microorganisms to invade. Ports require heparinization only once a month to maintain patency. There is no dressing involved unless the port is accessed for therapy. Accessing the port requires inserting a specially designed non-coring needle called a Huber needle, using sterile technique. Implanted ports allow patients to shower, swim, and exercise without worrying about dislodging the device.

Maintaining a CVL (central venous line) requires meticulous care of the device, the insertion site, end caps, and tubing. Become familiar with your facility policy regarding care of the patient with a CVL. To reduce the rates of infection associated with a CVL, some facilities require the patient to get a full body bath with Chlorhexidine before insertion of the catheter and then daily as long as the catheter is in place. Others require a bath 3 times a week. It is imperative that you handle the catheters carefully as they can easily tear or kink. Check the insertion site every hour, every shift, with every medication delivered, or with every bag change and charting your findings. You will want to use the same lumen each time for a specific task. In general, the distal port is used for CVP monitoring, delivery of large volume of fluids or blood/blood products, and medication delivery. The proximal port is used for blood draws, medication delivery, and delivery of fluids or blood/blood products. The medial port is used for delivery of TPN and lipids. Label the ports as to what they are being used for or make sure there is a note in the Kardex. Cleanse end caps before each use with approved cleaning agent. Just like with a peripheral I.V., the tubing will be changed at least every 72 hours or more often for specific therapy using strict aseptic technique. The fluid bag will be changed every 24 hours, again using strict aseptic technique, to prevent bacterial growth. Change the end cap every 7 days, when soiled, or per policy using sterile technique. Flush the catheter and unused ports per policy. Change the dressing every 48 hours if it is a gauze dressing, every week, or if it becomes wet, loose, or soiled, or per policy using sterile technique.

All lumens of a CVL must be flushed regularly. The Infusion Nurses Society recommends flushing with heparin at set intervals to maintain patency of intermittently used CVLs. The schedule for flushing and the type and amount of flush will be determined by type of catheter used and facility policy. Recommended concentrations vary from 10 to 100 units/ml. The frequency for flushing CVLs varies from once every 8 hours to once a week if not in use. Different catheters will require different amounts of solution. Most facilities will recommend 3 to 10 ml of solution to flush the catheter. The size of the syringe used for flushing will vary according to the type of catheter. Catheters with a valve tip (Groshong) do not require heparin solution for flushing, nor should they ever have heparin solution instilled through them. Follow

the facility policy when it comes to flushing these catheters. The following table is just a guideline.

Catheter	Flushing solution/strength	Amount - Frequency
P.I.C.C. (non-Groshong)	Normal saline Heparin 100 units/ml	2 ml normal saline, followed by 2 ml of heparin solution to each lumen every 12 hours and after each use
P.I.C.C. (Groshong)	Normal saline	2 ml normal saline every 8-12 hours to each lumen and after every use
CVL (double, triple, quadruple lumen) <u>without</u> positive pressure cap	Normal saline Heparin 100 units/ml	2 ml normal saline followed by 2 ml of heparin solution every 24 hours to each lumen and after each use
CVL (double, triple, quadruple lumen) <u>with</u> positive pressure cap	Normal saline	2 ml normal saline every 24 hours to each lumen and after each use
Hickman & Broviac catheters <u>without</u> positive pressure cap	Normal saline Heparin 100 units/ml	5 ml normal saline followed by 2-3 ml of heparin every 24 hours to each lumen and after each use
Hickman & Broviac catheters <u>with</u> positive pressure cap	Normal saline	5 ml normal saline every 24 hours to each lumen and after each use
Implanted ports accessed <u>without</u> positive pressure cap	Normal saline Heparin 100 units/ml	5 ml normal saline followed by 5 ml heparin every 24 hours to each lumen and after each use
Implanted ports accessed <u>with</u> positive pressure cap	Normal saline	5 normal saline to each port every 24 hours and after each use

With CVLs, problems arising from the catheter will require special care. Some catheters do not have clamps on them. When changing the tubing or end cap, you will need to use a hemostat to clamp the catheter to avoid an air embolism. Using a serrated hemostat will eventually break down silicone rubber causing the catheter to tear. Sometimes the catheter can become kinked or pinched either above or below the skin. Kinks below the skin are detected by x-ray. The catheter may have to be unsutured and repositioned or replaced. To help prevent external kinks, tape and position the catheter properly. Proper taping helps prevent the catheter from moving or telescoping at the insertion site, which is a major cause of catheter related infections and site irritation. When having difficulty withdrawing blood or infusing fluid, a fibrin sheath may have formed at the tip of the catheter. This will impede the flow of blood and provides a protein-rich environment for bacterial growth. The fibrin sheath may be removed surgically or dissolved by instilling a thrombolytic agent. Follow policy guidelines for use of this agent.

As stated earlier, the CVL dressing is changed per facility policy, every 48 hours if it is a gauze dressing, once a week, or if it becomes moist, loosed, or soiled. The dressing is changed using sterile technique. Obtain a sterile dressing change kit. Wash your hands and then place the patient in a comfortable position. If the patient is able, inform them that they will have to turn

their head away from the CVL site during the procedure. If they cannot turn their head, they will need to wear a mask. Open the kit, put on the mask, and prepare the sterile field. Next put on a pair of gloves and remove the old dressing. Check the position of the catheter, and note if sutures (if any) are intact, if there is any swelling, redness, tenderness, or drainage. Put on the sterile gloves and clean the skin around the insertion site with chlorhexidine, or approved cleansing agent. Apply Biopatch around the catheter if this is the facility policy. If the CVL is not sutured, or the sutures have given way, secure the device using sterile tape or steri-strips to keep it in place. Apply the transparent dressing and then label the dressing with the date, time, and your initials. Document the procedure and your findings.

Hypodermoclysis

The administration of fluids and medications into the subcutaneous space is seen in all practice settings and in all age groups. Fluids and medications administered in the subcutaneous space are absorbed via perfusion, diffusion, hydrostatic pressure, and osmotic pressure. The absorption is slow and gradual which make for more consistent drug levels. In fact, studies show that the use of hypodermoclysis for the management of pain at the end of life, have the same analgesic effects as I.V. infusions without the peaks and troughs associated with prn dosing. All analgesics can be given via this route with the exception of meperidine hydrochloride which causes tissue necrosis.

Advantages include:

- Low cost
- More comfortable than IV administration
- Less likely than IV administration to cause pulmonary edema or fluid overload
- Simple insertion, less distressing than IV; easier reinsertion at new site
- More suitable for home care than IV line, with less staff supervision and less need for hospitalization
- Can be set up and administered by nurses in almost any setting
- Does not cause thrombophlebitis
- Has not been shown to cause septicemia or systemic infection
- Can be started and stopped at any time by opening and closing the clamp on clysis tubing; no danger of clot formation
-

Disadvantages include:

- Usual rate only 1 mL per minute; only 3,000 mL (at two sites) can be given in 24 hours
- Limitations on administration of electrolytes, nutrition additives and medications
- Edema at infusion site is common
- Possibility of local reactions

Hypodermoclysis has been shown to be absorbed at rates comparable to I.V. fluids. At first, this therapy was used to treat dehydration in children, but is now more commonly used for the older patient in the long-term care setting. Therapy is intended for short-term therapy only, lasting for as much as 5 days. Hypodermoclysis is used for patients:

- To prevent dehydration (patients who are dysphagic or confused)
- To treat mild to moderate dehydration

- Limited vascular access
- Prehydration prior to IV insertion
- To provide comfort measures in end-of-life care (prevent dry mouth or constipation)
- Unable to ingest adequate amounts of fluids orally
- For fluid loss due to vomiting, diarrhea, or use of diuretics
- Hyperthermia
- Fluid requirements less than 3 L/day

Hypodermoclysis is not indicated for:

- Circulatory failure
- Severe dehydration
- Severe electrolyte imbalance
- Patients who are severely emaciated
- Patients with gross edema
- Obvious coagulopathy
- Fluid volume excess
- Skin disorders or lesions
- Fluid requirements more than 3 L/day

Fluids used for infusion will include:

- Normal saline (0.9% NS)
- D5NS
- Lactated Ringers
- Normosol-R

Potassium chloride may be added to the fluid in the amount of 20-40 mmol/L. Hyaluronidase may also be added. This enhances subcutaneous fluid absorption.

Areas appropriate for hypodermoclysis include the upper arms, supraclavicular area, abdomen, and thighs. You must be able to “pinch” up at least 2.5 cm of subcutaneous tissue between the thumb and forefinger. Avoid the bony prominences, waistline, scar tissue, any bruised areas, areas that may be irritated by clothing, or any area that interferes with patient mobility.

Preparing for hypodermoclysis requires the same steps as for I.V. therapy. Check and verify orders, prepare the patient for the procedure, and gather your supplies:

- Fluids
- Administration set
- Flush
- 23 – 25 gauge Butterfly needle
- Antiseptic
- Transparent dressing
- Infusion device

Bring all the supplies into the patients’ room. Wipe down the table with antimicrobial soap, and then wash your hands. After inspecting the fluid, spike the bag and purge the tubing of all air. Open the package containing the needle. Put on gloves. Flush the needle. Using aseptic

technique, cleanse the selected site with Chloroprep, alcohol, or Betadine allowing the solution to dry completely. “Pinch” up the tissue, and insert the needle with bevel up at a 45-60 degree angle. Aspirate the device. If blood is aspirated, remove the needle and select another site. Once access is obtained, cover the needle and the site using a transparent dressing. Attach the administration set and begin the therapy at rate ordered. Fluids may be administered at a rate of 1-5 ml/min. If using Hyaluronidase, the infusion rate can be faster. One site can have up to 1.5 L/day infused through it. An infusion pump is required for the infusion of medications and recommended for the infusion of fluids.

Adverse reactions include:

- Injection site irritation
- Pain during infusion (Needle inserted too deep)
- Swelling at the injection site (Needle inserted too shallow)
- Abscess formation
- Puncture of a blood vessel
- Cellulitis
- Bruising

For most of these reactions, discontinue the infusion and apply cool compresses to the area. Avoid using harsh soaps or lotions in the area.

Assess the site at least every 8 hours. The site should be rotated every 3 – 5 days or more often if indicated. Dressings are changed at the time of site rotation, or when the dressing becomes moist, loose, or soiled. To remove the needle, pull it out at the same angle it was inserted. Apply pressure to the site using sterile gauze. Cover the site with a sterile bandage.

Arterial Lines

Arterial lines are usually found in a critical care environment. This line, which is inserted directly into an artery, provides a way to continually measure the blood pressure and also provides access for frequent blood sampling. It is inserted into the radial (wrist), axillary (armpit), femoral (groin), or pedal (foot) arteries. The doctor will insert the catheter into the artery using a technique similar to inserting a peripheral IV. The catheter is then sewn in place. This line can be kept in place for 5-7 days. Extreme care must be taken to avoid accidental dislodgement and hemorrhage. Site assessment and dressing changes are the same as for IV lines. Absolutely no fluids or medications are infused in the arterial line with the exception of heparinized normal saline to maintain patency.

Transfusion Therapy

Transfusion therapy is the introduction of whole blood or blood products directly into the bloodstream. This therapy is used mainly to restore and/or maintain blood volume, improve the oxygen carrying capacity of the blood, to replace deficient blood components, or to improve coagulation. Hemorrhage, trauma, or burns can deplete the circulating fluid volume in the body. A blood transfusion will help maintain fluid balance. Blood harvests oxygen from the air mixture in the lungs and carries it throughout the body. The oxygen carrying capacity of the blood can be depleted from respiratory disorders, sepsis, carbon monoxide poisoning, acute anemia, sickle cell disease, or other chronic diseases. A transfusion of RBCs (red blood cells) can help

improve the oxygen carrying capacity of the blood. When a blood transfusion is contraindicated, e.g. Jehovah Witness, fluid infusions will restore volume. Fluid infusions will not improve the oxygen carrying capacity or replace deficient components. For these patients Hetastarch (Hespan, Hextend) or Haemaccel will help with the oxygen carrying capacity of the blood. The coagulation capacity of the blood can be depleted by hemorrhage, liver failure, bone marrow suppression, platelet depletion (thrombocytopenia), vitamin K deficiency, or medication or disease induced coagulopathies. Transfusion may be used to replace the missing coagulation components of the blood.

Most states do not allow LPNs to administer blood and blood products. In some states, LPNs may regulate transfusion flow rates, observe patients for reaction, discontinue transfusions, and document the procedure. Know what the state practice act allows before performing this procedure.

Blood contains two components, the cellular elements and plasma. The cellular, or formed, elements make up about 45% of the blood volume. This includes RBCs (erythrocytes), WBCs (leukocytes), and platelets (thrombocytes). Plasma, the liquid component of blood, makes up about 55% of the blood volume. The two most important components of plasma are the serum (water) and protein (albumin, globulin, and fibrinogen). Plasma also includes lipids, electrolytes, vitamins, carbohydrates, nonprotein nitrogen compounds, bilirubin, and gases. Individual blood components can be used to correct specific blood deficiencies. For this reason, it is rarely necessary to transfuse whole blood.

The following table reviews the indications for transfusion of the various blood products:

Blood component	Indications
Whole blood	<ul style="list-style-type: none"> • Restores blood volume lost from hemorrhage, trauma, or burns • Exchange transfusion in sickle cell disease
Packed RBCs (80% of plasma removed)	<ul style="list-style-type: none"> • Restores or maintains oxygen carrying capacity • Corrects anemia • Corrects surgical blood loss • Increases RBC mass • Red cell exchange
Leukocyte poor RBCs (70% of leukocytes removed)	<ul style="list-style-type: none"> • Same as packed RBCs • Prevents febrile reactions from leukocyte antibodies • To treat immunocompromised patients • Restore RBCs in patients who have had two or more nonhemolytic febrile reactions
WBCs (leukocytes)	<ul style="list-style-type: none"> • To treat sepsis that is unresponsive to antibiotics – patient with positive blood cultures or persistent fever greater than 101 degrees F (38.3

	degrees C) and life threatening granulocytopenia
Platelets	<ul style="list-style-type: none"> • Treat bleeding caused by decreased circulating platelets • Treat bleeding caused by functionally abnormal platelets • Improve platelet count preoperatively in a patient whose count is less than 50,000
FFP (fresh frozen plasma)	<ul style="list-style-type: none"> • Treat postoperative hemorrhage • Correct an undetermined coagulation factor deficiency • Replace a specific factor when that factor isn't available • Warfarin reversal
Albumin 5% (buffered saline) or Albumin 25% (salt-poor)	<ul style="list-style-type: none"> • Replace volume lost because of shock due to burns, trauma, surgery, or infections • Treat hypoproteinemia
Factor VIII concentrate	<ul style="list-style-type: none"> • Treat a patient with hemophilia A • Treat a patient with Willebrand's disease
Cryoprecipitate	<ul style="list-style-type: none"> • Treat factor VIII deficiency • Treat fibrinogen disorders • Treat significant factor XIII deficiency

There are two kinds of transfused blood: autologous and homologous. Autologous transfusions come from the recipient. In preparation for surgery, the patient may donate blood for themselves or in an emergency situation where they are bleeding excessively the blood is collected in a special container, then filtered and given back to the patient. Homologous transfusions come from a donor. Because recipient blood reacts to donor blood, a type and crossmatch must be done to establish compatibility. Any incompatibility can cause a potentially life threatening emergency. The four blood types in the ABO system include: A, B, AB, and O. An antigen is a substance that can stimulate the formation of an antibody. Each blood group in the ABO system is named for antigens that are carried on a person's RBCs. An antigen may induce the formation of a corresponding antibody if given to someone who does not carry the antigen. When mismatching occurs, antibodies attach to the surfaces of the recipients RBCs, which causes the cells to clump together. The clumped cells can plug small blood vessels. The antibody-antigen reaction activates the body's complement system which causes RBC destruction (hemolysis), which in turn leads to the release of free hemoglobin into the blood stream. The free hemoglobin can damage renal tubules that can lead to kidney failure.

The major antigens in the ABO system are inherited. Blood transfusions can introduce other antigens and antibodies into the body. Most are harmless, but any transfusion could cause a reaction. A hemolytic reaction occurs when donor and recipient blood types are mismatched, and can be life threatening. In as little as 15 minutes or with as little as 10 ml infused, symptoms

can occur. Symptoms include: chest pain, dyspnea, facial flushing, fever, chills, hypotension, flank pain, burning sensation along the vein, shock, and renal failure.

The following table shows ABO compatibility:

Blood group	Antibodies in plasma	Compatible Blood
<i>Recipient</i>		
O	Anti-A and Anti-B	O
A	Anti-B	A, O
B	Anti-A	B, O
AB	Neither Anti-A or Anti-B	AB, A, B, O

The other major antigen system is the Rhesus or Rh system. The two groups here are Rh-positive and Rh-negative and refer to the presence of the D antigen. A person with Rh-negative blood who receives Rh-positive blood will develop anti-Rh antibodies. Anti-Rh antibodies are slow to form, so the first exposure won't cause a reaction. Further exposures may pose a risk of hemolysis and agglutination. The two ways Rh-positive blood can get into Rh-negative blood is by transfusion or during a pregnancy in which the fetus has Rh-positive blood. About 85%-95% of the population has Rh-positive blood.

The universal *donor* is type O negative and the universal *recipient* is AB positive.

HLA or human leukocyte antigens are found on the surface of the white blood cells and platelets. They can cause febrile reactions when blood transfusions are given to sensitive patients. Patients who are immunocompromised are sensitive to HLAs and should be HLA typed when a type and cross is ordered. Also, patients who have received multiple transfusions have been exposed to a variety of HLAs, and have produced antibodies. They also require HLA typing. Before administration of blood, these patients require premedication with acetaminophen. HLA typing is very important when considering organ transplantation.

Transfusion of blood products that have been processed and preserved will increase the risk of complications for the patient, especially if they receive frequent transfusion of large volumes. Your patient can experience hemolytic, febrile, and allergic reactions with any transfusion. In addition, they can experience reactions from multiple transfusions. The following chart addresses the reactions, interventions, and preventive measures:

Reaction	Intervention	Prevention
Reaction from any transfusion		
Hemolytic	<ul style="list-style-type: none"> • Monitor blood pressure • Treat shock (fluids, oxygen, epinephrine, diuretic, a vasopressor) • Obtain posttransfusion blood and urine samples • Observe for signs of D.I.C. 	<ul style="list-style-type: none"> • Before transfusion check to ensure blood compatibility and patient identity with another practitioner • Transfuse slowly first 15 minutes
Febrile	<ul style="list-style-type: none"> • Relieve symptoms with an antipyretic or antihistamine 	<ul style="list-style-type: none"> • Premedicate with an antipyretic, antihistamine, and

		<p>possibly a steroid</p> <ul style="list-style-type: none"> • Use leukocyte poor or washed RBCs • Use a leukocyte removal filter specific to the component being used
Allergic	<ul style="list-style-type: none"> • Administer antihistamines • Monitor for anaphylactic reaction and treat as indicated 	<ul style="list-style-type: none"> • If patient has a history of allergic reactions, premedicate with an antihistamine
Plasma protein incompatibility	<ul style="list-style-type: none"> • Treat shock (fluids, oxygen, epinephrine, and maybe a steroid) 	<ul style="list-style-type: none"> • Transfuse only immunoglobulin A deficient blood or washed RBCs
Bacterial contamination	<ul style="list-style-type: none"> • Treat with a broad spectrum antibiotic and steroids 	<ul style="list-style-type: none"> • Inspect blood for gas, clots, or dark purple color • Change tubing and filter with each unit of blood • Infuse each unit of blood over 2 to 4 hours • Maintain sterile technique when administering blood and/or blood products
Circulatory overload	<ul style="list-style-type: none"> • Stop infusion • Maintain I.V. with normal saline • Administer oxygen • Elevated head of bed • Administer diuretics as ordered 	<ul style="list-style-type: none"> • Transfuse blood slowly • Do not exceed 2 units within a 4 hour period; fewer for the elderly, infants, or patients with a cardiac history
Reactions from multiple transfusions		
Hemosiderosis	<ul style="list-style-type: none"> • Perform a phlebotomy to remove excess iron 	<ul style="list-style-type: none"> • Administer blood only when necessary
Bleeding tendencies	<ul style="list-style-type: none"> • Administer platelets • Monitor platelet count 	<ul style="list-style-type: none"> • Use only fresh blood when possible (less than 7 days)
Elevated blood ammonia level	<ul style="list-style-type: none"> • Monitor ammonia level • Decrease the amount of protein in diet 	<ul style="list-style-type: none"> • Use only RBCs, FFP, or fresh blood, especially if patient

		has hepatic disease
Increased oxygen affinity for hemoglobin	<ul style="list-style-type: none"> • Monitor ABGs • Give respiratory support as necessary 	<ul style="list-style-type: none"> • Use only RBCs or fresh blood if possible
Hypothermia	<ul style="list-style-type: none"> • Stop the transfusion • Warm the patient • Obtain ECG 	<ul style="list-style-type: none"> • Warm the blood to 95 to 98 degrees F (35 to 37 degrees C) especially before massive transfusions
Hypocalcemia	<ul style="list-style-type: none"> • Monitor potassium and calcium levels • Use blood less than 2 days old when giving multiple units • Slow or stop transfusion depending on reaction (reactions will be worse in patients with hypothermia or elevated potassium) • Slowly administer calcium gluconate I.V. 	<ul style="list-style-type: none"> • Infuse blood slowly
Potassium intoxication	<ul style="list-style-type: none"> • Obtain ECG • Administer Kayexalate orally or by enema • Administer I.V. insulin and glucose 	<ul style="list-style-type: none"> • Use fresh blood when giving massive transfusions

Before beginning a transfusion always insure that you have a working I.V. as most blood products have to be infused within 4 hours. When picked up, the blood/blood product is cold since some components start to deteriorate at room temperature. Infusing blood products over the 4 hour limit increases the risk of contamination and sepsis. Gather all the equipment you will need: gloves, gown, goggles, filter tubing, normal saline, and delivery device. No solution other than normal saline should ever be given with blood. If the primary line has had another solution other than normal saline infusing through it, flush the line thoroughly before hanging the blood. Filter tubing with a 170-micron filter is always used when transfusing blood products to avoid infusing fibrin clots or cellular debris that forms in the blood bag. Use a new filter and new tubing for every unit of blood to be transfused. In addition, a HLA filter may be used for patients who will be undergoing organ or tissue transplant, have severe febrile transfusion reactions, or are immunocompromised.

Before transfusing blood, verify that there is a signed consent for the procedure in the chart. At the bedside, you and another practitioner must check, check, and check again the following information: patient name and medical record number, the type, Rh, and expiration date of the blood/blood product, and the blood bank identification number. Then both of you must sign the blood slip affixed to the bag. Wash your hands and put on your PPE. Spike the blood bag and prime the tubing. Also have available a bag of normal saline already primed at the bedside in

case of a transfusion reaction. Take the patient's vital signs for baseline values, and then flush the I.V. with normal saline. Start the infusion slowly at about 5 ml/minute for the first 15 minutes. At 15 minutes, take the patient's vital signs and ensure there are no symptoms of a transfusion reaction such as: fever, chills, headache, nausea, and facial flushing. Vital sign changes to watch for include:

- Temperature: A rise of 1 degree C or 1.8 degrees F
- Pulse: A 20% deviation from baseline
- Respirations: Increased (more than 20) and labored
- Blood Pressure: A systolic pressure less than 90 and a diastolic pressure less than 60
- Most acute hemolytic reactions occur within the first 30 minutes, so watch the patient carefully. Continue to take the patient's vital signs according to the facility policy throughout the transfusion. At the end of the transfusion, flush the blood tubing with enough saline to clear the tubing. When using a Y-type set, close the clamp on the blood line and open the clamp on the saline line. Assess the patient's condition and take their vital signs.

If during the transfusion you detect any signs or symptoms of a reaction, stop the transfusion immediately, disconnect the blood tubing, and connect and start infusing the normal saline to keep the vein open. Take the patient's vital signs and notify the doctor. Send the blood bag and tubing back to the blood bank, along with a posttransfusion blood or urine samples per facility policy.

Parenteral Therapy

Parenteral nutrition is administered when illness or surgery prevents a patient from eating and metabolizing food. Critically ill patients will require this type of nutrition if they are hemodynamically unstable or if GI tract blood flow is impaired. Essential nutrients found in food provide energy and maintain body tissues. It also aids in body processes, such as growth, cell activity, enzyme production, and temperature regulation. Parenteral solution, also known as hyperalimentation, contains two or more of the following elements: dextrose, proteins, lipids, electrolytes, vitamins, trace elements, and water. Depending on type of therapy ordered, hyperalimentation can be administered via a peripheral I.V. or a midline catheter and a P.I.C.C. or CVL. PPN, peripheral parenteral nutrition, is used for therapy lasting 3 weeks or less and delivers between 1,300 and 1,800 calories per day. The maximum glucose concentration for this therapy is 10%. TPN, total parenteral nutrition, is used for long term therapy and delivers 2,000 to 3,000 calories per day or more. It will have a glucose concentration 10% to 50% and greater. Indications for TPN include:

- Debilitating illness lasting longer than 2 weeks
- Deficient or absent oral intake for longer than 7 days (multiple trauma, burns, anorexia)
- Loss of at least 10% of pre-illness weight
- Serum albumin level below 3.5 g/dl
- Poor tolerance of long term enteral feeds
- Chronic vomiting/diarrhea
- Inability to sustain adequate weight with oral/enteral feeds
- GI disorders that prevent/reduce absorption (bowel obstruction, Crohn's disease, ulcerative colitis, short bowel syndrome, cancer malabsorption syndrome, and bowel fistulas)
- Inflammatory GI disorders (wound infection, fistulas, abscesses)

Nutritional deficiencies result from a nonfunctional GI tract, decreased food intake, or increased metabolic need. Food intake may be decreased because of illness, injury, decreased physical ability, paralytic ileus, surgery, or sepsis. Increased metabolic activity can result from fever, burns, trauma, disease, or stress. A nonfunctional GI tract can occur from a paralytic ileus, fistula, obstruction, IBD, or severe malabsorption.

Parenteral nutrition solutions are individualized to treat a patient's specific metabolic deficiency. The solution will contain two or more of the following elements. In addition, insulin or heparin may need to be added.

- Dextrose: (Carbohydrates) Provides most of the calories needed to maintain nitrogen balance. It is available in concentrations of 5% to 50%.
- Amino acids: Supply enough protein to replace essential acids, to maintain protein stores, to prevent protein loss from muscle tissues, and for tissue repair.
- Fats: Supplied as lipid emulsions of 10% or 20% concentrations. They are a concentrated source of energy that prevents or corrects fatty acid deficiencies. It provides 30% to 50% of the patient's daily calorie requirements.
- Electrolytes and minerals: Added to the solution based on metabolic needs and chemistry profile. Acetate prevents metabolic acidosis. Calcium promotes the development of bones/teeth and aids in blood clotting. Chloride regulates the acid base balance and maintains osmotic pressure. Magnesium aids in protein and carbohydrate absorption. Phosphate minimizes the potential for development of peripheral paresthesia. Phosphorus is essential for cell energy and calcium balance. Potassium is needed for cellular activity and tissue synthesis. Sodium helps regulate water distribution and maintain normal fluid balance.
- Vitamins: Ensure normal body functions. Folic acid is needed to promote growth and development and deoxyribose nucleic acid formation. Vitamin B complex aids in the final absorption of protein and carbohydrates. Vitamin C helps in wound healing. Vitamin D is essential for bone metabolism and in the maintenance of serum calcium levels. Vitamin K helps prevent bleeding disorders.
- Trace elements: Promote normal metabolism. They include: zinc, copper, cobalt, chromium, selenium, and manganese. They also help in wound healing and red blood cell synthesis.
- Water: Added based on fluid requirements and electrolyte balance.

Before starting TPN either through a peripheral line or a CVL, ensure that you have a functioning I.V. Before spiking the bag of TPN, thoroughly check the written order against the label on the bag. Inspect the bag for clouding, debris, or a change in color that could indicate contamination, pH change, or a problem with the integrity of the solution. After checking the label, gather all equipment including the bag of solution, a pump, tubing, lipid tubing, appropriate filter, cleansing agent, and gloves. TPN solutions serve as a wonderful medium for bacterial growth and a CVL provides systemic access, which puts patients at increased risk for infection and sepsis. According to the CDC, adhering to strict aseptic technique when spiking the bag and initiating therapy has been shown to reduce the number of infections related to TPN therapy. If the lipids have been added to the bag of TPN, a 1.2-micron filter will be used that will allow the lipid molecules through. When the lipids are hung separately, a 0.22-micron filter will be attached to the tubing.

Once TPN therapy has been initiated, the following nursing considerations should be observed:

- TPN solution should be hung for 24 hours only
- Change tubing and filter every 24 hours maintaining strict aseptic technique
- Change lipid tubing every 12 hours
- Always use an infusion pump to deliver TPN
- Perform I.V. site care and dressing changes according to policy
- Take vital signs every 4-8 hours or more often if indicated. An increase in temperature is one of the earliest signs of catheter related sepsis
- Monitor glucose levels as ordered
- Strict I's and O's
- Daily weights
- Daily (?) lab work including electrolytes, BUN, and glucose
- Serum triglyceride level each week
- Monitor for signs/symptoms of fluid overload and electrolyte imbalance
- Frequent mouth care
- Document assessment findings and nursing interventions

TPN may be delivered in one of two ways, either continuously or cyclically. Obviously the infusion runs over a 24-hour period with continuous delivery. In cycled TPN therapy, the entire 24-hour volume is delivered between 8 and 16 hours. Due to the high glucose concentration of this fluid, the flow rate must be weaned down to prevent hypoglycemia. For example, reducing the flow rate by half (100 ml to 50 ml) for 1 hour before stopping the infusion. Check blood sugar one hour after the infusion ends, and monitor the patient for signs of hypoglycemia. Follow facility policy regarding weaning of TPN.

As with other forms of I.V. therapy, TPN has complications.

Mechanical complications from TPN therapy include:

- Clotted catheter
- Dislodged catheter
- Cracked/broken tubing
- Pneumothorax
- Sepsis
- Air embolism
- Phlebitis
- Venous thrombosis
- Extravasation

Metabolic complications from TPN therapy include:

- Hyperglycemia or hypoglycemia
- Hyperosmolar hyperglycemic nonketotic syndrome
- Hyperkalemia or hypokalemia
- Hypomagnesemia
- Hypophosphatemia
- Hypocalcemia
- Metabolic acidosis

- Liver dysfunction

Chemotherapy

Chemotherapy is delivered via the I.V., oral, subcutaneous, intrathecal, I.M., intra-arterial, and intracavitary routes. Suppressing rapidly dividing cancer cells with chemotherapy requires effective delivery of an exact dose of toxic drugs. I.V. chemotherapy not only achieves this effective dosing, but also ensures complete absorption and systemic distribution. The goal of chemotherapy is to control or eliminate cancer cells. Since these drugs can't differentiate between healthy or cancerous ones, healthy cells are attacked when the drugs are delivered. The healthy and cancerous cells pass through similar life cycles, thus they are similarly vulnerable to chemo drugs. For this reason, patients will receive cycle-specific as well as cycle-nonspecific drugs. With cycle-specific drugs, different drugs will target a different site or take action during a different phase of the cell cycle. Cells in the resting phase survive. With cycle-nonspecific drugs, a fixed percentage of normal and malignant cells will die and a percentage of the same cells survive.

Most health care facilities require nurses involved in the delivery of chemotherapy to complete a certification program, covering the different drugs, the safe delivery of those drugs, side effects, and care of the patient with cancer.

If you are caring for a patient who is receiving chemotherapy, you must take precautions to avoid accidental exposure from body fluids. This includes: an impermeable gown with long sleeves and a closed front, chemotherapy gloves, and goggles. If no chemotherapy gloves are available, two pairs of latex or non-latex gloves are acceptable. If the chemotherapy medications or body fluids come in contact with your skin, wash the skin thoroughly with soap and water. This will help prevent the drug from absorbing into the skin. If the drug or fluids come in contact with your eye, immediately flood the eye with water or isotonic eyewash for at least 5 minutes, while holding the eyelid open. After an accidental exposure, notify the supervisor immediately.

Complications from chemotherapy administration can be categorized according to where or when exposure to the drug began.

Infusion related complications:

- Infiltration
- Extravasation
- Vein flare
- Anaphylactic reaction – can occur with the initial dose of the drug or during subsequent infusions

Short term adverse effects:

- Nausea and vomiting –anticipatory, acute, or delayed
- Hair loss (alopecia)
- Diarrhea
- Myelosuppression
- Stomatitis

Remember, all patients are different and not all will experience adverse effects.

Long term adverse effects:

- Organ system dysfunction – GI, renal, pulmonary, cardiac, reproductive, neurologic
- Secondary malignancy

Clinical Solutions
Central Line Dressing/End Cap Change Check Sheet

Name: _____ **Date:** _____

	Completed	Not Yet Completed
1. Gather supplies		
2. Wash hands		
2. Prepare patient...position for comfort...have patient put on mask (if unable to turn head)		
4. Open central line kit, remove mask and put it on		
5. Put on gloves. Remove dressing being careful of catheter		
6. Put on sterile gloves. Prepare sterile field		
7. Clean site/skin with alcohol swabs		
8. Clean site with Chloroprep swabs		
9. Apply Bio patch or other antimicrobial agent		
10. Apply skin prep if needed		
11. Apply additional tape to catheter if needed		
12. Apply transparent dressing		
13. Apply label to dressing (date, time, initials)		
14. Tape catheter/IV tubing to skin		
15. Clamp each catheter port...remove old end cap. Put on new sterile gloves. Clean port with alcohol swab. Flush new end cap with saline and attach to port. Unclamp and pull back on syringe to remove all air.		
16. Document: Date/time Length of catheter from insertion site Sutures intact (if applicable) No redness, swelling, drainage at site Condition of skin End caps changed per policy Patient tolerated well		

Instructor: _____ **Date:** _____

**Clinical Solutions
IV Insertion Check Sheet**

Name: _____ Date: _____

	Completed	Not Yet Completed
1. Check orders		
2. Prepare patient: History of IV therapy Age/Preference/Activity Prior surgery/scars Presence of shunt/graft		
3. Gather supplies: IV solution IV tubing 2 – IV catheters IV start kit Extension tubing Saline flush Delivery device Arm board if needed Pad/towel for bed		
4. Wash hands...wash bedside table		
5. Prepare fluid: Verify 7 rights of medication administration Inspect bag for clarity, volume, expiration date, leaks, label Close roller clamp Spike bag Fill drip chamber half way...prime tubing		
6. Open kit-remove tape and tourniquet Flush extension tubing Prepare tape (One 3" piece of tape torn in half plus 2 more 2" pieces) Open IV catheter Apply tourniquet and select vein		
7. Apply gloves Cleanse area around vein for 15 seconds Reapply tourniquet		
8. With non-dominant hand, hold skin taut Insert needle with bevel up at 10-30 degree level		

Once blood is seen in chamber, advance until hub of catheter is flush with the skin Remove needle, activating safety device		
9. With non-dominant hand, hold pressure 2 inches above insertion site Remove tourniquet Attach extension tubing Draw back to verify blood return Flush catheter Clean skin with gauze		
10. Place skinny piece of tape across hub With sticky side up, slide next piece of skinny tape under hub of catheter using chevron or U method to place tape One more piece of tape over hub Apply transparent dressing Loop tubing and tape to arm Attach IV tubing and adjust flow Apply label (gauge, date, time, initials)		
11. Document: Date/time Location/gauge Number of attempts Blood return obtained/flushed easily What fluid is infusing (additives, rate) Patient tolerated well		
IV Removal		
1. Check orders		
2. Prepare patient		
3. Wash hands...Apply gloves		
4. Holding catheter, peel tape While holding gauze over site, pull catheter out, apply pressure for 1-2 minutes, and inspect tip of catheter Once bleeding has stopped, apply band-aid		
5. Document: Date/time IV removed No redness, swelling, or drainage Catheter tip intact Patient tolerated well		

Instructor: _____ **Date:** _____

Glossary

Administration set: primary I.V. tubing that has one or more Y-sites.

Air embolism: a systemic complication of I.V. therapy that occurs when air is introduced into the venous system.

Albumin: a protein that can not pass through the capillary walls. It draws water into the capillaries.

Anaphylactic reaction: severe allergic reaction to fluids, medications, or blood.

Antibody: an immunoglobulin molecule synthesized in response to a specific antigen.

Antigen: a major component of blood that exists on the surface of blood cells and can initiate an immune response.

Autotransfusion: the collection and filtration of blood from a patient that is then infused back into the patient.

Backcheck valve: a device that prevents backflow of a secondary solution into a primary solution.

Bevel: the slanted edge on the opening of a needle.

Body fluids: water and dissolved substances in the body.

Butterfly needle: a winged infusion set

CVL: central venous line, whose tip lies in the superior/inferior vena cava.

CVP: central venous pressure which is an indicator of circulatory function and the pumping ability of the right side of the heart.

Chylothorax: puncture of a lymph node with leakage of lymph fluid.

Distal: farthest from a given point of reference; throughout this course, “distal” denotes the equipment end (farthest from the patient’

Gauge: diameter of a needle.

Hemothorax: bleeding into the pleural cavity.

Heparin Lock: used for intermittent therapy. Heparin flush is infused through an end (injection) cap that has been affixed to the access device.

Hydrothorax: infusion of a solution into the chest.

Implanted port: central venous catheter consisting of a silicone catheter attached to a titanium or plastic reservoir covered by a self-sealing silicone rubber septum that is surgically placed in subcutaneous tissue.

Midline catheter: a catheter that is greater than 3 inches in length, with the tip located level with the axilla.

Nontunneled catheter: a central venous catheter placed in the subclavian, internal/external jugular vein, or femoral vein whose tip lies in the superior or inferior vena cava.

P.I.C.C.: a peripherally inserted central catheter inserted in a large peripheral vein with the tip lying in the superior vena cava.

Piggyback infusion: use of a secondary I.V. set to deliver medications or solutions via the I.V.

Proximal: closest to a given point of reference; throughout this course “proximal” denotes the inserted end (nearest the patient’s heart).

Pneumothorax: air in the thorax.

Saline lock: used for intermittent therapy. Saline is infused through an end (injection) cap that has been affixed to the access device.

Tunneled catheter: a central venous catheter with a cuff at the exit site. A segment of the catheter lies in a subcutaneous tract. It is placed surgically and the tip lies in the superior vena cava.

Volume-control set: I.V. administration set that can deliver small amounts of fluids or

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Additional Calculation Practice

1. The order reads, give Amoxicillin 50 mg p.o.. The label reads 125mg/5ml. How many ml will be needed?
2. The order reads, give Phenobarbital 5 mg p.o.. The label reads 20mg/5ml. How many ml are needed?
3. The order reads, give 400 mg EES. The label reads 125mg/5ml. How many ml are needed?
4. The order reads, give 50 mg Aminophylline I.V. The label on the vial reads 250mg/10ml. How many ml will be needed?
5. The order reads, give Amoxicillin 200 mg orally. The label reads 250mg/5ml. How many ml are needed?
6. The order reads, give SoluMedrol 3 mg/kg I.M. to a patient weighing 20kg. The label reads 125mg/2ml. How many ml are needed?
7. The order reads, give Kay Ciel 30 mg p.o. B.I.D. The label reads 45mg/15ml. How many ml are needed?
8. The order reads, give 40 mg Lasix I.V.. The label reads 20mg/2ml. How many ml are needed?
9. The order reads, give Phenobarbital 160 mg. The label reads 60mg/ml. How many ml are needed?
10. The order reads, give 30 mg Lasix I.V.. The label reads 10mg/1ml. How many ml are needed?
11. The order reads, give Keflex 80 mg p.o.. The label reads 250mg/5ml. How many ml are needed?
12. The order reads, give Apresoline 30 mg I.V.. The label reads 20mg/ml. How many ml are needed?

Calculate Flow Rate (answers will be in ml/hr)

1. The order reads, deliver 2L D5W over the next 24 hours. What is the flow rate?
2. The order reads, deliver 500ml NS bolus to run over 2 hours. What is the flow rate?
3. The order reads, deliver 1L NS over the next 9 hours. What is the flow rate?
4. The order reads, deliver 1L D5.45NS over 16 hours. What is the flow rate?
5. The order reads, deliver 750ml of NS over the next 6 hours. What is the flow rate?
6. The order reads, deliver 1L LR over 8 hours. What is the flow rate?
7. The order reads, deliver 1,500ml of NS over 20 hours. What is the flow rate?
8. The order reads, deliver 6L NS over the next 3 days. What is the flow rate?
9. The order reads, deliver 500ml D5W over 10 hours. What is the flow rate?

10. The order reads, deliver 250ml of NS over 5 hours. What is the flow rate?

Calculate Drip Rate (answers will be in gtt/min)

1. The order reads, give 1000 ml D5W over the next 8 hours. The tubing you are using has a drip factor of 15gtt/ml. What is the drip rate?
2. The order reads, over the next 4 hours, infuse 500 ml of D5NS with 20MEq KCL. The tubing you are using has a drip factor of 10gtt/ml. What is the drip rate?
3. The order reads, give 350 ml of PRBC over 2 hours. The blood tubing has a drip factor of 10gtt/ml. What is the drip rate?
4. The order reads, give Zinacef 1g every 8 hours. The label on the bag reads 1g/100ml D5W to be infused in 1 hour. The tubing has a drip factor of 10gtt/ml. What is the drip rate?
5. The order reads, give Ceftriaxone 500mg every 8 hours. The label on the bag reads 500mg/50ml D5W to be infused in 20 minutes. The tubing has a drip factor of 15gtt/ml. What is the drip rate?
6. The order reads, give 1200 ml NS over the next 6 hours. The tubing has a drip factor of 15gtt/ml. What is the drip rate?
7. The order reads, give 200 ml of NS over 2 hours. The tubing has a drip factor of 60gtt/ml. What is the drip rate?
8. The order reads, give 350 ml of NS over the next 7 hours. The tubing has a drip factor of 60gtt/ml. What is the drip rate?
9. The order reads, give Rocephin 1g every 12 hours. The label on the bag reads 1g/150ml D5W to be infused in 45 minutes. The tubing has a drip factor of 15gtt/ml. What is the drip rate?
10. The order reads, give 2L D5W over 16 hours. The tubing has a drip factor of 10gtt/ml. What is the drip rate?
11. The order reads, give 500 ml of Albumin over the next 4 ½ hours. The tubing has a drip factor of 15gtt/ml. What is the drip rate?
12. The order reads, give 1.5L D5W over 4 hours. The tubing has a drip factor of 10gtt/ml. What is the drip rate?
13. The order reads, deliver 2L of NS over 5 hours. The tubing has a drip factor of 10gtt/ml. What is the drip rate?
14. The order reads, deliver 1L of NS over 9 hours. The tubing has a drip factor of 15gtt/ml. What is the drip rate?
15. The order reads, give 100 ml of NS over ½ hr. The tubing has a drip factor of 10gtt/ml. What is the drip rate?

Unit Dose (answers will be in ml/hr)

1. The order reads, deliver 8 units/hr of Regular Insulin. The solution is prepared with 100 units Insulin in 100 ml NS. How many ml/hr are needed to deliver this dose?
2. The order reads, deliver 7 mg/hr Morphine Sulfate via continuous infusion. The solution is prepared with 125 mg Morphine in 250 ml of D5W. How many ml/hr are needed to deliver this dose?
3. The order reads, deliver 4 units/hour of Regular Insulin. The solution is prepared with 100 units Insulin in 250 ml NS. How many ml/hr are needed to deliver this dose?
4. The order reads, deliver 1000 units/hr Heparin via continuous infusion. The solution is prepared with 50,000 units Heparin in 500 ml D5W. How many ml/hr are needed to deliver this dose?
5. The order reads, deliver 1000 units/hr heparin via continuous infusion. The solution is prepared with 25,000 units in 500 ml D5W. How many ml/hr are needed to deliver this dose?

Intake and Output

(answers will be in ml and the patient will either be in a positive or a negative balance...for the purposes of these calculations: 1 coffee cup=6 oz, 1 cup water, tea, milk, soda, or juice=8 oz, jello=4oz, 1 cup ice=4 oz, soup=8oz)

1. In the past 24 hours, your patients' input includes: 3 cups of coffee, 4 oz of juice, 2 cups of water, 3 cups of tea, and 750 ml of IV fluids. The output includes 2500 ml of urine and 300 ml drainage from a JP drain. Calculate how much input and how much output. Then determine if this patient is in a positive or negative fluid balance and by how much.
2. In the past 24 hours, your patients' input includes: 2 cups coffee, 4 oz of juice, $\frac{3}{4}$ cup milk, 1 bowl of soup, $\frac{1}{2}$ cup jello, 2 cups water, and 2L of IV fluid. Output includes 2,000 ml urine and 400 ml emesis. Calculate how much input and how much output. Then determine if this patient is in a positive or negative fluid balance and by how much.
3. In the past 24 hours, your patients' input includes: 3L IV fluids and 4 cups of ice. The output includes 3200 ml of urine and 280 ml of emesis. Calculate how much input and how much output. Then determine if this patient is in a positive or negative fluid balance and by how much.

You are caring for a patient who has had extensive surgery, and currently has a triple lumen central catheter placed in the right subclavian. Over the last 24 hours the input includes: D5.45NS at 125 ml/hr, 2 doses of Zantac 50 mg in 50 ml D5W, 3 doses of Gentamicin 80 mg in 50 ml D5W, 500 ml of PRBC, and the NG tube has been flushed every 2 hours with 30 ml of NS. The output includes: 3,000 ml of urine, 360 ml of NG output, and 500 ml drainage from the JP drain. Calculate how much input and how

much output. Then determine if this patient is in a positive or negative fluid balance and by how much.

ANSWER KEY

Dosage:

1. 2 ml
2. 1.25 ml
3. 16 ml
4. 2 ml
5. 4 ml
6. 0.96 ml
7. 10 ml
8. 4 ml
9. 2.7 ml
10. 3 ml
11. 1.6 ml
12. 1.5 ml

Flow Rate:

1. 83 ml/hr
2. 250 ml/hr
3. 111 ml/hr
4. 63 ml/hr
5. 125 ml/hr
6. 125 ml/hr
7. 75 ml/hr
8. 83 ml/hr
9. 50 ml/hr
10. 50 ml/hr

Drip Rate:

1. 31 gtt/min
2. 21 gtt/min
3. 29 gtt/min
4. 17 gtt/min
5. 38 gtt/min
6. 50 gtt/min
7. 100 gtt/min
8. 50 gtt/min

9. 50 gtt/min
10. 21 gtt/min
11. 28 gtt/min
12. 63 gtt/min
13. 67 gtt/min
14. 28 gtt/min
15. 33 gtt/min

Unit dose:

1. 8 ml/hr
2. 14 ml/hr
3. 10 ml/hr
4. 10 ml/hr
5. 20 ml/hr

Intake and Output

1. 2,610 ml in...2,800 ml out...-190 ml
2. 3,340 ml in...2,400 ml out...+1,040 ml
3. 3,480 ml in...3,480 ml out...even
4. 4,110 ml in...3,860 ml out...+250 ml

IV Therapy Pre-Test

1. Hypodermoclysis is used to treat:
 - a. Increased acetone level
 - b. Circulatory failure
 - c. Serum alkalosis
 - d. Mild to moderate dehydration

2. How do you assess a decrease in ascites?
 - a. Ankle edema remains the same
 - b. The skin is shinier over the abdomen
 - c. Urine output increases
 - d. Pulse rate increases

3. The patient has a serum sodium level of 116 mEq/L, and is lethargic and complains of headache. What is appropriate treatment for this patient?
 - a. Raise the head of the bed to 45 degrees
 - b. Administer an opioid
 - c. Obtain a CT of the head
 - d. Administer a hypertonic solution

4. Which blood group can be transfused in an emergency to any patient regardless of blood type with little risk of reaction?
 - a. Type O negative
 - b. Type A positive
 - c. Type AB positive
 - d. Type B negative

5. A patient whose total body fluid is normal can still exhibit signs and symptoms of hypovolemia due to:
 - a. Vomiting and diarrhea
 - b. Diuretic therapy
 - c. Third spacing
 - d. Hypermetabolism

6. A patient must sign a consent form for I.V. administration.
 - a. True
 - b. False

7. Indications for I.V. therapy include:
 - a. Administer medications
 - b. Provide enteral nutrition
 - c. Administer fluids

- d. Monitor hemodynamic functions
 - e. A, C, D
 - f. All of the above
8. Handwashing is the first step in infection control.
- a. True
 - b. False
9. Fluids include:
- a. Cations
 - b. Anions
 - c. Protein
 - d. Glucose
 - e. None of the above
 - f. All of the above
10. The advantages of central line therapy include:
- a. Ability to infuse fluids rapidly, draw blood specimens, measure CVP
 - b. Minimal or no complications on insertion
 - c. Increased patient mobility
 - d. Decreased risk of infection
 - e. None of the above
 - f. All of the above
11. Blood flows from the right side of the heart directly to:
- a. Lungs
 - b. Left Atrium
 - c. Superior Vena Cava
 - d. Aorta
12. When hanging TPN, use a 1.2 micron filter.
- a. True
 - b. False
13. Human leukocyte antigen filters are used for patients who:
- a. Are immunocompromised
 - b. Have received multiple transfusions of platelets
 - c. Are anemic
 - d. Require organ transplants
 - e. A, B, and D
 - f. All of the above
14. Which of the following is considered both an advantage and a disadvantage of IV drug administration?
- a. Control of the rate of flow
 - b. Control of absorption of the drug

- c. Immediate drug action
 - d. Control of dose of drug
15. You are administering amphotericin B, but neglect to wrap the tubing in the protective foil. This will result in a:
- a. Metabolic incompatibility
 - b. Therapeutic incompatibility
 - c. Physical incompatibility
 - d. Chemical incompatibility
16. A patient receiving an infusion of KCL complains of pain soon after the infusion starts. The best way to respond to this is:
- a. Remove and restart the IV
 - b. Apply cold compresses
 - c. Increase the rate of the infusion
 - d. Apply warm compresses
17. An arterial line can be used for infusion of all medications and fluids.
- a. True
 - b. False
18. You suspect your patient has a pneumothorax after a central venous catheter is placed in the subclavian vein. The signs and symptoms include:
- a. Chest pain
 - b. Cyanosis
 - c. Crepitus
 - d. Decreased breath sounds
 - e. All of the above
 - f. B and D only
19. The following factor will place a patient at greatest risk for a febrile transfusion reaction:
- a. Gm negative sepsis
 - b. Renal disease
 - c. Multiple transfusions
 - d. Liver disease
20. Before hanging any blood product, ensure that:
- a. Two practitioners have checked the label
 - b. The IV is working
 - c. Vital signs are taken
 - d. Patient is identified
 - e. A, B, and D only
 - f. All of the above

21. A patient may benefit from Parenteral Nutrition when they have which of the following nutritional deficiencies:
- increased metabolic needs, decreased food intake, GI disorders
 - CHF, high blood pressure, anemia
 - Pneumonia, multiple fractures, low HCT
 - Hemorrhage, electrolyte imbalance, high platelet count
22. When applying a transparent dressing, it is important to:
- Stretch the dressing as tight as possible
 - Cover the site and the tubing
 - Tuck the dressing around and under the hub of the catheter
 - Always place a gauze dressing over the insertion site
23. One EKG change you will see if a patient has hyperkalemia is:
- Peaked T waves
 - Tachycardia
 - PVC's
 - Shortened QT interval
24. Which is the preferred and most accessible site for IV insertion in an infant under 6 months of age?
- Foot
 - Hand
 - Antecubital fossa
 - Scalp
25. Signs and symptoms of a blood transfusion reaction include:
- Increased temperature, tachycardia, respiratory distress, hypotension
 - Hypothermia, tachycardia, decreased respirations, hypertension
 - Muscle twitching, arrhythmias, decreased respirations, nausea
 - Increased temperature, bradycardia, increased respirations, hypotension
26. The patient complains of swelling at the IV site, blanching, and that the arm feels cool to touch and tight. This indicates:
- Phlebitis
 - Extravasation
 - Infiltration
 - Occlusion
27. A life-threatening event associated with hypercalcemia is:
- Symptomatic bradycardia
 - Prolonged QT interval
 - Seizures

- d. Laryngospasm
28. Any IV drug must be compatible with the solution it is mixed in. The solution which would carry the least risk for incompatibility would be:
- a. Mannitol solution
 - b. TPN
 - c. Bicarbonate solution
 - d. Saline solution
29. The same procedure is followed whenever transfusing whole blood, RBC's, WBC's, or platelets.
- a. True
 - b. False
30. When taking the blood pressure, the patient exhibits a carpal spasm. Which should be assessed next?
- a. Assess the Babinski reflex
 - b. Check for Chvostek's sign
 - c. Evaluate the apical pulse
 - d. Determine the LOC
31. Which route for administering medication is the most effective for quickly reaching therapeutic levels?
- a. Subcutaneous
 - b. I.M.
 - c. Oral
 - d. I.V.
32. To minimize the risk of blood transfusion reaction, which tests are most important to screen for incompatibilities?
- a. Blood typing
 - b. Hemoglobin, hematocrit, platelets
 - c. Rh typing
 - d. Cross match
 - e. A, C, and D
 - f. All of the above
33. A patient has an IV solution of dextrose 5% in half-normal saline infusing. This is an example of:
- a. Isotonic fluid
 - b. Extracellular fluid
 - c. Hypertonic fluid
 - d. Hypotonic fluid

34. The most common vein used for insertion of a central line is:
- Femoral
 - Brachial
 - Cephalic
 - Subclavian
35. One of the causes of hyperchloremia is hyponatremia.
- True
 - False
36. Which of the following statements regarding solutes and diffusion is accurate?
- They move from an area with a lower concentration to an area with a higher one
 - They ascend against the gradient of the concentration
 - They move from an area with a higher concentration to an area with a lower one
 - They move freely without regard to a gradient
37. Most of the calories in TPN come from which element?
- Fats
 - Dextrose
 - Amino acids
 - Electrolytes
38. When caring for a patient receiving chemotherapy and there is a risk for exposure from the drug or body fluids, you must wear:
- Disposable gloves
 - Two pairs of latex surgical gloves
 - Only non-latex gloves
 - Chemotherapy gloves
39. To treat an extravasation, the first step is to:
- Give the antidote
 - Notify the practitioner
 - Stop the infusion
 - Apply warm or cold compresses
40. A patient receiving IV therapy has redness at the site. In addition, the site is swollen, the patient complains of pain, and you feel a cord when palpating. These findings suggest what degree of phlebitis?
- 4+
 - 3+
 - 2+

d. 1+

41. The order reads: "Infuse 100 ml NS over 30 minutes." The administration set has a drip factor of 10gtt/ml. How many drops/minute are needed to deliver the volume ordered?
42. The order reads: "Over the next 9 hours, infuse 1L of D5NS with 20 mEq KCL." The administration set has a drip factor of 15gtt/ml. How many drops/minute are needed to deliver the volume ordered?
43. The patient has an order for 1.5L of NS to be delivered over the next 4 hours. The administration set has a drip factor of 10gtt/ml. Determine how many drops/minute are needed to deliver the volume ordered.
44. The order reads: "Infuse D5NS at 25 ml/hr." The administration set has a drip factor of 60gtt/ml. Determine how many drops/minute are needed to deliver the volume ordered.
45. The patient has an order for 500 ml of NS to be infused over the next four and a half hours. The administration set has a drip factor of 15gtt/ml. Determine how many drops/minute are needed to deliver the volume ordered.
46. You receive an order to give the patient 30mg of Lasix every 12 hours. The vial contains Lasix 10mg/ml. Determine the correct number of ml needed.
47. The order reads: "Give 50mg of Aminophylline every 8 hours." You have a vial that contains Aminophylline 250mg/10ml. Determine the correct number of ml needed.
48. You receive an order to give 200mg Augmentin every 8 hours. The syringe contains 600mg of Augmentin/6ml. Determine the correct number of ml needed.
49. The order reads: "Infuse 1Gm of magnesium sulfate per hour." Pharmacy delivers a bag of 1L D5W containing 8Gm of magnesium sulfate. How many ml/hr are needed to deliver the dose ordered?
50. The order reads: "Infuse heparin at 1,000units/hr." Pharmacy sends you a bag containing 40,000 units of heparin in 1L of D5W. Determine how many ml/hr are needed to deliver the dose ordered.

Name: _____ Date: _____

Answer Sheet
IV Therapy Pre-Test

- 1. A B C D E F
- 2. A B C D E F
- 3. A B C D E F
- 4. A B C D E F
- 5. A B C D E F
- 6. A B C D E F
- 7. A B C D E F
- 8. A B C D E F
- 9. A B C D E F
- 10. A B C D E F
- 11. A B C D E F
- 12. A B C D E F
- 13. A B C D E F
- 14. A B C D E F
- 15. A B C D E F
- 16. A B C D E F
- 17. A B C D E F
- 18. A B C D E F
- 19. A B C D E F
- 20. A B C D E F
- 21. A B C D E F
- 22. A B C D E F
- 23. A B C D E F

- 26. A B C D E F
- 27. A B C D E F
- 28. A B C D E F
- 29. A B C D E F
- 30. A B C D E F
- 31. A B C D E F
- 32. A B C D E F
- 33. A B C D E F
- 34. A B C D E F
- 35. A B C D E F
- 36. A B C D E F
- 37. A B C D E F
- 38. A B C D E F
- 39. A B C D E F
- 40. A B C D E F
- 41. _____
- 42. _____
- 43. _____
- 44. _____
- 45. _____
- 46. _____
- 47. _____
- 48. _____

24. A B C D E F

25. A B C D E F

49. _____

50. _____