Nursing Advanced Skills

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OPEN RESOURCES FOR NURSING (OPEN RN)

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Content is based on the Wisconsin Technical College System (WTCS) statewide nursing curriculum for the Nursing Advanced Skills course (543-112) and the NCLEX-RN Test Plan.[1] Content includes advanced skills for registered nurses, such as intravenous infusion, blood product administration, management of central lines and chest tube systems, basic electrocardiogram interpretation, and nasogastric/feeding tube insertion, and builds on basic nursing skills discussed in the Open RN *Nursing Skills* OER textbook.

The following YouTube video provides a quick overview of how to navigate the online version.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=4#oembed-1

1. NCSBN. (n.d.). *2023 NCLEX-RN test plan*. https://www.ncsbn.org/exams/testplans.page

Preface

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Standards and Conceptual Approach

The Open RN *Nursing Advanced Skills* textbook is based on several external standards and uses a conceptual approach.

External Standards

American Nurses Association (ANA)

The ANA establishes Standards for Professional Nursing Practice and the Nursing Code of Ethics.[1,2,3]

- https://www.nursingworld.org/ana/about-ana/standards/

The National Council Licensure Examination for Registered Nurses: NCLEX-RN Test Plans

The NCLEX-RN test plans are updated every three years to reflect fair, comprehensive, current, and entry-level nursing competency.[4]

- https://www.ncsbn.org/nclex.htm

The National League of Nursing (NLN): Competencies for Graduates of Nursing Programs

NLN competencies guide nursing curricula to position graduates in a dynamic health care arena with practice that is informed by a body of knowledge to help ensure the public receives safe, quality care.[5]

- https://www.nln.org/education/nursing-education-competencies/competencies-for-graduates-of-nursing-programs

1. American Nurses Association. (2021). *Nursing: Scope and standards of practice* (4th ed.). American Nurses Association.
2. American Nurses Association. (2015). *Code of ethics for nurses with interpretive statements*. American Nurses Association. https://www.nursingworld.org/practice-policy/nursing-excellence/ethics/code-of-ethics-for-nurses/
3. American Nurses Association. (2014). *Psychiatric-mental health nursing: Scope and standards of practice* (2nd ed.). Nursesbooks.org.
4. NCSBN. (n.d.). *2023 NCLEX-RN test plan*. https://www.ncsbn.org/exams/testplans.page
5. National League of Nursing. *Competencies for graduates of nursing programs*. https://www.nln.org/education/nursing-education-competencies/competencies-for-graduates-of-nursing-programs

American Association of Colleges of Nursing (AACN): The Essentials: Competencies for Professional Nursing Education

The AACN provides a framework for preparing individuals as members of the discipline of nursing, reflecting expectations across the trajectory of nursing education and applied experience.[6]

- https://www.aacnnursing.org/Portals/42/AcademicNursing/pdf/Essentials-2021.pdf

Infusion Nurses Society

Infusion therapy standards of practice, established by the Infusion Nurses Society, are incorporated into the chapters regarding initiating intravenous (IV) therapy, administering IV push medications, administering blood products, and managing central lines..[7]

- https://www.ins1.org/

Quality and Safety Education for Nurses (QSEN) Institute: Prelicensure Competencies

Quality and safety competencies include knowledge, skills, and attitudes to be developed in nursing prelicensure programs. QSEN competencies include patient-centered care, teamwork and collaboration, evidence-based practice, quality improvement, safety, and informatics.[8]

- https://qsen.org/competencies/

Wisconsin State Legislature, Administrative Code Chapter N6

6. American Association of Colleges of Nursing. (2021). *The essentials: Core competencies for professional nursing education*. https://www.aacnnursing.org/Portals/42/AcademicNursing/pdf/Essentials-2021.pdf
7. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org
8. QSEN. (n.d.). *About*. https://qsen.org/about-qsen/

The Wisconsin Administrative Code governs the Registered Nursing and Practical Nursing professions in Wisconsin.[9]

- https://docs.legis.wisconsin.gov/code/admin_code/n/6

Healthy People 2030

Healthy People 2030 envisions a society in which all people can achieve their full potential for health and well-being across the life span. Healthy People provides objectives based on national data and includes social determinants of health.[10]

- https://health.gov/healthypeople

Conceptual Approach

The Open RN *Nursing Advanced Skills* textbook incorporates the following concepts:

- **Evidence-Based Practice (EBP).** Evidence-based practices are referenced by footnotes throughout the textbook. To promote the development of digital literacy, links are provided to credible, free online resources that supplement content. The Open RN textbooks will be updated as new EBP is established and after the release of updated NCLEX Test Plans every three years.
- **Clinical Judgment.** Learning activities include case studies written to reflect verbiage by the NCSBN Clinical Judgment Measurement Model used on the NCLEX-RN. Formative assessments encourage students to recognize cues, analyze cues, prioritize hypotheses, generate solutions, take action, and evaluate outcomes.[11]

9. Wisconsin State Legislature. (2018). *Chapter 6: Standards of practice for registered nurses and licensed practical nurses.* Board of Nursing. https://docs.legis.wisconsin.gov/statutes/statutes/441
10. Healthy People 2030. (n.d.). *Social determinants of health*. U.S. Department of Health and Human Services. https://health.gov/healthypeople/objectives-and-data/social-determinants-health
11. Dickison, P., Haerling, K. A., & Lasater, K. (2019). Integrating the National Council of State Boards of Nursing clinical judgment model into nursing educational frameworks. *Journal of Nursing Education*. *58*(2), 72-78. https://doi.org/10.3928/01484834-20190122-03

- **Cultural Competency.** Nurses have an ethical obligation to practice with cultural humility and provide culturally responsive care to the clients and communities they serve based on the ANA Code of Ethics[12] and the ANA Scope and Standards of Practice.[13]
- **Safe, Quality, Patient-Centered Care.** Content reflects the priorities of safe, quality, patient-centered care.
- **Clear and Inclusive Language.** Clear language is used based on preferences expressed by prelicensure nursing students to enhance understanding of complex concepts.[14] "They" is used as a singular pronoun to refer to a person whose gender is unknown or irrelevant to the context of the usage, as endorsed by APA style. It is inclusive of all people and helps writers avoid making assumptions about gender.[15]
- **Open-Source Images and Fair Use.** Images are included to promote visual learning. Students and faculty can reuse open-source images by following the terms of their associated Creative Commons licensing. Some images are included based on Fair Use as described in the "Code of Best Practices for Fair Use and Fair Dealing in Open Education" presented at the OpenEd 2020 conference. Refer to the footnotes of images for source and licensing information throughout the text.
- **Open Pedagogy.** Students are encouraged to contribute to the Open RN project in meaningful ways by reviewing content for clarity and assisting in the creation of open-source images.[16]

Supplementary Material Provided

Several supplementary resources are provided with this textbook.

12. American Nurses Association. (2015). *Code of ethics for nurses with interpretive statements*. American Nurses Association. https://www.nursingworld.org/practice-policy/nursing-excellence/ethics/code-of-ethics-for-nurses/
13. American Nurses Association. (2021). *Nursing: Scope and standards of practice* (4th ed.). American Nurses Association.
14. Verkuyl, M., Lapum, J., St-Amant, O., Bregstein, J., & Hughes, M. (2020). Healthcare students' use of an e-textbook open educational resource on vital sign measurement: A qualitative study. *Open Learning: The Journal of Open, Distance and e-Learning*. https://doi.org/10.1080/02680513.2020.1835623
15. American Psychological Association. (2021). *Singular "they."* https://apastyle.apa.org/style-grammar-guidelines/grammar/singular-they
16. The Open Pedagogy Notebook by Steel Wagstaff is licensed under CC BY 4.0

- Supplementary, free videos promote student understanding of how to perform procedures.
- Online, interactive, and written learning activities provide formative feedback.
- Critical thinking questions encourage the development of clinical judgment as students apply content to realistic patient scenarios.
- Free downloadable textbook versions are available for offline use.
- Affordable soft cover print versions are published by XanEdu and available on Amazon and in college bookstores based on the finding that over 65% of students prefer a print version of their textbooks.[17]

17. Verkuyl, M., Lapum, J., St-Amant, O., Bregstein, J., & Hughes, M. (2020). Healthcare students' use of an e-textbook open educational resource on vital sign measurement: A qualitative study. *Open Learning: The Journal of Open, Distance and e-Learning*. https://doi.org/10.1080/02680513.2020.1835623

PART I

CHAPTER 1 INITIATE IV THERAPY

1.1 Introduction

Learning Objectives

- Discuss methods for blood sampling
- Compare/contrast management of peripheral venous access devices and central venous access devices
- Review infection control principles associated with peripheral venous access devices
- Explain the principles of peripheral intravenous site selection and contraindications
- Discuss appropriate selection of IV catheter type and size
- Explain nurse management of IV therapy and peripheral IV access devices
- Identify modifications for performing IV therapy across the life span
- Outline nursing management for patients with a patient-controlled analgesia (PCA) pump
- Describe nursing implications for a patient with an epidural infusion for pain management

Intravenous (IV) therapy is an important part of clinical care. It can be used to restore fluids, administer blood products or medications, or serve as an alternate route for nutrition when the gastrointestinal tract is not functioning adequately. IV therapy is a common intervention in nursing practice and useful for rapidly addressing symptoms and restoring hemostasis. Although initiating IV therapy is a common nursing intervention, it is an invasive skill and requires diligent safety practices to prevent and address complications.

1.2 Basic Concepts of Venipuncture and Intravenous Therapy

Nurses access clients' veins to collect blood (i.e., perform phlebotomy) and to administer intravenous (IV) therapy. This section will describe several methods for collecting blood, as well as review the basic concepts of IV therapy.

Blood Collection

Nurses collect blood samples from clients using several methods, including venipuncture, capillary blood sampling, and blood draws from venous access devices. Blood may also be drawn from arteries by specially trained professionals for certain laboratory testing.

Venipuncture

Venipuncture involves the process of introducing a needle into a client's vein to collect a blood sample or insert an IV catheter. See Figure 1.1[1] for an image of venipuncture. Blood sampling with venipuncture may be initiated by a nurse, phlebotomist, or other trained personnel. Venipuncture for collection of a blood sample is an important part of data collection to assess a client's health status. It is commonly performed to examine hematologic and immune issues such as the body's oxygen carrying capacity, infection, and clotting function. It is also useful for assessing metabolic and nutrition issues such as electrolyte status and kidney functioning.

1. "Venipuncture_using_a_BD_Vacutainer.JPG" by MatthewLammers is licensed under CC BY-SA 4.0

Figure 1.1 Venipuncture

Blood collection is commonly performed via venipuncture from veins in the arms or hands. The most common sites for venipuncture are the large veins located on the antecubital fossa (i.e., the inner side of the elbow). These veins are often preferred for venipuncture because their larger size increases their ability to withstand repetitive blood sampling. However, these veins are not preferred for intravenous therapy due to the mechanical obstruction that can occur in the IV catheter when the elbow joint is contracted.

To perform the skill of venipuncture, the nurse performs many similar steps that occur with IV cannulation. The process of venipuncture for blood sample

collection is outlined in the "Perform Venipuncture Blood Draw" checklist later in this chapter.

Blood Samples From Central Venous Access Devices

Blood may also be collected by nurses from a client's existing **central venous access device (CVAD)**. A CVAD is a type of vascular access that involves the insertion of a catheter into a large vein in the arm, neck, chest, or groin.[2] CVADs are discussed in more detail in the "Manage Central Lines" chapter that also contains the "Obtain a Blood Sample From a CVAD" checklist.

Capillary Blood Sampling

Nurses also collect small amounts of blood for testing via capillary blood sampling. **Capillary blood testing** occurs when blood is collected from capillaries located near the surface of the skin. Capillaries in the fingers are used for testing in adults whereas capillaries in the heels are used for infants. An example of capillary blood testing is bedside glucose testing. See Figure 1.2[3] for an image of capillary blood glucose testing.

2. Centers for Disease Control and Prevention. (2010, November 25). *Central line-associated bloodstream infection (CLABSI)*. https://www.cdc.gov/hai/bsi/bsi.html
3. "Blood_Glucose_Testing.JPG" by David-i98 is licensed under CC BY-SA 3.0

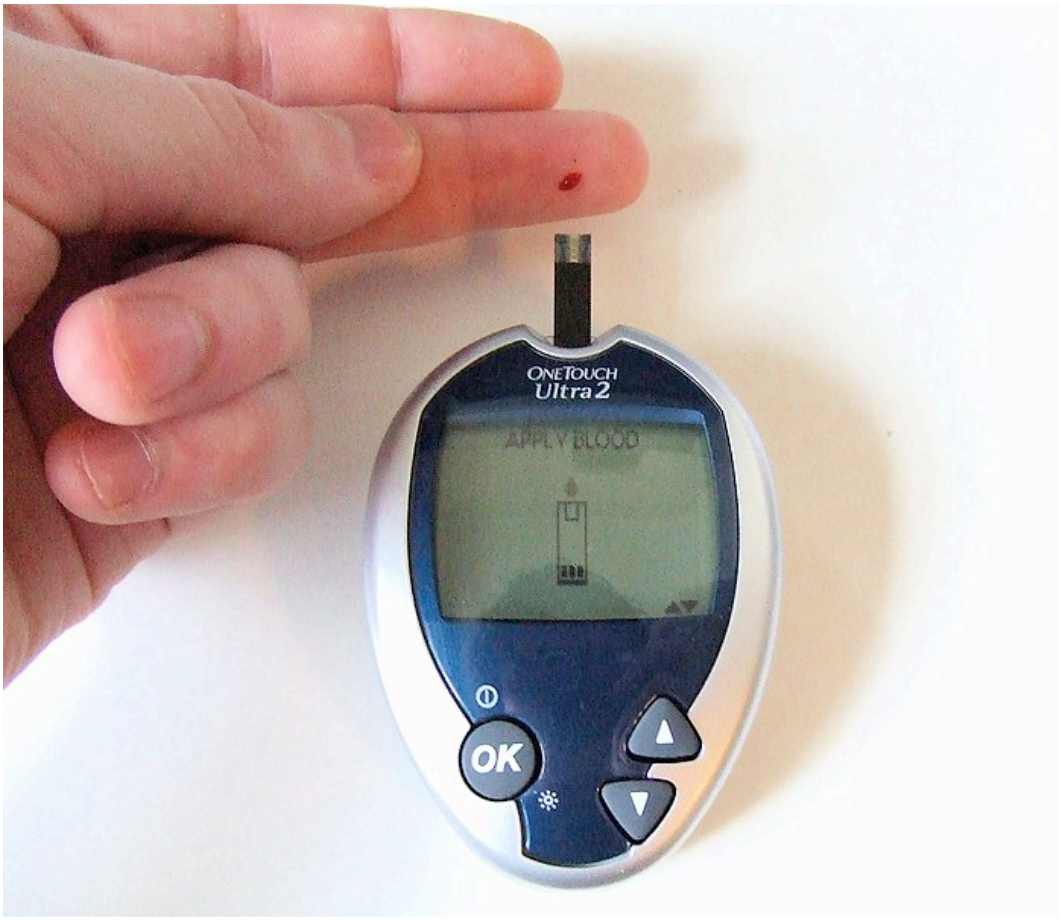

Figure 1.2 Capillary Blood Glucose Testing

Capillary blood testing is typically used when repetitive sampling is needed. However, not all blood tests can be performed on capillary blood, and some clinical conditions make capillary blood testing inappropriate, such as when a client is hypotensive with limited venous return.

> Review how to perform capillary blood glucose testing in the "Blood Glucose Monitoring" section of the "Specimen Collection" chapter of Open RN *Nursing Skills*.

Arterial Blood Sampling

Arterial blood sampling occurs when blood is obtained via puncture into an artery by specially trained registered nurses and other health care personnel,

such as respiratory therapists, physicians, nurse practitioners, and physician assistants. Arterial blood collection is most commonly performed to assess the body's acid-base balance in a diagnostic test called an arterial blood gas. (For more information on arterial blood gas interpretation, please review Open RN *Nursing Fundamentals* Chapter 15). The most common access site for arterial blood sampling is the radial artery. See Figure 1.3[4] for an image of arterial blood sampling. Arterial blood tests are known to be more painful for the patient than venipuncture and have a higher risk of complications such as bleeding and arterial occlusion with subsequent ischemia to the area distal to the puncture.

ARTERIAL LINES

For clients who require repetitive arterial blood sampling or are hemodynamically unstable, an arterial line may be inserted by specially trained personnel. Arterial lines are specialized tubes that are inserted and maintained in an artery to assist with continuous blood pressure monitoring. They also allow for repeated blood sampling without repetitive puncture, thus decreasing the amount of discomfort for the client. The radial artery is the most common site used for arterial lines. Nurses must not confuse arterial lines with peripheral or central vein access devices. Arterial lines can be distinguished from venous lines by their specialized pressure tubing, which is firm and non-pliable and is connected to a pressure bag to maintain constant pressurized fluid in the tubing. Medications, fluid boluses, and maintenance IV fluids must never be infused through an arterial line. See Figure 1.3[5] for an image of arterial lines. The condition of the arterial access site, as well as perfusion of the client's hand, is continually monitored when an arterial line is in place to prevent complications.

4. American Nurses Association. (2021, April). Use of medication assistant/aides/technicians. *ANA Issue Brief.* https://www.nursingworld.org/~498e32/contentassets/a2ff1bd2d5ca467699c3bc764f7d9198/issue-brief-medication-aides-4-2021.docx
5. "Arterial line.jpg" by Chippewa Valley Technical College is licensed under CC BY 4.0

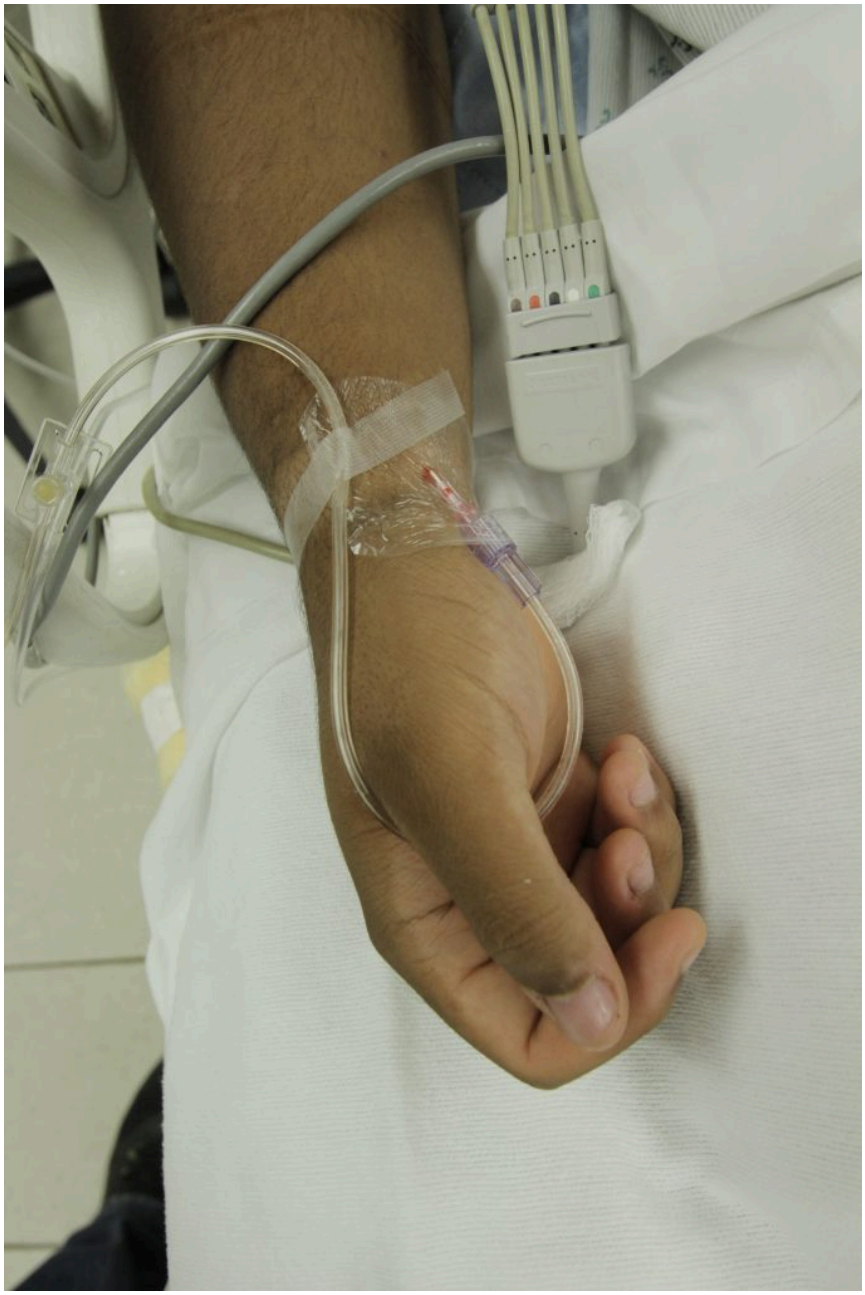

Figure 1.3 Arterial Lines

Intravenous Therapy

In addition to collecting blood samples, nurses also access clients' veins to administer intravenous therapy.**Intravenous therapy (IV therapy)** involves the administration of substances such as fluids, electrolytes, blood products, nutrition, or medications directly into a client's vein. The intravenous route is preferred to administer fluid and medications when rapid onset of the medication or fluid is needed. The direct administration of medication into the bloodstream allows for a more rapid onset of medication actions,

restoration of hydration, and correction of nutritional deficits. IV therapy is often used to restore fluids and/or electrolyte balances more efficiently than what would be achieved via the oral route.

Fluid Balance

Fluid balance is an important part of optimal cellular functioning, and administration of fluids via the venous system provides an efficient way to quickly correct fluid imbalances. Additionally, many individuals who are physically unwell may not be able to tolerate fluids administered through their gastrointestinal tract, so IV administration is necessary.

When clients experience deficient fluid volume, intravenous (IV) fluids are often used to restore fluid to the intravascular compartment or to facilitate the movement of fluid between compartments through the process of osmosis. There are three types of IV fluids: isotonic, hypotonic, and hypertonic.[6]

> Review movement of fluid between compartments of the body in the "Basic Fluid and Electrolyte Concepts" section of the "Fluids and Electrolytes" chapter in Open RN *Nursing Fundamentals*.

ISOTONIC SOLUTIONS

Isotonic solutions are IV fluids that have a similar concentration of dissolved particles as found in the blood. Examples of isotonic IV solutions are 0.9% normal saline (0.9% NaCl) or lactated ringers (LR). Because the concentration of isotonic IV fluid is similar to the concentration of blood, the fluid stays in the intravascular space, and osmosis does not cause fluid movement between

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cells. See Figure 1.4[7] for an illustration of isotonic IV solution administration that does not cause osmotic movement of fluid. Isotonic solutions are typically used for patients with fluid volume deficit (also called hypovolemia) to raise their blood pressure. However, infusion of too much isotonic fluid can cause excessive fluid volume (also referred to as hypervolemia).[8]

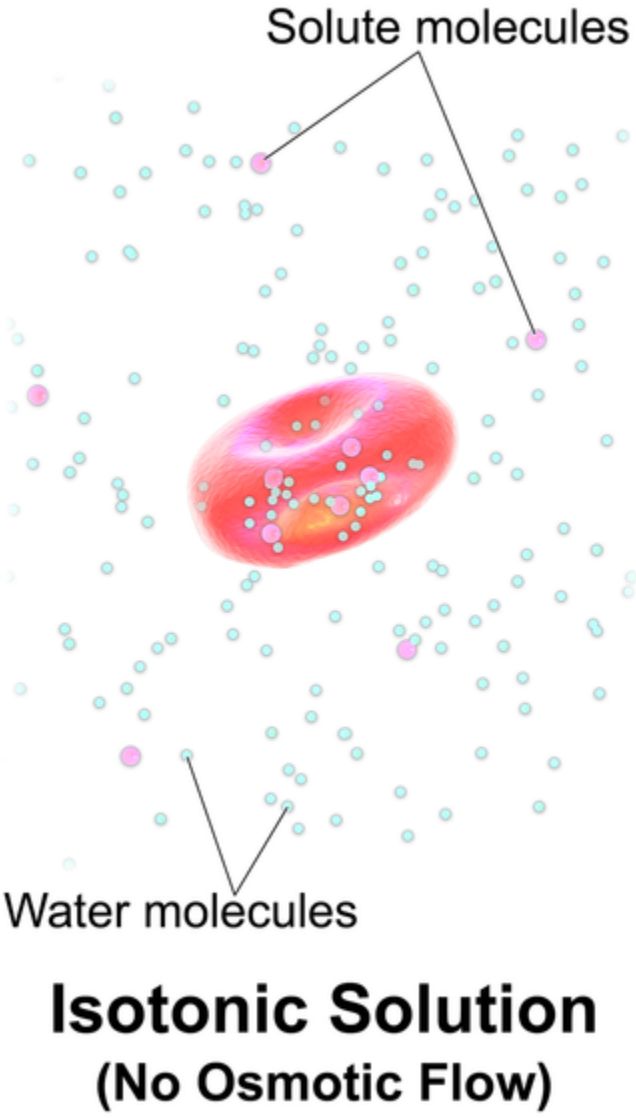

Figure 1.4 Isotonic IV Solution Causes No Osmotic Fluid Movement

7. "Blausen_0685_OsmoticFlow_Isotonic.png" by BruceBlaus.com staff is licensed under CC BY 3.0
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HYPOTONIC SOLUTIONS

Hypotonic solutions have a lower concentration of dissolved solutes than blood. An example of a hypotonic IV solution is 0.45% normal saline (0.45% NaCl). When hypotonic IV solutions are infused, it results in a decreased concentration of dissolved solutes in the blood as compared to the intracellular space. This imbalance causes osmotic movement of water from the intravascular compartment into the intracellular space. For this reason, hypotonic fluids are used to treat cellular dehydration. See Figure 1.5[9] for an illustration of the osmotic movement of fluid into a cell when a hypotonic IV solution is administered, causing lower concentration of solutes (pink molecules) in the bloodstream compared to within the cell.[10]

However, if too much fluid moves out of the intravascular compartment into cells, cerebral edema can occur. It is also possible to cause worsening hypovolemia and hypotension if too much fluid moves out of the intravascular space and into the cells. Therefore, client status should be monitored carefully when hypotonic solutions are infused.[11]

9. "Blausen_0684_OsmoticFlow_Hypotonic.png" by BruceBlaus.com staff is licensed under CC BY 3.0
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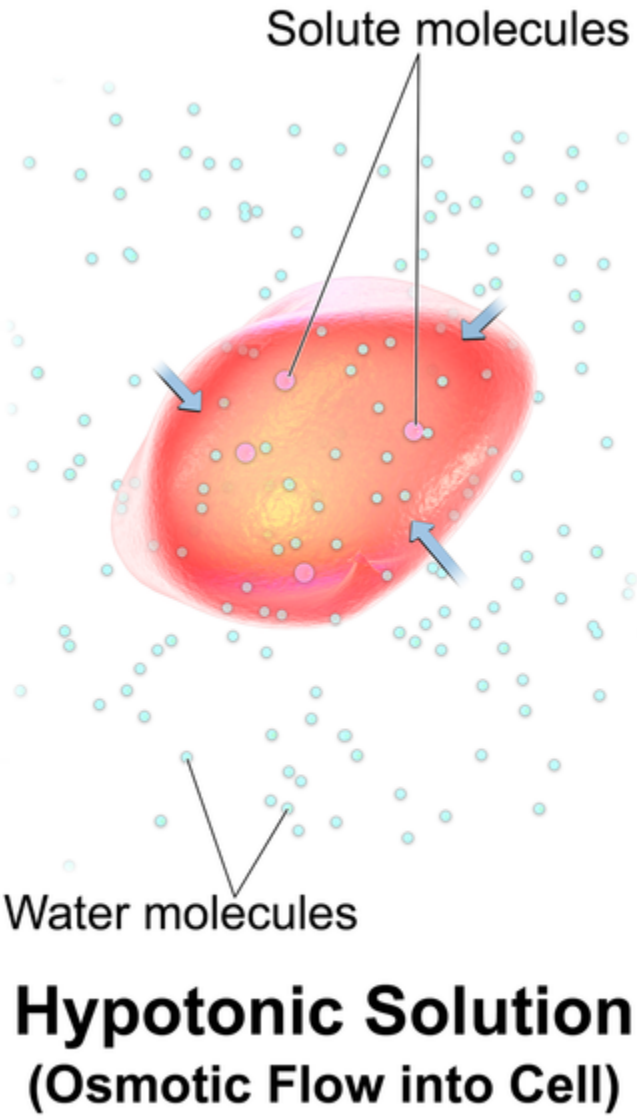

Figure 1.5 Hypotonic IV Fluid Causes Osmotic Fluid Movement Into Cells

HYPERTONIC SOLUTIONS

Hypertonic solutions have a higher concentration of dissolved particles than blood. An example of hypertonic IV solution is 3% normal saline (3% NaCl). When infused, hypertonic fluids cause an increased concentration of dissolved solutes in the intravascular space compared to the cells. This causes the osmotic movement of water out of the cells and into the intravascular space to dilute the solutes in the blood. See Figure 1.6[12] for an illustration of osmotic movement of fluid out of a cell when hypertonic IV fluid is

12. "Blausen_0683_OsmoticFlow_Hypertonic.png" by BruceBlaus.com staff is licensed under CC BY 3.0

administered due to a higher concentration of solutes (pink molecules) in the bloodstream compared to the cell.

When administering hypertonic fluids, it is essential to monitor for signs of hypervolemia, such as breathing difficulties and elevated blood pressure. Additionally, if hypertonic solutions with sodium are given, the client's serum sodium level should be closely monitored.[13]

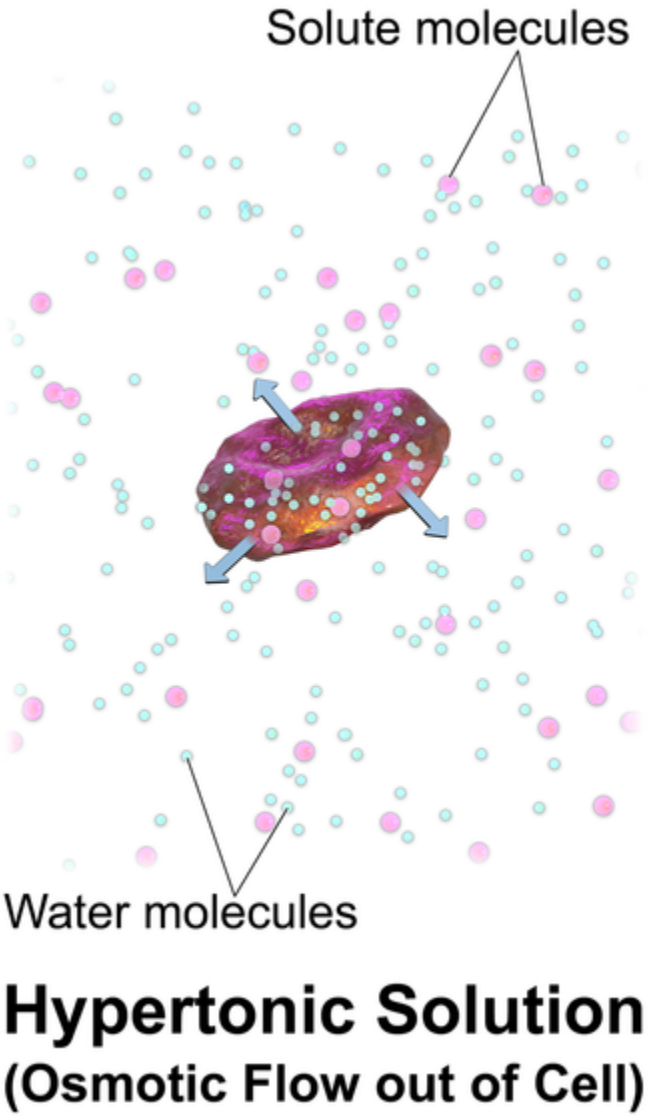

Figure 1.6 Hypertonic IV Solution Causes Osmotic Movement of Fluid Out of Cells

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See Figure 1.7[14] for an illustration comparing how different types of IV solutions affect red blood cell size.

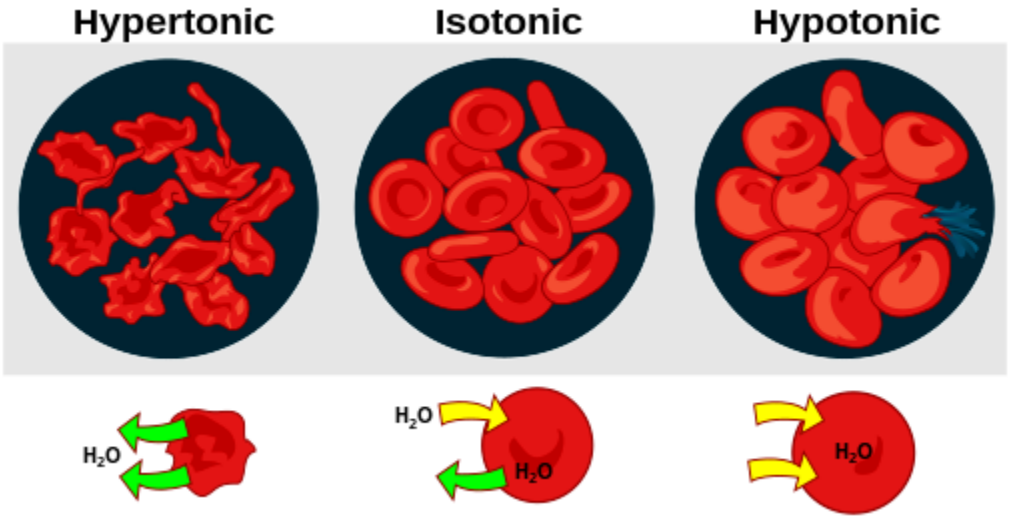

Figure 1.7 Comparison of Osmotic Effects of Hypertonic, Isotonic, and Hypotonic IV Fluids on Red Blood Cells

IV fluids are considered medications. As with all medications, nurses must check the rights of medication administration according to agency policy before administering IV fluids. What began as five rights of mediation administration has been extended to eight rights according to the American Nurses Association. These eight rights include the following[15]:

- Right Patient
- Right Medication
- Right Dose
- Right Time
- Right Route
- Right Documentation
- Right Reason
- Right Response

14. "Osmotic pressure on blood cells diagram.svg" by LadyofHats is in the Public Domain.
15. American Nurses Association. (2021, April). Use of medication assistant/aides/technicians. *ANA Issue Brief.* https://www.nursingworld.org/~498e32/contentassets/a2ff1bd2d5ca467699c3bc764f7d9198/issue-brief-medication-aides-4-2021.docx

With any IV infusion, it is important for the nurse to pay close attention to the provider's order and make sure that it contains the specific type of fluid, any additives or medications, amount to be infused, rate of infusion, and the length of time that the therapy should continue. The nurse should also carefully assess a client's hydration status and oral intake to ensure that IV fluids are stopped appropriately as a client's condition changes. For example, weight should be assessed daily for clients receiving IV fluids to monitor for fluid overload.

> Review how to check the rights of medication administration in the "Administration of Enteral Medications" chapter of Open RN *Nursing Skills*.

Electrolyte Imbalance

In addition to rapidly improving hydration status, IV fluids may also be administered to rapidly correct electrolyte imbalances. Infusing fluids with electrolytes such as potassium, calcium, and magnesium can correct electrolyte imbalances more rapidly and effectively than by oral supplementation.

Electrolytes administered via the IV route must always be administered cautiously at the correct infusion rate because over supplementation can be deadly. For example, potassium infusions administered too rapidly into a client's system can cause sudden cardiac arrest.

Blood Administration

Whole blood and blood components are administered by IV infusion. Blood is typically administered through larger-sized IV catheters. Read more information about blood administration in the "Administer Blood Products" chapter.

Nutrition

Nutritional therapy can be administered through an intravenous route for clients who do not have an adequately functioning gastrointestinal tract and/or are unable to take in food or fluids appropriately. Peripheral nutrition may be ordered through a peripheral IV site for nutritional needs such as albumin replacement.

Total parenteral nutrition (TPN) may be ordered for a client based on their specific electrolyte and/or nutritional needs. TPN is a very concentrated solution that must be administered via a central line. Central lines are placed in a larger vessel rather than a smaller, peripheral vessel. Accessing a central vessel requires additional training and expertise to prevent complications with insertion and is further discussed in the "Manage Central Lines" chapter. If a nurse receives an order for TPN therapy for a client who does not have central line access, the order should be clarified with the prescribing provider.

Medications

The IV route is preferred for the administration of many medications when immediate onset is required. For example, many types of pain medications can be given directly into the bloodstream with a much more rapid onset of action than if they were to be administered orally. Rapid relief of pain can be achieved in minutes rather than hours required for oral medications to reach their peak. Rapid onset can also be achieved with other medications such as those used to treat cardiac emergencies or severe allergic reactions to quickly restore clients to optimal body functioning. Additional information about IV administration of medications is discussed in the "Administer IV Push Medications" chapter. Additional information about administration of patient-controlled analgesia (PCA) is discussed in the "Specialized Infusions" section of this chapter.

IV Administration Equipment

Intravenous (IV) substances are administered through flexible plastic tubing called an IV administration set. The IV administration set connects the bag of

solution to the client's IV access site. There are two major types of IV administration sets: primary administration sets and secondary administration sets. Administration sets require routine replacement to prevent infection. Follow agency policy regarding tubing changes before initiating a new bag of fluid or medications.

Primary Administration Sets

Primary administration sets can be used to infuse continuous or intermittent fluids, electrolytes, or medications. These substances may be administered by infusion pump or by gravity, and each method requires its own type of administration set.

Primary fluids are typically administered using an IV pump. An IV pump is the safest method of administration to ensure specific amounts of fluid are administered. The rate of infusion through an IV pump is typically calculated in mL/hour.

For infusion by gravity, a primary IV administration set can be a macro-drip or a micro-drip solution set. Macro-drip sets are used for routine primary infusions for adults. Micro-drip IV tubing is used in pediatric or neonatal care where small amounts of fluids are administered over a long period of time. A macro-drip infusion set delivers fluid at 10, 15, or 20 drops per milliliter, whereas a micro-drip infusion set delivers 60 drops per milliliter. The drop factor is located on the packaging of the IV tubing and is important to verify when calculating medication administration rates.

Primary IV administration sets consist of the following parts:

- **Sterile spike:** Used to spike the IV fluid bag and must be kept sterile.
- **Roller clamp:** Used to regulate the speed or stop an infusion by gravity.
- **Drip chamber:** Allows air to rise out from a fluid so that it is not passed onto the client. The drip chamber should be kept ¼ to ½ full of solution. When setting a rate by gravity to "drops per minute," the dripping from this chamber is counted.
- **Backcheck valve:** Prevents fluid or medication from travelling up into the primary IV bag.

- **Access ports:** Used to infuse secondary medications and to administer IV push medications. These may also be referred to as "Y ports."

Secondary Administration Sets

Secondary IV administration sets are used to intermittently administer a secondary medication, such as an antibiotic, while the primary IV is also running. Secondary IV tubing is shorter in length than primary tubing and is connected to a primary line via an access port above the infusion pump. The infusion pump is then set at the prescribed secondary infusion rate while the secondary medication is administered. By hanging the secondary medication bag higher than the primary bag, gravity pulls fluid from the secondary bag until it is empty rather than the primary bag.

Secondary medications may be "piggybacked" into primary infusion lines so the solution from the primary fluid line can be used to prime the secondary tubing. To prime the secondary tubing, after the secondary tubing is connected to the primary tubing, the bag connected to the secondary tubing is held lower than the primary bag, causing fluid from the primary tubing to backflow up the secondary tubing. This eliminates air from the secondary tubing.

See Figure 1.8[16] for an illustration of the setup of primary and secondary administration sets for primary administration of fluids and secondary administration of medication by gravity. See Figure 1.9[17] for an image of an IV infusion pump.

16. "intravenous_equipment_labels-2.png" by British Columbia Institute of Technology is licensed under CC BY 4.0. Access for free at https://opentextbc.ca/clinicalskills/chapter/8-2-types-of-iv-therapy/
17. "DSC_0738-e1443533768679-678x1024.jpg" by British Columbia Institute of Technology is licensed under CC BY 4.0. Access for free at https://opentextbc.ca/clinicalskills/chapter/8-2-types-of-iv-therapy/

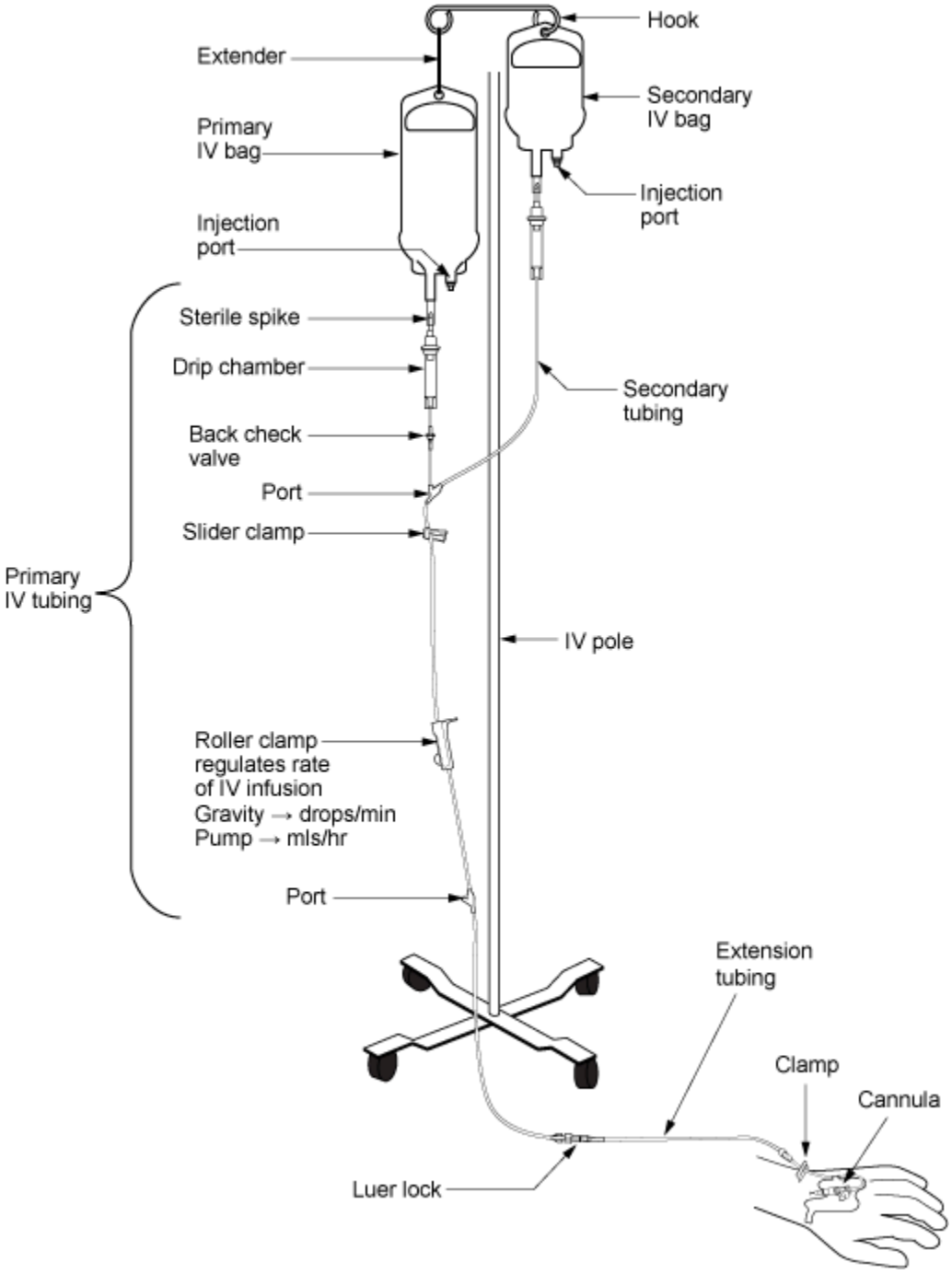

Figure 1.8 Setup of Primary and Secondary Administration Sets

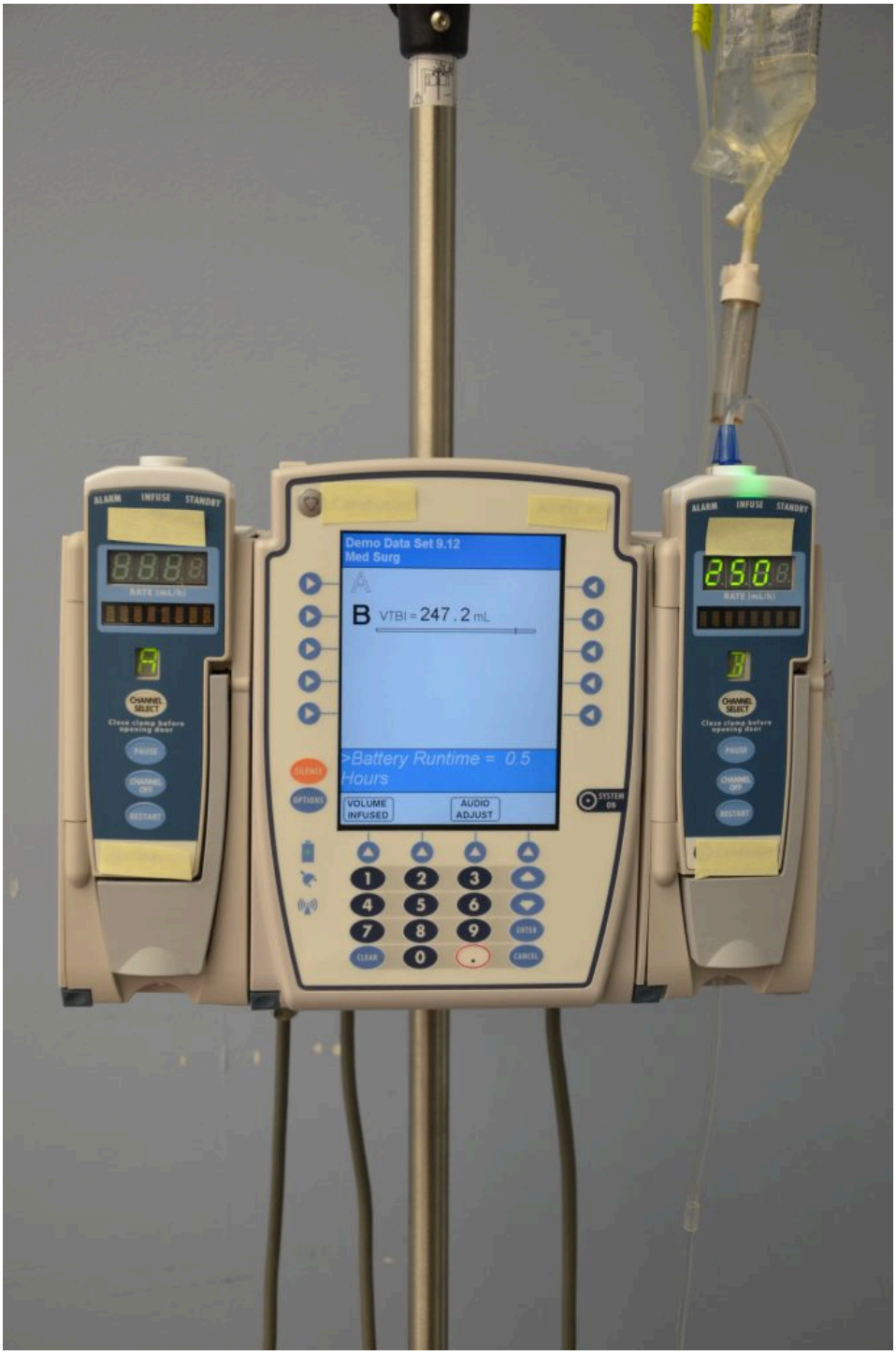

Figure 1.9 IV Infusion Pump

Priming IV Tubing

Primary administration sets, secondary administration sets, and extension tubing must be primed with IV solution to prevent air from entering the client's circulatory system and causing an air embolism. Priming refers to the process of filling the IV tubing with IV solution prior to attaching it to the

client. Review steps for setting up and priming primary and secondary administration sets using the information in the following box.

> Review checklists of steps for "Primary IV Solution Administration" and "Secondary IV Solution Administration" in the "IV Therapy Management" chapter of Open RN *Nursing Skills*.

Infection Control

Aseptic technique must be maintained throughout all IV therapy procedures, including initiation of IV access, preparing and maintaining IV equipment, administering IV fluids and medications, and discontinuing an IV system. Hand hygiene and strict aseptic technique must be performed when handling all IV equipment. These standards can be reviewed in the "Aseptic Technique" chapter in Open RN *Nursing Skills*. Additionally, if an IV catheter or IV administration set should become contaminated by contact with a nonsterile surface, it should be replaced with a new one to prevent introducing bacteria or other contaminants into the system.

Types of Venous Access

There are several types of venous access devices used to administer IV therapy that are categorized as peripheral devices or central devices. Venous access device selection is tailored to each client's needs and to the type, duration, and frequency of infusion.

Peripheral Devices

Peripheral venous access devices are commonly used for short-term IV therapy in the hospital setting. A **peripheral IV** is a intravenous catheter inserted by percutaneous venipuncture into a peripheral vein and held in

place with a sterile transparent dressing. The transparent dressing helps to keep the site sterile, prevents accidental dislodgement, and allows the nurse to visualize the insertion site through the dressing. A securement device may be added to prevent accidental dislodgement.

The client's upper extremities (hands and arms) are the preferred sites for insertion. However, a potential limitation of using the hand veins is they are smaller than the cephalic, basilic, or brachial veins in the arm. If the client requires rapid infusions where a larger gauge IV is warranted, the larger veins in the upper arm should be considered.

Peripheral IVs are used for short-term infusions of fluids, medications, or blood. Peripheral IVs are easy to monitor and can be inserted at the bedside by nurses and other trained professionals. After IV access has been obtained, the hub of an intravenous catheter is attached to a short extension set or a primary IV administration set. Luer lock connectors on the extension tubing and/or administration sets permit syringes to be attached to administer medications or fluid flushes.

Saline lock refers to the use of a short extension set that allows IV access without requiring ongoing IV infusions. When not in use, the lock is flushed with saline according to agency policy and clamped to ensure the site remains sterile and blood does not flow out of the extension tubing. See Figure 1.10[18] for an image of a saline lock.

18. "DSC_0896.jpg" by Glynda Rees Doyle and Jodie Anita McCutcheon is licensed under CC BY 4.0. Access for free at https://opentextbc.ca/clinicalskills/chapter/3-3-care-of-iv-tubing-administration-sets/

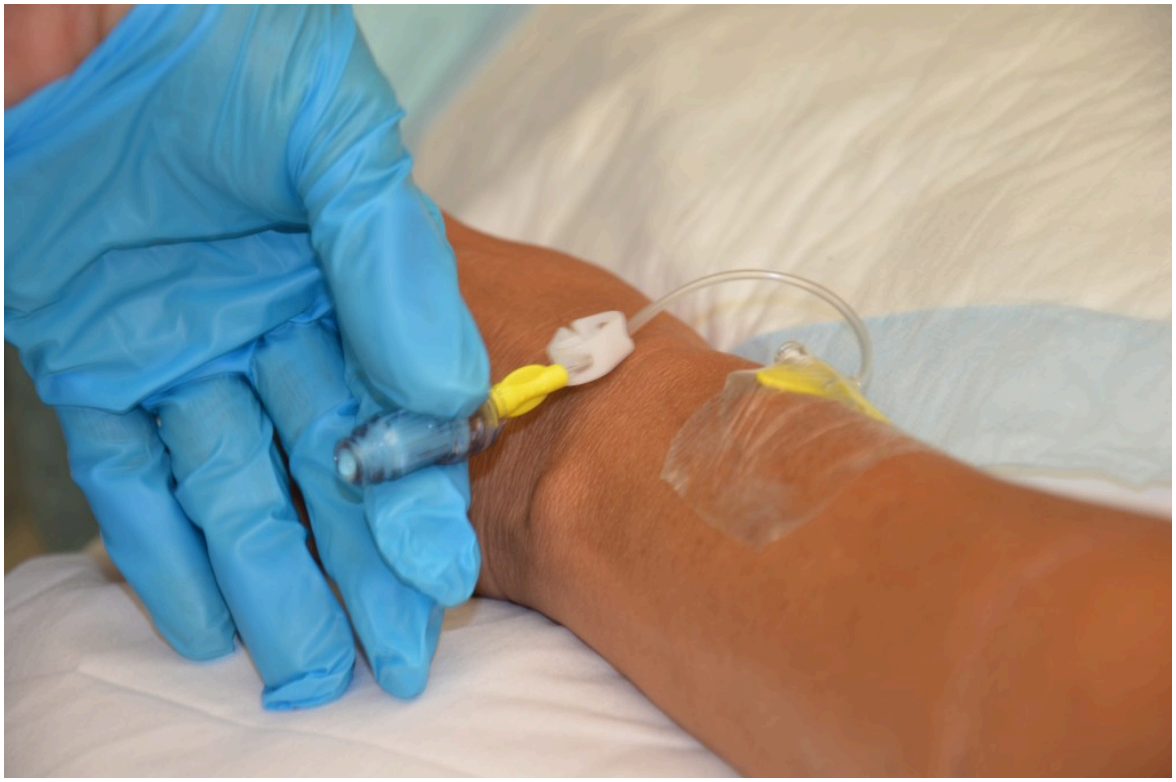

Figure 1.10 Saline Lock

If the client requires continuous infusion of IV fluids, the extension tubing from the IV catheter is connected to a primary IV administration set. The IV tubing can be run through an infusion pump to administer fluids or medications at a programmed rate of infusion (typically calculated in mL/hour) or via gravity by setting a drip rate with the roller clamp (typically calculated at drops/minute). Manufacturers list the drop rate on the IV packaging. Because of the risk of error that can occur with infusion by gravity, many agencies require the use of an infusion pump to ensure correct flow rate.

CONTRAINDICATIONS TO PERIPHERAL IV ACCESS SITES

Before inserting a peripheral IV, the client should be assessed for contraindications related to insertion sites in the upper extremities. For example, clients who have a history of lumpectomy or mastectomy, an arteriovenous fistula, or current lymphedema often have restrictions that

prohibit venipuncture into the affected extremity.[19] Additionally, deep vein thrombosis (DVT), fractures, contractures, or extensive scarring may also prohibit the placement of a peripheral IV. Hospitalized patients may have signage or a bracelet stating "limb alert" to alert heath care professionals to these conditions.

MIDLINE PERIPHERAL CATHETERS

Midline peripheral catheters have a larger catheter (i.e., 16-18 gauge) that allow for rapid infusions. Insertion is ultrasound-guided and can be inserted by RNs with additional training or other trained professionals. Midline catheters are typically inserted into the basilic, cephalic, or brachial veins of the upper arm with the tip placed near the level of the axilla. They are much longer and inserted deeper than a peripheral IV, but do not extend into a central vessel, so are not considered a central line. Therefore, they have a lower risk of infection than central venous access. Any medication that can be administered through a peripheral line can be administered via a midline peripheral catheter. They can also be used for longer duration than traditional peripheral venous access, which is ideal for clients needing extended hospital stays or IV access. Based on agency policy, midline catheters may also be used for blood sample collection, thus limiting the number of venipunctures a client receives. Site care for a midline peripheral catheter is similar to a peripheral IV dressing change.[20,21]

Central Venous Access Devices

A **central venous access device (CVAD)** is a type of vascular access that involves the insertion of a tube into a vein in the neck, chest, or groin and

19. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0
20. Villalba-Nicolau, M., Chover-Sierra, E., Saus-Ortega, C., Ballestar-Tarín, M. L., Chover-Sierra, P., & Martínez-Sabater, A. (2022). Usefulness of midline catheters versus peripheral venous catheters in an inpatient unit: A pilot randomized clinical trial. *Nursing Reports*, 12(4), 814–823. https://doi.org/10.3390/nursrep12040079
21. Nickel, B. (2021). Does the midline peripheral intravenous catheter have a place in critical care? *Critical Care Nurse, 41*(6), e1-e21. https://doi.org/10.4037/ccn2021818

threaded into a central vein (most commonly the internal jugular, subclavian, or femoral) and advanced until the tip of the catheter resides within the inferior vena cava, superior vena cava, or right atrium.[22] Only specially trained health professionals may insert central venous access devices, but nurses provide routine care of CVADs, including dressing changes. See Figure 1.11[23] for an image of a central line requiring a dressing change.

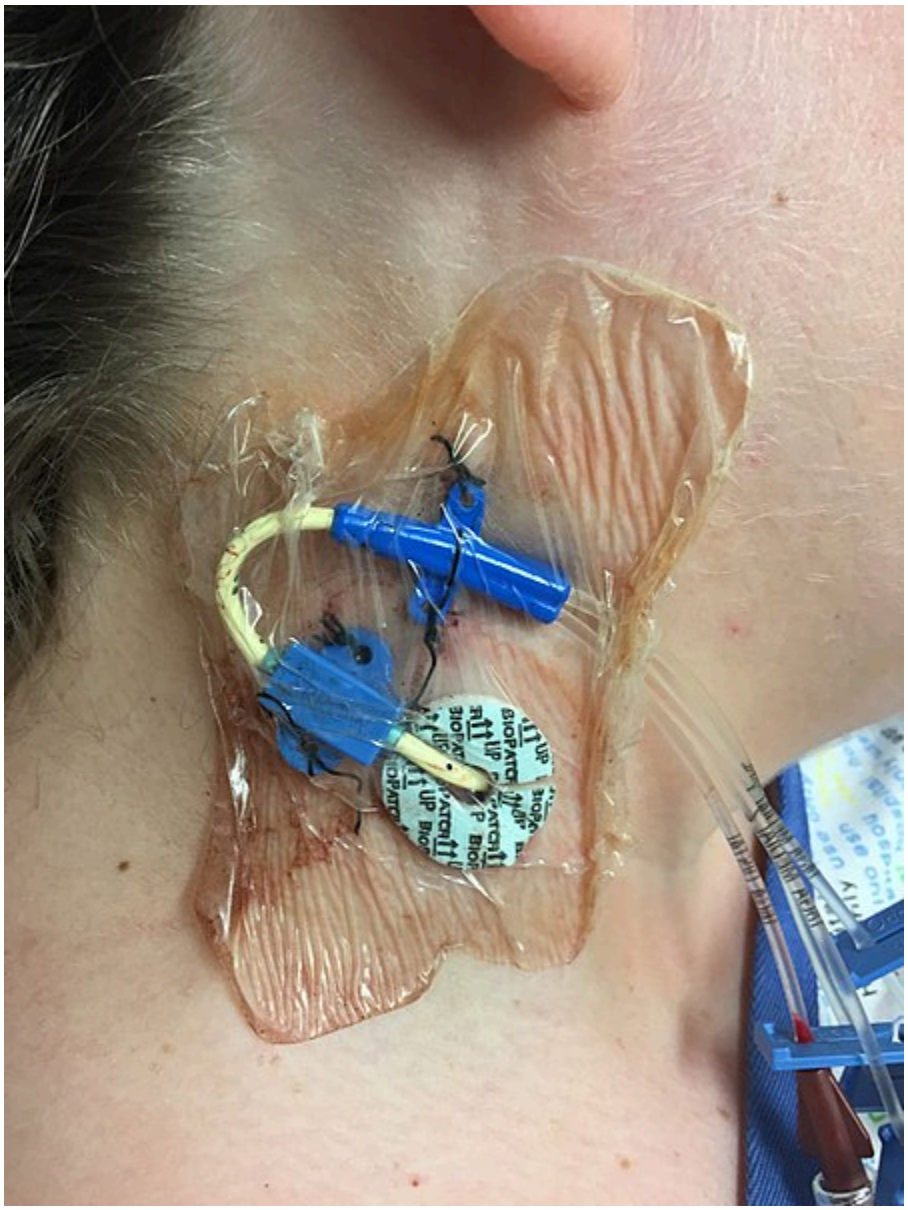

Figure 1.11 Central Line

22. This work is a derivative of StatPearls by Kolikof, Peterson, and Baker and is licensed under CC BY 4.0
23. "Central_Line_Sutures.jpg" by Red minx is licensed under CC BY-SA 4.0

A central venous access device can be left in for longer periods of time and is useful for administering concentrated medications and fluids, such as TPN or hyperosmotic fluids, that would be otherwise irritating to smaller peripheral veins. However, central venous access devices have an increased risk for the development of bloodstream infections, so strict aseptic technique is required during insertion and maintenance. Central venous access devices are further discussed in the "Manage Central Lines" chapter.

PERIPHERAL INSERTED CENTRAL CATHETERS

A **peripheral inserted central catheter (PICC)** is a thin, flexible tube inserted into a vein in the upper arm and guided into the superior vena cava. It is used to give intravenous fluids, blood transfusions, chemotherapy, and other medications requiring a central line. It can also be used for blood sampling. A PICC may stay in place for weeks or months and helps avoid the need for repeated needlesticks. PICC lines are further discussed in the "Manage Central Lines" chapter.

General Guidelines for IV Therapy

The following are general guidelines for peripheral IV therapy[24]:

- IV fluid therapy is ordered by a provider. The order must include the type of solution or medication, total amount of fluid, rate of infusion, duration, date, and time.
- IV therapy is an invasive procedure. Significant complications can occur if the wrong amount of IV fluids or incorrect medication is given or if aseptic technique is not strictly followed.

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- Nurses must understand the indications and duration for IV therapy for each client. Practice guidelines recommend that clients receiving IV therapy for more than six days should be assessed for an intermediate or long-term device such as a central venous access device (CVAD).
- Hospitalized patients may have an order for a small hourly infusion rate, such as 10-20 mL/hour, historically referred to in practice as a "to keep open" (TKO) or "keep vein open" (KVO) rate.
- IV administration sets require routine replacement to promote client safety and reduce the risk of infection. Primary and secondary continuous administration sets used to administer solutions other than lipids, blood, or blood products are typically changed every 96 hours, or up to every 7 days, as directed by agency policy and/or the manufacturer's instructions. Administration sets should also be changed if contamination or compromise in the integrity of the product or system is suspected. Secondary administration sets that are detached from a primary administration set are typically changed every 24 hours or as directed by agency policy. Administration sets should be labelled according to agency policy with the date of initiation or the date of change indicated.[25]

25. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org

1.3 Peripheral IV Access

The initiation and maintenance of a peripheral venous access includes selecting an appropriate site, selecting an appropriate IV catheter and size, establishing IV access, and monitoring for potential complications. The nurse also incorporates life span considerations while following general guidelines for maintaining peripheral venous access sites.

Selection of Venous Access Site Selection

The process of IV start and vessel cannulation includes a comprehensive vein search, identification, and assessment process. Veins in the upper extremities (hands and arms) are typically the preferred sites for insertion. The nurse should be systematic when assessing potential vessels for insertion, examining potential sites both visually and through palpation while progressing up the patient's extremity. The arms should be rotated so that vessels on the dorsal surface can be considered as well. Taking time to identify the best access site will increase the chances for successful cannulation and decrease discomfort for the patient. See Figure 1.12[1] for an illustration of vein anatomy in the upper extremity.

1. "2134_Thoracic_Upper_Limb_Veins.jpg" by OpenStax College is licensed under CC BY 3.0. Access for free at http://cnx.org/content/col11496/1.6/

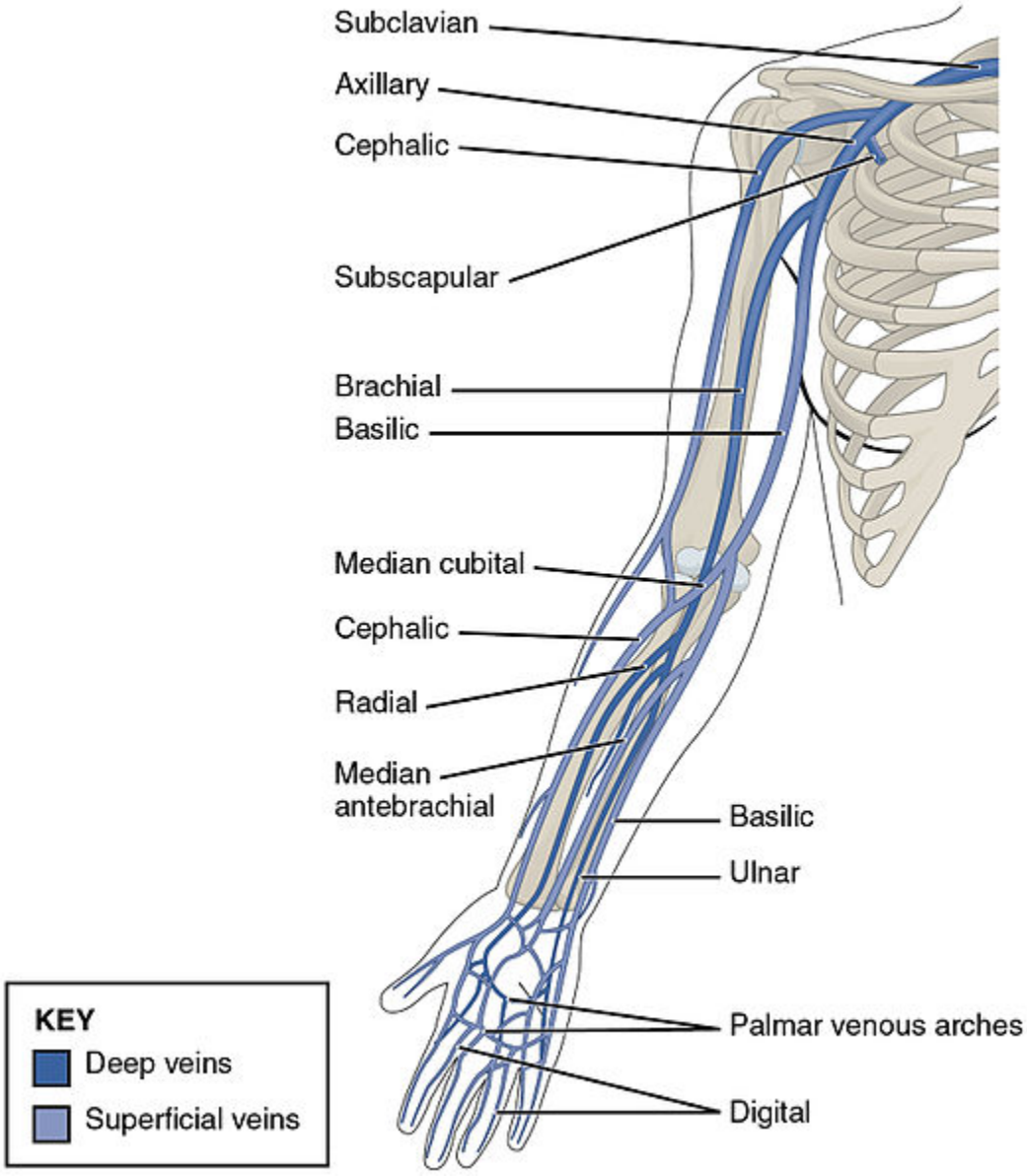

Figure 1.12 Upper Extremity Veins

The veins of the hands are common places to begin one's assessment. These veins on the dorsal surface of the hand are typically easily visualized and palpated due to the proximity to the surface of the skin. See Figure 1.13[2] for an image of the veins in a hand. Veins on the palmar side of the wrist should be avoided due to potential nerve damage. A limitation of using hand veins for venous access is they are smaller than the cephalic, basilic, or brachial veins in the arm. For example, if the patient requires rapid infusion of fluid or

2. "3029775415_7458f6461b_o.jpg" by charcoal soul is licensed under CC BY-ND 2.0

administration of blood products, a large-gauge IV cannula is typically placed in large vein in the upper arm.

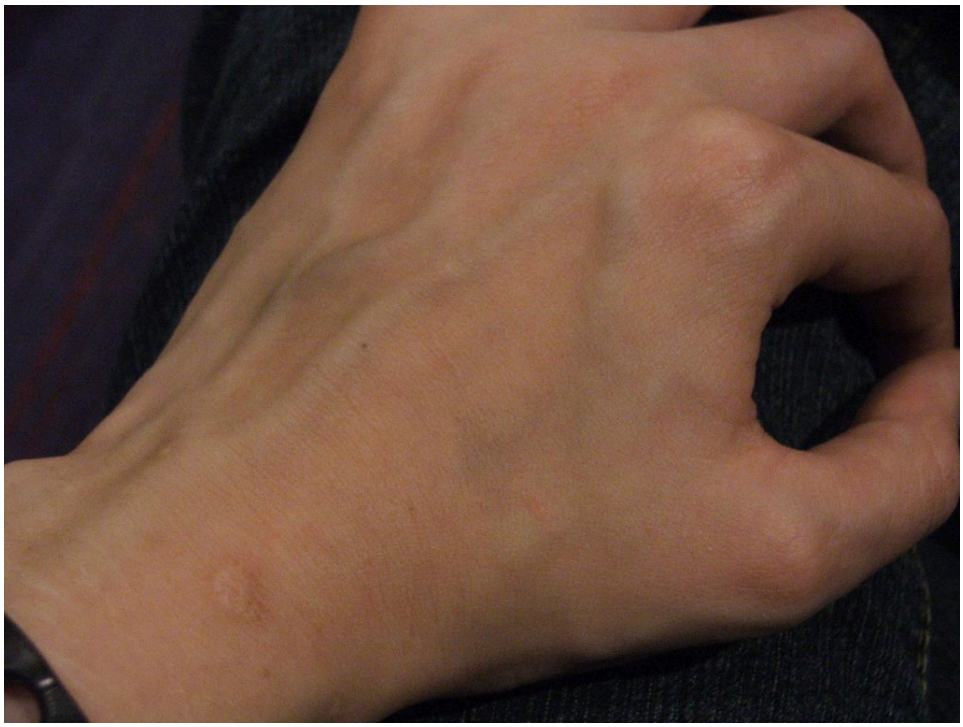

Figure 1.13 Veins in a Hand

If no suitable veins are found on the hand, the nurse should progress up the arm and continue to assess for good access sites. The basilic and cephalic veins are good alternatives for establishing IV access. The brachial vein can be considered, but caution must be used due to its location near the brachial artery in the antecubital fossa. Palpating for a pulse and then avoiding the area where the pulse is located can help ensure cannulation occurs into a vein rather than the artery.[3]

Nurses must also reflect on the purpose for venous access to determine the appropriate access site and catheter lumen size. For example, consider the venous access site required to obtain a blood sample specimen versus that to provide intravenous fluid administration. For blood sampling, the nurse should direct attention to the large veins located in the antecubital fossa (i.e., the interior aspect of the elbow) because the veins are larger in size and can

3. Engström, Å., & Forsberg, A. (2019). Peripheral intravenous catheter difficulty – A clinical survey of registered nurse and critical care nurse performance. *Journal of Clinical Nursing, 28*(3-4), 686-694. https://doi.org/10.1111/jocn.14668

be accessed frequently. However, these veins are not optimal for routine IV fluid administration because every time the patient bends their elbow, a mechanical obstruction in the IV catheter may occur. Despite the potential disadvantage of mechanical obstruction when accessing veins in the antecubital fossa, the nurse may still decide to access veins in the antecubital fossa if rapid IV access is needed or if the patient is only receiving intermittent short-term infusions. In this manner, the purpose for a patient's venous access plays a strong role in determining the appropriate access site.

When considering a potential site for IV cannulation, it is important to note that a catheter must be inserted and threaded for a short distance into the vein. Veins that have ¼- to ½-inch sections of straight surface are usually easily accessed. Suitable IV access sites include lengths of veins that feel spongy and resilient to the touch. Veins that bifurcate (i.e., divide into branches), narrow significantly, or are curved can be difficult to access and thread the cannula. Nurses should also palpate for knobby bumps in a vein that may indicate the presence of valves in that area. Valves can be difficult to cannulate through and, therefore, should be avoided.

If a patient has several suitable venous access sites, preference should be given to establishing an access site on their nondominant hand or arm. Patients typically use their dominant hand when moving to reposition themselves, take meals or fluids, or operate the television remote. These movements can increase the chance of the cannula dislodging from the vein.[4]

Additional considerations for vein selection include avoiding extremities with restrictions such as those with a previous history of mastectomy, lymph node dissection, or arteriovenous (A/V) fistula; the presence of a cast or other assistive device; or those with conditions causing reduced sensation such as paralysis or stroke. The presence of an IV cannula in extremities with these conditions increases the risk for localized infection and other complications.

The nurse should also consider the condition of the patient's skin when selecting an access site. Skin that is scarred can be fibrous and tough to

4. Takahashi, T., Ryoko, M., Abe-Doi, M., Miyahara-Kaneko, M., Chiho, K., Nakamura, M., Mariko, M., Chieko, K., & Hiromi, S. (2020). Preventing peripheral intravenous catheter failure by reducing mechanical irritation. *Scientific Reports, 10*(1), 1550. http://dx.doi.org/10.1038/s41598-019-56873-2

penetrate with a needle, causing increased discomfort. Sites below a recent venipuncture or IV access site should also be avoided due the potential for fluids to seep out of the site. Additionally, skin that is tattooed or extremities with edema should also be avoided whenever possible. Tattoos and edema make a vein not only more difficult to identify, but also more difficult to assess for signs of complications such as cannula dislodgement and the presence of fluid leaking into subcutaneous tissues.

There are many methods that nurses can use to dilate veins and determine the presence of suitable access sites if the veins are not visually apparent. A simple method is to apply a single-use tourniquet. The tourniquet should be snug but still allow for the presence of arterial blood flow. Blood flow can be easily assessed by applying the tourniquet and assessing the presence of the radial pulse. Tourniquets should only be applied for short periods of time and released periodically during the vein search and selection process to ensure resolution of systemic blood flow. In a similar manner, a blood pressure cuff can be also applied and pumped up for a short period of time.

Application of warmth can also be helpful for vein identification. Wrapping the upper extremities in warm blankets, or applying warm compresses, promotes vessel dilation. The blankets or compresses should be in place for short intervals (i.e., 3-5 minutes) to allow time for the vessels to respond to the warm stimuli.

Placing the upper extremities in a dependent position is another useful method for enhancing vessel dilation. Allowing the arm and hand to hang dependently (i.e., below the level of the heart) allows venous blood to migrate by gravity into the lower arms and hands. The pooling of venous blood into the small vessels of the hands promotes vessel dilation and vein identification.

In addition to promoting vessel dilation, nurses may also be trained in some facilities to use equipment to visually detect veins, such as illumination lights or ultrasound equipment. Some agencies also have specially trained venous access teams who insert intravenous lines and can be consulted if vascular access proves challenging.

Many patients have had previous experience with IVs and can provide helpful information regarding strategies for success. For example, if a patient

states, “My veins often ‘roll’ when they try to start an IV,” the nurse should take special caution to anchor the vessel when puncturing the skin.

Nurses should restrict IV insertion attempts to no more than two attempts per clinician. Multiple unsuccessful attempts cause pain to the client, delay treatment, limit future vascular access, increase cost, increase the risk for complications, and decrease trust in the nurse. After two unsuccessful attempts, the nurse should seek a clinician with a higher skill level or consider alternative routes of medication administration.[5]

Catheter Size and Type Selection

Peripheral IV catheters are available in a variety of sizes, most commonly ranging from 14 gauge to 24 gauge. Note that the lower the gauge size, the wider the diameter of the catheter, with 14-gauge catheters allowing for the greatest flow rate.[6] Catheter sizes are color coded to allow for easy identification of the catheter size after a vein is accessed. See Figure 1.14[7] for colors associated with IV catheter sizes and their associated flow rates.

5. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org
6. This work is a derivative of StatPearls by Beecham & Tackling and is licensed under CC BY 4.0
7. "Color-coding_of_IV_cannulas.jpg" by Dr.Vijaya Chandar is licensed under CC BY-SA 4.0

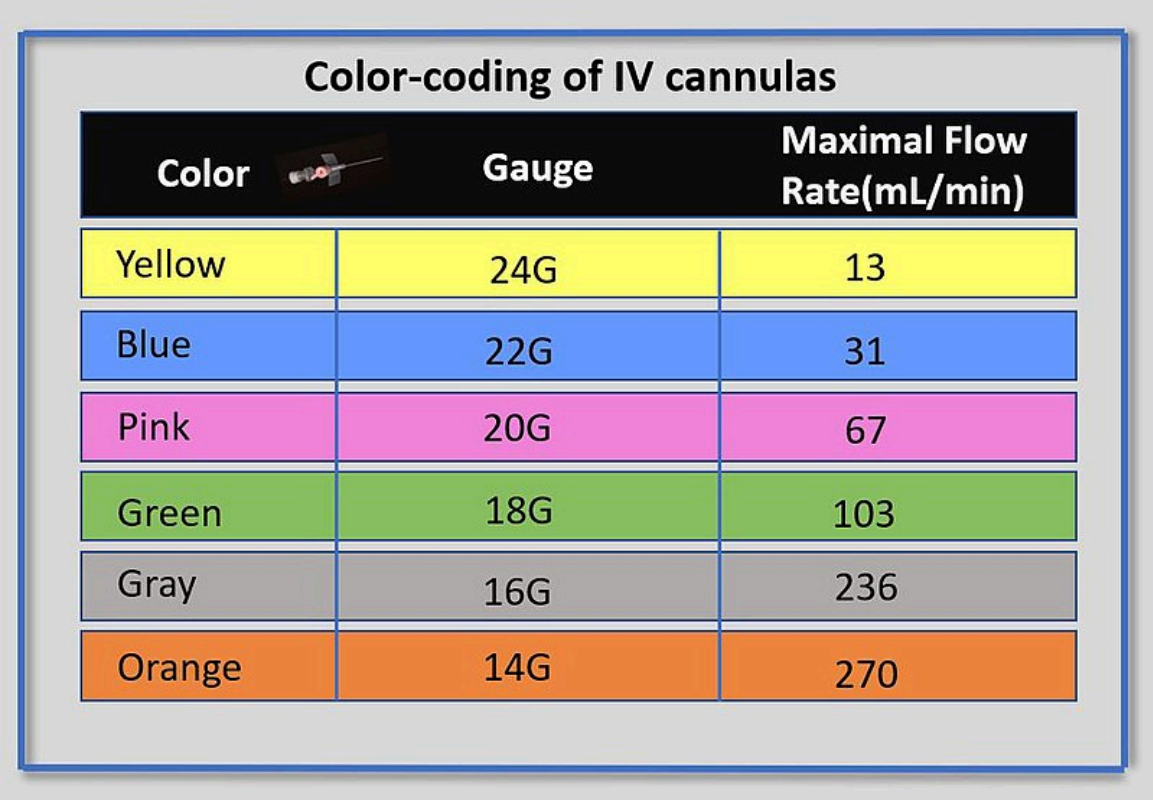

Figure 1.14 Color Coding of IV Catheters

Nurses must consider the purpose for venous access, along with assessment of the client's vessel size, when selecting an IV catheter to attempt cannulation. Catheters with a smaller gauge (i.e., larger diameter) permit infusion of viscous fluids, such as blood products, at a faster rate with decreased opportunity for catheter occlusion.[8] Additionally, an appropriately sized catheter also allows for adequate blood flow around the catheter itself. The most common IV catheter size for adult patients is 18- or 20-gauge catheters. However, frail elderly patients and children have smaller vasculature, so a 22-gauge catheter is often preferred.

There are different manufacturer brands of IV catheters, but all include a beveled hollow needle, flashback chamber in which one can visualize blood return when entering the vein, and a flexible catheter that is left in the vein after the catheter has been threaded into the vein and the needle removed.

IV insertion equipment varies among institutions, but common types include shielded IV catheters or winged (i.e., "butterfly") devices. Variation is

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often related to the presence of a stabilizing device at the site of insertion, as well as the presence of short extension tubing. For shielded catheter types, the stabilizing device and extension tubing are typically added to the catheter itself and not included with the cannulation needle. See Figure 1.15[9] for an image of shielded IV catheters.

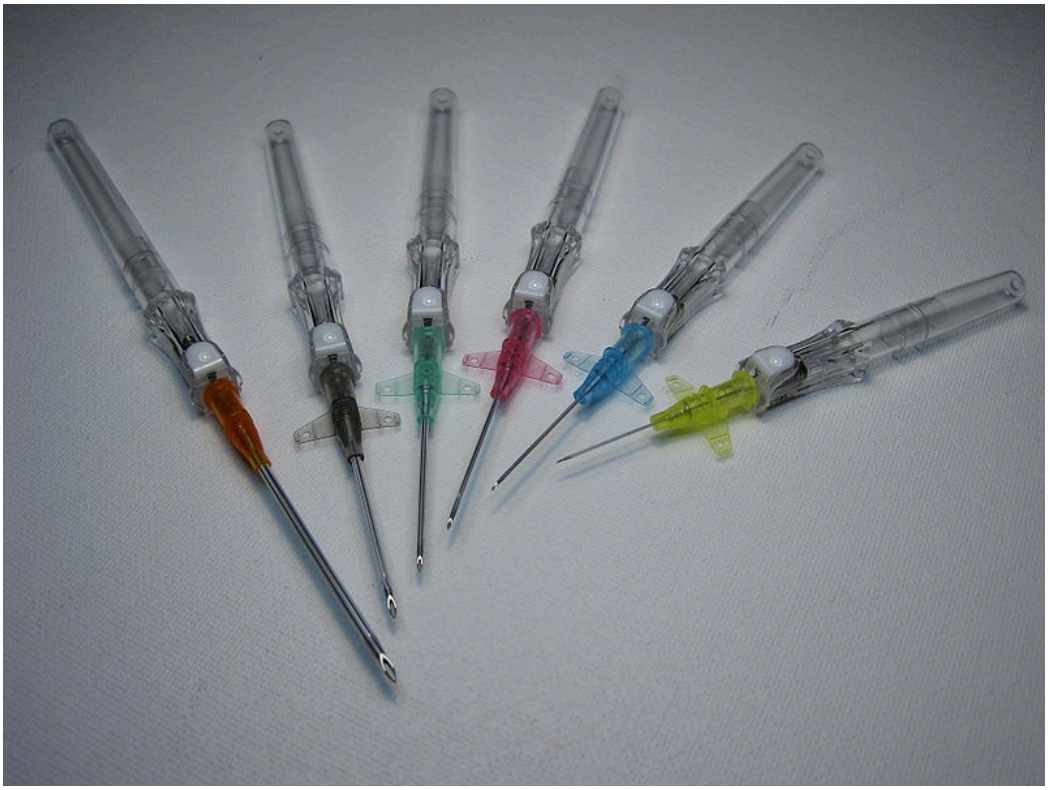

Figure 1.15 Shielded IV Catheters

Nurses must ensure the selected size and type of IV catheter are appropriate for the procedure or infusion that is ordered because not all peripheral IV catheters are suitable for all procedures. For example, if a procedure requires the infusion of contrast dye, a specific size infusion port is required.

Despite the wide variation in catheter equipment that is available, there has been significant focus among manufacturers regarding the need for safety equipment during venipuncture. Many devices utilize mechanisms to self-contain needles within a plastic sheath after withdrawal from the client. These devices can be activated through a button in the devices or a manual trigger initiated by the individual attempting cannulation. Regardless of the

9. "IV_Catheters_(9).JPG" by Intropin is licensed under CC BY-SA 3.0

type of safety lock, it is important to utilize the equipment as intended and never attempt to disable or override the mechanism. These mechanisms are important to help prevent accidental needlesticks or injury with a contaminated needle after it has been removed from the patient. Additionally, after cannulation is attempted, the individual who attempted cannulation is responsible for ensuring all needles are disposed of in a sharps container. It is good practice to be aware of how many sharps were brought into the room, opened, and disposed. This helps to ensure that any needles are not inadvertently left in a patient's bed, tray table, floor, etc. Nurses must be familiar with the equipment used at the health care facility and receive orientation on the specific mechanics related to the equipment and safety practices.

Initiating Peripheral IV Access

The steps for initiating peripheral IV access are described in the "Perform IV Insertion and IV Removal" checklist later in this chapter.

Monitoring for Potential Complications

Several potential complications may arise from peripheral intravenous therapy. It is the responsibility of the nurse to monitor for signs and symptoms of complications and intervene appropriately. Complications can be categorized as local or systemic. See Table 1.3a for potential local complications of peripheral IV therapy.

Table 1.3a Local Complications of Peripheral IV Therapy[10,11]

10. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0
11. Simin, D., Milutinović, D., Turkulov, V., & Brkić, S. (2018). Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: An observational prospective study. *Journal of Clinical Nursing, 28*(9-10), 1585-1599. https://doi.org/10.1111/jocn.14760

Complications	Potential Causes and Prevention	Treatment
Phlebitis: The inflammation of the vein's inner lining, the tunica intima. Clinical indications are localized redness, pain, heat, purulent drainage, and swelling that can track up the vein leading to a palpable venous cord.	**Mechanical causes:** Inflammation of the vein's inner lining can be caused by the cannula rubbing and irritating the vein. To prevent mechanical inflammation, use the smallest gauge possible to deliver the medication or required fluids. **Chemical causes:** Inflammation of the vein's inner lining can be caused by medications or fluids with high alkaline, acidic, or hypertonic qualities. To avoid chemical phlebitis, follow the parenteral drug therapy guidelines in a drug reference resource for administering IV medications, including the appropriate amount of solution and rate of infusion. **Infectious causes:** May be related to emergent VAD insertions, poor aseptic technique, or contaminated dressings.	**Chemical phlebitis:** Evaluate infusion therapy and the need for different vascular access, different medication, slower rate of infusion, or more dilute infusate. If indicated, remove the Vascular Access Device (VAD).[12] **Transient mechanical phlebitis:** May be treatable by stabilizing the catheter, applying heat, elevating limb, and providing analgesics as needed. Consider requesting other pharmacologic interventions such as anti-inflammatory agents if needed. Monitor site for 24 hours post-insertion, and if signs and symptoms persist, remove the catheter.[13] **Infectious phlebitis:** If purulent drainage is present or infection is suspected, remove the catheter and obtain a culture of the purulent drainage and catheter tip. Monitor for signs of systemic infection.[14]

12. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224.

https://doi: 10.1097/NAN.0000000000000396.org

13. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org
14. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org

Infiltration: A condition that occurs when a nonvesicant solution is inadvertently administered into surrounding tissue. Signs and symptoms include pain, swelling, redness, the skin surrounding the insertion site is cool to touch, there is a change in the quality or flow of IV, the skin is tight around the IV site, IV fluid is leaking from IV site, or there are frequent alarms on the IV pump.	Infiltration is one of the most common complications in infusion therapy involving an IV catheter.[15] For this reason, the patency of an IV site must always be checked before administering IV push medications. Infiltration can be caused by piercing the vein, excessive patient movement, a dislodged or incorrectly placed IV catheter, or too rapid infusion of fluids or medications into a fragile vein. Always secure a peripheral IV catheter with tape or a stabilization device to avoid accidental dislodgement. Avoid sites that are areas of flexion.	Stop the infusion and remove the cannula. Follow agency policy related to infiltration.

15. Wang, J., Li, M. M., Zhou, L. P., Xie, R. H., Pakhale, S., Krewski, D., & Wen, S. W. (2022). Treatment for grade 4 peripheral intravenous infiltration with type 3 skin tears: A case report and literature review. *International Wound Journal, 19*(1), 222–229. https://doi.org/10.1111/iwj.13624

Extravasation: A condition that occurs when vesicant (an irritating solution or medication) is administered and inadvertently leaks into surrounding tissue and causes damage. It is characterized by the same signs and symptoms as infiltration but also includes burning, stinging, redness, blistering, or necrosis of the tissue.	Extravasation has the same potential causes of infiltration but with worse consequences because of the effects of vesicants. Extravasation can result in severe tissue injury and necrosis. For this reason, known vesicant medications should be administered via central lines.	Stop the infusion. Detach all administration sets and aspirate from the catheter hub prior to removing the catheter to remove vesicant medication from the catheter lumen and as much as possible from the subcutaneous tissue.[16] Follow agency policy regarding extravasation of specific medications. For example, toxic medications have a specific treatment plan.
Hemorrhage: Bleeding from the IV access site.	Bleeding occurs when the IV catheter becomes dislodged.	If dislodgement occurs, apply pressure with gauze to the site until the bleeding stops and then apply a sterile transparent dressing.
Local infection: Infection at the site is indicated by purulent drainage, typically two to three days after an IV site is started.	Local infection is often caused by nonadherence to aseptic technique during IV initiation or IV maintenance or the dressing becomes contaminated or non-intact over the access site.	Remove the cannula and clean the site using sterile technique. If infection is suspected, remove the catheter and obtain a culture of the purulent drainage and catheter tip. Monitor for signs of systemic infection.
Nerve injury[17]	Paresthesia-type pain occurring during venipuncture or during an indwelling IV catheter can indicate nerve injury.	Immediately remove the cannula, notify the provider, and document findings in the chart.

16. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org
17. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org

In addition to local complications that can occur at the site of IV insertion, there are many systemic complications that nurses must monitor for when initiating peripheral IV access, as well as monitoring a client receiving IV therapy. See Table 1.3b for a list of systemic complications, signs, symptoms, and treatment.

Table 1.3b Systemic Complications of Peripheral IV Therapy[18]

18. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0

Complication	Signs, Symptoms, and Treatment
Pulmonary Edema	Pulmonary edema, also known as fluid overload or circulatory overload, is a condition caused by excess fluid accumulation in the lungs due to excessive fluid in the circulatory system. It is characterized by decreased oxygen saturation; increased respiratory rate; fine or coarse crackles in the lung bases; restlessness; breathlessness; dyspnea; and coughing up pink, frothy sputum. Pulmonary edema requires prompt medical attention and treatment. If pulmonary edema is suspected, raise the head of the bed, apply oxygen, take vital signs, complete a cardiovascular assessment, and immediately notify the provider.
Air Embolism	Air embolism refers to the presence of air in the cardiovascular system. It occurs when air is introduced into the venous system and travels to the right ventricle and/or pulmonary circulation. Air embolisms can occur during catheter insertion, changing IV bags, adding secondary medication administration, and catheter removal. Inadvertent administration of 10 mL of air can have serious and fatal consequences. However, small air bubbles are tolerated by most patients. Signs and symptoms of an air embolism include sudden shortness of breath, continued coughing, breathlessness, shoulder or neck pain, agitation, feeling of impending doom, light-headedness, hypotension, wheezing, increased heart rate, altered mental status, and jugular venous distension. If an air embolism is suspected, occlude the source of air entry. Place the patient in a Trendelenburg position on their left side (if not contraindicated), apply oxygen at 100%, obtain vital signs, and immediately notify the provider. To prevent air embolisms, perform the following steps when administering IV therapy: ensure the drip chamber is one-third to one-half filled, remove all air from the IV tubing by priming it prior to attaching it to the client, use precautions when changing IV bags or adding secondary medication bags, ensure all IV connections are tight, and ensure clamps are used when the IV system is not in use.
Catheter Embolism	A catheter embolism occurs when a small part of the cannula breaks off and flows into the vascular system. When removing a peripheral IV cannula, inspect the catheter tip to ensure the end is intact. Notify the provider immediately if the catheter tip is not intact when it is removed.

Catheter-Related Bloodstream Infection (CR-BSI)	Catheter-related bloodstream infection (CR-BSI) is caused by microorganisms introduced into the bloodstream through the puncture site, the hub, or contaminated IV tubing or IV solution, leading to bacteremia or sepsis. A CR-BSI is a hospital-acquired preventable infection and considered an adverse event. A CR-BSI is diagnosed when infection occurs with one positive blood culture in a patient with a vascular device (or a patient who had a vascular device within 48 hours before the infection) with no apparent source for the infection other than the vascular access device. Treatment for CR-BSI is IV antibiotic therapy. To prevent CR-BSI, it is vital to perform hand hygiene prior to care and maintenance of an IV system and to use strict aseptic technique for care and maintenance of all IV therapy procedures.

Life Span Considerations

IV initiation procedures vary significantly for pediatric patients and older adults due to patient size and variation in vessel size and condition. For example, in neonatal patients, venous access may be achieved through cannulation of a vein in their hand, foot, or scalp. However, IV initiation into a scalp vessel requires specific modifications and additional training. Additionally, use of a lower extremity for venous access should be specifically addressed with the provider prior to any attempt at cannulation to ensure that a lower extremity site is appropriate based on the patient condition.

When working with pediatric patients, it is important to consider the stability of the IV access. Many pediatric patients are very mobile and may not be able to understand the need to leave a saline lock or continuous infusion line in place. Utilizing stabilizing arm boards or gauze wraps may be helpful reminders that also create stability in the line and access site. Many health care organizations have additional tools and strategies to ease IV cannulation for pediatric patients, such as topical anesthetics including lidocaine cream, to minimize discomfort with insertion. Special procedural rooms oriented toward children are often used with helpful visual distractors like dolls, toys,

stuffed animals, videos, or support of child life specialists.[19] See Figure 1.16[20] for an image of toys used as distractors with a hospitalized pediatric patient.

Figure 1.16 Hospitalized Pediatric Patient With Toys

Providing education to the parents regarding the process of the IV start and what might work best for the child ahead of the procedure can be helpful for ensuring cannulation occurs with minimal complications. Parents can often be excellent sources of support when pediatric patients undergo invasive procedures, but it is important that the parents are comfortable and informed regarding their role and the manner in which they will offer assistance.

There are also modifications nurses can make independently based on their

19. Olsen, K., & Weinberg, E. (2017). Pain-less practice: Techniques to reduce procedural pain and anxiety in pediatric acute care. *Clinical Pediatric Emergency Medicine, 18*(1), 32–41. https://doi.org/10.1016/j.cpem.2017.01.007
20. "DN-SD-06-07603.jpeg" by Department of Defense. American Forces Information Service. Defense Visual Information Center. (1994 - 10/26/2007) is licensed in the Public Domain.

clinical knowledge of a patient's condition. For example, many elderly patients who receive steroids have vessels that are very fragile and difficult to cannulate. Nurses may modify the procedure by omitting the use of a tourniquet. This decreases pressure in the vessel during venipuncture and helps to prevent the vein from rupturing or **"blowing"** (i.e., leaking blood due to rupture). The use of a tourniquet may also be omitted to prevent skin tears.

Many elderly patients have less subcutaneous tissue as a result of the aging process, and the nurse may note that their vessels, particularly those located in the hands, appear more superficial than is seen in younger patients. See Figure 1.17[21] for an image of superficial veins. As a result, the experienced nurse may modify their vessel cannulation technique by inserting the needle at a decreased or shallower angle when attempting cannulation. Decreasing the angle of insertion will provide less chance of passing the needle through the vessel when first puncturing through the skin.[22]

Figure 1.17 Superficial Veins

21. "the-elderly-g2ddfbcc36_1920.png" by f_qian on Pixabay is licensed under CC0
22. Simin, D., Milutinović, D., Turkulov, V., & Brkić, S. (2018). Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: An observational prospective study. *Journal of Clinical Nursing, 28*(9-10), 1585-1599. https://doi.org/10.1111/jocn.14760

General Guidelines for Maintaining Peripheral Venous Access Sites

Health care agencies have policies regarding site assessment, flushing, maintenance, and dressing changes. The following general guidelines apply to maintaining peripheral IV access sites:

- **Site assessment:** In inpatient and nursing facilities, peripherally inserted IV sites should be assessed at least every four hours and more frequently for patients receiving infusions of vesicant medications. Sites should be assessed every 1-2 hours for patients who are critically ill/sedated or have cognitive deficits and every hour for neonatal/pediatric patients.[23] In outpatient or home settings, the patient or caregiver should be taught to check the site every four hours during waking hours for signs of complications and immediately report concerns to their health care provider.[24]
- **Duration of site:** Traditionally, IV access sites were changed every 72-96 hours, but research indicates no clear difference in rates of infection, phlebitis, mortality, or pain if catheters are kept in place until IV therapy is complete or a complication occurs requiring site discontinuation.[25]
- **Routine flushing of saline locks:** When not in continuous use, saline locks should be flushed with two times the amount of external catheter length plus catheter (i.e., 5 mL in adults) with normal saline every 8-12 hours to ensure patency.[26]
- **Securement devices:** To maintain integrity of the IV site and prevent infiltration and other complications, proper securement devices should

23. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org
24. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org
25. Webster, J., Osborne, S., Rickard, C. M., & Marsh, N. (2019). Clinically-indicated replacement versus routine replacement of peripheral venous catheters. *The Cochrane Database of Systematic Reviews, 1*(1), CD007798. https://doi.org/10.1002/14651858.CD007798.pub5
26. Lee, P. T., & Terry, J. (2021). Changing practice to using pre-filled syringes for flushing IV cannulas. *British Journal of Nursing*, *30*(14), S14–S22. https://doi.org/10.12968/bjon.2021.30.14.S14

be used, when available, to keep the IV secure and prevent dislodgement. Examples of securement devices are stat locks, chevron tape, arm boards, and arm wraps.

- **Peripheral IV dressing changes:** Gauze dressings should be changed at least every two days and transparent dressings at least every seven days. They should be changed immediately if the dressing becomes visibly soiled, loosened, dislodged, or if there is any moisture, drainage, blood, or compromised skin.[27]
- **Site care:** Protective measures for the IV site include no tub baths or soaking and wrapping with a protective covering if showering. Restrictive clothing should be avoided, and blood pressure should be taken in an arm without an IV site present.

27. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharp, E., & Alexander, M. A. (2021). Infusion therapy standards of practice. *Journal of Infusion Nursing, 44*(Suppl 1S), S1–S224. https://doi: 10.1097/NAN.0000000000000396.org

1.4 Checklist: Perform Venipuncture Blood Draw

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Perform Venipuncture Blood Draw[1,2]

- Verify the provider's order.
- Review the patient's medical record for conditions that increase the risk of bleeding or hematoma formation and allergies to antiseptics, adhesive, and latex. Use an alternative product if necessary. Also, check the patient's medical record for factors that may affect peripheral vasculature.
- Gather the necessary supplies:
    - Clean gloves
    - Antiseptic solution/agent (such as an alcohol wipe, chlorhexidine, or povidone-iodine)
    - Needleless blood sampling access device (vacutainer) or syringes
    - Venipuncture needle or winged collection device
    - Single patient-use tourniquet
    - Blood specimen tubes and labels
    - Needleless connector
    - Labels
    - 2" x 2" gauze pads
    - Tape or adhesive bandage
    - Biohazard specimen transport bag or container
- Perform hand hygiene.
- Confirm the patient's identity using two patient identifiers per agency policy and ask if they have any allergies.
- Provide privacy.
- Explain the procedure.
- Ask whether the patient has ever felt faint, sweaty, or nauseated when having blood drawn. If so, place the patient in a supine position.

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com

- Raise the bed to a working level.
- Perform hand hygiene.
- Put on gloves and, as needed, other personal protective equipment.
- Position the patient's arm horizontally or slanting slightly downward.
- Inspect the patient's veins.
- Check if the patient has a history of easy bruising, increased risk of bleeding, compromised circulation, or fragile veins or skin.
- Apply a tourniquet about 2" (5 cm) above the site. Make sure that you can palpate an arterial pulse distal to the tourniquet. Be aware the tourniquet should only be applied for 2 minutes or less.
- Prepare the venipuncture site using an antiseptic agent. Apply the agent using a single-use sterile applicator. Allow the agent to dry completely.
- Immobilize the vein with the nondominant thumb or forefinger and thumb.
- Position the needle holder or syringe with the needle bevel up and the shaft parallel to the path of the vein at a 30-degree angle to the arm.
- Tell the patient you are about to perform the venipuncture.
- Insert the needle into the vein. Push the collection tube into the holder when the vein is cannulated.
- Release the tourniquet when blood begins to flow.
- Remove the first tube from the holder when the first tube fills. Continue to fill the tubes using the correct order of draw to avoid cross-contamination of the sample by additives found in different collection tubes (Review information about Order of Blood Draw Tubes.)[3] Remove each tube from the holder, gently invert it, and return it to its upright position.
- After drawing all samples, place a gauze pad over the puncture site, disengage an evacuated tube, and remove the needle from the vein. Do not remove the needle with the collection tube still in the vacutainer.
- Activate the needle protector safety device, if applicable.
- Apply pressure to the puncture site until bleeding stops.
- Apply an adhesive bandage or tape a gauze bandage to the needle

3. Clinical Lab Standards Institute. (2019, March 19). *Order of blood tube draws and additives*. https://clsi.org/about/blog/order-of-blood-draw-tubes-and-additives/

insertion site.
- If a syringe was used to collect the sample instead of a vacutainer, transfer the blood sample immediately to a collection tube.
- Carefully invert each collection tube according to the additive.
- Label all samples in the presence of the patient.
- Place the labeled specimen in a biohazard bag and transport it to the laboratory immediately per agency policy.
- Discard used supplies and place sharps into a sharps container.
- Remove the gloves and perform hand hygiene.
- In an inpatient setting, help the patient into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the patient knows how to use the call light to summon assistance. To ensure the patient's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Perform hand hygiene.
- Document the procedure and assessments.

Documentation Cues:

- Site and location of vein used, the appearance of the site, and the condition and type of dressing used over the blood draw site
- Date, time, and blood samples drawn
- Patient teaching
- Any unexpected outcomes, related nursing interventions, health care provider notification, and the patient's response to treatment
- Communication of laboratory results to the provider (if applicable)

View a YouTube video[4] showing an instructor demonstration of this skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=63#oembed-1

4. Chippewa Valley Technical College. (2023, January 5). *Performing venipuncture* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/CLVyxRY8lZU

1.5 Checklist: Perform IV Insertion & IV Removal

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: IV Insertion[1,2]

- Verify the provider's order.
- Review the patient's medical record for allergies to antiseptic solutions, adhesives, latex, and anesthetic agents. Also, review the medical record for factors that may affect peripheral vasculature.
- Gather the necessary supplies:
    - Clean/nonsterile gloves
    - Single-use tourniquet
    - Appropriate type and size of peripheral IV catheter based on patient status
    - Needless cap/extension tubing set
    - Appropriate antiseptic agent/pad based on client's allergy status (chlorhexidine-based, povidone-iodine, or 70% alcohol)
    - Prescribed IV solution or medication with attached and primed administration set (Refer to the "Checklist for Primary IV Solution Administration" in Open RN *Nursing Skills*.)
    - Sterile 10-mL prefilled syringe (or a syringe specifically designed to generate lower injection pressure) containing preservative-free normal saline solution
    - IV pole
    - Securement device (integrated securement device, subcutaneous anchor securement system, tissue adhesive, or adhesive securement device)
    - Transparent semipermeable dressing
    - Label

NOTE: Commercial IV insertion kits come with or without an IV access

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com

device. Many facilities keep venipuncture equipment on a tray or cart, enabling increased choice of access devices and easy replacement of contaminated items.

- Perform hand hygiene.
- Confirm the patient's identity using at least two patient identifiers and ask if they have any allergies.
- Provide privacy.
- Explain the procedure.
- If the patient is in bed in an inpatient setting, raise the patient's bed to waist level. Place the patient in a comfortable sitting or reclining position, leaving the arm in a dependent position.
- Apply a tourniquet on an upper extremity to dilate the veins and assess for an appropriate insertion site. Verify the radial pulse. If the intended site is visibly soiled, clean it with soap and water. Clip the hair around the insertion site if needed. Administer a local anesthetic, if indicated and prescribed.
- Assess the veins in the upper extremity and identify potential sites that are easily seen or palpated. Choose an insertion site based on the assessment findings.
- Lightly palpate the site of the selected vein without visible valves or bifurcations with the index and middle fingers of the nondominant hand. Stretch the skin to anchor the vein. If it feels hard or ropelike, select another vein. If the vein is easily palpable but not sufficiently dilated, place the extremity in a dependent position for several seconds or lightly stroke the vessel. Apply dry heat, if necessary.
- Release the tourniquet for site preparation.
- Perform hand hygiene and put on gloves**.**
- Open and prepare the supplies. Flush the needleless cap/extension set with normal saline and keep the syringe attached. Maintain the sterility of the end of the connector.
- Clean the intended insertion site and surrounding skin with a facility-approved antimicrobial, and then allow it to dry completely.
- Reapply the tourniquet. Verify the radial pulse.

- Using the thumb of the nondominant hand, stretch the skin taut below the puncture site to stabilize the vein.
- Tell the patient that the device will be inserted.
- Place the short peripheral catheter on top of the vein at a 10- to 15-degree angle from the skin. Puncture the skin and anterior vein wall, watching for blood to appear in the catheter, flashback chamber, or both. Lower the catheter until almost flush with the skin. Advance the needle slightly into the vein after flashback is observed to ensure the needle tip and cannula are inserted into the vein.
- After inserting the IV catheter into a patient's vein, do not let go until it has been properly secured to prevent accidental dislodgment.
- While continuing to hold the skin taut, use the device's push-off tab to separate the catheter from the needle stylet. Advance the catheter into the vein.
- Release the tourniquet.
- Activate the device's safety mechanism, as applicable, to cover the needle following the manufacturer's instructions for use.
- Stabilize the catheter hub while attaching the extension set to the catheter hub and tighten the Luer lock, making sure the Luer lock does not come in contact with the patient's skin and maintaining sterility of the insertion site and Luer lock.
- Slowly aspirate to assess for blood return that is the color and consistency of whole blood. If no blood return occurs, take steps to locate an external cause of obstruction. It may be necessary to slightly withdraw the catheter if the tip is against a valve in the vein.
- If blood return occurs, slowly inject preservative-free normal saline solution into the catheter according to facility policy while ensuring there is no swelling of surrounding tissue.
- Clamp the catheter.
- Remove and discard the syringe.
- Stabilize and secure the catheter using an engineered stabilization device, if available. If an engineered stabilization device is unavailable, secure the catheter with sterile tape.
- Using sterile technique, apply a transparent semipermeable dressing over

the insertion site, following the manufacturer's instructions.
- Curl the extension set to the side and tape it to the inside of the patient's arm if needed for extra securement.
- Label the dressing with the current date or the date the dressing is due to be changed, as directed by agency policy.
- Discard needle(s) into a sharps container.
- Dispose of used equipment in appropriate receptacles.
- Remove and discard gloves and other personal protective equipment, if worn.
- Perform hand hygiene.
- In an inpatient setting, help the patient into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the patient knows how to use the call light to summon assistance. To ensure the patient's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Perform hand hygiene.
- Document the procedure and assessments.

View a YouTube video[3] showing an instructor demonstration of the IV insertion skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=65#oembed-1

3. Chippewa Valley Technical College. (2023, January 5). *Inserting an IV* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/Vl7VPU6oo8U

Checklist: IV Removal[4,5]

- Gather the appropriate equipment:
    - Disposable gloves
    - Sterile 2” X 2” dressing
    - Antiseptic swab
    - Tape
- Remove the tape and dressing while keeping the cannula secure (pull toward insertion site).
- Clean the site with an alcohol swab if noted by facility policy. Use caution around the open puncture site, which may be sensitive to alcohol.
- Remove the cannula with slow steady motion and then apply light pressure to the site with a 2” X 2” sterile dressing for a minimum of 30 seconds until bleeding has stopped. *Note:* Apply pressure for at least 5 to 10 minutes if the patient is on anticoagulant therapy or has bleeding tendencies.
- Maintain the folded pressure dressing over the insertion site and secure with tape.
- Inspect the catheter for intactness after removal by noting the integrity and length of the catheter tip.
- If specimen cultures of the catheter tip are ordered, cut the distal tip of the catheter with sterile scissors and place it in a sterile specimen container.
- Monitor for complications such as bleeding, pain, exudate, and swelling.
- Inspect the IV insertion site for signs of complications resulting from infusion therapy and report any concerns.
- Apply a sterile, folded gauze dressing over the insertion site, and secure it with tape.
- Discard the IV catheter in the regular trash or sharps container, based on agency policy.
- Discard the used supplies, remove gloves, and perform hand hygiene.

4. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
5. Lippincott procedures. http://procedures.lww.com

- If in an inpatient setting, help the patient into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the patient knows how to use the call light to summon assistance. To ensure the patient's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Remove other personal protective equipment, if worn.
- Perform hand hygiene.
- Document the procedure and assessments.
- Monitor for complications such as bleeding, pain, exudate, and swelling.

Documentation Cues

- Procedure, location, and IV site assessment prior to removal
- IV catheter tip assessment and intactness
- Type and size of cannula removed
- Type of dressing applied
- Patient's tolerance of procedure and patient education provided
- Unexpected outcomes and related nursing interventions

View a YouTube video[6] showing an instructor demonstration of the IV removal skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=65#oembed-2

6. Chippewa Valley Technical College. (2023, January 5). *Removing an IV* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/-FOvDjZkIv4

1.6 Documentation for IV Initiation

Documentation Cues:

Accurate and complete documentation regarding IV initiation should include the following:

- Date/Time of procedure
- Manufacturer's brand name of device
- Gauge and length of device
- Location of the accessed vein
- Use of local anesthetic
- Number of attempts for a successful IV start
- Description of the insertion site, such as "cephalic vein on dorsal surface of right lower arm, 2.5 cm (1 inch) above the wrist"
- Condition of extremity and IV site
- Type of dressing with which the cannula was secured
- Patient's tolerance of the procedure and patient education provided
- If saline lock was established or if fluid was infused after IV initiation. If fluid was infused, the method of infusion (gravity or infusion pump), type and rate of infusion should be included.
- Patient's status and integrity and patency of the system according to agency policy

Sample Documentation:

12/7/20XX 0845

Obtained peripheral IV access as ordered by provider. A suitable vein was identified in the patient's right hand, and the site was cleansed with chlorhexidine per protocol. A 20-gauge 1-inch Protect IV was placed in the patient's right hand. The vein was cannulated with one attempt, and no complications were noted during cannulation. The catheter was freely threaded into the vein after blood return was noted, and the site was flushed with normal saline and clamped. The site was dressed with a sterile tegaderm dressing and extension set tubing was secured. Following application of the dressing, the site was saline locked. The patient tolerated the procedure well with no signs of redness, swelling, or other complications.

Janika Smith, RN

1.7 Specialized Infusions

In addition to the provision of IV fluid therapy and medication administration via the intravenous route, nurses must also be aware of specialized infusions and the safety implications that may be associated with these types of infusions. Two types of specialized infusions include medication administered via a patient-controlled analgesia (PCA) pump and those administered via epidural infusion. There are many unique advantages and risks associated with specialized infusions, and nurses must be aware of the safety implications and associated interventions to ensure quality patient care.

Patient-Controlled Analgesia

Patient-controlled analgesia (PCA) is a method of pain management that allows hospitalized patients with severe pain to safely self-administer opioid medications using a programmed pump according to their level of discomfort. A computerized pump contains a syringe of pain medication and is connected directly to a patient's intravenous (IV) line. Doses of medication can be administered as either a basal (i.e., continuous) rate, self-administered as needed on demand, or a combination of both methods. Doses are self-administered by the patient by pressing a button that initiates a "demand" for medication. However, the pump is programmed to only allow administration of medication every set number of minutes with a maximum dose of medication every hour. These pump settings and the design of the system require the patient to be alert enough to press the button to receive a demand dose. These design features are safety measures to help prevent overmedication that can cause sedation and respiratory depression. However, despite these safety measures it is vital for nurses to closely monitor patients receiving PCA for respiratory depression.[1] See Figure 1.18[2] for an image of a PCA pump.

1. Soffin, E. M., & Liu, S. S. (2018). Patient-controlled analgesia. In H. T. Benzon, S. N. Raja, S. M. Fishman, S. S., & S. P. Cohen's (Eds.). *Essentials of pain medicine* (4th ed., pp. 117-122.e2). Elsevier. https://doi.org/10.1016/B978-0-323-40196-8.00013-9
2. "alaris-pca-module-IF-0518-0034" by unknown author used on the basis of Fair Use. Access original image at https://www.bd.com/en-us/products-and-solutions/products/product-families/bd-alaris-pca-module.

Figure 1.18 PCA Pump. Used under Fair Use.

Patient-controlled analgesia can be very beneficial for select patients, reducing the time for medication administration and allowing pain medication to reach the patient more rapidly to reduce pain symptoms. This can help prevent out-of-control pain levels that require a significant length of time to resolve. The principles behind the method of patient-controlled analgesia involve the patient's experience of pain, subsequent administration of a drug via the PCA pump, the drug action within the bloodstream, and the patient response. Depending on the level of pain relief, the patient may experience symptom resolution or may proceed with a dose demand process by activating the PCA pump at a subsequent interval. The patient becomes an active party in medicating themselves to help control the pain experience.

It is critical that patients who are prescribed a PCA pump with demand dosing understand the safety principles behind the medication administration. Patients and their family members must be aware that only the patient is allowed to initiate the demand dose by pressing the medication button to ensure they are alert enough to do so. In this manner, oversedation

and life-threatening respiratory depression can be avoided with demand dosing.

Additionally, patients should receive education regarding the frequency with which they will receive a demand dose in order to be reassured that they cannot accidentally overdose themselves by pressing the demand button too frequently. Cues such as an audible “beep” often accompany the demand dose and can help cue the patient that the medication was administered. Conversely, if the demand button has been initiated too closely within the programmed interval, an audible “chirp” may signal to the patient that the demand dose was too soon. The patient should receive instruction that if the chirp has been noted, they may wish to wait a few minutes and reinitiate the demand.

Patients with impaired cognition or restricted upper extremity dexterity may not be appropriate for PCA. If a nurse has concerns regarding the appropriateness of self-administration of pain medication via a PCA pump based on characteristics and clinical condition of an individual patient, the prescribing provider should be notified, and alternate pain control measures should be considered.

The basic principles of a PCA medication order include the following:

Loading dose: Ordered amount of medication administered at the time of PCA initiation

Demand dose: Medication dose given on activation of demand (pressing the demand button)

Lockout interval: Time period in which no follow-up demand dose may be administered (even if demand button is activated)

Basal infusion: Continuous rate of medication administration, regardless of demand attempts

Lockout maximum: The maximum dose of medication that can be administered within a certain period, commonly prescribed to 1 hour limit

Breakthrough bolus dose: A dose of opioid or non-opioid medication administered by the nurse for breakthrough pain.

Medications that are commonly prescribed for PCA administration include opioids such as morphine, hydromorphone, and fentanyl. Nurses must be familiar with specific institutional policies and protocols regarding the use of

PCA administration. These protocols commonly include the use of specific provider orders, safety checks, and patient monitoring. Many organizations have transitioned to the use of preprinted PCA order sets to help guarantee that required PCA dosing parameters are appropriately addressed. Within a PCA order, the prescriber must include the following information: identification of the specific medication to be used in the PCA pump, the medication concentration, the specific quantity of the demand dose, the lockout interval, and the order lockout maximum. When a nurse is initiating a PCA pump, it is critical that the order be reviewed and verified with another registered nurse according to agency policy. The double-check verification helps ensure that the pump is programmed correctly, and lockout limits are included to decrease the risk of accidentally self-administering too much medication.[3]

Due to the potential adverse effects of opioids administered via a PCA pump, there is a significant risk for patient safety requiring specific monitoring by the nurse. Continuous pulse oximetry, end tidal carbon dioxide monitoring, and frequent vital signs monitoring may be required with initiation and ongoing use of a PCA pump. Individuals with obstructive airway disease, sleep apnea, obesity, renal or hepatic impairment, and recent analgesia, sedation, or anesthesia are at increased risk of complications associated with PCA administration, such as decreased level of consciousness, respiratory distress, and hypotension.[4] Dosing parameters must account for patient specific factors and individualized clinical need when initiated by the prescribing provider. Additionally, nurses must be especially vigilant when first initiating PCA infusion because initial infusion is when administration complications may be more frequently observed.

3. Soffin, E. M., & Liu, S. S. (2018). Patient-controlled analgesia. In H. T. Benzon, S. N. Raja, S. M. Fishman, S. S., & S. P. Cohen's (Eds.). *Essentials of pain medicine* (4th ed., pp. 117-122.e2). Elsevier. https://doi.org/10.1016/B978-0-323-40196-8.00013-9
4. Soffin, E. M., & Liu, S. S. (2018). Patient-controlled analgesia. In H. T. Benzon, S. N. Raja, S. M. Fishman, S. S., & S. P. Cohen's (Eds.). *Essentials of pain medicine* (4th ed., pp. 117-122.e2). Elsevier. https://doi.org/10.1016/B978-0-323-40196-8.00013-9

Please review the "Adverse Effects of Opioids" section in Open RN *Nursing Fundamentals* for more information about potential patient side effects.

Nursing staff must also be cognizant of the post-administration assessment and individualized response of each patient to PCA. Even though the patient is actively participating in their pain control plan through self-administration, pain response must be thoroughly documented. Nurses must frequently assess the patient's number of demands and subsequent doses received. Nurses should also carefully monitor the patient's vital signs, pain self-report, and nonverbal indications of the pain experience. This focused pain assessment helps ensure that the pain level is adequately controlled.

The use of PCA pumps require vigilant checks by two licensed registered nurses minimally at the start of every shift. The secure PCA pump holds the prescribed opioid medication in a locked device with a demand button that is given to the patient. Keys to the PCA pump are safely stored in secure areas such as within an automated drug dispensing machine. The pumps also have an access code to ensure that tampering with the pump settings does not occur. To document the amount and frequency of pain medication the patient is receiving, as well as to prevent drug diversion, the settings on the pump are checked at the end of every shift as part of the bedside report. The incoming and outgoing nurses double-check and document the pump settings, the amount of medication administered during the previous shift, and the amount of medication left in the syringe. When a PCA is discontinued, nurses must carefully document the remainder of medication left in the PCA syringe and follow organizational policies related to narcotic wasting and documentation.

PCA pumps often have specialized tubing and connections to prevent inadvertent connection of secondary medication to the dedicated PCA line above the pump. If a bolus of medication is administered via a dedicated PCA

line below the pump, the nurse must ensure it is compatible with the PCA medication.

Epidural

Epidural medication administration is a type of specialized infusion that is different than intravenous infusion. The use of an epidural involves administering analgesics and anesthetics directly into the spinal fluid via an epidural catheter for severe pain management. It is inserted by specially trained health professionals and requires additional safety measures and nurse monitoring to help prevent patient complications. Safety measures such as specially colored tubing and different Luer lock systems are incorporated to ensure only epidural medications are administered via the epidural line.

Epidurals are typically used with surgical procedures or during labor and delivery. Epidural infusions may also be used to treat chronic pain that has not responded to more conservative treatments. Common anesthetics that are used in epidural infusions include bupivacaine and ropivacaine administered alone or in combination with opioid medications. Anesthetics and analgesics administered via the epidural route work synergistically (i.e., cooperatively) to provide greater pain relief at lower doses.[5] See Figure 1.19[6] for an image of an epidural pump with colored tubing and an image of freshly inserted lumbar epidural catheter. The epidural site has been prepared with tincture of iodine, and the dressing has not yet been applied.

5. Benzon, H. T., Raja, S., Liu, S. S., Fishman, S., Cohen, S. P., & Hurley, R. W. (Eds.). (2018). *Essentials of pain medicine* (4th ed., pp. 117-122.e2). Elsevier. https://doi.org/10.1016/C2014-0-03837-3
6. "PCA-01.JPG" by DiverDave is licensed under CC BY-SA 3.0 and Epidural.JPG" by User:Ravedave is licensed under CC BY-SA 3.0

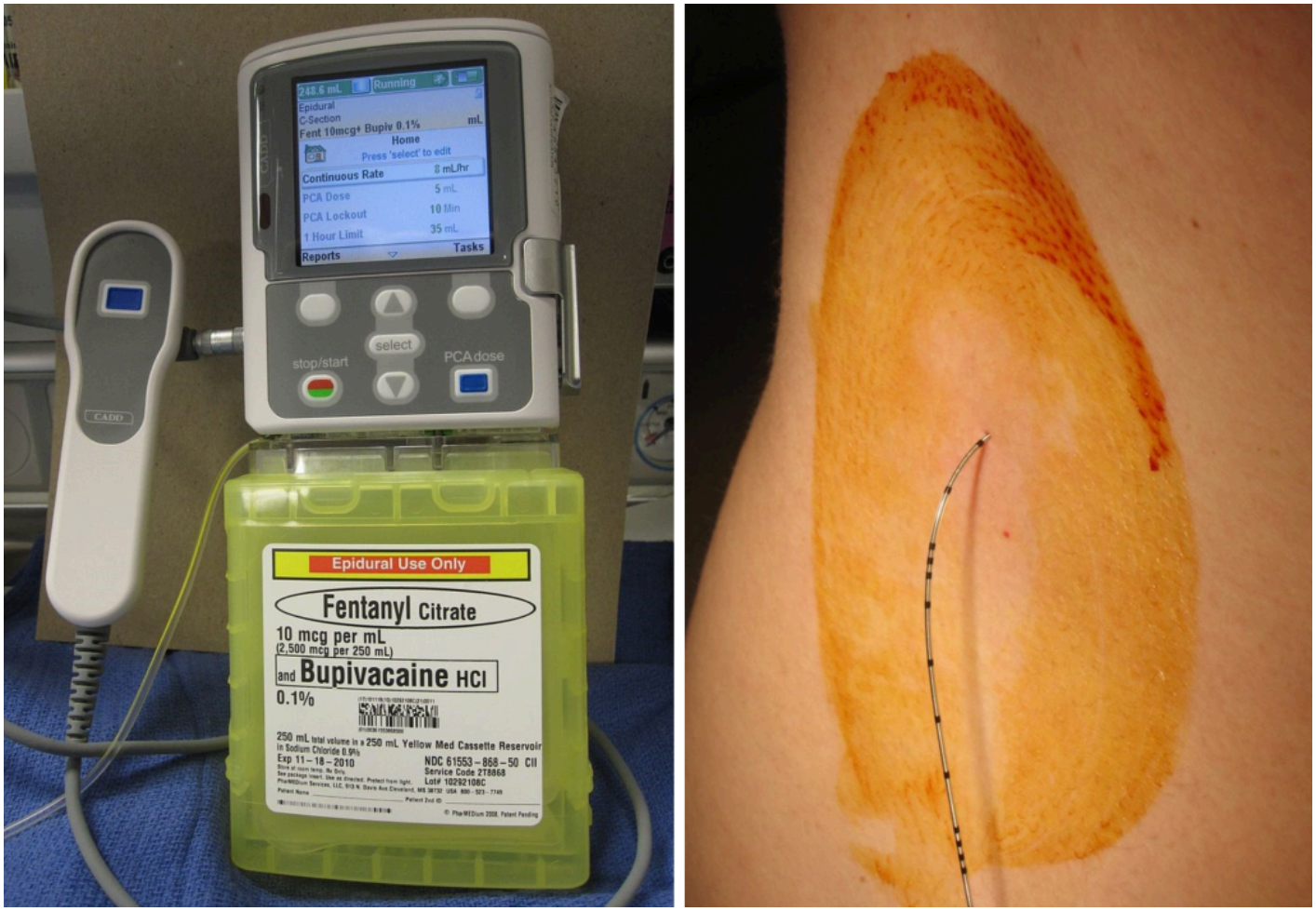

Figure 1.19 Epidural Pump and Epidural

Epidural catheters are inserted and may only be repositioned by trained anesthesia professionals. The anesthesia provider will administer a test dose of medication into the epidural to ensure that it is appropriately positioned. Once adequate positioning has been confirmed, the anesthesia provider will record the documented **block height** by assessing the patient's response to cold at various levels of the thoracic spine. This should be recorded in the patient's chart and is the subsequent block height for all future neurosensory assessments. Any block level that progresses up the body or is recorded above a level of T4 (fourth thoracic vertebra) must be immediately

communicated to the anesthesia provider to prevent respiratory distress and cardiovascular collapse.[7]

Once the catheter has been inserted and the position safely confirmed, a prescribing provider will order the medication for epidural infusion. The order must contain the medication name, concentration, and infusion rate. The epidural pump is similar to a PCA pump in that it must be locked and the infusion settings securely programmed. Some epidural pumps allow patients to self-administer on-demand doses. The initiation of the epidural medication may involve setting the pump to infuse at a constant rate or by providing an initial bolus dose and then a constant infusion rate.

Nurses caring for patients receiving epidural medications must monitor patient response to the medication and the epidural insertion site for potential complications associated with epidural infusion. Follow agency policy regarding focused assessments that typically include the patient's pain management response, vital signs, and motor/sensory checks. Signs of respiratory depression must be carefully monitored and reported to the provider if the patient exhibits a respiratory rate of less than eight breaths/minute, declining oxygen saturation, or decreased level of consciousness. Nurses must also carefully observe the patient's blood pressure and heart rate with epidural analgesia. Changes in vital signs may be associated with the epidural infusion but can also be the result of post-procedural complications, so vigilant postoperative monitoring must occur. Patients receiving epidural administration are also at risk for bradycardia, so atropine should be readily available in case the patient experiences symptomatic bradycardia.[8,9]

Nurses should be prepared to assess for signs of potential clinical problems associated with epidural usage. Table 1.7 summarizes common clinical problems associated with epidural infusions.

7. Galligan, M. (2020). Care and management of patients receiving epidural analgesia. *Nursing Standard, 35*(12), 77-82. https://doi.org/10.7748/ns.2020.e11573
8. Galligan, M. (2020). Care and management of patients receiving epidural analgesia. *Nursing Standard, 35*(12), 77-82. https://doi.org/10.7748/ns.2020.e11573
9. Woodall, W. G. (2019). Care for the patient receiving epidural analgesia. *Medsurg Nursing, 28*(3), 194-195. https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/scholarly-journals/care-patient-receiving-epidural-analgesia/docview/2242627838/se-2?accountid=12085

Table 1.7 Clinical Problems and Interventions With Epidural Infusions[10,11]

Clinical Problem	Potential Interventions
Inadequate pain control; partial block	Work with the anesthesia provider to adjust the patient's position or increase infusion rate. If the block is one-sided, position the patient painful side down to allow gravity to assist the medication to travel down the nerves on the side of pain.
Hypotension	Hypotension may occur with epidural use due to the dilation of blood vessels. Notify the provider. The epidural rate may need to be decreased or bolus fluids administered. The patient may require placement in Trendelenberg position.
Bradycardia	May occur as the result of blockage of sympathetic nerves. If symptomatic, notify the provider and anticipate possible administration of atropine.
Increasing sensation block height/difficulty breathing	The patient may first report signs of tingling in fingers, especially the fifth digits. Notify the provider, turn off infusion, elevate the patient's head, and administer oxygen.
Motor blockage	Leg weakness may occur as a result of an epidural block to the low motor nerves. A reduction in rate may be needed if significant paralysis is experienced. Be cautious of mobility implications associated with reduced sensation.
Respiratory depression	If a patient experiences respiratory depression of less than eight breaths per minute, stop the infusion and notify the provider. If indicated, request emergency assistance and administer rescue breaths via a bag-valve-mask.
Catheter disconnection	Disconnection of the epidural line presents an increased infection risk. Immediately contact the anesthesia provider, but do NOT reconnect the line. The end of the line may be covered with sterile gauze, according to agency policy, until the anesthesia provider arrives.
Catheter migration	Migration of the epidural catheter into a blood vessel may result in exacerbated respiratory depression and sedation. Monitor the patient for any report of tingling around the mouth, numbness, twitching, convulsion, or cardiac arrest. Immediately stop the epidural infusion and provide emergency assistance and cardiopulmonary support.

10. Galligan, M. (2020). Care and management of patients receiving epidural analgesia. *Nursing Standard, 35*(12), 77-82. https://doi.org/10.7748/ns.2020.e11573
11. Woodall, W. G. (2019). Care for the patient receiving epidural analgesia. *Medsurg Nursing, 28*(3), 194-195. https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/scholarly-journals/care-patient-receiving-epidural-analgesia/docview/2242627838/se-2?accountid=12085

Common side effects of epidural medication infusion include nausea and itching associated with the specific medications included in the infusions. Many times, these side effects can be adequately managed with medications, and the epidural infusion may continue. Another common side effect is urinary retention. Nurses should monitor urine output for patients who do not have a urinary catheter in place. Intermittent or indwelling catheterization may be required to drain the bladder and prevent discomfort.[12,13]

Review a handout on how to assess sensation and motor function for a patient receiving epidural anesthesia.

12. Galligan, M. (2020). Care and management of patients receiving epidural analgesia. *Nursing Standard, 35*(12), 77-82. https://doi.org/10.7748/ns.2020.e11573
13. Woodall, W. G. (2019). Care for the patient receiving epidural analgesia. *Medsurg Nursing, 28*(3), 194-195. https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/scholarly-journals/care-patient-receiving-epidural-analgesia/docview/2242627838/se-2?accountid=12085

Exercises

(Answers to the exercises are located in the Answer Key at the back of the book).

Case Study #1

Eli, age 4, arrives at Urgent Care with his grandmother; he is staying with his grandparents while his parents are on vacation. Eli was playing in the woods behind his grandparents' home today while his grandpa was clearing brush and returned to the house with a raised, red rash on the left side of his face and arms and hands bilaterally. "I am really itchy," Eli says, "And my face and arms really hurt." His grandmother states that they have seen poison ivy in the woods in the past, and Eli's grandpa didn't warn him before they went out today. You notice as you observe Eli that he is itching his arms, and his left eye appears swollen.

The MD gives you the following orders:

- Start a peripheral IV STAT
- Administer diphenhydramine 25 mg IV now and q8h prn for rash

1. What should you consider when initiating an IV for Eli?

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=69#h5p-1

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=69#h5p-2

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=69#h5p-3

Test your knowledge using a NCLEX Next Generation-style question. You may reset and resubmit your answers to this question an unlimited number of times.

I Glossary

Air embolism: The presence of air in the vascular system that occurs when air is introduced into the venous system and travels to the right ventricle and/or pulmonary circulation.

Arterial blood sampling: Blood is obtained via venipuncture into an artery.

Basal infusion: Continuous rate of medication administration, regardless of demand attempts.

Block height: Level of epidural nerve block recorded by assessing the patient's response to cold at various levels of the thoracic spine.

Blown vein: A ruptured vein that is leaking blood.

Breakthrough bolus dose: A dose of opioid or non-opioid medication administered by the nurse for breakthrough pain when a patient is receiving patient-controlled analgesia.

Capillary blood testing: A blood sample collected from the capillary blood vessels (i.e., tiny blood vessels located near the surface of the skin).

Catheter embolism: An embolism that occurs when a small part of the cannula breaks off and flows into the vascular system.

Catheter-related bloodstream infection (CR-BSI): An infection caused by microorganisms introduced into the bloodstream through the puncture site, the hub, or contaminated IV tubing or IV solution, leading to bacteremia or sepsis. A CR-BSI is a hospital-acquired preventable infection and considered an adverse event.

Central venous access device (CVAD): A type of vascular access that involves the insertion of a tube into a vein in the neck, chest, or groin and threaded into a central vein (most commonly the internal jugular, subclavian, or femoral) and advanced until the terminal lumen resides within the inferior vena cava, superior vena cava, or right atrium.

Demand dose: Medication dose given on activation of demand (pressing the demand button).

Epidural: Administration of analgesics and anesthetics into the spinal fluid via an epidural catheter for severe pain management associated with surgical procedures or during labor and delivery.

Extravasation: A condition that occurs when vesicant solution (medication) is administered and inadvertently leaks into surrounding tissue, causing

damage to surrounding tissue. It is characterized by the same signs and symptoms as infiltration but also includes burning, stinging, redness, blistering, or necrosis of the tissue.

Hypertonic solutions: IV fluids with a higher concentration of dissolved particles than blood.

Hypotonic solutions: IV fluids with a lower concentration of dissolved solutes than blood.

Infiltration: A condition that occurs when a nonvesicant solution (IV solution) is inadvertently administered into surrounding tissue. Signs and symptoms include pain, swelling, redness, the skin surrounding the insertion site is cool to touch, there is a change in the quality or flow of IV, the skin is tight around the IV site, IV fluid is leaking from IV site, or there are frequent alarms on the IV pump.

Intravenous therapy (IV therapy): Administration of a substance directly into a person's vein.

Isotonic solutions: IV fluids with a similar concentration of dissolved particles as blood.

Loading dose: Ordered amount of medication administered at the time of PCA initiation.

Lockout interval: Time period in which no follow-up demand dose may be administered (even if demand button is activated).

Lockout maximum: The maximum dose of medication that can be administered within a certain period, commonly prescribed to 1 hour limit.

Midline peripheral catheters: Larger peripheral catheters (i.e., 16-18 gauge) that allow for rapid infusions and blood sampling and can be used for longer duration that traditional peripheral catheters. They are ultrasound-guided and can be inserted by RNs with additional training or other trained professionals.

Patient-controlled analgesia (PCA): A method of pain management that allows hospitalized patients with severe pain to safely self-administer opioid medications using a programmed pump according to their level of discomfort.

Peripheral IV (PIV): A short intravenous catheter inserted by percutaneous

venipuncture into a peripheral vein and held in place with a sterile transparent dressing.

Peripheral inserted central catheter (PICC): A thin, flexible tube inserted into a vein in the upper arm and guided into the superior vena cava used to give intravenous fluids, blood transfusions, chemotherapy, and other medications.

Phlebitis: The inflammation of the vein's inner lining, the tunica intima. Clinical indications are localized redness, pain, heat, and swelling that can track up the vein leading to a palpable venous cord.

Pulmonary edema: A condition caused by excess fluid accumulation in the lungs due to excessive fluid in the circulatory system. It is characterized by decreased oxygen saturation; increased respiratory rate; fine or coarse crackles in the lung bases; restlessness; breathlessness; dyspnea; and coughing up pink, frothy sputum. Pulmonary edema requires prompt medical attention and treatment.

Saline locks: A short extension set that allows intermittent IV access without ongoing infusion.

Total parenteral nutrition (TPN): A concentrated solution that is ordered for a patient based on their specific electrolyte and nutritional needs.

Venipuncture: The process of introducing a needle into a patient's vein to collect a blood sample or insert an IV catheter.

PART II

CHAPTER 2 ADMINISTER IV PUSH MEDICATIONS

2.1 Introduction

Learning Objectives

- Explain the advantages, disadvantages, and precautions associated with IV medication administration
- Identify information that must be checked before an IV push medication is administered
- Define “speed shock” and measures to prevent it from occurring
- Compare the procedure for administering an IV push medication through a primary IV line versus through a saline lock

In acute care settings, nurses frequently administer medications via the intravenous (IV) route. Medications may be administered through a primary line that is already infusing fluids or through a saline lock inserted into a patient’s vein with direct access to the bloodstream. Medications given via the IV route enter the bloodstream immediately, so extreme caution must be observed while performing this procedure. Administering medications via the IV route requires diligent attention to the rights of medication administration and IV safety. When utilized appropriately, medications administered via IV push can provide rapid symptom resolution and therapeutic effect. There are many advantages and potential disadvantages to using the IV route for administering medications; therefore, a nurse must have a strong understanding of its benefits, risks, and safety implications.

2.2 Basic Concepts of IV Push Medication

There are several advantages, disadvantages, and potential complications that can occur when administering IV push medication, requiring the nurse to implement many safety considerations.

Advantages

Intravenous push (IV push) is a process of introducing a medication or fluid substance directly into the bloodstream via the venous system. When the medication is administered directly into the bloodstream, it immediately enters the circulatory system and travels to a site of action. Administering the medication directly into the bloodstream reduces the **first-pass effect** or the action that occurs when a medication must be first metabolized or broken down prior to entering the blood. First-pass effect results in a diminished volume of available circulating drug and a subsequent decrease in therapeutic action.[1] As a result, when utilizing IV push medications, a decreased dosage of medication can be given compared to an oral dosage to achieve the same therapeutic effect.

First-pass metabolism significantly impacts the bioavailability of many medications. For example, larger oral doses of morphine must be provided than intravenous dosages to obtain the same therapeutic pain relief, but the risks of oversedation and respiratory depression are higher with intravenous doses. Nurses who have concerns about an ordered dose of intravenous medication should clarify the dosage with the pharmacist and/or prescribing provider before administering it.

Intravenous medication administration also has a more rapid onset than oral medication. Because the bioavailability of the medication is directly in the circulatory system, the medication is readily transported to the site of action. This is a significant benefit when a rapid response is needed, such as when clients are experiencing severe hemodynamic instability or severe pain.

Let's consider the following scenario: A nurse on a medical telemetry unit received a direct admission from a cardiac clinic for an 85-year-old male client

1. This work is a derivative of StatPearls by Herman & Santos and is licensed under CC BY 4.0

admitted with an exacerbation of chronic heart failure. The client's vital signs are heart rate 102, blood pressure 144/88, respiratory rate 24, and pulse oximetry reading of 90% on room air. The nurse listens to the client's lung sounds and notes crackles in both posterior lungs. The nurse reviews the admitting orders from the provider and sees an order for furosemide 40 mg IV push STAT. Review furosemide's drug action profile in Table 2.2a and note the different onsets of action for the different routes of furosemide. It is clear that the IV push route of administration will work quickly to remove this client's excess fluid and positively impact their respiratory status.

Table 2.2a Furosemide Drug Action Profile[2]

Route	Onset	Peak
PO	30-60 minutes	1-2 hours
IM	10-30 minutes	Unknown
IV	5 minutes	30 minutes

Intravenous medication administration can also be of great benefit when clients are experiencing gastrointestinal issues that may affect absorption, such as impaired swallowing or esophageal, stomach, or intestinal absorption issues. Administering a medication directly into the cardiovascular system allows the substance to freely circulate throughout the body and bypass the breakdown and absorption barriers created by the gastrointestinal tract. See Figure 2.1[3] for an image of a nurse administering IV push medication.

2. Vallerand, A. H., & Sanoski, C. A. (2023). Furosemide. *Davis's drug guide for nurses* (18th ed.). F.A. Davis. https://www.drugguide.com/ddo/view/Davis-Drug-Guide/51345/all/furosemide
3. "Stem-cells-iv-administration-dmd-ama-regenerative-medicine.jpg" by Alice Pien, MD is licensed under CC BY-SA 4.0

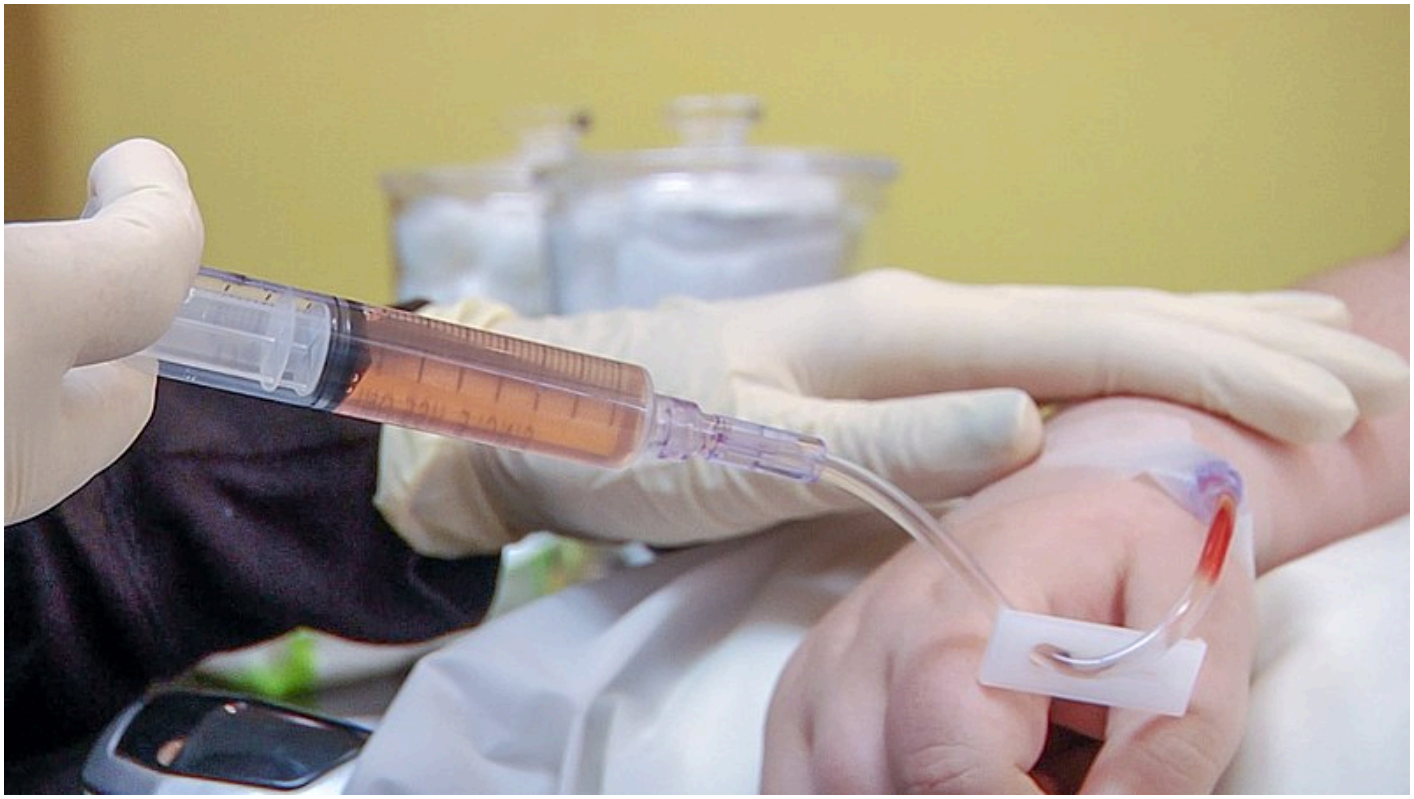

Figure 2.1 Administering IV Push Medication

In addition to rapid onset, some medications are only formulated to administer via the IV route, such as certain vasoactive substances. As a result, many patients who are hospitalized may have an "IV lock" inserted to facilitate rapid IV access if their condition deteriorates. An **IV lock** (also referred to as a "saline lock") is an IV cannula that has been inserted into a peripheral vein with a short extension tube that is filled with saline and clamped to keep the cannula patent. This type of IV access may also be referred to as a "peripheral lock" because it is inserted into the peripheral vasculature. Historically, many IV locks were flushed with heparin to keep the line from clotting, so they were referred to as a "heparin lock" or "hep lock." Although evidence-based practice no longer recommends heparin be used to maintain patency of a peripheral IV access device, the name "hep lock" may still be used in practice. An IV lock is beneficial because it provides rapid access to administering medications in the venous system if needed, but continuous infusion of medication or fluid is not required.

IV push medication can also be a valuable alternative route of administration for clients at risk for fluid volume overload. For example, clients who are experiencing acute renal failure or an acute exacerbation of heart failure may benefit from IV push

medications administered with smaller amounts of fluids compared to a typical IV infusion of medication.[4]

One of the most obvious benefits of IV push medication administration from a client's perspective is that it does not require repeated needlesticks for administering repetitive doses of medications intramuscularly or subcutaneously. As a result, client discomfort is minimized when intravenous access can be maintained.

Disadvantages and Potential Complications

When administering IV push medication, nurses must always proceed with significant caution. Remember that medication administered via IV push cannot be retrieved! For this reason, it is vital for the nurse to perform the rights of medication administration before giving IV push medications. The rights of medication administration are reviewed in the "Safety Concepts" subsection later in this section.

Prior to administration, the nurse must carefully review the client's current IV solutions and/or medications for incompatibilities with the medication to be administered. Many maintenance fluids (i.e., fluids given intravenously to facilitate hydration status) may include additives like electrolytes that may not be compatible with all medications. Nurses must ensure that all components are compatible with one another to ensure that a precipitate does not form when the substances come into contact with one another. A **precipitate** is the formation of small crystals as the incompatible substances come in contact with one another. Precipitate can occlude the infusion catheter line, inactivate the medications, or create an embolism, putting the client at significant risk for harm.[5] See Figure 2.2[6] for an example of a client's existing fluids and medications being infused that must be checked for compatibility

4. Spencer, S., Ipema, H., Hartke, P., Krueger, C., Rodriguez, R., Gross, A. E., & Gabay, M. (2018). Intravenous push administration of antibiotics: Literature and considerations. *Hospital Pharmacy, 53*(3), 157–169. https://doi.org/10.1177/0018578718760257
5. Institute for Safe Medication Practices. (2017, April 6). *Two unsafe practices: Administration of a product with a precipitate and reuse of a saline flush syringe*. https://www.ismp.org/resources/two-unsafe-practices-administration-product-precipitate-and-reuse-saline-flush-syringe#:~:text=If%20a%20precipitate%20is%20observed,organ%20failure%20or%20even%20death
6. "IV_pole_top_portion.JPG" by BrokenSphere is licensed under CC BY-SA 3.0

before IV push medication is administered in the same line and/or access site.

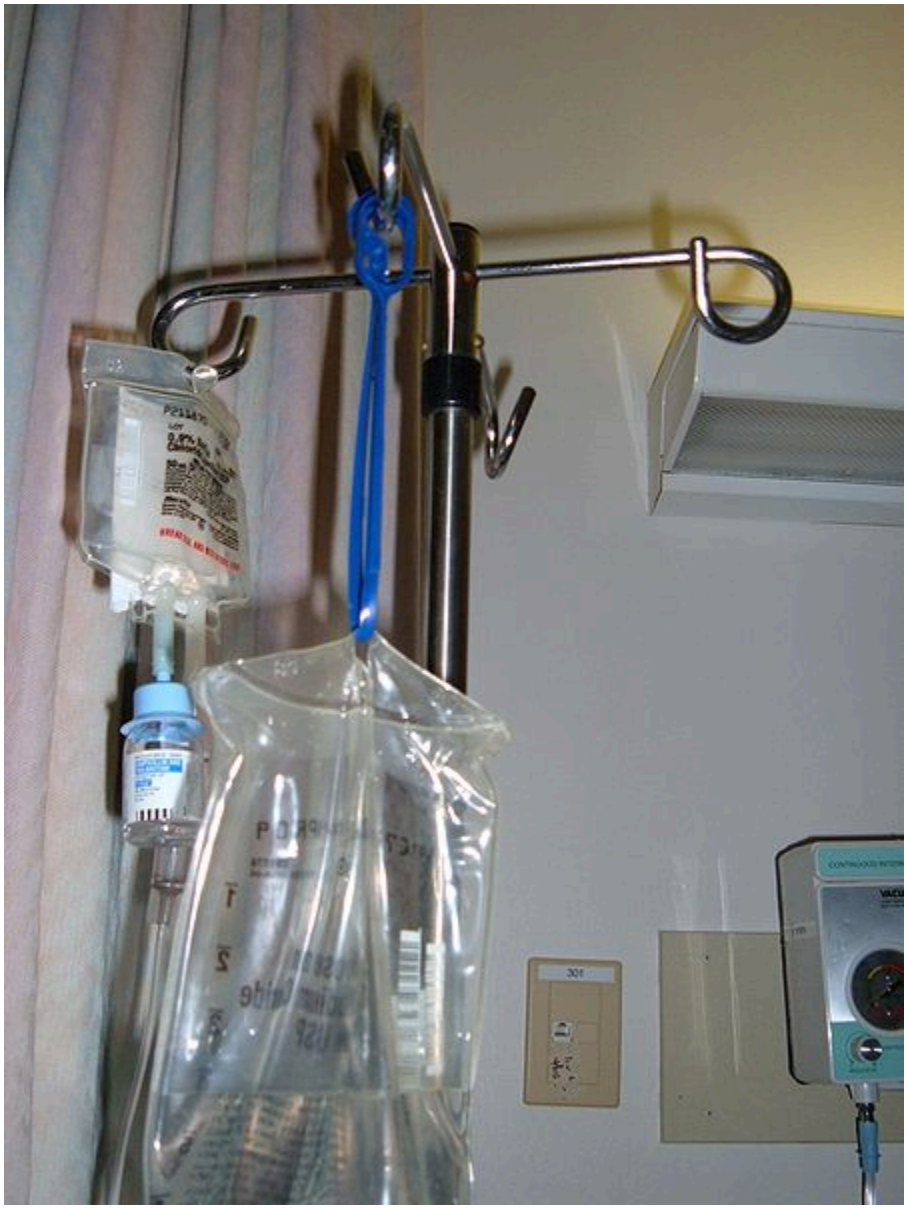

Figure 2.2 Existing IV Fluids and Medications to Check for Compatibility

An additional potential disadvantage of administering medication via IV push when other fluids and/or medications are infusing is that the infusate can move backwards into the existing IV administration set if not performed correctly and thus reduce the amount of medication that reaches the client. For this reason, the nurse should pinch the existing tubing above the site of the hub in which the IV push medication is being administered.

In addition to leaching, many IV push medications require reconstitution to dissolve the medication powder into a fluid for administration. With

reconstitution, there is a potential for nurse error in calculating total volume to be administered so the ordered dose reaches the patient.

The risk of patients experiencing speed shock with IV push medication administration is also a significant potential concern. **Speed shock** is characterized as an adverse systemic reaction when a foreign substance is introduced into the bloodstream. Speed shock may occur with IV push medication administration when the medication peaks very quickly. This sudden peak increases the risk of significant side effects. When medication is administered in a short period of time (typically in less than one minute), there is little opportunity to stop the medication if the client experiences an allergic response. Signs of speed shock include a systemic reaction such as tightness or pressure in the chest, irregular pulse, flushed skin, headaches, change in the level of consciousness, a feeling of impending doom, or cardiac arrest. Clients who have reduced liver and kidney function or those with cardiac problems are at increased risk of speed shock. If a nurse notes the signs of speed shock during IV push administration, they should immediately stop the infusion, maintain the IV line for emergency access, notify the provider, and begin CPR if indicated.

IV site complications are an additional disadvantage with IV push medication administration. Any time a medication or fluid is given into an IV site, there is increased risk for complications such as infiltration, extravasation, and phlebitis. Review information about these complications in Table 1.3a in the "Peripheral IV Access" section in the "Initiate IV Therapy" chapter.

See Table 2.2b for a summary of common advantages and disadvantages associated with the use of IV push medications.

Table 2.2b IV Push Medication Advantages and Disadvantages[7]

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Advantages	Disadvantages
Intravenous medications can deliver an immediate, fast-acting therapeutic effect, which is important in emergent situations, such as cardiac arrest or narcotic overdose. They are useful to manage pain and nausea by quickly achieving therapeutic levels, and they are more consistently and completely absorbed compared with medications given by other routes of injection.	Once an intravenous medication is delivered, it cannot be retrieved. When giving IV medications, there is very little opportunity to stop an injection if an adverse reaction or error occurs. IV medications, if given too quickly or incorrectly, can cause significant harm or death.
Doses of short-acting medication can be titrated according to patient responses to drug therapy. Medication can be prepared quickly and given over a shorter period of time compared to the IV piggyback route.	Any toxic or adverse reaction can occur immediately and may be exacerbated by a rapidly injected medication.
Minimal dilution is required for some medications, which is desirable for a patient's fluid restrictions.	Infiltration and extravasation can cause tissue damage, nerve damage, and scarring.
There is minimal or no discomfort for the patient in comparison to receiving subcutaneous and intramuscular injections.	Not all medications can be given IV route.
Intravenous medications provide an alternative to the oral route for drugs that may not be absorbed by the GI tract. They are ideal for patients with GI dysfunction or malabsorption, as well as for patients who are NPO (nothing by mouth) or unconscious.	There is a high risk for infusion reactions, ranging from mild to severe because most IV medications peak rapidly (i.e., they have a quick onset of effect). A hypersensitivity reaction can occur immediately or be delayed and requires supportive measures.
IV push medication provides a more accurate dose of medication because none is left in the intravenous tubing.	The route for administering medications may damage surrounding tissues. There is an increased risk of phlebitis with highly concentrated medication, especially with small peripheral veins or a short venous access device.

Safety Concepts

Checking Rights of Medication Administration

When administering IV push medications, it is essential for nurses to vigilantly check the rights of medication administration three times. What began as five rights of mediation administration has been extended to eight rights according to the American Nurses Association. These eight rights include the following[8]:

- **Right patient:** Check that you have the correct patient using two patient identifiers according to agency policy (e.g., name and date of birth).
- **Right medication:** Check that you have the correct medication and that it is appropriate for the client in the current context. Understand the purpose of the medication and why the client is receiving it.
- **Right dose:** Check that the dose is safe for the age, size, and condition of the client. Different dosages may be indicated for different conditions, and pediatric dosages are typically much lower than adult dosages. Be aware of the medication side effects, peak, and onset of action. The peak of the medication administration occurs when the medication is at the highest level in the client's bloodstream. The onset of medication administration occurs when the action of the medication begins to take effect. It is important for nurses to be aware of both the peak and onset and of IV administration to help assess when client response to medication may start to be observed.
- **Right route:** Check that the route is appropriate for the client's current condition. Is the medication available to be administered via IV push? Does it require dilution with a substance such as normal saline? Does it require reconstitution? Can it be administered via peripheral access, or does it require central line access into a larger size vein?
- **Right time:** Adhere to the prescribed scheduling of the IV medication.

8. American Nurses Association. (2021). *ANA issue brief: Use of medication assistants/aides/technicians.* https://www.nursingworld.org/~498e32/contentassets/a2ff1bd2d5ca467699c3bc764f7d9198/issue-brief-medication-aides-4-2021.docx

Additionally, the rate of administration of the IV medication and the post-procedure saline flush must be administered according to manufacturer recommendations in a drug reference.

- **Right documentation:** Always verify any unclear or inaccurate documentation prior to administering medications.
- **Right reason:** Verify this medication is being administered to this client at this time for the right reason. If signs and symptoms no longer warrant administration of the prescribed medication, notify the prescribing provider.
- **Right response:** After administering the IV push medication, the nurse must evaluate for expected outcomes with the time frame of expected onset and peak. The nurse must also evaluate for unanticipated adverse outcomes and notify the provider if expected outcomes are not achieved or adverse effects occur.

In addition to checking the eight rights of medication administration, it is important to collect any baseline assessment information and nursing implications for administration. For example, nurses may be required to have certain vital signs monitoring capabilities available when administering certain medications, a certain size vascular access device, or access into the central versus peripheral vascular system.

Additionally, it is important to consider the specific time frame for drug administration. Many IV medications must be infused over a period of time and cannot be pushed into the venous system rapidly due to potential adverse hemodynamic effects. Medications administered by direct IV route are commonly given very slowly per guidelines outlined in a drug reference guide. Nurses must routinely consult drug reference guides when administering IV push medications to check medication and fluid compatibilities and to ensure that medications are given at the correct rate to prevent complications.

Checking for Potential Incompatibilities

When administering medications via the intravenous route, it is also

important to consider potential incompatibilities that may exist. Incompatibilities for the IV route are often organized into three different categories, including physical, chemical, and therapeutic issues.

- **Physical:** When one drug is mixed with other drugs or solutions, a product is produced that is unsafe for administration. An example would be mixing oil with a water base.
- **Chemical:** When a drug reacts with other drugs or solutions, resulting in alterations of the integrity and potency of the active ingredient. A cloudy or crystalline precipitate may form.
- **Therapeutic:** When agents are antagonistic to one another, resulting in an undesired pharmacological action in a patient. This is the largest class of incompatibilities.

It is critical that nurses administering IV push medications are aware of available reversal agents for that medication. For example, when administering an opioid such as fentanyl via IV push, the nurse must monitor for oversedation and respiratory depression. The nurse should have naloxone, the reversal agent, readily available and accessible if an adverse reaction occurs.

Checking Current Status of the Client

As with administration of any medication, nurses must ensure that the medication to be given is appropriate based on the client's current condition. Therefore, associated physical assessment findings, vital signs, pain assessment, and laboratory results must be reviewed before administering IV push medications. For example, if administering morphine via IV push for pain management, the nurse should perform and document a detailed pain assessment prior to administration. Pre-assessment data guides the nurse in determining if morphine is appropriate to administer at this time or if a lower-tier pain medication is more appropriate. It also guides the nurse in determining if a medication should be withheld based on current signs and symptoms and the provider notified. Ultimately, if the medication is

administered, the pre-assessment data will be used to compare post-administration data to determine the therapeutic effect of the medication.

The condition and appropriateness of the specific IV site that will be used for administration of IV push medication must be assessed prior to medication administration and monitored for signs of complications. If infiltration of a medication occurs at the site, there may be neutralizing agents that can be given to minimize the impact of the medication on the surrounding tissues. For example, phentolamine mesylate may be injected into the extravasation site of a vasopressor to prevent dermal necrosis. Furthermore, some medications have pH values that must be controlled with a buffering agent to create a more tolerable pH for infusion. Finally, medications that are more viscous may require larger IV cannula sizes to push the medication through the cannula. Medication administered via IV route should never be forced through the IV cannula line. Pushing medication forcefully through a blocked IV cannula may force a clot into the client's circulatory system.

Select an IV site with a large vein and IV cannula to use for IV push medication administration. Administration of medication through a large cannula allows for greater dilution and minimizes the chance of vascular irritation.

Infection Control

Aseptic technique must be maintained throughout all IV push procedures, including preparing and maintaining equipment and administering IV push medications. Hand hygiene and aseptic non-touch technique (ANTT) must be performed when handling all IV equipment and accessing IV sites. These standards can be reviewed in the "Aseptic Technique" chapter in Open RN

Nursing Skills. Cleansing techniques must be followed when accessing an IV site according to agency policy. Additionally, if a syringe becomes contaminated by contact with a nonsterile surface, it should be replaced with a new one to prevent introducing bacteria or other contaminants into the system.

2.3 Equipment

To perform IV push medication administration, nurses must gather basic equipment to perform the task. The main supplies that are required to administer medications via the IV push route include syringes, needles, needleless vial accesses, saline flush syringes, and antiseptic pads (chlorhexidine-based, alcohol, or tincture of iodine). The syringe and needle sizes that are selected to draw out the medication from the medication vial often depend on the characteristics of the fluid and the volume of medication to be given. For example, medications that are more viscous (such as lorazepam) may require a larger bore needle in order to be easily drawn into the syringe.

Additional equipment that will be needed to safely administer medications via the IV push route include gloves, the specific medication ampule or vial, a drug reference guide, and a watch with a second hand so that a nurse can accurately time the rate of administration for the IV push. Common syringe sizes range from 1 mL- to 60 mL-syringes. See Figure 2.3[1] for an image of various sizes of syringes. Most IV push medication for adult patients will be delivered in sizes ranging from 3 mL, 5 mL, or 10 mL using a Luer lock syringe. Luer lock syringes have interlocking threads to hold the connection together. When selecting a syringe, ensure the size will hold the total volume of medication with reconstitution solution. When reading the volume of medication within the syringe, read the volume where the plunger is in contact with the solution being administered.

1. “Syringes 3I3A0446.jpg” by Chippewa Valley Technical College is licensed under CC BY 4.0

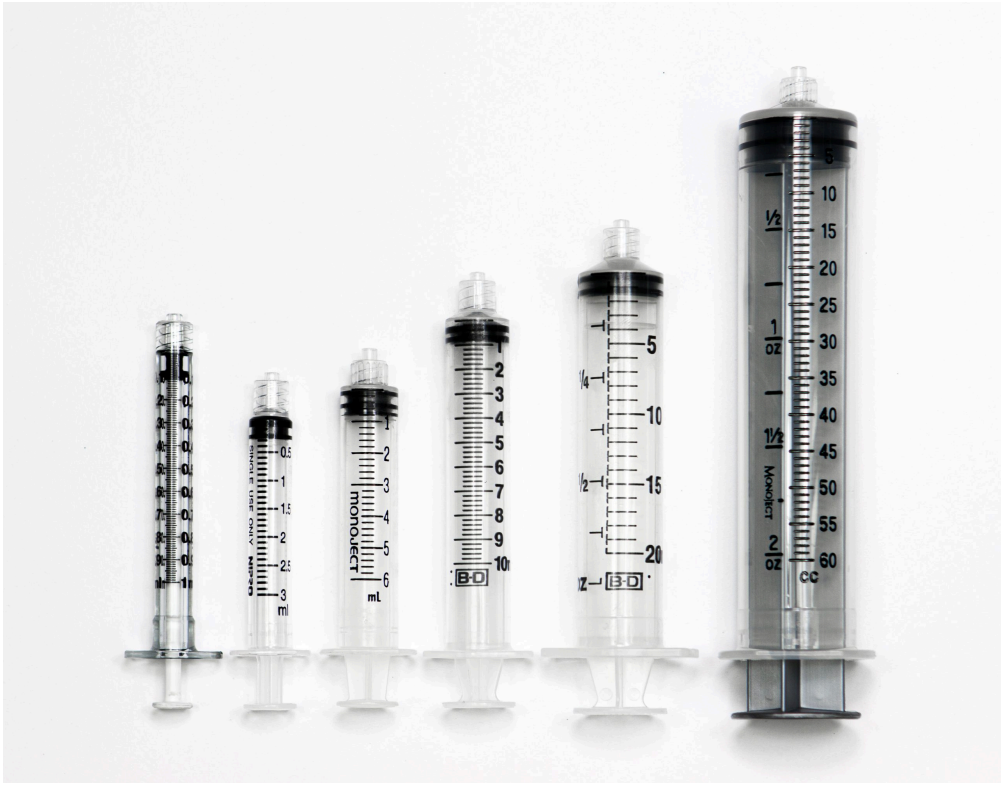

Figure 2.3 Syringes of Varying Sizes

View a YouTube video[2] on how to read a syringe:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=108#oembed-1

Needles used to withdraw medication from the vial should also be appropriately sized to account for the type of solution being withdrawn. The gauge of a needle is the diameter of the needle. Gauges can vary from very small diameter (25 to 29 gauge) to large diameter (18 to 22 gauge). Note the higher the number of gauge, the smaller the diameter of the needle. A

2. RegisteredNurseRN. (2017, June 12). *How to read a syringe 3 mL, 1 mL, insulin, & 5 mL/cc | Reading a syringe plunger* [Video]. YouTube. All rights reserved. Video used with permission. https://youtu.be/_TnDr8cKums

needle will have its gauge and length marked on the outer packaging.[3] See Figure 2.4[4] for images of various needle sizes.

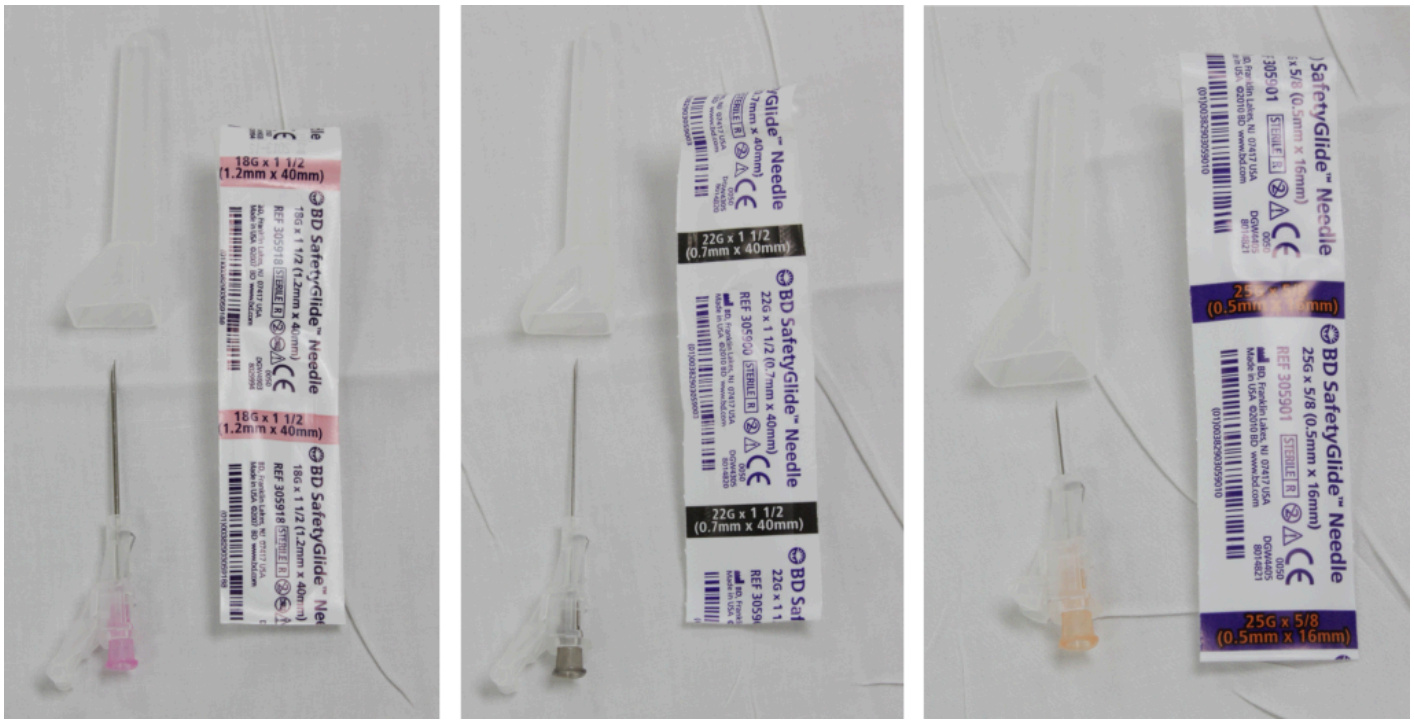

Figure 2.4 Various Needle Sizes (18g, 22g, 25g)

More viscous medications require an 18-gauge or 20-gauge needle to ensure easy withdrawal of the medication from the vial and into the syringe. Smaller gauge needles may bend or break when accessing vial rubber stops, placing a nurse at risk for a needlestick or injury when withdrawing the medication.

There are also many needleless access devices, often referred to as **blunt needle devices**, available in medical facilities. The "blunt needles" can be used to puncture a vial rubber stop and withdraw medication but should not be used to inject medication into patients. These needleless accesses are commonly made of plastic and reduce the danger of needle puncture. Needleless devices should be utilized whenever possible to reduce the risk of inadvertent needlesticks. Some blunt needle devices also have filters and should be used when withdrawing medication from an ampule.

3. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0
4. "Needle 18g," "Needle 22g," and "Needle 25g" by Chippewa Valley Technical College are licensed under CC BY 4.0

Ampules, Vials, and Prefilled Syringes

There are various types of parenteral medication containers in which medications may be stored, such as glass ampules, single dose or multi-dose vials, and prefilled syringes.

Ampules are glass containers in 1 mL to 10 mL sizes that hold a single dose of medication in liquid form. They are made of glass and have a scored neck to indicate where to break the ampule. Because there is risk of being cut by glass when opening a glass ampule, the nurse should use an ampule breaker or wrap an alcohol swab package around the neck of the ampule for protection See Figure 2.5[5] for an image of opening an ampule. It is important that the nurse use caution and firmly grasp the ampule neck, breaking the ampule at the neck with firm pressure applied. Nurses should break the ampule away from their hands to help ensure that they do not inadvertently cut themselves in the process of breaking open an ampule. Once the ampule is open, a blunt needle device with a filter must be used when withdrawing medication to prevent glass particles from being drawn up into the syringe. Glass ampule pieces must be disposed of in a sharps containers following medication administration.

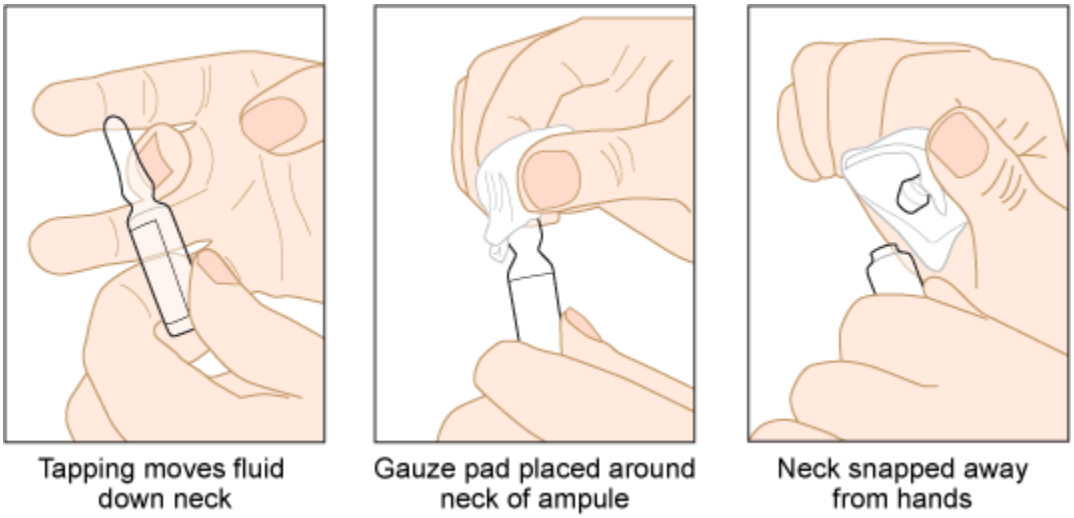

Figure 2.5 Opening an Ampule

5. "preparing-an-ampule-1.png" by unknown author at Thomson Rivers University is licensed under CC BY 4.0. Access for free at https://pressbooks.bccampus.ca/clinicalproceduresforsaferpatientcaretrubscn/chapter/safe-injection-administration-and-preparing-medication-from-ampules-and-vials/

A **vial** is a single- or multi-dose plastic container with a rubber seal top, covered by a metal or plastic cap. A single-use vial must be discarded after one use. A multi-dose vial must be labeled with the date it was opened and its "beyond use date" (BUD). Guidelines indicate a multi-dose vial may be used for up to a maximum of 28 days of opening unless there is a specific expiration date labelled by the manufacturer.[6]

Needless caps on vials are dust covers only and are not considered sterile. After removing the vial cap, scrub the diaphragm of the cap using 70% isopropyl alcohol. If using more than one vial, separate alcohol wipes must be used on each vial.[7]

Because a vial is a closed system, air equal to the volume of solution to be withdrawn must first be injected into the vial to permit the removal of the solution. See Figure 2.6[8] for an image of medication being withdrawn from a vial.

Figure 2.6 Withdrawing Medication From a Vial

6. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharpe, E., & Alexander, M. (2021). Infusion therapy standards of practice (8th ed.). *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 44*(1S Suppl 1), S1–S224. https://doi.org/10.1097/NAN.0000000000000396
7. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharpe, E., & Alexander, M. (2021). Infusion therapy standards of practice (8th ed.). *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 44*(1S Suppl 1), S1–S224. https://doi.org/10.1097/NAN.0000000000000396
8. "Book-pictures-2015-620.jpg" by unknown author is licensed under CC BY 4.0. Access for free at https://opentextbc.ca/clinicalskills/chapter/safe-injection-administration-and-preparing-medication-from-ampules-and-vials/

Prefilled syringes contain prefilled volumes of medication. Many medications used during emergency medication situations are contained in prefilled syringes, such as epinephrine or naloxone. See Figure 2.7[9] for an image of a prefilled syringe. Some prefilled syringes require connection to a syringe device containing a plunger. Prior to administering medication via a prefilled syringe, examine the volume of medication within the syringe, verify the amount with the dose in the medication order, and perform any math calculations required. Remove protective caps from the syringe barrel and medication cartridges and secure the plunger device onto the prefilled syringe by screwing the end of the push device into the plunger barrel. Per manufacturer guidelines, advance the plunger to expel air contained within the device.

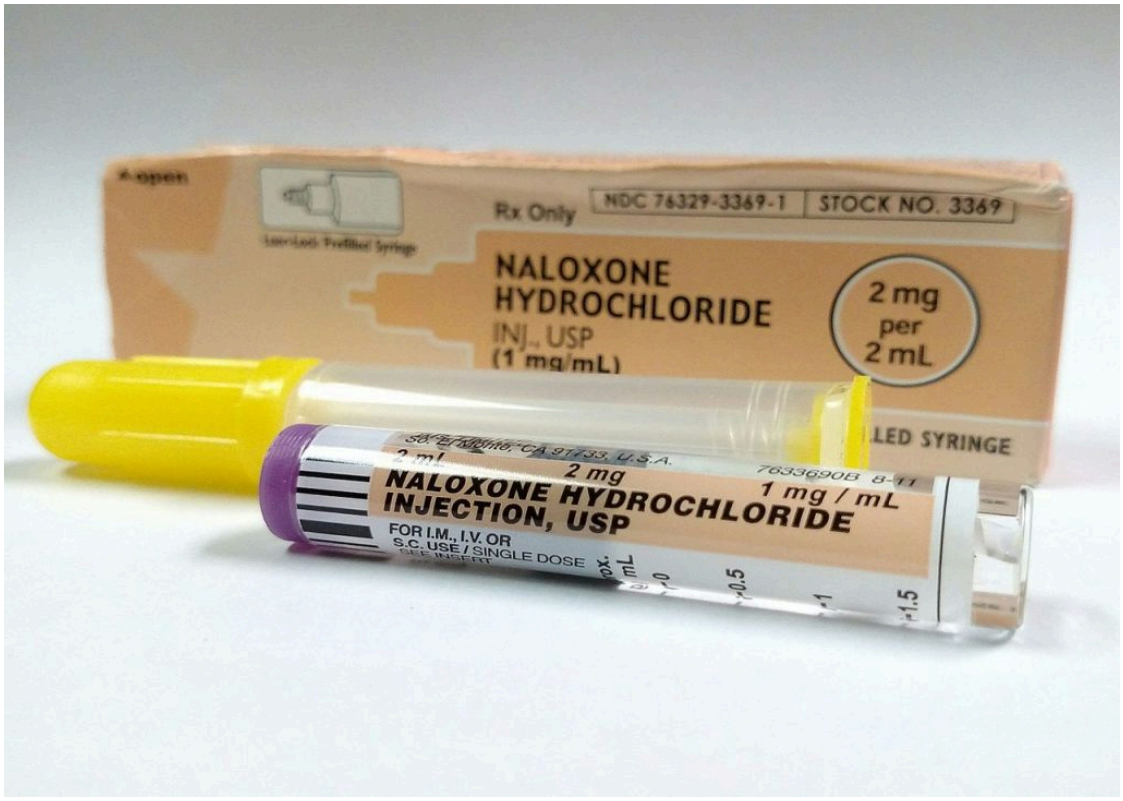

Figure 2.7 Pre-filled Syringe

9. "Naloxone_2_(cropped).jpg" by Mark Oniffrey is licensed under CC BY 4.0

Assessments Prior to the Procedure

Prior to administering medication via IV push, the nurse should assess the patient and the IV site to ensure appropriateness of medication administration. Pre-administration patient considerations ensure vital signs, pain level, laboratory results, and other focused assessments related to the medication to be administered are within the appropriate ranges. The skin around the IV access site must be assessed for swelling, erythema, blanching, warmth, coolness, or pain that may indicate the site is compromised or the cannula is not located in the appropriate position within the vein's inner lumen. Ensure the type of catheter is appropriate for its planned use. For example, if a patient has a peripheral IV ordered prior to a diagnostic procedure using contrast dye, an 18-gauge IV catheter is typically required for this procedure.

To comprehensively examine the IV insertion site following visual observation, the nurse should assess for patency of the cannula by aspirating to check for blood return and infusing 1-2 mL of saline (for adult patients) into the IV site. The site should flush freely, and no significant resistance or pain should be noted. Blood return may not be noted on aspiration, but it should be assessed and documented.[1] If no blood return occurs, the vein may be lightly palpated as the normal saline is injected to feel the fluid travel in a straight line in the vein. While checking the patency of the IV cannula, the nurse should also carefully observe the insertion site for swelling or fluid leakage to confirm the cannula has not dislodged and the solution is properly entering the vein and not leaking into the surrounding tissue. Peripheral sites should be routinely flushed per agency policy, typically once per shift for saline locks.

Additional nursing considerations related to IV push medication administration include measures to decrease potential hazards. Proper hand

1. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharpe, E., & Alexander, M. (2021). Infusion therapy standards of practice (8th ed.). *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 44*(1S Suppl 1), S1–S224. https://doi.org/10.1097/NAN.0000000000000396

hygiene, aseptic technique, standard precautions, appropriate personal protective equipment, and sharps safety must always be implemented. The nurse should also review a drug reference guide for medication information related to drug dosage requirements, proper rate for administration of the push, and the appropriateness of the existing infusion site. For example, if the medication requires a central line for administration, a peripheral access site should not be used. The nurse should also be aware of the availability of monitoring equipment required for post-administration assessments, such as a pulse oximeter, blood pressure cuff, cardiac monitoring, or hemodynamic monitoring via an arterial line.

Additional safety principles when preparing for IV push medication administration to protect the safety of the patient and the nurse are described in the following section.

Other Safety Considerations for IV Push Administration

- To reduce the risk of needlestick injuries, use a blunt needle or blunt filter needle when preparing injections from vials or ampules. Use a needleless system when injecting medication into existing IV tubing.
- After preparing the medication, label the medication syringe with two patient identifiers, date, time, medication, dose, your initials, and any diluent added. Never leave the syringe unattended.
- Verify the peripheral IV access is appropriate for administration of the IV push medication.
- Always verify the compatibility of the medication with other running IV fluids and medications.
- Check agency policies for flushing and locking peripheral IV sites prior to administering the medication.
- Check the patient's medical record for allergies and also verify by asking them if they have any allergies. This is especially important if a new medication has been prescribed.
- Administer the post-administration saline flush at the same rate as the IV push medication rate (based on rate of administration guidelines in a drug reference guide). Know the volume to be flushed based on type of tubing and equipment to ensure the medication is not under-dosed.

- Always assess the patient's current status and need for the ordered IV medication prior to administration.
- Provide patient education and confirm their understanding of the prescribed medication and potential side effects to report.

Whenever possible, premixed medications should be used to decrease the chance of vial contamination or calculation error with administration.

Review the following table for additional safety principles that should be followed prior to medication administration.

Table 2.4a IV Push Safety Principles[2]

2. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0

Principle	Additional Information
Verify your qualifications for administration of this medication on this unit.	Are you qualified to administer this type of medication? For example, administration of chemotherapy agents requires specialized training, and many vasoactive medications require cardiac monitoring.
Review the route of administration for this medication.	Review a drug reference guide to verify this medication can be given by the IV route.
Review preparation and medication administration information.	Review a drug reference guide for how this medication should be administered by the IV route. For example, does it require dilution or reconstitution? Use less-concentrated solutions whenever possible. If diluting the medication, discard (i.e., waste) the unused portion before going to the bedside. • Preparation and supplies: Is a pre-flush required for a saline lock? • Does the patient have any allergies? • Administration rate: What is the correct rate of administration (e.g., over 1 minute, over 5 minutes)? Review agency policy regarding the frequency of vital signs monitoring before, during, and after administration.
Identify when a medication should start to work.	What are the onset, peak, and duration of the medication?
Assess the dosage and safe range for this medication.	Is the ordered dose safe for this patient based on their age, kidney function, liver function, etc.? When did the patient last receive this medication? What was the effect of the medication on the patient the previous time they received it?
Understand the therapeutic effect.	What is the expected therapeutic effect of this medication for this patient, and when is it anticipated to occur? What assessments should be performed to evaluate the effectiveness of this medication for this patient?
Know the adverse effects.	What are the potential adverse effects of the medications? How should severe adverse effects be managed? Is there an antidote for overdose?

Know potential incompatibilities.	Are there any potential incompatibilities with existing IV solutions or medications? Is a second peripheral access site required?
Know how to complete the procedure.	Is a post-saline lock flush required? If so, what is the amount? The amount can vary based on the size of the tubing and equipment, as well as agency policy.
Document the procedure.	Where will you chart the administration of this medication and what will you chart (i.e., Medication Administration Record, intake of IV fluid flush, pre- and post-pain assessment, pre- and post-vital signs, etc.)?

Additional Administration Considerations

Prior to administering an IV push medication, the nurse should consider whether or not the administration will be given via a saline lock or a primary IV line with infusing fluids and/or medications. Procedural considerations vary depending on the type of access that is available.

If medication is being administered via a primary line, the nurse should first assess the insertion site and then determine the compatibility of the ordered medication with the infusing fluid. If the ordered medication is not compatible with the infusing fluids, a second peripheral IV access site may be required, or it may be possible to first flush the primary line with saline to clear it of incompatible fluids.

If continuous IV fluids are being administered, the IV pump should be paused after noting the current infusion rate of the primary line. The port on the IV tubing closest to the IV insertion site must be identified and cleaned per agency policy. Many agencies require caps on unused ports that are impregnated with alcohol. The tubing should be clamped above this port and the IV site flushed with normal saline before administering the IV push medication. If the IV solution is not compatible with the IV push medication, then the site must be flushed with a minimum of 5 to 10 mL. The IV push medication is then administered according to the correct administration rate and followed by a saline flush with the same rate and volume of saline as the medication that was administered. The nurse may restart the infusing fluids at the rate previously noted if the fluids are compatible with the medication.[3]

3. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharpe, E.,

If IV push medication is to be administered into a saline lock, the site must be assessed and determined to be in good condition. The port is cleaned, and a saline flush syringe attached. Prior to pushing saline into the lock, the plunger is pulled back gently to check for blood return. The presence of blood return indicates the cannula is appropriately located within the patient's vein but may not occur. If blood return is not noted, the nurse may proceed to slowly flush a small amount of saline while monitoring for resistance, leaking, pain, or swelling with the first few milliliters of saline flushed into the lock device. If no complications are noted, the flush syringe is removed, the port is cleaned, the medication syringe is attached, and the medication is administered using the recommended administration rate. The timing of the rate of administration begins immediately if a cap is present; otherwise, if a J-loop is present, timing starts after 1 mL of the medication has been instilled. After administration of the medication, the syringe is removed, the port is cleaned, and another saline flush syringe is attached. The saline flush should be administered at the same rate as the medication was administered to ensure that medication still present within the saline lock line is safely administered at the appropriate rate. The connection port should be swabbed with each exchange and attachment of saline and medication syringes.

Clinical Tip: A common acronym for administration of IV push medication into a peripheral IV is SAS (Saline – Administration of medication – Saline). Follow agency policy for maintaining IV patency.

Evaluation After the Procedure

Follow agency policies and procedures regarding IV administration guidelines and the type and frequency of monitoring after IV medications are administered. The nurse performs this monitoring and documents the patient's response to the medication. This includes performing any necessary reassessments. Recall that medications administered via the IV route peak

& Alexander, M. (2021). Infusion therapy standards of practice (8th ed.). *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 44*(1S Suppl 1), S1–S224. https://doi.org/10.1097/NAN.0000000000000396

much more quickly than oral medications absorbed through the gastrointestinal tract.

2.5 Checklist: Administer IV Push Medications

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Administer IV Push Medications[1,2,3,4]

- Verify the provider's order.
- Review the patient's medical record for factors that increase the patient's risk of adverse reactions and toxicity to the prescribed medication. Check for allergies or any other contraindication to the prescribed medication. Verify when the last dose of this medication was administered, the indication for this medication for this patient, and related pre-administration assessments, vital signs, lab results, or other clinical data.
- Gather and prepare the necessary equipment: syringe, medication, saline flush, antiseptic pads, and needle/vial access device.
- If medication preparation is required, do so in a designated clean, quiet environment away from sinks using the aseptic non-touch technique (ANTT).[5]
- Check the expiration date on the medication. If it's expired, return it to the pharmacy and obtain new medication. Inspect the medication for discoloration or compromised integrity.
- Verify the medication can be given by bolus based on agency policy.
- Confirm the following information in a drug reference guide: appropriate dosage, need for dilution or reconstitution, compatibility with running IV fluids and medications, rate of administration, action of medication, potential adverse effects, antidote, and patient education.
- Perform hand hygiene.

1. Dorn, L. (2022). *IV push evidence-based practice checklist*. https://qsen.org/iv-push-evidence-based-practice-checklist/
2. Institute for Safe Medication Practices. (2015). *Safe practice guidelines for adult IV push medications*. https://www.ismp.org/guidelines/iv-push
3. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
4. Lippincott procedures. http://procedures.lww.com
5. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharpe, E., & Alexander, M. (2021). Infusion therapy standards of practice (8th ed.). *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 44*(1S Suppl 1), S1–S224. https://doi.org/10.1097/NAN.0000000000000396

- Confirm patient identity using at least two patient identifiers and ask about allergies.
- Provide privacy.
- Explain the procedure to the patient. Provide education regarding the medication, its purpose, and potential side effects.
- Perform necessary pre-administration assessments in accordance with the type of medication being given.
- Raise the bed to waist level when providing care.
- Perform hand hygiene and put on gloves. Adhere to standard aseptic non-touch technique (ANTT) when preparing medication, administering IV push medication, flushing, and locking venous access devices.[6]
- If the medication is not in a prefilled syringe and dilution is required, dilute it and draw it up in a syringe using sterile technique. Do not dilute or reconstitute IV push medications by drawing up the contents in a commercially prefilled saline flush syringe.[7] Only dilute medications when recommended by the manufacturer, supported by evidence in peer-reviewed biomedical literature, or in accordance with approved agency guidelines.
- Check the rights of medication administration X 3 while preparing the medication. When performing three checks, check against the provider order, check as you are reaching for the medication, and check right before administering the medication.
- Prepare one medication syringe at a time. Label all IV push medication syringes unless they are prepared at the bedside and immediately administered. Never pre-label an empty syringe in advance of its use.[8]
- If continuous running IV fluid is compatible with the medication, pause the infusion. Trace the IV line from the patient to its point of origin and use the port closest to the patient and clamp the line.
- If a saline lock is in place, unclamp the catheter.

6. Institute for Safe Medication Practices. (2015). *Safe practice guidelines for adult IV push medications.* https://www.ismp.org/guidelines/iv-push
7. Institute for Safe Medication Practices. (2015). *Safe practice guidelines for adult IV push medications.* https://www.ismp.org/guidelines/iv-push
8. Institute for Safe Medication Practices. (2015). *Safe practice guidelines for adult IV push medications.* https://www.ismp.org/guidelines/iv-push

- Perform a vigorous mechanical scrub of the needleless connector for at least five seconds using 70% alcohol or an alcohol-based chlorhexidine solution and then allow the connector to dry completely. Do not fan or wave over the site.
- Assess the venous access device prior, during, and after administering IV push medication for signs and symptoms of complications, such as pain, infiltration, phlebitis, or extravasation.
- Assess for patency using a single-use 10-mL syringe with 0.9% normal saline. While maintaining the sterility of the syringe tip, attach the syringe to the needleless connector port. Slowly aspirate for blood return. Patency is determined by evidence of brisk, bright red blood return, although blood return is not always present. Slowly inject preservative-free normal saline solution into the catheter. Never forcibly flush a venous access catheter. Remove and discard the syringe.[9]
- Perform a second vigorous mechanical scrub of the needleless connector with a new swab for at least five seconds and allow it to dry completely.
- Maintaining the sterility of the syringe tip, attach the medication syringe to the needleless connector of the venous access device. Administer the medication at the recommended rate of administration according to the MAR, drug reference guide, or manufacturer using a watch or clock with a second hand. Remove and discard the syringe.
- Perform a third vigorous mechanical scrub of the needleless connector with a new swab for at least five seconds and allow it to dry completely.
- Maintaining the sterility of the syringe tip, attach a prefilled 10-mL syringe containing preservative-free 0.9% normal saline to the needleless connector and flush at the same rate of administration as the medication. The volume of the flush should be twice the internal catheter volume (i.e., a J-loop would be 2 mL and extension tubing would be 4 mL). Continue to flush at a slow, steady pace to clear the line, typically another 2 to 7 mL.[10]
- If continuous IV fluids are present, unclamp the tubing and resume the

9. Institute for Safe Medication Practices. (2015). *Safe practice guidelines for adult IV push medications.* https://www.ismp.org/guidelines/iv-push
10. Institute for Safe Medication Practices. (2015). *Safe practice guidelines for adult IV push medications.* https://www.ismp.org/guidelines/iv-push

infusion. If locking the venous access device, follow agency policy regarding the sequence of flushing, clamping, and disconnecting the syringe.
- Discard used supplies in appropriate receptacles.
- Remove and discard the gloves.
- Perform hand hygiene.
- Return the bed to the lowest position. Provide for patient safety and comfort.
- Evaluate patient response to the medication and monitor for adverse reactions based on the onset and peak of the prescribed medication. Instruct the patient to call the nurse if feeling any adverse effects.
- Document the administration of the medication per agency policy.

View a YouTube video[11] showing an instructor demonstration of this skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=114#oembed-1

11. Chippewa Valley Technical College. (2023, January 5). *Administering IV push medications* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/4w9JndX9-uI

2.6 Documentation

When performing IV push medication administration, documentation must include the following components:

- Date/Time of administration
- Medication amount and dose
- IV site location
- Administration route and rate
- Flush solution
- Indication for medication
- Patient assessments related to medication
- Patient's response

Many electronic health records have integrated electronic medication administration records that allow nurses to document IV push medications and pre- and post-administration assessments directly within the EMAR. If developing a written note regarding the administration, it should include the components listed above.

Sample Documentation:

11/20/20XX 1445

Patient was admitted to the cardiac floor for HF exacerbation, difficulty breathing, and weight increase of 10 pounds in the past three days. Furosemide 40 mg IV push was administered via 20-gauge catheter in the right forearm per order from Margaret Vang NP for HF exacerbation. The IV site flushed freely with appropriate blood return prior to medication administration. Furosemide was administered via slow push at 10 mg/min and followed with 5-mL saline flush at the same rate.

1745 Patient voided 600 mL clear yellow urine one hour post administration. Patient lung sounds are clear, and bilateral ankle pitting edema decreased to 1+. Patient appears comfortable.

Gus Martinez, RN

Exercises

(Answers to the exercises are located in the Answer Key at the back of the book).

Case Study #1

Gary, a 68-year-old male client, arrives in the ED with his wife. During the triage assessment, the client states, “It feels as if there is someone standing on my chest. I can’t breathe, and I have a headache.” His vital signs show hypertension and tachycardia. Gary was walking with his wife in their neighborhood when he began experiencing these symptoms. His wife adds, “I ran into our neighbor’s house, and he drove us here immediately. Our dog is still at the neighbor’s house.”

The client has a history of hypertension, diabetes, and colon cancer. He recently retired from hospital administration, following a long medical leave for treatment of his cancer, including chemotherapy and steroid medications. Gary says to you, “I can’t believe that I am feeling this way. Please help!”

The MD gives you the following orders:

- Start a peripheral IV STAT
- Administer metoprolol 5 mg rapid IV q2min, up to 3 doses for chest pain and MI symptoms

1. What will you consider when initiating an IV for Gary?
2. Based on the provided supply of metoprolol of 10 mg/10 mL,

what will be the amount you will administer for each dose? What will be the rate of administration?

3. What are the following for the ordered medication?

- Indication and action of medication
- Onset, peak, and duration of the medication
- Nursing considerations or special instructions for use
- Assessments pre-, post-, and during administration
- Patient education

Case Study #2

Karen is a 55-year-old female client in the medical-surgical unit. She arrived this afternoon with uncontrolled vomiting. She received oral antiemetics in the ED, with no effect. During your admission assessment, Karen states, "I feel so terrible. My stomach is turning constantly; I haven't eaten anything since yesterday morning, and I have only sipped a little water here and there. I'm worried about becoming dehydrated. Whatever they gave me in the Emergency Department didn't help at all. Can't you give me something that will work more quickly?"

You note that Karen is pale, and her lips are dry. She closes her eyes frequently and is holding her stomach. After arriving on the unit an hour ago, she has vomited a small amount of clear liquid.

Karen has a history of chronic kidney disease and biweekly dialysis, as well as depression. You immediately call the doctor on call for further orders.

The MD gives you the following orders:

- Start a peripheral IV STAT
- Administer ondansetron 8 mg IV now
- Start NaCl 0.9% IV at 500 mL/hr

1. What will you consider when initiating an IV for Karen?

2. Based on the provided supply of 16 mg/8 mL, what will be the amount you will administer? What will be the rate of administration?

3. What are the following for the ordered medication?

- Indication and action of medication
- Onset, peak, and duration of the medication
- Nursing considerations or special instructions for use
- Assessments pre-, post-, and during administration
- Patient education

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https://wtcs.pressbooks.pub/nursingadvancedskills/?p=120#h5p-5

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=120#h5p-6

Test your knowledge using a NCLEX Next Generation-style question. You may reset and resubmit your answers to this question an unlimited number of times.

II Glossary

Ampules: Glass containers in 1 mL to 10 mL sizes that hold a single dose of medication in liquid form.

Blunt needles: Needleless access devices.

Extravasation: Occurs when medication is administered via an IV site and leaks into surrounding tissues and results in tissue injury such as blisters, redness, or even necrosis.

First-pass effect: The action that occurs when a medication must be first metabolized or broken down prior to entering the blood.

Intravenous push (IV push): Process of introducing a medication or fluid substance directly into the bloodstream via the venous system.

IV lock: An IV cannula that has been inserted into a vein and saline locked or clamped.

Phlebitis: Occurs when there is irritation of the inside of the vessel wall in response to a triggering agent such as medication or dilution solution.

Precipitate: Formation of small crystals as the incompatible substances come into contact with one another.

Prefilled syringe: Syringes that contain prefilled volumes of medication within the device.

Speed shock: An adverse systemic reaction when a foreign substance is introduced into the bloodstream.

Vial: A single- or multi-dose plastic container with a rubber seal and covered by a metal or plastic cap.

PART III

CHAPTER 3 ADMINISTER BLOOD PRODUCTS

3.1 Introduction

Learning Objectives

- Describe the types of blood products prescribed for common conditions
- Explain how a person's ABO blood type and Rh factor impact blood product compatibility
- Describe transfusion reactions and their treatments
- Apply evidence-based guidelines for the safe administration of blood products
- Apply the nursing process to prevent, identify, and treat potential complications associated with blood administration
- Describe autologous blood donation
- Incorporate modifications in blood product administration to reflect variations across the life span and cultural beliefs

A **blood product** is any therapeutic substance derived from human blood, including whole blood and other blood components for transfusion and plasma-derived medicinal products.

Quality-assured blood products contribute to improving and saving millions of lives every year by doing the following[1]:

- Addressing child and maternal health and mortality
- Dramatically improving the life expectancy and quality of life of patients suffering from life-threatening inherited disorders, such as hemophilia, thalassemia, and immune deficiency, and acquired conditions such as

1. World Health Organization. (2022). *Blood products.* https://www.who.int/health-topics/blood-products#tab=tab_1

cancer and traumatic hemorrhage
- Supporting complex medical and surgical procedures, including transplantation

Types of blood products include whole blood, packed red blood cells (PRBCs), individual factor concentrates, fresh frozen plasma (FFP), platelet concentrates, and cryoprecipitate. Transfusion of blood products is a common procedure with nearly 16 million blood components transfused each year in the United States.[2]

Transfusion therapy can restore intravascular volume, increase oxygen-carrying capacity, and provide coagulation factors. However, it also involves risks for the development of life-threatening complications. The nurse plays an integral role in safe transfusion therapy from initiation to completion and must meticulously adhere to best practices and safety guidelines. In this chapter you will be introduced to the basic concepts of blood product administration and apply the nursing process to blood product administration.

2. American Red Cross. (2022). *Importance of the blood supply.* https://www.redcrossblood.org/donate-blood/how-to-donate/how-blood-donations-help/blood-needs-blood-supply.html#:~:text=Facts%20About%20Blood%20Needs&text=Approximately%2029%2C000%20units%20of%20red,each%20year%20in%20the%20U.S

Compatibility and Blood Types

ABO Antigen Markers

There are four main types of blood groups based on antigens on the surface of red blood cells. Some of these antigens are also present on platelets and in other tissues in the body. The ABO system uses the presence or absence of these specific antigens to identify four main blood groups: A, B, AB, and O. See Figure 3.1[1] for an illustration of ABO antigens and blood groups.

1. Derivative of “a9fa9181b953f0a6a9596420b0f714ad4a497b16” by unknown author is licensed under CC BY 4.0. Access for free at https://openstax.org/books/anatomy-and-physiology-2e/pages/18-6-blood-typing

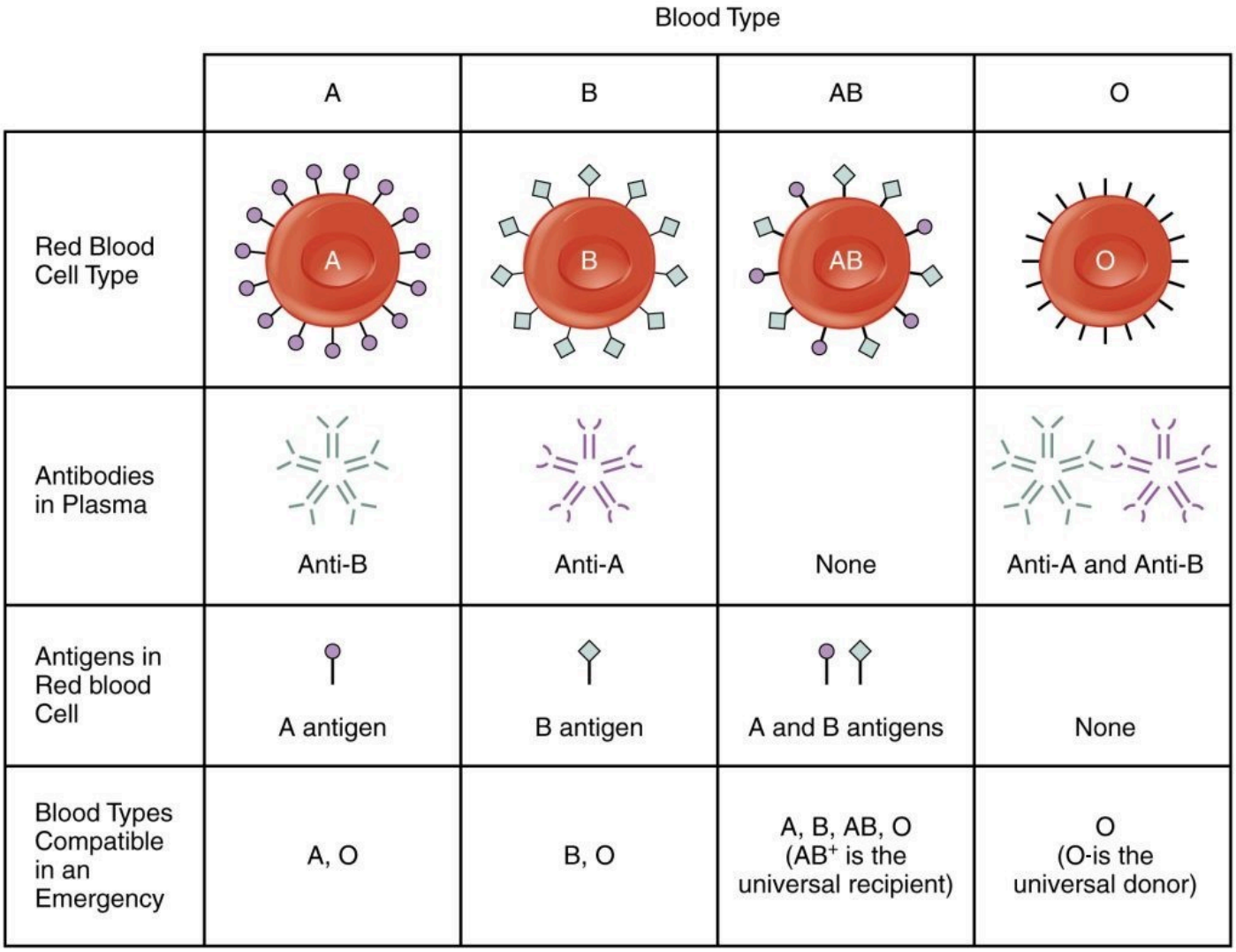

Figure 3.1 ABO Antigens

In addition to the antigens present on the red blood cell, people in certain blood groups have naturally occurring antibodies in the serum against the antigens they don't have. For example, people with blood type A have anti-B antibodies, people with blood type B have anti-A antibodies, people with blood type O have anti-A and anti-B antibodies, and people with AB blood type have no anti-A or anti-B antibodies. For these reasons, the presence of antigens on a person's red blood cells dictates the type of blood they can receive. However, type O blood does not have an antigen, so it can be given to a person with any blood type. As a result, people with type O negative blood are often referred to as "universal blood donors." Likewise, people with type AB blood are referred to as "universal recipients" because they can receive blood from any blood type.

If a person receives blood that is not compatible with their blood type, red

cell destruction called **hemolysis** occurs. ABO incompatibility can cause significant transfusion reactions that can be fatal. Nurses play a major role in safe blood product transfusions and constitute the last link in the chain of the transfusion process to ensure incompatible blood types are not administered and patients are closely monitored for transfusion reactions.[2]

Rh Factor

In addition to ABO blood types, another major consideration for compatibility of blood products is the person's Rh factor. There are over 50 Rh antigens, and five are most antigenic. The most important Rh factor is D, located on the surface of the red blood cell. If a person has the D antigen, they are referred to as "Rh positive" or "Rh+." If the D antigen is not present, the person is considered "Rh negative" or "Rh-."

In contrast to ABO antigens, people do not have naturally occurring antibodies against the Rh factor, but they develop them on exposure. For this reason, a person who is Rh negative develops antibodies against Rh factor only if they are exposed to Rh-positive cells. If this occurs and antibodies develop, subsequent exposure to Rh-positive blood causes a potentially life-threatening immune response with hemolysis of cells.

Rh factor is especially important during maternity care of a mother and her baby. For example, if a mother with Rh-negative blood carries a fetus with Rh-positive blood, her body develops antibodies to the Rh factor. If she becomes pregnant again with a Rh-positive fetus, these antibodies can enter the circulation of the fetus and cause a hemolytic reaction. Therefore, women with Rh-negative blood receive RhoGAM during and after pregnancy to prevent this reaction from occurring in future pregnancies.

See Table 3.2a for an overview of blood types a person can receive based on their ABO blood type and Rh factor.

Table 3.2a Blood Compatibility Based on ABO Blood Type and Rh Factor

2. Bediako, A. A., Ofosu-Poku, R., & Druye, A. A. (2021). Safe blood transfusion practices among nurses in a major referral center in Ghana. *Advances in Hematology, 2021.* https://www.hindawi.com/journals/ah/2021/6739329/

Person's Blood Type	Types of Blood They Can Receive
Type A	Types A and O
Type B	Types B and O
Type AB	Types A, B, AB, and O
Type O	Only Type O
Rh+	Rh+ and Rh-
Rh-	Only Rh-

See Figure 3.2[3] for an image of a unit of blood labeled with blood type and Rh factor.

3. "Blausen_0086_Blood_Bag.png" by Blausen.com staff (2014) at "Medical gallery of Blausen Medical 2014." *WikiJournal of Medicine* is licensed under CC BY 3.0

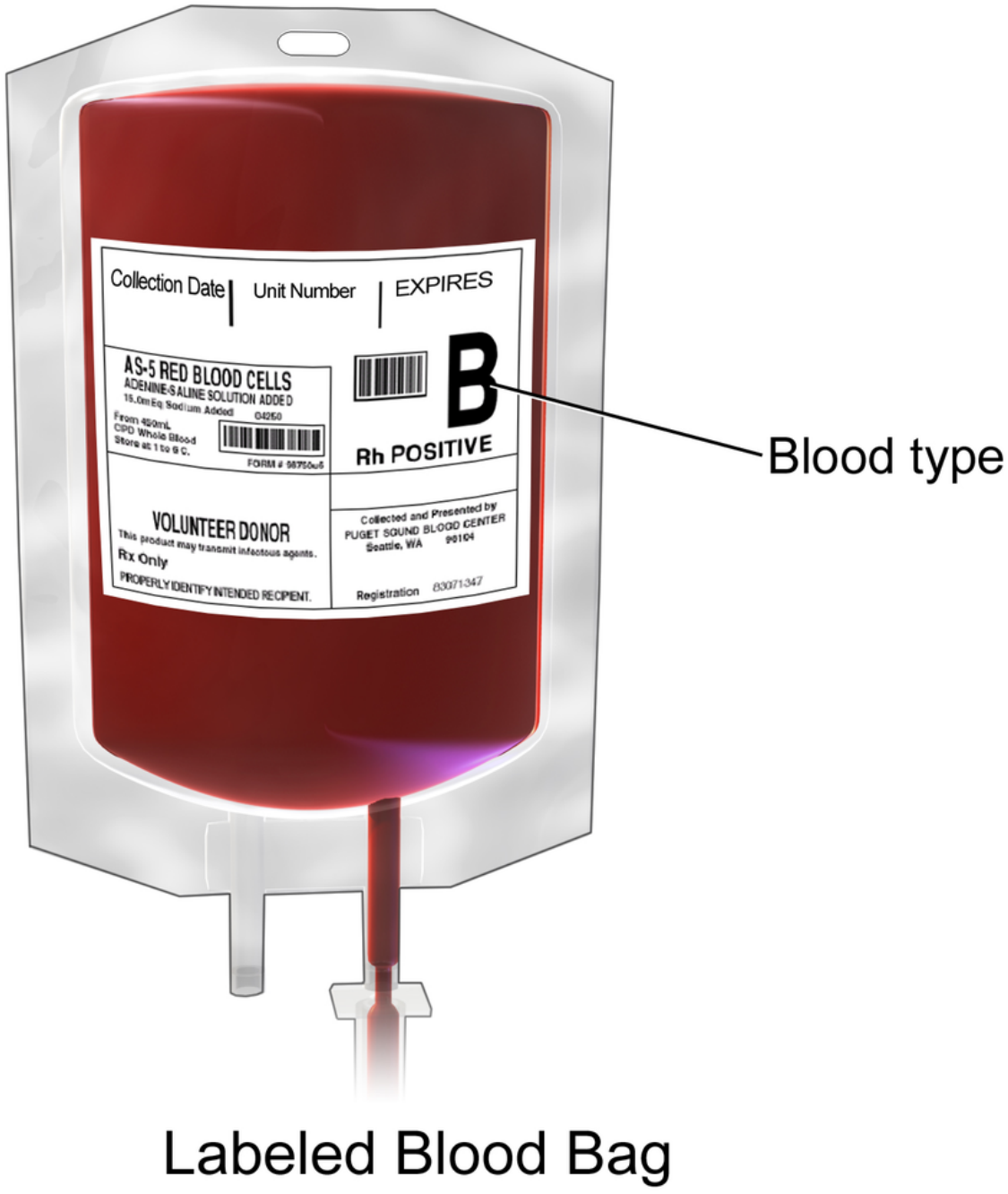

Figure 3.2 Labeled Blood Bag

Human Leukocyte Antigen

The human leukocyte antigen (HLA) is an immune-type antigen that can also pose a serious transfusion complication. HLA is located on the surface of leukocytes and may be found on lymphocytes, granulocytes, monocytes, and platelets. HLA contributes to a person's tissue type and varies among individuals. HLA tests must be completed before any stem cell or organ

transplantation is completed to help ensure that the donor and recipient tissues are a match. HLA antigens are a part of an individual's genetic makeup. Individuals may develop antibodies against HLA antigens following exposure through blood transfusion or pregnancy.

Type and Screen

"Type and screen" refers to pre-transfusion tests that include the determination of client's ABO group, Rh type, and a screen for the detection of atypical antibodies. Nurses ensure type and screen testing has been completed before initiating a blood transfusion and also use this information during a two-person verification of a blood product before it is administered to a client.

Types of Blood Products

Blood transfusion refers to the intravenous administration of whole blood or blood components into a person's circulatory system. Blood components include red blood cells (RBC), white blood cells (WBC), platelets, fresh frozen plasma (FFP), clotting factors, cryoprecipitates, and albumin. Whole blood is rarely used in the United States for transfusion because most clients require a specific element of blood, such as red blood cells or platelets, and the required dose can be optimized according to the client's condition. See Table 3.2b for summarized information about various blood products, including infusion times for adults, ABO/Rh testing requirements, actions, indications, and benefits.[4]

Table 3.2b Blood Products[5,6]

Used for life-threatening hemorrhage where oxygen-carrying capacity,	

4. Association for the Advancement of Blood & Biotherapies. (n.d.). *Regulatory for blood and blood components*. https://www.aabb.org/regulatory-and-advocacy/regulatory-affairs/regulatory-for-blood
5. Association for the Advancement of Blood & Biotherapies. (n.d.). *Regulatory for blood and blood components*. https://www.aabb.org/regulatory-and-advocacy/regulatory-affairs/regulatory-for-blood
6. Bloodworks Northwest. (n.d.) *Transfusion medicine: Typical rates, volumes, and durations for routine (non-emergent) transfusions*. https://www.bloodworksnw.org/medical-services/transfusion-medicine/rates-volumes-duration-transfusions

coagulation factors, platelets, and volume expansion are all needed. Whole blood contains approximately 150 mL of plasma, which provides volume expansion and stabilization of clotting factors.

Blood Product	Volume/ Infusion Time	ABO/Rh Testing Required	Actions/Indications/Benefits
Whole Blood	For massive blood loss, infuse as fast as the client can tolerate.	Yes	Used for life-threatening hemorrhage where oxygen-carrying capacity, coagulation factors, platelets, and volume expansion are all needed. Whole blood contains approximately 150 mL of plasma, which provides volume expansion and stabilization of clotting factors.
Red Blood Cells (RBC)	Typical volume of 350 mL must be infused within 4 hours. Commonly infused within 90 minutes to 3 hours.	Yes	Replaces red blood cells and increases oxygen-carrying capacity. Indicated for symptomatic anemia and gastrointestinal bleeding. One unit increases hemoglobin by 1 g/dL and hematocrit (HCT) by 2-3%.
Leukocyte-Reduced RBCs (Concentrate of RBCs With White Blood Cells Removed)	Infuse within 4 hours.	Yes	Indicated for symptomatic anemia for patients who are immunocompromised or at risk for reactions caused by leukocyte antibodies to the HLA. It is also recommended for children younger than six years old. It has the same actions/benefits as RBC infusion.
Fresh Frozen Plasma (FFP)	Typical volume of 200-250 mL is infused over 60 minutes but must be infused within 4 hours.	Yes	Increases clotting factors and expands blood volume. Indicated for clients with bleeding disorders, thrombotic thrombocytopenic purpura (TTP), and life-threatening hemorrhage in patients who have significant coagulation deficiencies. Also used to reverse a client's elevated INR when it needs to be brought down quickly to prevent complications from occurring. One unit increases clotting factors approximately 2-5%. Plasma is typically frozen within hours of donation to preserve the clotting factors and is thawed by the lab prior to administration.

Platelets	Typical volume of 250-350 mL is infused over one hour.	No	Increases the number of platelets to promote hemostasis (i.e., adequate blood clotting). Indicated for thrombocytopenia or platelet function abnormalities, as well as for patients undergoing treatment for leukemia, cancer, aplastic anemia, and marrow transplants. One unit of platelets is created from a pool of 4-6 whole blood donations or from one apheresis (i.e., harvested from one donor with the return of all other cells). One unit increases the platelet level by approximately 30,000-60,000. The bag should be agitated periodically because platelets may adhere to the bag.
Cryoprecipitate	Typical volume of 90-120 mL is infused over 15-30 minutes.	Yes	Provides Factor VIII, fibrinogen, vWF, and Factor XIII. Indicated for Hemophilia A, von Willebrand's disease, and Factor XIII deficiency. Also used as a part of "Mass Transfusion" protocols where clotting factor deficiencies are common. One pool increases fibrinogen approximately 50 mg/dL.
Albumin (Colloid-Containing Solution)	Refer to hospital policy. Rate is individualized.	No	Expands blood volume and provides plasma proteins. Indicated for the treatment of severe hypovolemia and/or hypoalbuminemia. Albumin helps hold fluid in the vascular space to temporarily prevent and/or correct third spacing. Used for critically ill patients who have a limited response to crystalloid solutions and those with burns, ascites, and anasarca (i.e., swelling of the whole body from fluid retention).

Intravenous Immunoglobulin (IVIG)	Infusion starts at a rate of 0.5 to 1 mL/kg/ hour for the first 15-30 minutes and then can be increased every 15-30 minutes to a maximum of 3 to 6 mL/kg/ hour if no adverse reactions.	No	Provides antibodies the client cannot make on their own (i.e., "humoral immunodeficiency"). Indicated as replacement therapy for immunodeficiencies, autoimmune conditions such as immune thrombocytopenia (ITP) and autoimmune hemolytic anemia (AIHA), Guillain-Barré syndrome, or chronic inflammatory demyelinating polyneuropathy (CIDP).[7]
Autologous	Refer to agency policy for collection and infusion.	No	Provides patient's own blood to prevent potential transfusion reactions but has risk for bacterial infection. Used to replace blood loss during planned elective surgery.

Conditions Requiring Blood Product Transfusion

Blood product transfusions can offer life-saving therapeutic benefits for several conditions, such as non-hemorrhagic anemia, active bleeding or symptomatic anemia, loss of coagulation factors, and platelet deficiency or dysfunction.[8]

Non-Hemorrhagic, Asymptomatic Anemia

The current guidelines from the Association for the Advancement of Blood & Biotherapies (AABB) recommend the use of restrictive hemoglobin thresholds to indicate the need for RBC transfusion for anemia, as well as the

7. Shehata, N. (2023). Patient education: Intravenous immune globulin (IVIG) (Beyond the basics). *UpToDate.* www.uptodate.com
8. Bediako, A. A., Ofosu-Poku, R., & Druye, A. A. (2021). Safe blood transfusion practices among nurses in a major referral center in Ghana. *Advances in Hematology, 2021.* https://www.hindawi.com/journals/ah/2021/6739329/

use of “standard-issue” rather than “fresh” RBCs.[9,10] **Anemia** is a hematological condition where there is a lack of healthy red blood cells and/or hemoglobin to carry adequate oxygen to the body’s tissues.

- Recommendation 1:
  - A threshold of hemoglobin level of 7 g/dL or less is recommended for the indication of RBC transfusion for hospitalized adult patients with asymptomatic anemia who are hemodynamically stable, including critically ill patients.
  - A threshold of 8 g/dL or less is recommended for RBC transfusion for patients undergoing orthopedic surgery, cardiac surgery, and those with preexisting cardiovascular disease.

- Recommendation 2:
  - Patients, including neonates, should receive “standard issue” RBCs (i.e., units selected at any point within their licensed dating period) rather than limiting patients to transfusion of only “fresh” RBCs (i.e., units with storage length less than ten days).

Active Bleeding and Symptomatic Anemia

RBC transfusions are indicated for patients who are actively bleeding or for those with symptomatic anemia whose hemoglobin is less than 8 g/dL. Symptoms of anemia include, but are not limited to, weakness, dyspnea with exertion, and tachycardia. Each case is individually evaluated to compare the patient’s need for transfusion with its risks and benefits. Unless the patient is actively bleeding, it is recommended to transfuse one unit of packed red cells at a time, which typically increases the patient’s hemoglobin level by 1 g/dL

9. Association for the Advancement of Blood & Biotherapies. (n.d.). *Regulatory for blood and blood components*. https://www.aabb.org/regulatory-and-advocacy/regulatory-affairs/regulatory-for-blood
10. Carson, J. L., Guyatt, G., Heddle, N. M., Grossman, B. J., Cohn, C. S., Fung, M. K., Gernsheimer, T., Holcomb, J. B., Kaplan, L. J., Katz, L. M., Peterson, N., Ramsey, G., Rao, S. V., Roback, J. D., Shander, A., & Tobian, A. A. (2016). Clinical practice guidelines from the AABB: Red blood cell transfusion thresholds and storage. *JAMA, 316*(19), 2025–2035. https://doi.org/10.1001/jama.2016.9185

and their hematocrit by 3%. Hemoglobin levels should be checked 4-24 hours post-transfusion or according to agency policy.[11]

Loss of Coagulation Factors

Transfusion of fresh frozen plasma (FFP) is commonly used for prophylaxis in non-bleeding patients. It is also indicated for acutely bleeding patients to replace their lost coagulation factors. Other clinical situations that may indicate coagulation factor replacement include cardiopulmonary bypass, massive transfusion, decompensated liver disease, extracorporeal pulmonary support techniques, acute disseminated intravascular coagulation (DIC), and prior to invasive procedures for patients with decreased clotting factors and/or elevated INR.[12]

Platelet Deficiency/Dysfunction

Platelet transfusions are an effective treatment for patients with platelet deficiency and/or platelet dysfunction, such as bone marrow insufficiency or **thrombocytopenia**. Platelet transfusions for patients who are thrombocytopenic may be done prophylactically to either prevent or reduce the severity of spontaneous patient bleeding with platelet counts less than 10,000/uL and no other risk factors are present for bleeding. If a client is actively hemorrhaging and thrombocytopenia is contributing to the hemorrhaging, platelets should be infused if the platelet count is less than 50,000/uL.[13]

There are different types of platelet infusions, and they yield different results. A typical unit of apheresis platelets should increase the recipient's platelet count by 30,000 to 60,000/uL. Apheresis is a procedure in which whole blood is collected from a donor, part of the blood such as platelets or white blood cells is removed, and the rest of the blood is returned to the

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donor. In comparison to apheresis platelets, whole-blood derived platelets, which are often pooled from several donors, are expected to raise the platelet count by 5,000 to 10,000/uL.[14]

Fibrinogen Deficiency or Disorders

Cryoprecipitate transfusion is indicated in dysfibrinogenemia or fibrinogen deficiency (hypofibrinogenemia) when the patient is experiencing active bleeding, traumatic injury, invasive procedures, or acute disseminated intravascular coagulation (DIC).[15] **Dysfibrinogenemia** is a coagulation (clotting) disorder characterized by an abnormal form of fibrinogen. **Hypofibrinogenemia** is a rare, autosomal dominant condition characterized by bleeding and obstetric problems such as abruption, postpartum hemorrhage, and recurrent pregnancy loss. Fibrinogen is a protein produced by the liver that helps control bleeding by helping blood clots to form; abnormal or deficient fibrinogen results in defective clot formation.

Severe Hypovolemia

Rapid infusion of crystalloid solutions (such as 0.9% normal saline) is the standard, evidence-based first-line treatment for severe hypovolemia or hypovolemic shock. However, in cases where the patient has limited response to crystalloid solutions or for those whom hypoalbuminemia is thought to be a contributing factor, colloid fluids (i.e., albumin) may be infused. Albumin is the main modulator of fluid distribution among the compartments of the body by providing plasma oncotic pressure. It treats hypovolemia by attracting sodium and, therefore, water into the intravascular compartment and increasing circulatory volume.[16,17]

14. This work is a derivative of StatPearls by Lotterman & Sharma and is licensed under CC BY 4.0
15. This work is a derivative of StatPearls by Lotterman & Sharma and is licensed under CC BY 4.0
16. Caraceni, P., Tufoni, M., & Bonavita, M. E. (2013). Clinical use of albumin. *Blood Transfusion = Trasfusione del Sangue, 11*(Suppl 4), s18–s25. https://doi.org/10.2450/2013.005s
17. Mandel, J., & Palevsky, P. M. (2022). Treatment of severe hypovolemia or hypovolemic shock in adults. *UpToDate*. https://www.uptodate.com

Transfusion Reactions

Transfusion reactions are adverse events that are directly related to the transfusion of blood products and may range from mild to severe with life-threatening effects. The onset of transfusion reactions may occur during the transfusion (known as acute transfusion reactions) or in days or weeks following the transfusion (known as delayed transfusion reactions). Reactions may be an immune-related reaction or non-immunological condition. Immune-related reactions are often due to a mismatch or incompatibility of the transfused blood product and the recipient's blood type or Rh factor. Non-immunologic reactions are typically caused by the physical effects of the blood component or the transmission of a disease.

It can be difficult to ascertain if a reaction will occur and what kind of reaction is occurring because some reactions can present with non-specific, overlapping manifestations. The most common manifestations of transfusion reactions include fever, urticaria, chills, and itching. Some mild symptoms may resolve without treatment, but some are severe, presenting with high fevers, respiratory distress, hypotension, and hemoglobinuria.[18]

The most common types of transfusion reactions include acute hemolytic, febrile non-hemolytic, delayed hemolytic, anaphylactic, simple allergic, transfusion-associated circulatory overload (TACO), transfusion-related acute lung injury (TRALI), and septic (bacterial contamination).[19] If a patient experiences a blood transfusion reaction, always follow agency policy to manage mild to severe blood reactions. See Table 3.2c for additional information about different types of transfusion reactions, their causes, onset, manifestations, prevention, and related nursing interventions.[20] See Figure 3.3 for an illustration of common manifestations of transfusion reactions.

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19. This work is a derivative of StatPearls by Lotterman & Sharma and is licensed under CC BY 4.0
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Life-threatening transfusion reactions typically occur within 15 minutes of initiating a transfusion. Remain with the patient during this time and monitor their physiologic responses.

Table 3.2c Transfusion Reactions and Related Nursing Interventions[21]

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Transfusion Reaction	Cause	Onset	Manifestations	Prevention	Nursing Interventions
Mild to Moderate Allergic Reaction	Hypersensitivity to a foreign protein in the donor product.	During the transfusion and up to 24 hours post-transfusion.	Pruritus, erythema, local hives, urticaria, and bronchospasm.	If known history of a previous allergic reaction, may require administration of an antihistamine prior to infusion.	Stop transfusion and notify the provider. Administer antihistamine if prescribed and carefully monitor for new or progression of symptoms. Analyze vital signs every 15 minutes.
Anaphylactic	Recipient allergy to donor antigen (most often IgA).	Occurs within 5-15 minutes of initiation of transfusion.	Similar to mild/ moderate allergic reaction, but more severe with nausea/ vomiting, shortness of breath, cough, wheezing, hypotension, and loss of consciousness. May lead to cardiac arrest.	If known history of previous allergic reaction, transfuse with leukocyte – depleted RBCs.	Stop transfusion and notify the provider. Maintain IV access. Administer epinephrine, antihistamines, and corticosteroids as prescribed. Monitor vital signs frequently until stable.
Febrile Non-Hemolytic	Caused by cytokines released from blood donor's leukocytes or platelets. Most common transfusion reaction that typically occurs in immunocompromised patients.	Occurs 30 minutes after initiation of transfusion to 6 hours post-transfusion.	Increased fever greater than 1 degree Celsius above baseline with associated flushing, chills, muscle pain, and headache. Tachycardia, tachypnea, and hypotension may also occur.	If known history of a previous febrile non-hemolytic reaction, use a leukocyte-reduced blood product.	Stop transfusion and notify the provider. If prescribed, administer antipyretics. Monitor temperature every four hours and as needed.
Acute Hemolytic	ABO and Rh incompatibility results in destruction of RBCs.	Occurs within 15 minutes of initiation of transfusion.	Flank pain, chest pain, increased heart rate, chills, increased temperature, low back pain, headache, dyspnea, bronchospasm, anxiety, hypotension, or pain along the accessed vein.	Considered a hospital-acquired condition preventable by diligent patient identification and blood product compatibility verification.	Stop transfusion, remove blood tubing, and maintain access with 0.9% normal saline. Notify the provider and monitor vitals every 15 minutes. Obtain blood and urine samples and send to the lab with unused portion of blood product.
Septic	Contamination of blood product with bacterial microorganisms.	During transfusion and possibly up to two hours post-transfusion.	High fever, skin flushing, hypotension, back pain, abdominal cramping, nausea, and vomiting and diarrhea.	Complete transfusion within four hours to avoid bacterial growth. Proper care of blood product is required from donation through administration.	Stop the transfusion, remove blood product and tubing, and maintain IV access with 0.9% normal saline. Notify the provider. Monitor vital signs. Obtain blood cultures as prescribed. Administer fluids, obtain gram stain, and provide broad-spectrum antimicrobials as prescribed.
Transfusion-Associated Circulatory Overload (TACO)	Occurs when the volume of the transfusing blood component causes volume overload (hypervolemia) from an overly rapid administration rate or amount.	Can occur anytime during the transfusion or within 1-2 hours post-transfusion.	Crackles in lung bases, dyspnea, cough, tachypnea, tachycardia, hypertension, jugular vein distension, and headache.	Follow prescribed rate of infusion, typically 2 – 4 mL/ kg/hr. Use caution with older adults and with those who have cardiac and renal disorders.	Reduce rate or stop transfusion as prescribed by provider. Monitor and manage patient manifestations. Elevate head of bed and administer diuretic as prescribed.

Transfusion – Related Acute Lung Injury (TRALI)[22]	Acute lung injury caused by antibodies in the donor blood products that react with antigens in the recipient. Recipient chemical mediators are released and lead to pulmonary edema.	Within 6 hours to 72 hours of transfusion of blood products that are rich in plasma.	Cyanosis, dyspnea, fever, hypoxemia, hypotension, and pulmonary edema that is not cardiac-related (i.e., due to fluid overload).	Assess for contributing factors that predispose the patient to this condition, including infection, inflammation, or recent surgery.	Stop the transfusion immediately and notify the provider. Administer treatment to support blood pressure as prescribed. Administer supplemental oxygen as prescribed. Prepare for endotracheal intubation and mechanical ventilation. Notify the blood bank so they can screen for certain donor antibodies.

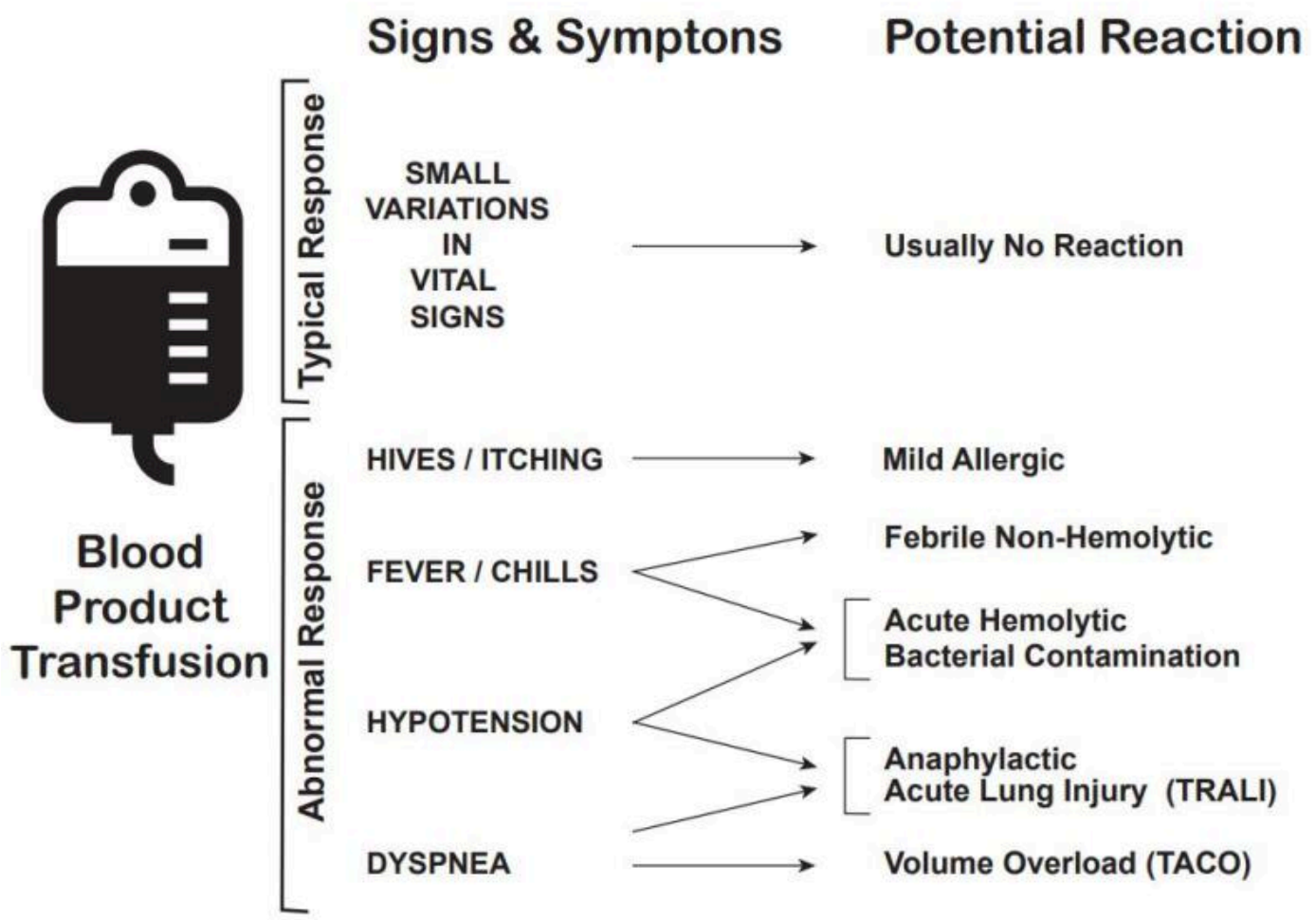

Figure 3.3 Potential Blood Transfusion Reactions

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For more information, review the article "Transfusion Reactions."[23]

View this supplementary YouTube video[24] on blood transfusion reaction types.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=133#oembed-1

Initiating Blood Product Therapy

Nurses and health care practitioners who administer blood products must complete specific training for safe transfusion practices and demonstrate competency in the transfusion administration process. Always refer to agency policy for guidelines for preparing, initiating, and monitoring blood product transfusions. The nurse is responsible for knowing which blood components are appropriate for specific client situations and serving as the last link in the chain of safety events.

Agency policy and procedures must be strictly followed to prevent client harm. The nurse must verify that the client has signed informed consent for the procedure in their medical record. Prior to blood product administration, the nurse confirms that a blood sample has been collected from the client and transported to the laboratory within the past 72 hours for typing and

23. This work is a derivative of StatPearls by Suddock and Crookston and is licensed under CC BY 4.0
24. RegisteredNurseRN. (2018, March 20). *Blood transfusion procedure nursing | Reaction types, complications (hemolytic/ febrile) NCLEX* [Video]. YouTube. Used with permission. https://youtu.be/v4PHCwvkH24

compatibility screening. This is the first step in maintaining patient safety and preventing errors.

Diligent patient identification and blood product compatibility verification are vital for safe blood product administration. A two-person verification process is used for blood product transfusions. The first individual is the qualified transfusionist who will administer the blood or blood product to the client. The second individual conducting the identification verification process is qualified to participate in the verification process, as determined by the hospital.

Blood is stored within a refrigerated area. Blood products should never be heated in a microwave or hot water or vigorously shaken because this will destroy the blood cells. In certain circumstances, such as trauma or surgery, blood may be warmed with an appropriate blood warmer, but this is prescribed within designated conditions and not a routine practice.

Health Care Team Collaboration

Blood product transfusion therapy is implemented by several members of the health care team. Nurses must be knowledgeable of the transfusion process, potential complications, and management of possible complications. The majority of transfusion reactions occur because of clinical error. Engaging in interprofessional teamwork, utilizing effective communication, and adhering to evidence-based protocols improve patient outcomes and safety. If there are any concerns during any step in the blood product administration process, the nurse must advocate for patient safety.[25]

Blood product transfusion therapy cannot be delegated to unlicensed assistive personnel (UAP). However, if the client is stable, UAP may obtain vital signs as instructed during the transfusion and report any concerns or complaints to the supervising nurse.

Cultural Considerations

When administering blood products, be aware of the client's beliefs (and in

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the case of minors, their parents' religious beliefs). Some religions, such as Jehovah's Witnesses, oppose blood transfusions. They may be excommunicated from their church and the facility can be sued, even if the transfusion is implemented to save their life. This is another reason why it is critical to obtain written informed consent prior to initiating blood or blood product administration. It is essential to follow agency policies and procedures if a client (or the parent of a minor) refuses blood therapy.[26]

Autologous Blood Transfusion

Autologous blood transfusion is a procedure in which blood is removed from the client and returned to their circulation at a later time, instead of relying on blood donated by others (referred to **allogeneic blood**). Autologous blood transfusion can be performed in different ways, such as elective preoperative blood collection and retransfusion of blood during surgery or intraoperative hemodilution.

Autologous blood transfusion avoids the risks of transfusion reactions that can occur with allogeneic blood. It may also be acceptable for clients prior to stem cell transplantation, clients with leukemias or lymphomas, or clients with religious beliefs who oppose blood transfusions.

26. Sagy, I., Jotkowitz, A., & Barski, L. (2017). Reflections on cultural preferences and internal medicine: The case of Jehovah's Witnesses and the changing thresholds for blood transfusions. *Journal of Religion and Health, 56*(2), 732–738. https://doi.org/10.1007/s10943-016-0353-1

3.3 Applying the Nursing Process

The procedural steps for blood product administration while applying the nursing process are described in Table 3.3 with associated rationale.

Table 3.3 Blood Product Administration Procedure and Rationale[1]

1. Blood and blood product transfusion. (2022). *Lippincott procedures.* http://procedures.lww.com

Assessment	Rationale
Verify written informed consent has been received for the procedure. Check the form to ensure it is properly completed and signed and assess client understanding of the procedure.	Infusion of blood is an invasive procedure with inherent risks and requires specific informed consent. Patient understanding of the procedure and its rationale must be assessed by the nurse prior to its initiation.
Verify provider order for the blood product to be administered. Note any pre- or post-transfusion medications that have been prescribed.	A prescription from a health care provider is necessary before transfusing any blood product. Verifying the order and associated medications ensures they are appropriately administered.
Obtain client allergies, previous transfusion history, and transfusion reactions.	Gathering this data helps prevent transfusion reactions. If the client has had previous transfusion reactions, measures can be taken to help prevent another one from occurring.
Assess the recent laboratory values and results related to the blood product being transfused.	Ensure the type and screen has been completed. Assessment of other laboratory values provides a baseline comparison when evaluating the patient's response to the transfusion or in the event of a complication.
Analyze recent vital signs and notify the provider of any concerns. For example, if the client has a fever, clarify the order with the provider before obtaining the blood product from the blood bank.	If the client has any vital signs that are out of range and require clarification from the provider, this clarification should be addressed before obtaining the blood product because it typically must be initiated within 20-30 minutes of retrieval and cannot be returned.
Perform a respiratory assessment, skin assessment, and pain assessment.	Establish a baseline to use to trend future assessments and recognize changes in the event a transfusion reaction occurs.
Planning	
Review the indication for the transfusion with clinical supportive data.	The nurse develops a plan of care and formulates expected outcomes of the procedure based on the indication for the transfusion.
Determine expected outcomes for the client receiving a blood product transfusion. Expected outcomes of the transfusion are based on the indications for the transfusion.	Examples of expected outcomes for a PRBC transfusion include improved activity tolerance and improved hemoglobin and hematocrit to target range.

Determine if pre- or post-medication is needed for this specific client.	Diphenhydramine and acetaminophen are commonly prescribed for clients with a previous history of reactions. Anticipate that a client with a history of heart failure who will be receiving multiple units of blood may require furosemide to prevent fluid overload.
Implementation	
Start or verify venous access. Use short peripheral catheters (20G to 24G) based on vein size and patient preference or 18G to 20G if rapid transfusion is required. Verify the integrity and patency of IV catheters already in place. The distal lumen of a central venous access device may also be used to administer blood. Consider establishing a second peripheral venous access site for administration of other medications while blood is transfusing.	Correct catheter use ensures appropriate size, gauge, and viable intravenous access for the blood product. A second venous access site may be required for administration of other fluids, medications, or other substances while blood is transfusing because they cannot be administered using the same line.
Retrieve appropriate Y-infusion tubing set specific to blood product administration (for example, a microaggregate filter for leukocyte-reduced RBC) and 0.9% normal saline IV fluid. Inspect the tubing and filter.	Only IV normal saline is compatible with simultaneous blood product administration. Lactated ringers, dextrose, hyperalimentation (artificial nutrients supplied intravenously), and other intravenous solutions with medications are not compatible with blood products. A **microaggregate filter** is a blood filter with a pore size of 20–40 µm that removes 75–90% of white cells. Inspection of the tubing and the filter ensures it is suitable for the specific blood product prescribed.
Obtain blood or blood product from facility blood bank (follow agency policy).	Blood should not remain in the client care area for more than 30 minutes before the transfusion begins, so the nurse must be prepared to begin the transfusion shortly after the blood is delivered.

Perform the following checks with a second nurse or agency-defined trained health professional: compare the blood unit to the order, verify the client's identity, verify the client's blood type and Rh factor against the type of blood that will be infused, check the expiration of the blood component, and compare the client's number against the blood product number. The nurses should also visually inspect the blood for any unusual color, precipitate, clumping, and any other unusual signs.	Checks by two nurses prevent transfusion reactions through proper client identification, verification of the prescription, and blood product compatibility. **Note:** The Joint Commission classifies a blood incompatibility error as a sentinel event (i.e., an event that is an unexpected occurrence resulting in death or serious physical or psychological injury, or the risk thereof).[2]
Obtain and document pre-transfusion vital signs and a baseline physical assessment. If the client is febrile (i.e., above 37.8° C or 100.4° F), notify the provider before starting the transfusion.	Baseline data and hemodynamic status must be established immediately before the transfusion begins so that manifestations of a transfusion reaction can be quickly recognized. For example, if a client develops fluid overload, a baseline assessment, including lung sounds, can be used for comparison with new findings.
Initiate the blood transfusion. The nurse must remain with and monitor the client for at least 15 minutes as the transfusion begins at a slow rate of 2 mL/min (i.e., 120 mL/hour). Ask the client to report unusual sensations (i.e., chills, hives, itching, shortness of breath, and chest pain). Note: All blood products must be completely administered in less than four hours. Administration sets are changed based on agency policy, commonly at the completion of every unit or every four hours.	Most transfusion reactions occur within the first 15 minutes of starting the transfusion. Blood products should not hang for more than four hours, and administration sets should be changed at the completion of each unit or every four hours to reduce bacterial contamination.
After 15 minutes, obtain another set of vitals. Determine an appropriate rate of transfusion based on agency policy and client considerations.	Most transfusion reactions occur within the first 15 minutes of starting the transfusion. The rate of infusion can be adjusted after the initial 15 minutes based on patient tolerance. For example, a client with an active hemorrhage requires a fast rate whereas an elderly, symptomatic anemic patient with a history of heart failure requires a slower rate.

If signs of a transfusion reaction occur, stop the transfusion and perform appropriate steps based on the agency's transfusion reaction policy and protocol. Assess the patient and obtain vital signs. Start normal saline with new primed tubing attached directly to the venous access device and notify the health care provider immediately. Do not infuse saline through the existing tubing because it will cause the blood in the tubing to enter the patient. Do not discard the blood product or tubing; prepare it for lab analysis according to agency policy.	These steps prevent increased risks to the client. New tubing ensures that none of the blood product will further infuse into the client. Agency policy typically requires additional steps such as labs drawn, urine collection, and forms to be filled out and sent to lab.
Frequently monitor and assess the IV site and surrounding area.	Early detection of IV site complications improves patient outcomes.

Never store blood in an agency refrigerator. Never inject medication into the same line with a blood component. Never use the same IV line to administer medication and blood because preservatives in the medication could cause hemolysis or clotting of the blood. Maintain a separate access line if IV solutions or medications are to be administered.

Delegation Tips:

Each state's Nurse Practice Act specifies if the skill of blood product transfusion can be delegated to a licensed vocational/

2. World Health Organization. (2022). *Blood products*. https://www.who.int/health-topics/blood-products#tab=tab_

practical nurse (LVN/PN) and if unlicensed assistive personnel (UAP) may collect vital signs after the first 15 minutes of the transfusion and the client's stability has been confirmed. During the delegation process, the registered nurse (RN) should specify the frequency in which the client should be monitored and vital signs collected, as well as the parameters for vital signs and symptoms that should be immediately reported. Examples of parameters include an increased temperature, decreased pulse oximetry reading, shortness of breath, chest pain, hives, or chills. The RN retains responsibility and accountability for monitoring the client's status during the transfusion. Read more information about delegation in the "Delegation and Supervision" chapter in Open RN *Nursing Management & Professional Concepts*.

Post-Procedure

Evaluation	
Evaluate and document client response and tolerance of the infusion, comparing current status to baseline data, such as physical assessment, vital signs, and lab results. Assess IV site to ensure integrity and patency after the infusion.	Evaluation determines if the goals of the transfusion therapy were achieved or if late onset transfusion complications are developing. **Note:** Some laboratory results may not reflect anticipated targets for several hours after the transfusion is completed.

3.4 Checklist: Administer Blood Products

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Administer Blood Products[1,2]

- Verify the provider's order. Confirm the order and the medical record are labeled with the client's first and last name and assigned identification number.
- Unless the transfusion is an emergency, confirm the provider has obtained written informed consent before initiating transfusion therapy and the consent is in the client's medical record.
- Review prescribed medications to be administered before, during, and after the transfusion.
- Ensure that a blood sample was obtained for compatibility testing according to agency policy, typically within the past 72 hours. Obtain a blood sample if needed.
- Ensure the agency's transfusion services receives a request with the client's first and last name, an identification number, the prescribed blood component and amount ordered, and the name of the provider.
- Gather the necessary equipment:
    - Blood or blood product administration set (with standard blood filter)
    - IV pole
    - Gloves
    - Blood or blood product
    - Preservative-free normal saline solution
    - 3-mL syringe
    - Antiseptic pad (chlorhexidine-based, povidone-iodine, or alcohol)
    - Disinfectant pad
    - Stethoscope
    - Vital signs monitoring equipment

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com

    - Blood request
    - Premedications (if prescribed), 250 mL of normal saline solution, IV catheter equipment (should include 18G to 24G catheters), electronic infusion device indicated for blood transfusion use, PPE, and pulse oximeter
- Perform hand hygiene and put on gloves.
- Confirm the client's identity using at least two patient identifiers.
- Ask the client if they have any allergies or any prior transfusion reactions.
- Assess the client's previous knowledge and understanding of the procedure. Assess the client's anxiety level and respond therapeutically.
- Ensure that the client has adequate venous access; insert an IV catheter if necessary.
- Remove and discard your gloves.
- Perform hand hygiene.
- Obtain the client's vital signs within 15 minutes of initiating the transfusion.
- Assess the client's breath sounds, skin color, and current laboratory tests, such as hemoglobin and hematocrit. Identify any conditions that may increase the risk of a transfusion reaction, such as a fever, heart failure, kidney disease, or the risk of fluid volume excess.
- Question the client about any symptoms that may later be mistaken for a transfusion reaction.
- Assist the client to the bathroom if necessary. Help the client to a comfortable position.
- If the client is in bed, raise the bed to waist level.
- Obtain the blood or blood product from transfusion services, making sure to verify the blood component with a transfusion services representative. Wear gloves or transport the component unit in a container that prevents direct contact with the unit bag. Start blood transfusion within 30 minutes of obtaining it from the blood bank.
- Perform hand hygiene.
- Put on gloves and other personal protective equipment, as needed.
- Use a two-person verification process in the presence of the client to match the blood or blood component to the provider's order and the

patient. Compare the name and identification number on the client's wristband with those on the blood bag label. Check the blood bag identification number, ABO blood group, Rh compatibility, and interpretation of compatibility testing. Compare the client's transfusion services identification number with the number on the blood bag.

- Check the expiration date and the integrity of the product; return expired or abnormal blood to transfusion services.
- Prime the administration set. When using a Y-type set, use normal saline solution to prime the tubing.
- Perform a vigorous mechanical scrub of the vascular access device for at least five seconds using an antiseptic pad. Allow it to dry completely.
- Trace the blood administration set from the client to its point of origin before beginning the transfusion. Route the tubing in a standardized direction if the client has other tubing and catheters that have different purposes. Label the tubing at the distal and proximal ends.
- Start the transfusion at a slow rate per agency policy, typically 2 mL/minute (i.e., 120 mL/hour).
- Remain with the client during the first 15 minutes to monitor for signs of transfusion reaction.
- If a reaction occurs, immediately stop the transfusion and notify the provider and transfusion services according to agency policy.
- During the first 15 minutes of the blood transfusion, obtain and analyze vital signs based on agency policy.
- If no evidence of a transfusion reaction occurs, increase the infusion rate to the prescribed rate to ensure administration is complete within a 4-hour time frame.
- Instruct the client to immediately report any unusual symptoms such as chills, itching, hives, shortness of breath, or chest pain and leave the call light within reach.
- Observe the client periodically during the transfusion and assess their respiratory status, skin appearance, and urine output. Monitor vital signs during the transfusion as directed by agency policy and/or the client's condition.
- Closely monitor the flow rate and inspect the IV insertion site for signs of

infiltration. If signs of infiltration are present, stop the transfusion immediately, disconnect the administration set, and aspirate fluid from the catheter using a 3-mL syringe. Remove the catheter and estimate the volume of fluid infiltrated. Notify the provider and insert a new IV catheter in a different location and restart the transfusion.

- Remove and discard gloves and any personal protective equipment.
- Perform hand hygiene.
- After the completion of the blood product administration, assess the IV site and obtain the client's vital signs and compare them with the baseline measurements.
- If additional units must be administered, repeat the procedure. If additional units aren't needed, perform hand hygiene, put on gloves, and reconnect the original IV fluid, saline lock the catheter, or discontinue the IV infusion, as prescribed.
- Appropriately discard the used equipment, blood bag, filter, and tubing in a biohazard bag or bin.
- Dispose of used equipment in appropriate receptacles.
- Remove and discard gloves and other personal protective equipment, if worn.
- Perform hand hygiene.
- In an inpatient setting, help the patient into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the patient knows how to use the call light to summon assistance. To ensure the patient's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Perform hand hygiene.
- Document the procedure and assessments.
- Continue to assess and monitor the client for 4 to 6 hours after the transfusion.
- Teach the client and family about the signs and symptoms of a delayed reaction.

View a YouTube video[3] showing an instructor demonstration of this skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=139#oembed-1

3. Chippewa Valley Technical College. (2023, January 5). *Administering blood products* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/1JzL1GTd99E

3.5 Documentation

All aspects of the administration of blood products are documented. Documentation must minimally include the following components:

- Date and time that the blood transfusion began
- Name of the second nurse who did the two-person verification process
- Name and amount of the specific type of transfusion (for example, 1 unit of packed red blood cells)
- Blood product number
- Confirmation that written informed consent was obtained
- Indications for the transfusion
- Premedications administered
- Donor identification number
- IV site location
- Size and gauge of IV catheter access
- Duration of the transfusion
- Vital signs before, during, and post-transfusion according to agency policy
- Pre- and post-transfusion focused assessments (lungs, heart, etc.) according to agency policy
- Indication that the client was informed about when and why to contact the nurse after the initial 15-minute monitoring period
- Amount of normal saline solution infused
- Client response to the transfusion
- If a transfusion reaction occurs:
    - Name of the provider notified
    - Time of notification
    - Interventions performed
    - Client's response to those interventions.
- Any teaching provided to the client and family, including their understanding of the teaching and any follow-up that was needed

Sample Documentation:

12/7/20XX 1445

Transfusion of one-unit (250mL) packed RBCs started at 1445 via 20-gauge saline lock in the right forearm. Unit product #G901 301 000 482. Blood product and client identification verified with Jane Smith, RN. Informed consent signed and in client chart. Infusion indication: symptomatic anemia with hemoglobin level at 7.4 mg/dL. Client verbalizes understanding of the reason for transfusion and the need to inform RN as soon as possible if any symptoms develop during transfusion. Microaggregate Y-tubing system attached to packed red blood cells and 0.9% normal saline. Pre-transfusion vital signs and assessments: T 98.2 F (temporal), HR 88 bpm, RR 20, BP 112/68, SpO2 97% on room air, lung sounds clear, regular heart rate with no extra sounds.

1500: Stayed with client for the first 15 minutes of initiation. Client tolerated infusion without any new or adverse signs or symptoms.

1715: Unit (250 mL) was infused within 2.5 hours, with 50 mL of normal saline 0.9%. Time of completion: 1715. Post-transfusion completion vital signs and assessments: T 97.6 F (temporal), HR, 78 bpm, RR 22, BP 128/72, SpO2 97% on room air, lungs sounds clear, regular heart rate with no extra sounds. IV site intact and patent without signs of phlebitis or infiltration. Client appears comfortable and denies discomfort.

Manuel Roberts, RN

Exercises

(Answers to the exercises are located in the Answer Key at the back of the book).

Case Study #1

Helen, age 80, has a history of myelodysplastic syndrome, anemia, and chronic heart failure. She is scheduled to receive a blood transfusion today for a Hgb of 6.5 g/dL this morning. She arrived at the clinic to see her primary care provider for follow-up appointment with her daughter Grace. "I feel so tired this morning," Helen groans, "It was really hard getting out of bed to get here. Grace had to help me into my wheelchair and helped get my hair fixed and get me dressed today too. I'm so exhausted now."

Grace nods as Helen talks, and adds, "I also think she looks really pale. She definitely needs a transfusion today. I'm worried about her."

As you complete your assessment prior to the transfusion, Helen begins coughing and has audible crackles when breathing. Additionally, her BP is elevated from baseline and rhonchi are auscultated bilaterally in the bases of her lungs.

The MD provides the following orders:

- Administer 2U PRBCs today
- Type and screen now
- Administer furosemide 20 mg IV now and

between units of blood

1. What are the indications for a blood transfusion for Helen?

2. Are there any considerations you need to make regarding starting an IV for the blood transfusion?

3. What steps will you take to prepare for the administration of blood for Helen?

4. What precautions or nursing considerations need to be made?

5. What assessments will you complete prior to the blood transfusion? During the blood transfusion?

6. Helen has blood type O-. What types of blood are compatible with this type?

7. You are notified that the blood has been prepared in the lab and is ready for administration. What steps do you take to ensure safety for the client?

8. Explain the remaining steps for the procedure of administering the blood transfusion.

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https://wtcs.pressbooks.pub/nursingadvancedskills/?p=143#h5p-7

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https://wtcs.pressbooks.pub/nursingadvancedskills/?p=143#h5p-8

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=143#h5p-9

Test your knowledge using a NCLEX Next Generation-style question. You may reset and resubmit your answers to this question an unlimited number of times.

III Glossary

Allogeneic blood products: Blood products donated by other people.

Anemia: A hematological condition where there is a lack of healthy red blood cells and/or hemoglobin to carry adequate oxygen to the body's tissues.

Autologous blood transfusion: A procedure in which blood is removed from the patient and returned to their circulation at a later time, instead of relying on blood donated by others (i.e., allogeneic blood).

Blood product: Any therapeutic substance derived from human blood, including whole blood and other blood components for transfusion, as well as plasma-derived medicinal products.

Dysfibrinogenemia: A coagulation (clotting) disorder characterized by abnormal fibrinogen.

Hemolysis: Red blood cell destruction.

Hypofibrinogenemia: A rare, autosomal dominant condition characterized by bleeding and obstetric problems such as abruption, postpartum hemorrhage, and recurrent pregnancy loss.

Microaggregate filter: A second-generation blood filter with a pore size of 20–40 μm that removes 75–90% of white cells, which is used to transfuse packed red cells.

Thrombocytopenia: Platelet deficiency causing bleeding, bruising, and slow blood clotting after injury.

Transfusion reactions: Adverse events that are directly related to the transfusion of blood products and may range from mild to severe with life-threatening effects. Transfusion reactions may be acute or delayed (i.e., up to days or weeks after the transfusion). Immune-related reactions are often due to a mismatch or incompatibility of the transfused blood product and the recipient's blood type or Rh factor. Non-immunologic reactions are typically caused by the physical effects of the blood component or the transmission of a disease.

PART IV

CHAPTER 4 MANAGE CENTRAL LINES

4.1 Introduction

Learning Objectives

- Outline indications for insertion of a central venous access device (CVAD)
- Compare and contrast the various types of CVADs and where they are inserted
- Describe the processes of verifying placement and securing a CVAD
- Describe infection control techniques to prevent infections associated with CVADs
- Identify potential complications associated with CVADs, prevention, and related nursing interventions
- Discuss how to safely change CVAD dressings and needleless connectors
- Outline the processes of safely accessing, flushing, and locking CVADs
- Describe blood sampling techniques from CVADs
- Discuss the components of routine documentation related to CVADs

As the complexity of client conditions continues to evolve within health care settings, the safe use and management of central lines are imperative. A central line is a thin, flexible, large-bore tube inserted into a client's large vein, also referred to as a **central venous access device (CVAD)**. There are various insertion sites for CVADs (see Figure 4.1[1]). CVADs are commonly guided into

1. "Central-venous-access-sites.png" by unknown author is licensed under CC B-NC-ND. Access for free at https://www.researchgate.net/figure/Central-venous-access-sites_fig1_334584348

the superior vena cava so the distal tip is located in the superior vena cava near the junction with the right atrium. Other CVADs are introduced through the femoral vein so the distal tip sits in the inferior vena cava. CVADs differ from short peripheral IV catheters used for intravenous access because they are placed in central circulation due to the distal tip location.

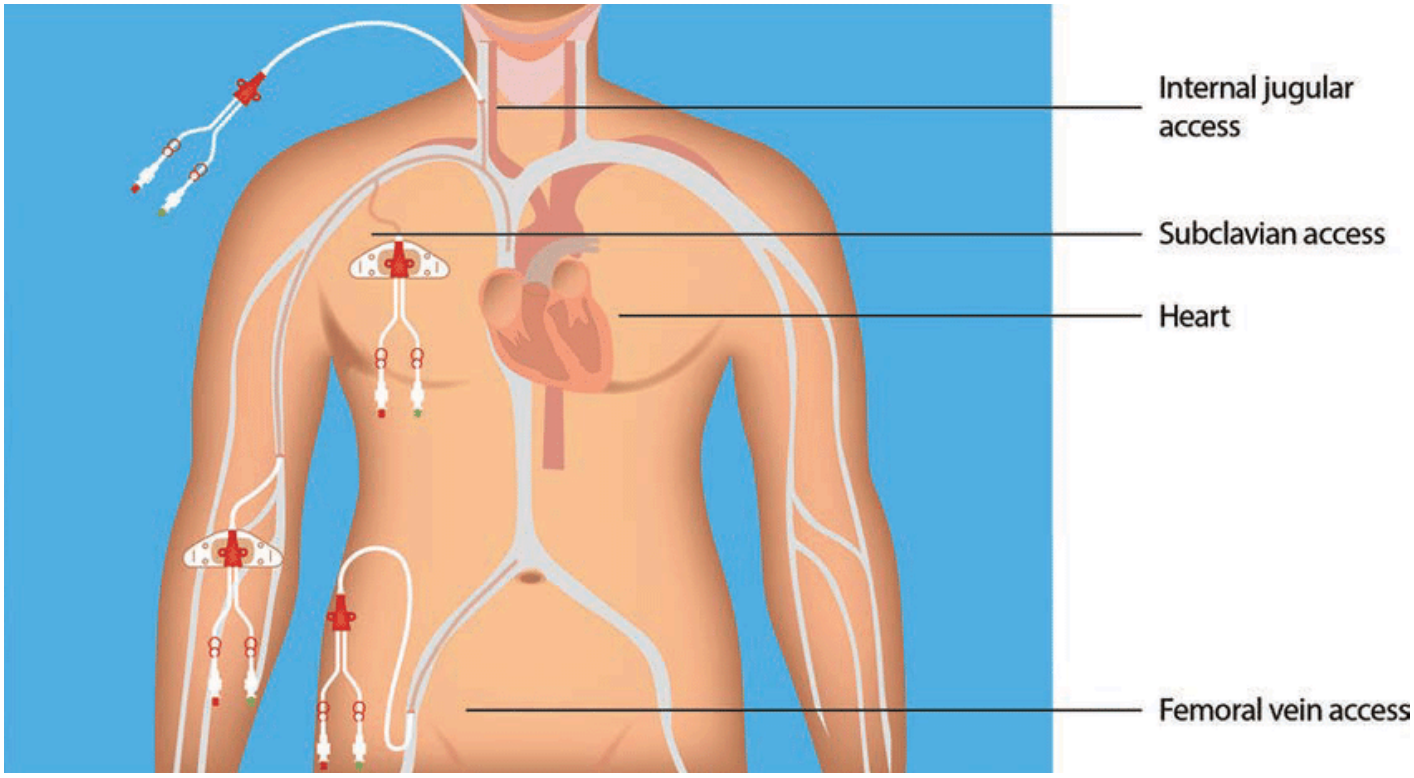

Figure 4.1 CVAD Insertion Sites

CVADs are used for delivery of medication, fluids, and nutrition and can remain in place long-term. They can also be used for blood draws, hemodynamic monitoring, and transvenous pacing. These lines help ensure consistent vascular access can be easily obtained and utilized by the health care team. This chapter will describe indications for CVADs, explore different types of CVADs, outline related nursing procedures, and discuss nursing management of clients with CVADs.

Indications for CVAD

Common indications for CVAD placement include delivery of medication, fluids, and nutrition, especially for clients requiring long-term therapy. CVADs are required for infusion of high osmolarity solutions and vesicant medications. They may also be placed for emergency venous access for clients requiring fluid resuscitation and hemodynamic monitoring.[1] Many clients who require CVADs are older adults, very young children, or those with chronic health conditions.[2]

High osmolarity solutions refer to a highly concentrated solution expressed as the total number of solute particles per liter. High osmolarity solutions, such as total parenteral nutrition and hypertonic IV fluids, are irritating to peripheral vessels and increase the client's risk for phlebitis, thrombosis, and occlusion. Additionally, **vesicant medications** (such as certain antineoplastic drugs, antibiotics, electrolytes, and vasopressors) can cause severe tissue injury or destruction if they extravasate. **Extravasation** refers to leakage of fluid into the tissues around the IV site, causing tissue injury when the catheter has dislodged from the blood vessel but is still in the nearby tissue. For this reason, infusions of high osmolarity solutions and vesicant medications are administered through a CVAD into a large vein such as the superior vena cava. When these solutions enter this larger vessel, the solution is hemodiluted, thus minimizing the risk of these complications from occurring.

Fluid resuscitation refers to infusing a large volume of fluid through the intravenous venous access to restore hemodynamics and optimize tissue perfusion and, ultimately, tissue oxygen delivery. Hemodynamic monitoring is often in place when a client requires fluid resuscitation. **Hemodynamic monitoring** is the assessment of a critically ill client's circulatory status and

1. This work is a derivative of StatPearls by Tse and Schick and is licensed under CC BY 4.0
2. Broadhurst, D., Moureau, N., & Ullman, A. J. The World Congress of Vascular Access (WoCoVA) Skin Impairment Management Advisory Panel. (2017). Management of central venous access device-associated skin impairment: An evidence-based algorithm. *Journal of Wound, Ostomy, and Continence Nursing, 44*(3), 211-220. https://journals.lww.com/jwocnonline/fulltext/2017/05000/management_of_central_venous_access.2.aspx

includes measurements of central venous pressure, cardiac output, and blood volume.[3] **Central venous pressure (CVP)** reflects the pressure in the central veins as they enter the right atrium and is often monitored during fluid resuscitation as measure of preload (i.e., volume status).

Types of Central Venous Access Devices and Locations

There are several types of CVADs, and the selection of which type is used depends upon the specific client's clinical situation, indication, and duration of treatment. The type of CVAD selected is based on the specific client's clinical situation. The decision process for selecting an appropriate CVAD involves collaboration among the provider, the client, and the health care team while considering the treatment requirements. Special considerations include examining the expected length of treatment; the specific prescribed treatment; and the client's vascular characteristics, age, cognitive level, medical history, infusion therapy history, and, if appropriate, their preference for the CVAD site location. Generally, other venous access or alternative delivery methods should be considered prior to inserting a CVAD due to its invasiveness and associated risks. Indications for CVAD insertion and its associated risks should be explained to the client by the provider and documented in their medical record.[4]

CVADs may be inserted centrally or peripherally. A centrally inserted central venous catheter is typically placed into the client's internal jugular, subclavian, or femoral vein. Peripherally inserted central venous catheters (referred to as PICC lines) are primarily placed through the basilic, cephalic, or brachial veins. Insertion is more successful with fewer complications when guided ultrasound is used for placement.[5]

Only specially trained health care clinicians can select and insert CVADs. The determination of which area (peripheral, midline, or central vein) used to

3. McCarthy, C. J., Behravesh, S., Naidu, S. G., & Oklu, R. (2016). Air embolism: Practical tips for prevention and treatment. *Journal of Clinical Medicine, 5*(11), 93. https://doi.org/10.3390/jcm5110093
4. NSW Agency for Clinical Innovation. (2021). *Central venous access devices (CVAD): Clinical practice guide*. Agency for Clinical Innovation. https://aci.health.nsw.gov.au/__data/assets/pdf_file/0010/239626/ACI-CVAD-clinical-practice-guide.pdf
5. Chopra, V. (2022). Central venous access devices and approach to device and site selection in humans. *UpToDate*. Retrieved November 28, 2022, from https://www.uptodate.com/

insert a CVAD is based on a suitable venous pathway, optimal vein characteristics, risk of nerve injury, and anatomical variations.[6]

Table 4.2a outlines various types of CVADs, their uses, expected durations, site considerations, and client safety considerations.

Table 4.2a Central Venous Access Devices

6. NSW Agency for Clinical Innovation. (2021). *Central venous access devices (CVAD): Clinical practice guide*. Agency for Clinical Innovation. https://aci.health.nsw.gov.au/__data/assets/pdf_file/0010/239626/ACI-CVAD-clinical-practice-guide.pdf

Device	Type of Therapy	Expected Duration	Site Considerations	Rationale and Safety Considerations
Peripherally Inserted Central Catheter (PICC) (See Figure 4.2[7])	Long-term use. May be used to infuse high osmolarity solutions or antibiotic therapy. Power ports may be used for high pressure rapid infusions.	Up to six months.	Utilize median cubital, cephalic, basilic, or brachial veins with sufficient diameter size.	Avoid in clients with end-stage renal disease requiring vein preservation for fistulas and grafts or those with a history of thrombosis, hypercoagulability states, or decreased peripheral vascular flow.
Non-Tunneled CVAD (See Figure 4.3[8])	May be used to infuse high osmolarity solutions.	Days to several weeks.	Insertion sites may be subclavian, external/internal jugular, or femoral veins.	The subclavian vein is favored in adult clients due to decreased risk of catheter-related thrombosis and/or infection.
External Tunneled CVAD (Hickman, Broviac, Groshong) (See Figure 4.4[9])	Long-term intravenous therapy, such as chemotherapy or hemodialysis.	May be long-term or permanent.	Inserted in the chest area via a subclavian or jugular vein. Tunneled subcutaneously from the proximal end of the insertion site to an exit site.	Surgery is required to tunnel the catheter so that part of the catheter lies in the subcutaneous tunnel. This helps prevent organisms from entering the bloodstream by separating where the catheter exists the skin from where it enters the vein. Passing the catheter under the skin also helps keep it better secured.

7. "Blausen_0193_Catheter_PICC.png" by Blausen Medical Communications, Inc. is licensed under CC BY 3.0

Implanted Venous Access Device (IVAD), also referred to as an Implanted Port (See Figure 4.5[10])	Long-term medication or IV therapy such as chemotherapy.	May be long-term or permanent.	Placed in a subclavian or jugular vein and attached to a reservoir pocket. The **reservoir pocket** is a small plastic or metal cylinder, usually placed just below the collar bone, that releases medication into the bloodstream. An IVAD is less obvious than a tunneled catheter and requires little daily care, with less impact on a person's activities than a PICC line or a tunneled catheter.	Surgery is required to place the port. The port is accessed with a noncoring needle and can be used immediately after placement.

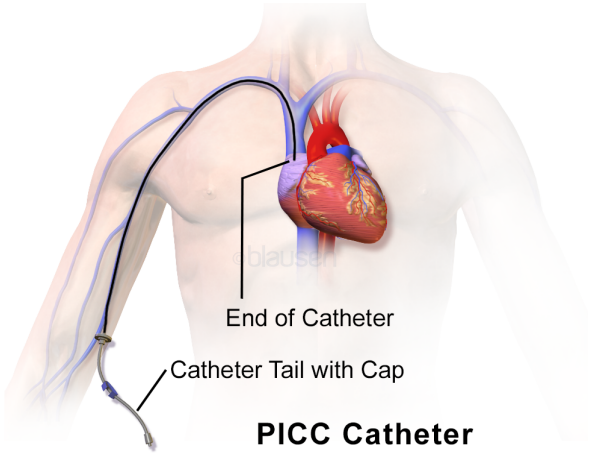

Figure 4.2 Peripherally Inserted Central Catheter (PICC Catheter)

8. "Blausen_0181_Catheter_CentralVenousAccessDevice_NonTunneled.png" by Blausen.com staff (2014) for "Medical gallery of Blausen Medical 2014" is licensed under CC BY 3.0
9. "Tunneled_venous_access_device.png" by Glynda Rees Doyle and Jodie Anita McCutcheon is licensed under CC BY 4.0
10. "Venous_Access_Port_Catheter.png" by BruceBlaus is licensed under CC BY-SA 4.0

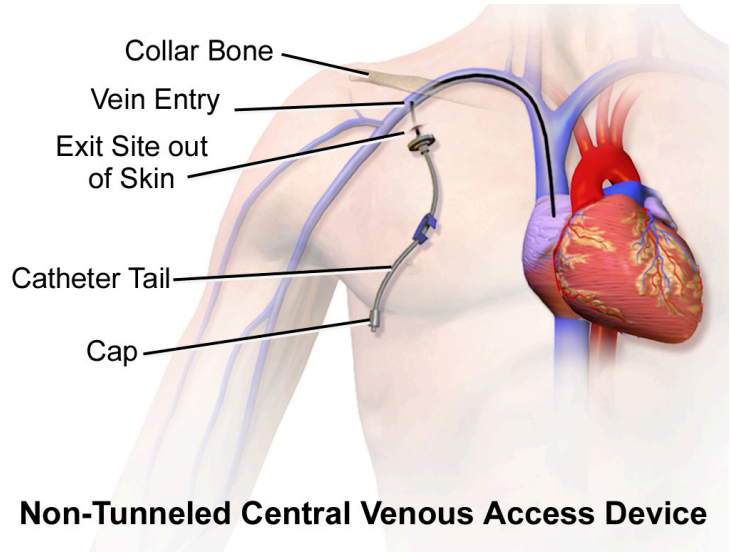

Figure 4.3 Non-Tunneled CVAD

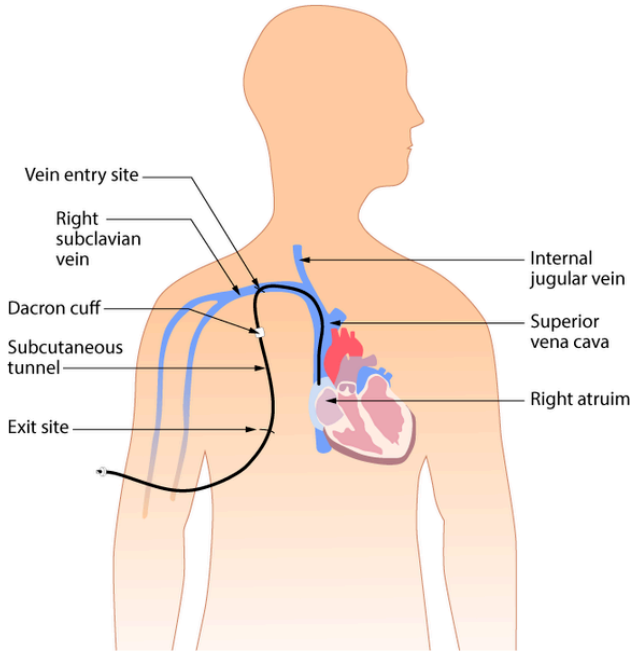

Figure 4.4 External Tunneled CVAD

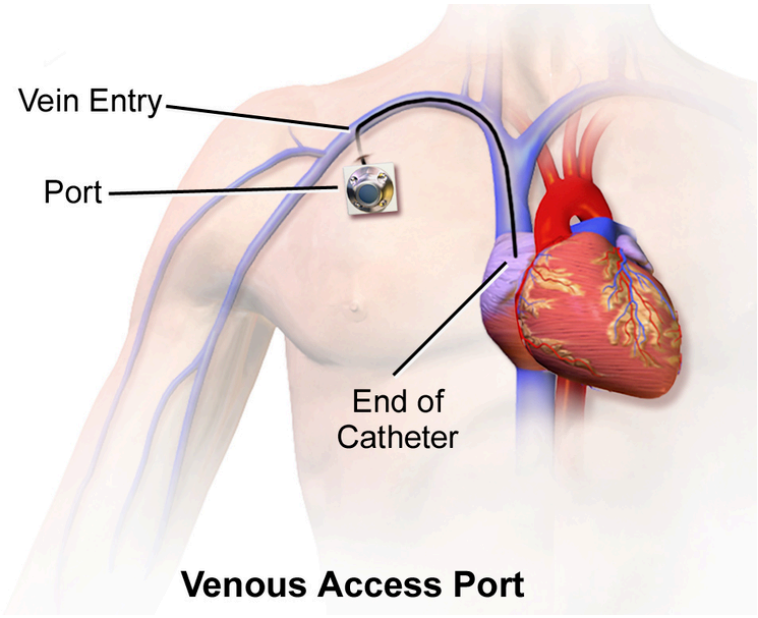

Figure 4.5 Implanted Venous Access Port

Lumens

CVADs may have a single lumen (opening), double lumen, or multiple lumens that exit at various places along the central catheter. See Figure 4.6[11] for an image of a CVAD with two lumens.

11. "xvthfl4exkgi9wdyt2twbf18gfpi3hdf.jpg" by unknown author used on the basis of Fair Use. Access original image at https://www.bd.com/en-us/products-and-solutions/products/product-families/powerline-central-venous-catheter#eifuresources.

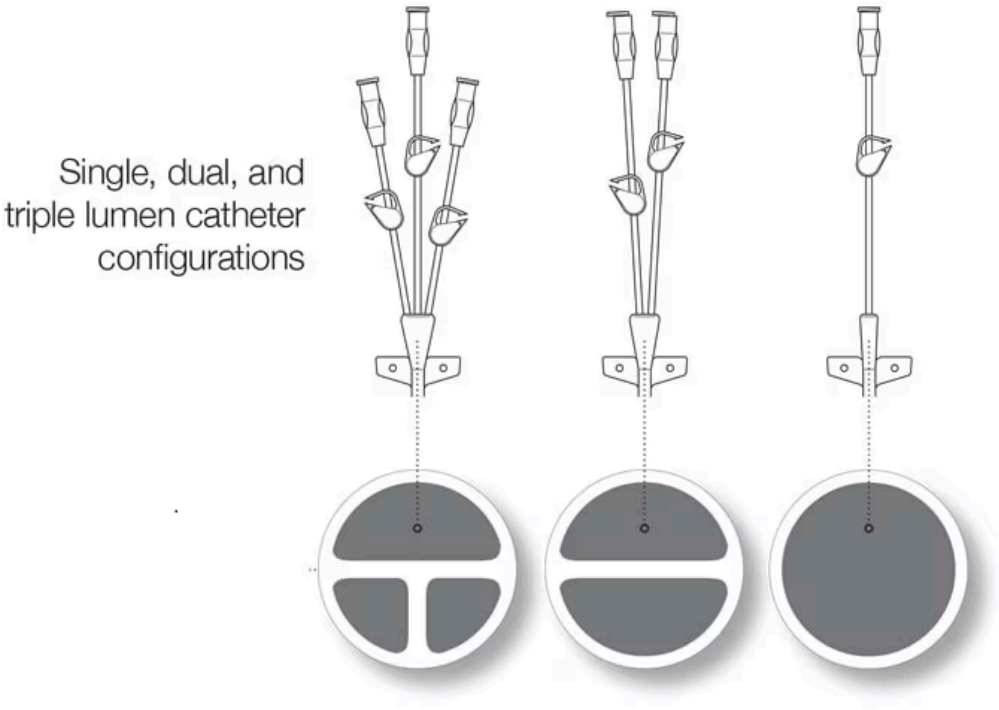

Figure 4.6 CVAD Catheters. Used under Fair Use.

Table 4.2b describes different types of lumens based on their exit points, their size, and their uses.

Table 4.2b Types of Lumens

Lumens	Proximal Lumen	Middle Lumen	Distal Lumen
Size	18 gauge	18 gauge	16 gauge
Uses	Fluids TPN/Lipids Medications	Medications	Blood draw Blood administration Central venous pressure (CVP) monitoring

Insertion of a CVAD

The insertion of a CVAD is an invasive medical procedure requiring informed consent from the client. The insertion should be performed only by a trained, credentialed health professional. Accurate placement of the CVAD tip is confirmed according to agency policy by fluoroscopy during insertion, post-procedure chest X-ray, or a magnet tip locator. **Fluoroscopy** is an imaging

technique that uses X-rays to obtain real-time moving images of the interior of an object within the body. If real-time fluoroscopy is used during the procedure to confirm tip placement, a post-procedure chest X-ray is not required. If fluoroscopy is not used, a post-procedure X-ray is used to confirm tip placement, as well as to check for a possible pneumothorax that can inadvertently occur during insertion. After the tip location is verified, it is essential to document the location in the client's medical record.[12]

Securement of CVADs

After the placement of the CVAD tip is confirmed, the CVAD must be stabilized and secured to the client. Dislodgement and premature removal of the CVAD increase complications such as infections, vessel injury, and treatment delays. Depending on the location and type of CVAD, it may be stabilized with sutures or a sutureless engineered stabilization device. See Figure 4.7[13] for illustrations of stabilization devices.

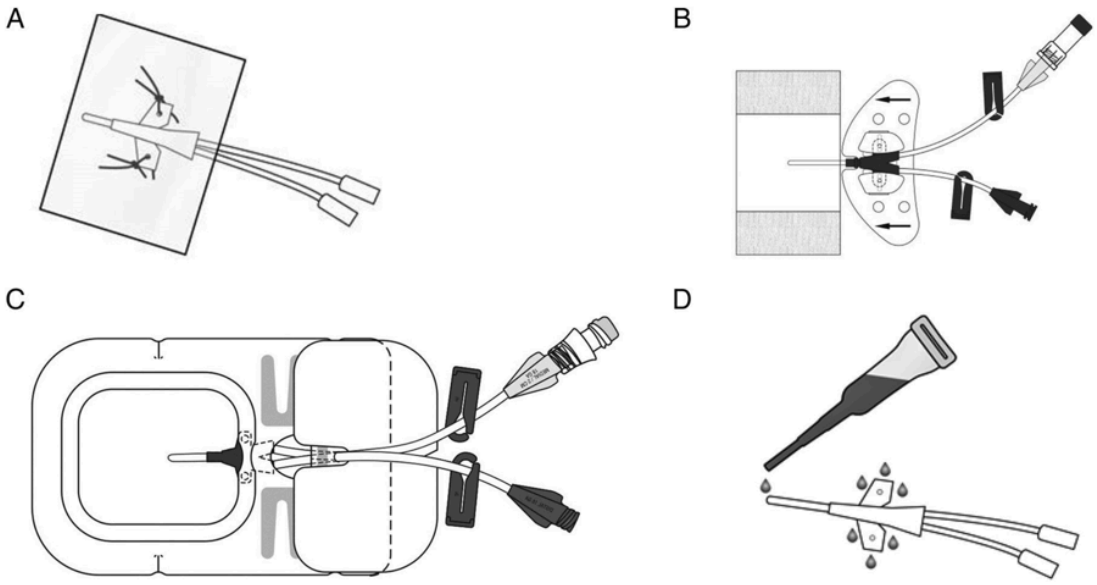

Figure 4.7 CVAD Stabilization Devices (A) Simple polyurethane and suture; (B) Sutureless securement device with simple polyurethane; (C) Integrated securement dressing product; (D) Tissue adhesive

12. NSW Agency for Clinical Innovation. (2021). *Central venous access devices (CVAD): Clinical practice guide*. Agency for Clinical Innovation. https://aci.health.nsw.gov.au/__data/assets/pdf_file/0010/239626/ACI-CVAD-clinical-practice-guide.pdf
13. "F1.medium.png" by Amanda Ullman et al., courtesy of BMJ Open is licensed under CC BY-NC 4.0. Access for free at https://bmjopen.bmj.com/content/6/6/e011197

The goal of the securement device is to maintain a secure hold on the central line and to prevent it from moving in and out of the insertion site. Sutureless devices, if appropriate, have less risk of infection because they maintain intact skin. Adhesive devices have the risk of causing a skin-related injury such as skin tear or a local reaction to the adhesive. Applying a prophylactic skin barrier prior to applying an adhesive device decreases this risk to the client.

After the catheter is secured, a sterile, transparent semipermeable dressing is applied to cover the insertion site. Some transparent dressings have an impregnated chlorhexidine gel or a biopatch that is directly placed over the insertion site to reduce the growth of microorganisms. In some cases, if there is blood or exudate leaking from the insertion site after initial placement, a sterile gauze dressing may be used to absorb the fluid until the leaking resolves.

Prevention of Central Line-Associated Bloodstream Infections (CLABSI)

When a client has a CVAD, it is crucial to follow evidence-based guidelines regarding its insertion, care, and maintenance to prevent the development of a life-threatening infection. Clients with CVADs are at risk for developing **central line-associated bloodstream infections (CLABSI)**. CLABSI is diagnosed when pathogens are found in the client's blood in the absence of another source of infection and the client has had a central line in place for more than two calendar days before the infection occurs. CLABSI continues to be one of the most deadly and costly hospital-acquired infections in the United States.[14]

A group of evidence-based practice standards has been formulated by the Institute of Healthcare Improvement (IHI) to reduce the risk of infection related to the insertion and management of CVADs and improve quality of care. CLABSI prevention strategies encompass three areas: clinical indications,

14. Institute for Healthcare Improvement. (n.d.). *Central line infection.* https://www.ihi.org/Topics/CentralLineInfection/Pages/default.aspx

insertion, and care and maintenance. These strategies include the following elements[15,16]:

- Hand hygiene as directed by CDC guidelines
- Maximal barrier precautions during insertion
- Skin antiseptic using chlorhexidine
- Optimal site selection, such as avoiding femoral vein access, when possible, for central venous access in adults
- Daily assessment of the necessity of the central line and prompt removal if deemed unnecessary
- Routine disinfection of catheter hubs, connectors, and injection ports
- Changing dressings over the site every two days for gauze dressings, every seven days for semipermeable dressings, or as needed if it becomes damp, loose, or visibly soiled

There have been improvements in CLABSI rates with these IHI practice standards, but, unfortunately, CLABSI continues to be an issue in hospitals despite these prevention measures. Read more information regarding the CDC recommendations to prevent CLABSIs in the following box.

Read the Infection Control Guidelines for Central Lines from the CDC's web page.

Potential Complications and Unexpected Outcomes of CVADs

Nursing management of clients with CVADs requires strict asepsis,

15. Institute for Healthcare Improvement. (n.d.). *Central line infection.* https://www.ihi.org/Topics/CentralLineInfection/Pages/default.aspx
16. The Joint Commission. (n.d.) *CLABSI toolkit - Chapter 3.* https://www.jointcommission.org/resources/patient-safety-topics/infection-prevention-and-control/central-line-associated-bloodstream-infections-toolkit-and-monograph/clabsi-toolkit---chapter-3/

knowledge of the purpose and functions of these devices, and routine interventions to prevent complications. Ongoing assessment and monitoring of the client and the CVAD system are essential for safety, quality care, and positive client outcomes. The following table summarizes possible complications associated with CVADs, their assessments, related prevention actions, and associated nursing interventions.

Table 4.2c Complications/Unexpected Outcomes of CVADs

Potential Complication	Assessment	Prevention	Nursing Intervention
Occlusion due to clot formation or malpositioning	Perform recommended site and CVAD system care, including equipment function and checking for blood return and the ability to infuse fluid. Assess for pain and edema at the insertion site (i.e., shoulder, ear, neck, or arm). If an implantable port is in place, assess the noncoring needle for correct placement.	Flush the catheter routinely as recommended and according to agency policy. Do not flush against resistance. Keep the catheter free from kinks. Do not mix incompatible medications during infusion that can cause precipitation within the catheter.	Initially, reposition the client. Raise the client's arm overhead, ask the client to cough and deep breathe, or assist them to stand up and sit down. If appropriate, administer thrombolytics as ordered by the provider. A clogged CVAD may require removal by trained health care personnel per provider order.
Catheter damage or breakage	Assess the site every shift and with flushing. Observe for leaks, tears, pinholes, or drainage after flushing.	Using a 10-mL syringe is preferred for CVADs to avoid increased pressure that can cause a potential rupture. Never flush against resistance. Use needleless system devices and avoid sharp objects such as scissors near the catheter. Follow agency policy regarding the proper clamping procedure if the access device has a closed catheter system.	Clamp the catheter near the insertion site and place sterile gauze over the break or hole until it is repaired. If repair of the catheter is safe and appropriate, use only a repair kit that is recommended by the manufacturer. The CVAD may require removal by trained health care personnel per provider order.

Infection (CLABSI)	Assess the catheter insertion site and surrounding area for redness, edema, drainage, and tenderness. Monitor pertinent laboratory results (e.g., WBC).	Maintain and utilize aseptic technique. Comply with guidelines and agency policies regarding CVAD and follow the recommended CLABSI prevention bundle.	Notify the health care provider and anticipate a blood culture order for suspected CLABSI. Follow agency sepsis prevention and implementation protocol. The CVAD may require removal by trained health care personnel per provider order. Anticipate obtaining a culture of the CVAD tip using sterile scissors and a sterile specimen cup. Diagnosed CLABSIs should be treated as life-threatening. Antibiotics specific to the organism should be initiated. Infection preventionists, vascular access specialists, providers involved with device insertion, and primary nursing staff should review each case in detail, looking for potential contributing factors.[17]
Dislodgment	Measure and document the catheter length per agency policy. Assess for dislodgement by identifying any edema at or around the catheter insertion site. Palpate for coiling of the catheter under the skin.	Ensure the catheter is secured at all times and the dressing is intact. Avoid pulling and manipulating the catheter.	If the catheter is completely dislodged, cover the insertion site and apply direct manual pressure while asking a colleague to call the rapid response team. The client will require monitoring for possible air embolus and reinsertion of a CVAD for critical medications.

17. DeVries, M. (2019). Revisiting CLABSI prevention strategies: Part 2 Learn about central line care and maintenance. *American Nurse Today, 14*(6), 44-47. https://www.myamericannurse.com/wp-content/uploads/2019/06/ant6-INFECTION-CLABSI-2-521a.pdf

Catheter migration (i.e., the catheter moved from its original position)	Assess the patency of the catheter, noting local irritation, swelling, or the inability to aspirate blood. Assess for edema of the arm and hand and distended neck veins. May be able to hear "gurgling" sounds from the catheter. If the catheter tip has advanced into the heart, cardiac dysrhythmias may occur.	Avoid site insertion of a CVAD in areas near the site of a local infection, disrupted skin integrity, or scar tissue.	Notify the provider. A catheter that has migrated externally from its original placement should not be readvanced. A catheter that has migrated internally should be retracted to the original insertion length by a trained health professional.
Skin erosion	Assess the skin at and around the CVAD insertion site. Note any skin separation from the catheter exit site, drainage, contusions, or any indication of skin involvement.	Maintain optimal client nutritional status. For implanted ports, avoid using the same insertion "hole" when accessing it multiple times because this increases the risk of tissue and port breakdown.	Plan for removal of the CVAD per order. Provide effective skin care. Improve nutrition as appropriate to the client's condition.

Air embolism[18]	An **air embolism** is the result of a pressure gradient that allows air to enter the bloodstream when flushing or removing the catheter. An air embolism can subsequently occlude blood flow. Signs and symptoms include sudden dyspnea, continuous coughing, and chest pain. Neurological symptoms include seizures, loss of consciousness, altered mental status, and hemiparesis.	Catheter hubs should not be open to air. Ensure all clamps are engaged appropriately for the device.	Call the rapid response team if an air embolism is suspected. Prevent further air embolism if a clamp is not engaged or a hub is open to air. Administer high-flow oxygen and place the client on their left side with their head down. Begin CPR if indicated.
Pneumothorax[19]	Pneumothorax may inadvertently occur during insertion of a CVAD if the needle in the CVAD placed in the neck or chest goes through the vein or misses the vein and pierces the lung, causing it to collapse. Symptoms of a pneumothorax include sharp, stabbing chest pain that worsens when trying to breathe in; shortness of breath; cyanosis; tachypnea; and a dry, hacking cough.	Not applicable.	Call for assistance and ask a colleague to call the rapid response team and notify the provider. Stay with the patient and administer high-flow oxygen. Anticipate placement of a chest tube if the client is hypoxic.

Infiltration or extravasation	Palpate over the catheter insertion site dressing and around the surrounding area for sponginess and observe for redness or swelling. Note any labored breathing exhibited by the client or complaints of pain with infusions. Observe IV flow rate for free-flowing fluid. Aspirate for blood return.	Stop the infusion and/or administration of the vesicant solution. If extravasation occurs, aspirate any remaining medication from the catheter after disconnection to prevent further damage to vessels. To maintain skin integrity, administer antidote or therapeutic medication as appropriate per protocol.[20]	Discontinue IV solutions. Apply warm/cold compresses as recommended by agency policy. Notify the provider and anticipate an order for a chest X-ray to evaluate catheter integrity and placement.
Incorrect placement	Assess for inadequate blood withdrawal, blood flowing back into the tubing, hypotension, cardiac dysrhythmias, and neck vein distension.	Verification of catheter placement by chest X-ray after insertion or during real-time guided fluoroscopy.	Stop all fluid and medication administration. Anticipate orders for an X-ray and electrocardiogram. The CVAD may require removal or withdrawal to the correct position by trained health care personnel per provider order.

18. McCarthy, C. J., Behravesh, S., Naidu, S. G., & Oklu, R. (2016). Air embolism: Practical tips for prevention and treatment. *Journal of Clinical Medicine, 5*(11), 93. https://doi.org/10.3390/jcm5110093
19. Tsotsolis, N., Tsirgogianni, K., Kioumis, I., Pitsiou, G., Baka, S., Papaiwannou, A., Karavergou, A., Rapti, A., Trakada, G., Katsikogiannis, N., Tsakiridis, K., Karapantzos, I., Karapantzou, C., Barbetakis, N., Zissimopoulos, A., Kuhajda, I., Andjelkovic, D., Zarogoulidis, K., & Zarogoulidis, P. (2015). Pneumothorax as a complication of central venous catheter insertion. *Annals of Translational Medicine, 3*(3), 40. https://doi.org/10.3978/j.issn.2305-5839.2015.02.11
20. Kim, J. T., Park. J. Y., Lee, H. J., & Cheon, Y. J. (2020). Guidelines for the management of extravasation. *Journal of Educational Evaluation for Health Professions, 17*:21.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7431942/

PICC Line Care[21]

- Avoid venipuncture, peripheral intravenous cannula insertion, and taking blood pressure on the same arm where the PICC is located. Place reminder signs for the health care team members according to agency policy.
- Ensure the PICC line dressing stays dry during showering.
- Avoid bandages or tight coverings over the PICC line insertion point. Tight elastic coverings can increase the risk of compressing the vein, leading to vein wall irritation, phlebitis, or thrombosis.

21. Cancer Institute NSW. (2021, July 19). *Central venous access devices.* https://www.eviq.org.au/clinical-resources/central-venous-access-devices-cvads/112-central-venous-access-devices#key-practice-points-for-clinical-procedures

4.3 Applying the Nursing Process

Ongoing nursing assessments and interventions are essential to provide safe, quality care when a client has a CVAD. These actions are guided by evidence-based practice standards. In acute care and outpatient settings, the overall goals of CVAD infusion therapy are safe administration of medications and the absence of complications.

Nurses provide routine care and maintenance of CVADs after their insertion, including the following responsibilities:

- Providing for ongoing assessment of the insertion site and the infusion system to ensure it is functioning as expected
- Performing CVAD dressing changes while ensuring catheter stabilization
- Accessing CVADs
- Performing intravenous line care and management
- Flushing and locking CVADs
- De-accessing inserted and implanted CVADs
- Performing blood sampling from a CVAD

The nurse may also be involved in other activities related to safe use of CVADs such as culturing for suspected infections and advocating for catheter removal as soon as it is no longer indicated for treatment. In home care and outpatient settings, the nurse also provides education to the client and their family members on how to safely manage the CVAD and when to call the provider with concerns.

Assessment

The nurse must be knowledgeable about the different types and placement locations of CVADs as described in Table 4.2a in the "Basic Concepts" section. Regardless of which type of CVAD device is used, the nurse must routinely assess the site and dressing for integrity, signs of infection, catheter migration, and other signs of complications. Areas beyond the site of insertion must also be assessed, such as the adjacent skin, neck, chest area, and the extremity on the side where the central line is placed. If the catheter is

tunneled under the skin, assessment also includes monitoring for pain, swelling, drainage, or erythema. External length is measured at the time of insertion and used for future measurement comparison. If a PICC line is in place, arm circumference is also measured each shift and results compared to previous readings. If arm circumference consistently increases, a deep vein thrombosis may be suspected.

The frequency of site assessment is dependent on the client's condition and agency policies. Typically, in the acute care setting, site assessment is performed every shift. If the client is in the home care setting, they are educated on how to inspect their site and how frequently this assessment should occur. Home health nurses will assess the site and arm circumference during each visit.

Accurate documentation of site assessment and related monitoring are essential. Documentation of the assessment in the client's medical record should include CVAD location, type of dressing, site assessment specifics, presence of any complications, and any actions or interventions performed. Table 4.3a summarizes the assessments related to CVADs.

Table 4.3a Summary of CVAD Assessments

Assessment* *Assessment of the CVAD should occur at least once every shift and as needed in acute care settings.	Description
Assess the entire infusion system.	A complete assessment includes the insertion site and surrounding area, securement device, functioning of the CVAD, and tip location.
Assess for proper functioning of the device.	Observe for constant flow of fluids, high pressure, or occlusion alarms. Assess for blood flow.
Inspect the CVAD dressing.	Determine if the dressing is clean, intact, and dated.
Inspect and palpate the insertion site and surrounding area through the intact dressing.	Check for redness, bluish discoloration on darker skin, swelling, drainage, or a palpable cord. Ask the client if they are experiencing any pain, paresthesia, numbness, or tingling around the area.
Measure the external catheter length.	Compare the measurement results to the initial placement verification results to detect any catheter migration or dislodgement.
Measure the upper arm circumference for PICC lines.	Monitor circumference measurements each shift and compare results. Increasing measurements may indicate possible edema and deep vein thrombosis (DVT). Measurement of the arm circumference should occur 10 cm above the antecubital fossa and compared to the baseline measurement. A 3 cm increase in the circumference may indicate edema associated with a DVT.
Ensure correct labeling of all infusing fluids.	Follow agency policy and procedures for labeling infusing IV fluid and medications.
Ensure all Luer-lock connections are secure.	Secure connections provide safety in guarding against microorganism and air entrance into the closed system, as well as leakage of medications out of the system.

Document the complete assessment in the client EMR.	Complete assessment documentation helps support QSEN or other quality and safety standard informatics.

CVAD Dressing Changes and Site Care

CVAD dressing changes should occur routinely at established intervals according to evidence-based guidelines and agency policies. Many agencies have designated CVAD dressing kits. The dressing protects the insertion site and surrounding tissue from microorganism growth that can accumulate within CVAD hubs and the skin and cause a CLABSI.[1] Ensuring a clean, dry, and intact dressing helps prevent microorganisms from entering the bloodstream.

If the integrity of the CVAD dressing is compromised by moisture or drainage, becomes loose, or if signs of infection are apparent, the dressing should be replaced immediately. The dressing should be labeled with the date, time, and initials of the person completing the task. All CVAD dressing changes should be documented in the client's medical record per agency policy.

CVAD site care is routinely performed, typically at the same time as the dressing change. Aseptic technique is required when providing site care and dressing changes with meticulous hand hygiene, sterile gloves, and a mask. The preferred skin disinfectant is 2% chlorhexidine for a client older than two months of age.[2] Chlorhexidine skin disinfectant provides antibacterial activity that persists for several hours after it is applied.

Implanted ports require dressings until the area is healed after the port has been implanted under the skin, as well as when accessing the port for intermittent and/or continuous infusions. A specialized noncoring needle is used when accessing implanted ports. (Refer to specific information on

1. NSW Agency for Clinical Innovation. (2021). *Central venous access devices (CVAD): Clinical practice guide*. Agency for Clinical Innovation. https://aci.health.nsw.gov.au/__data/assets/pdf_file/0010/239626/ACI-CVAD-clinical-practice-guide.pdf
2. Centers for Disease Control and Prevention. (2015, November 5). *Summary of recommendations: Guidelines for the prevention of intravascular catheter-related infections (2011).* https://www.cdc.gov/infectioncontrol/guidelines/bsi/recommendations.html

"Accessing and De-accessing an Implanted Venous Access Device" later in this section.)

The dressing regimen for tunneled catheters within the acute care setting is typically the same as for nontunneled catheters. However, if the tunneled area is well-healed, a dressing may not be required in the outpatient setting.

There are different types of dressings that may be selected for a CVAD dressing change based on client status, agency policy, and evidence-based guidelines. Transparent semipermeable membrane (TSM) or simple gauze dressings are commonly used. Because TSM dressings are transparent, they allow visualization and inspection of the site area without removing or disturbing the dressing. They are also cost-effective and promote a closed system. Gauze dressings are commonly used for clients who perspire excessively, which interferes with a TSM dressing staying in place. A gauze dressing is also appropriate if the site is draining or if the person has a sensitivity to the transparent dressing.

Per CDC guidelines and infusion nursing's standards of practice, TSM dressings should be changed at a minimum of every seven days, whereas gauze dressings must be changed at least every 48 hours. Dressings must also be changed as needed, such as for loss of dressing integrity, the presence of drainage or moisture, or signs of infection.[3]

TSM dressings with an impregnated chlorhexidine gel or disc are a newer technology that are becoming more commonly used. An antiseptic foam disc is placed around the catheter insertion site and covered with a TSM dressing. Other TSM dressings have an impregnated chlorhexidine gel within the dressing that is placed over the catheter insertion site. The CDC has not yet made a recommendation regarding use of impregnated dressings.[4] See Figure 4.8[5] for an image of a quad lumen CVAD with an impregnated

3. Gorski, L. (2021). A look at 2021 infusion therapy standards of practice. *Home Healthcare Now, 39*(2), 62-71. https://www.nursingcenter.com/wkhlrp/Handlers/articleContent.pdf?key=pdf_01845097-202103000-00002
4. Centers for Disease Control and Prevention. (2015, November 5). *Summary of recommendations: Guidelines for the prevention of intravascular catheter-related infections (2011).* https://www.cdc.gov/infectioncontrol/guidelines/bsi/recommendations.html
5. "ID-112-CVAD-IJ-CICC-Oct-2020-2.jpeg" by E. Alexandrou used with permission. Access the original image at https://www.eviq.org.au/clinical-resources/central-venous-access-devices-cvads/112-central-venous-access-devices#short-term-cvads

chlorhexidine disc, subcutaneous and adhesive external securement device (ESD), and bordered semipermeable dressing. In practice, all access ports would have sterile caps attached according to evidence-based practices for infection control.

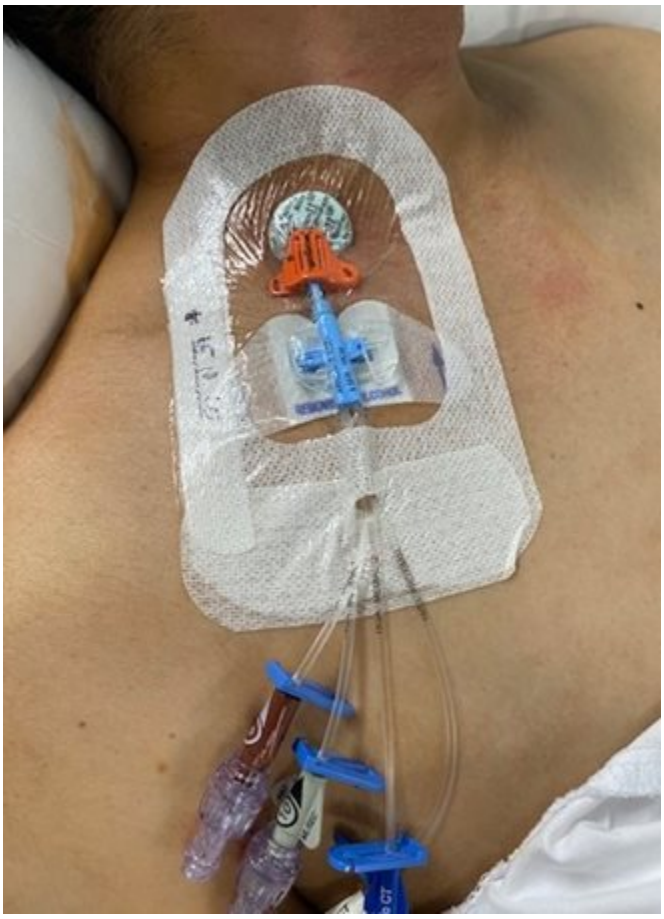

Figure 4.8 Quad lumen CVAD with a Chlorhexidine (CHG) Disc, Subcutaneous and Adhesive External Securement Device (ESD), and Bordered Semipermeable Dressing

Before performing a CVAD dressing change, review the client's medical record for previous history, allergies (including allergies to tape or adhesives), previous or baseline length and circumference measurements, and the type of dressing used. Most acute care settings utilize a central line dressing kit that includes standardized accessories necessary for the procedure.

When performing CVAD dressing changes, using aseptic nontouch technique (ANTT) is considered a global standard. The **"ANTT approach"** identifies key parts and key sites throughout the preparation and implementation of the procedure. A **key part** is any sterile part of equipment used during an aseptic procedure, such as needle hubs and dressings. A **key**

site is the insertion site, nonintact skin, or an access site for medical devices connected to clients. CVAD insertion sites are considered key sites. ANTT includes four underlying principles to keep in mind while performing invasive procedures:

- Always perform meticulous hand hygiene.
- Never contaminate key parts.
- Touch nonkey parts with confidence.
- Take appropriate infection control precautions.

Review Table 4.3b for a summary of CVAD dressing change steps and their rationale.

Table 4.3b CVAD Dressing Change Steps

Step
Follow standard aseptic nontouch technique (ANTT). Standard ANTT requires the use of a general aseptic field, such as a single use or disinfected surface for placement of all needed supplies to provide a controlled workspace and to promote asepsis. Apply PPE according to the client's health conditions. The client and the RN both wear a mask during a dressing change to prevent contamination of the site area. Ask the client to turn their head in the opposite direction of the dressing change site to avoid potential contamination of the site. • Standard ANTT and PPE reduce the risk of microorganism contamination and exposure to body fluids.
Nonsterile gloves are acceptable when removing a CVAD dressing. When removing the dressing, carefully roll up the edges and remove toward the insertion of the catheter to prevent dislodgement. After removing the dressing, remove the nonsterile gloves, perform hand hygiene, and don sterile gloves.
Most securement devices are integrated within the CVAD dressing kit and are changed with the dressing. If the catheter is secured with sutures, gently and carefully lift the suture plate to cleanse with agency-approved antiseptic, maintaining aseptic technique.
Cleanse the insertion site and surrounding skin with each dressing change using aseptic technique. Using chlorhexidine solution is considered standard practice, but if the client has an allergy or hypersensitivity to its use, povidone-iodine may be used as an alternative. A single-use antiseptic applicator is commonly used. When cleansing, do so in a back-and-forth motion for 30 seconds and allow it to dry. If dry blood or drainage is present on the skin and around the insertion site, it should be cleansed and removed using sterile technique prior to applying a new dressing.
Label the dressing with the date, time, and your initials, as well as the date the dressing should be changed again. • Labeling is a quality measure to promote ongoing adherence to agency policies and recommendations.
Document the related assessments, cleansing, and dressing change in the client's medical record. • Documentation in the legal record is required and is also used for reimbursement and quality improvement initiatives.

Accessing CVADs

Each time a CVAD is accessed, there is a chance for exposure to microorganisms from the clinician, the environment, or the client. To reduce this exposure, accessing and manipulations of a CVAD should be kept at a minimum. Adhering to strict hand hygiene and ANTT standards are important strategies to reduce the risk of infection.

When accessing a CVAD, the CVAD access hub or needleless port must be decontaminated with a vigorous scrub technique with a single-use aseptic swab or a scrub hub. A **scrub hub** is a specific scrubbing device for CVAD hubs and embedded with chlorhexidine and alcohol or 70% alcohol to disinfect catheter hubs or needleless connectors. The suggested scrub time is up to 60 seconds with a minimum of 15 seconds. When decontaminating the hub, generate friction by scrubbing in a twisting motion like juicing an orange. Ensure the top of the hub is scrubbed, as well as the sides.[6]

An alternative to aseptic swabs or scrub hubs is **aseptic-impregnated catheter hub** protective caps. These caps contain a sponge that is saturated with alcohol or chlorhexidine. They are attached to the access ports and eliminate the need to perform the vigorous scrub. After the caps are removed, they are discarded, and a new sterile cap is applied.

Flushing and Locking CVADs

Flushing is a manual injection of 0.9% sodium chloride to clean the lumen of the catheter. **Locking** is the injection of a limited volume of a liquid following the catheter flush, for the period of time when the catheter is not used, to prevent intraluminal clot formation and/or catheter colonization.[7]

CVADs require flushing to maintain patency of the line(s) and to prevent the mixing of incompatible solutions and/or medications. The recommended

6. The Joint Commission. (2023). *Central line-associated bloodstream infection toolkit and monograph*. https://www.jointcommission.org/resources/patient-safety-topics/infection-prevention-and-control/central-line-associated-bloodstream-infections-toolkit-and-monograph/
7. Godelieve, A. G. (2015). Flushing and locking of venous catheters: Available evidence and evidence deficit. *Nursing Research and Practice, 2015*. https://doi.org/10.1155/2015/985686

flush is sterile 0.9% sodium chloride unless manufacturer or agency policy requires flushing with an alternate solution.

Central line catheters are flushed according to agency policy. They must be flushed immediately after placement of the initial insertion has been verified, before and after each fluid or medication infusion, and before and after drawing blood from the central line. Additionally, flushing of all lumens of a multi-lumen catheter should be considered after obtaining blood samples to reduce the possibility of blood influx into other lumens due to changing intraluminal pressure. If a CVAD is not being routinely accessed, it is typically flushed and locked every seven days. Implantable ports that are not being accessed should be flushed and locked every 4-6 weeks.[8]

A 10-mL or larger syringe is used to access a CVAD to prevent excess pressure that can damage the lumen. Before flushing the lumen with 0.9% sodium chloride, aspiration of blood should be attempted to ensure patency. The volume of fluid used for flushing should be twice the volume of the lumen.

Instilling the flush fluid into the catheter lumen allows a column of fluid to maintain its patency. A pulsatile flushing technique is recommended with ten small boluses of 1 mL of fluid interrupted by brief pauses. This technique has been found to be more effective at removing solid deposits (such as fibrin, drug participate, or intraluminal bacteria) compared to continuous low flow techniques.[9] Flushing should never occur if force is required against resistance because this can cause rupture of the catheter or mobilization of an occlusive clot.

If resistance is met while flushing or there is inadequate blood return on aspiration, troubleshoot for potential causes and solutions such as repositioning or removing kinks in lines. If these initial steps are not successful, follow agency policy in using a thrombolytic medication (i.e.,

8. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharpe, E., & Alexander, M. (2021). Infusion therapy standards of practice (8th ed.). *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 44*(1S Suppl 1), S1–S224. https://doi.org/10.1097/NAN.0000000000000396
9. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharpe, E., & Alexander, M. (2021). Infusion therapy standards of practice (8th ed.). *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 44*(1S Suppl 1), S1–S224. https://doi.org/10.1097/NAN.0000000000000396

alteplase) or requesting an order for a port study or central line study with fluoroscopy.

There are different types of needleless connectors through which the CVAD is flushed. If using a negative needleless connector, clamp the lumen while injecting the last 0.5 mL and before the syringe is disconnected to prevent blood reflux back into the catheter tip when the syringe is disconnected. If using a positive needleless connector, clamp after the syringe is disconnected to allow the internal mechanism to activate. For neutral (anti-reflux) needleless connectors, there is no specific clamping procedure required.

Instilling a "locking" fluid into a CVAD catheter causes a column of fluid within the catheter to maintain patency. Recommendations regarding the type of locking solution to use vary. Some studies suggest 0.9% normal saline is as effective as heparin. Follow agency policy and recommendations from the manufacturer.[10]

Standard ANTT (Aseptic Nontouch Technique) is used when flushing and locking central lines, as well as when infusing other fluids and medications. ANTT requires use of meticulous hand hygiene and a single use or disinfected surface for placement of all supplies to provide a controlled workspace and promote asepsis.[11]

Accessing and De-Accessing an Implanted Venous Access Device

The management and care of an implanted venous access device (IVAD), as recommended by the CDC, includes utilizing proper aseptic technique before palpating, accessing, or performing dressing changes. See Figure 4.9[12] for an image of an IVAD that has been placed.

10. Gorski, L. (2021). A look at 2021 infusion therapy standards of practice. *Home Healthcare Now, 39*(2), 62-71. https://www.nursingcenter.com/wkhlrp/Handlers/articleContent.pdf?key=pdf_01845097-202103000-00002
11. Gorski, L. (2021). A look at 2021 infusion therapy standards of practice. *Home Healthcare Now, 39*(2), 62-71. https://www.nursingcenter.com/wkhlrp/Handlers/articleContent.pdf?key=pdf_01845097-202103000-00002
12. "Port-catheter.jpg" by Una Smith (talk) is licensed under CC0

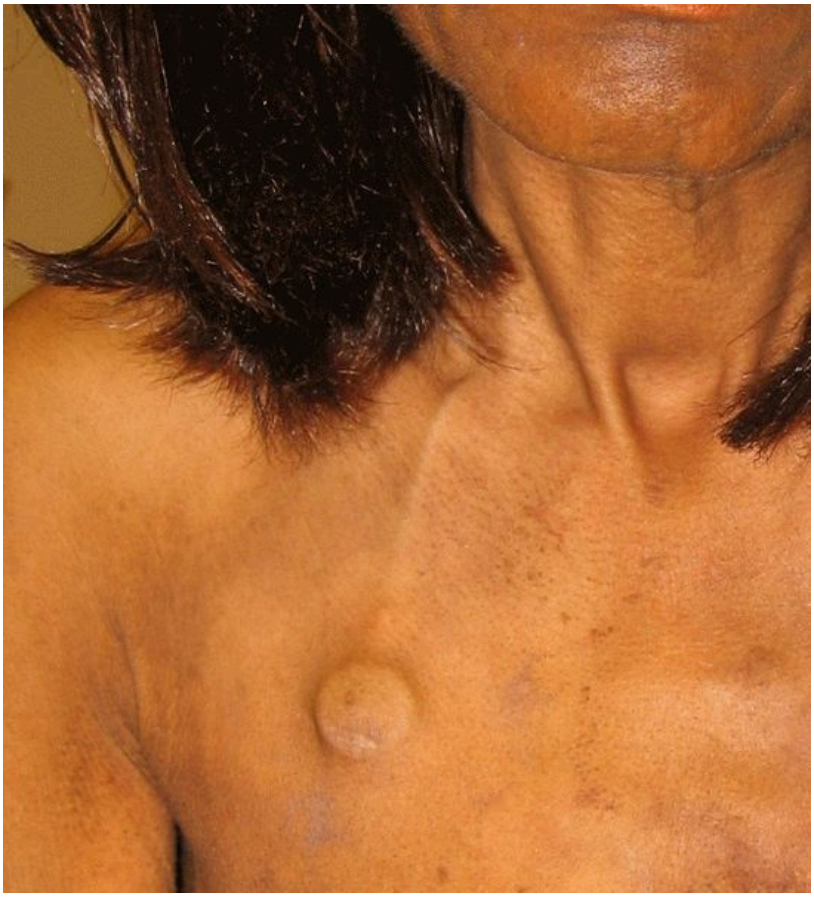

Figure 4.9 Implanted Venous Access Device (IVAD)

When accessing an IVAD, the skin at the site of access must be disinfected with chlorhexidine solution and allowed to dry before accessing the device. Many clients require a lidocaine medication (i.e., EMLA cream or intradermal lidocaine injection) prior to port access to prevent pain. This is especially true for vulnerable populations requiring IVADs such as pediatric, elderly, and oncology clients.

A noncoring needle must be used for accessing IVADs to prevent damage to the device. See Figure 4.10[13] for images related to accessing an IVAD.

13. "Diagram_showing_an_implantable_port_under_the_skin_CRUK_100.svg" by Cancer Research UK and "Venous_Access_Port_Catheter.png" by BruceBlaus are both licensed under CC BY-SA 4.0

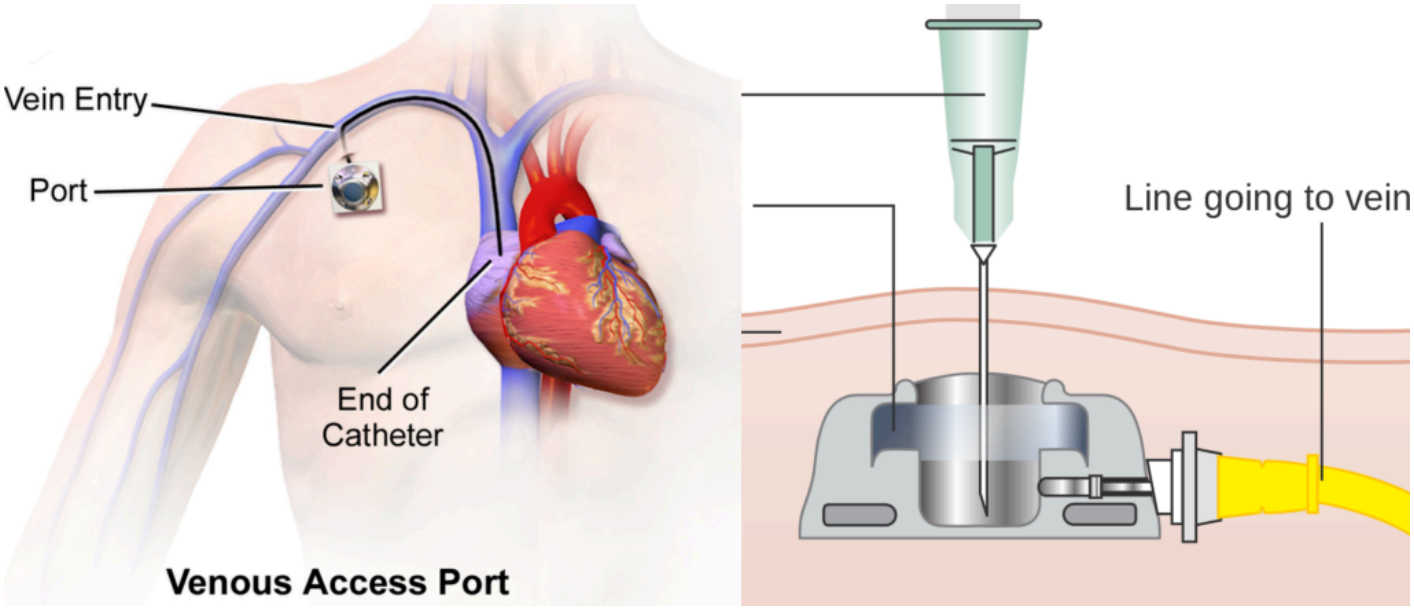

Figure 4.10 Implanted Venous Access Device

Some IVADs are "power-injectable" while others are not. This means that some ports can tolerate the pressure required for CT injectable dye while others cannot. The type of needle used to access the port depends on what type of port the client has implanted. Clients with a power-injectable port should have an ID card, bracelet, and some type of identifier. This information should also be recorded in the medical record. If no information is available, the port should be treated as a nonpower injectable port and accessed with a normal port needle and not used for CT dye.

As with all long-term vascular access devices, IVADs are at risk for occlusion or loss of patency because protein buildup can occur on the surface of the device. Flushing and locking implanted ports help to prevent occlusion, but there are no clear recommendations for standardized flushing techniques or volumes. Recommendations from the manufacturers vary with the type of device regarding the use of heparin or saline. Flushing guidelines are typically established by the manufacturer and agency policy.[14] Currently, the consensus of recommendations for flushing implanted ports that are used a minimum of every 8 hours in adult clients is to flush after each infusion of medication or blood administration with 10 mL of 0.9% normal saline or every 24 hours according to the manufacturer's recommendations.

14. Blanco-Guzman, M. O. (2018). Implanted vascular access device options: A focused review on safety and outcomes [Review]. *Transfusion, 58*, 558-568. https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/trf.14503

The majority of techniques that are used for locking IVADs consist of withdrawing the syringe while still applying positive pressure during the injection of the last 0.5 mL of fluid volume. The volume used for locking depends on the reservoir volume and catheter diameters. Formal recommendations for maintenance locking in implanted ports are to flush with 10 mL 0.9% normal saline every four weeks in closed ports. For open-implanted ports, the recommendation is to flush with 10 mL normal saline followed by 5 mL heparin every four weeks.[15] The dose of heparin required to maintain patency can vary from 10 to 1,000 iU/mL, with the concentration of 100 IU/mL in a volume of 3 mL the most commonly used.[16]

Current recommendations for the maintenance of implanted ports indicate the needle should be changed and the port re-accessed every seven days.[17]

View a supplementary YouTube video[18] on CVAD access and care: Ports: Access and Care.

Blood Sampling From a CVAD

Obtaining a blood sample from a CVAD is a responsibility of the registered nurse. Multiple venipunctures frequently occur in acute care settings due to the severity of the medical condition in a client who requires a CVAD. The main advantage of using a CVAD for frequent blood sampling is decreased pain and anxiety compared to the experience of multiple peripheral venipunctures. However, accessing CVADs also has potential risks associated

15. Blanco-Guzman, M. O. (2018). Implanted vascular access device options: A focused review on safety and outcomes [Review]. *Transfusion, 58*, 558-568. https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/trf.14503
16. Oliveira, F. J. G., Rodrigues, A. B., Ramos, I. C., & Caetano, J. Á. (2020). Dosage of heparin for patency of the totally implanted central venous catheter in cancer patients. *Revista Latino-Americana de Enfermagem, 28*, e3304. https://doi.org/10.1590/1518-8345.3326.3304
17. Oncology Nursing Society. (2017). *Access device standards of practice for oncology nursing*. https://www.ons.org/books/access-device-standards-practice-oncology-nursing
18. Moffott Cancer Center. (2018, October 31). *Ports: Access and care* [Video]. YouTube. All rights reserved. https://youtu.be/KtCwEdQbPRQ

with infection, occlusion, and improper sample taking, resulting in inaccurate test results. Following evidence-based infection prevention practices, limiting the frequency of blood sampling, and following ANTT guidelines help reduce the risk of infection. A summary of key points related to blood sampling from CVADs is outlined in Table 4.3d. See the "Checklist: Obtain a Blood Sample From a CVAD" for the complete steps for this procedure. Note that current guidelines recommend to not use CVADs infusing parental nutrition for blood sampling because manipulation may increase the risk for CLABSI.[19]

During the blood sampling procedure, if any signs or symptoms occur indicating an air embolism, place the client on the left side in Trendelenburg or left lateral decubitus position, call the rapid response team, and notify the provider.

Table 4.3d Summary of Key Points Related to Blood Sampling From a CVAD

19. Gorski, L. (2021). A look at 2021 infusion therapy standards of practice. *Home Healthcare Now, 39*(2), 62-71. https://www.nursingcenter.com/wkhlrp/Handlers/articleContent.pdf?key=pdf_01845097-202103000-00002

Steps	Rationale
Stop the infusion of fluids and medications into the catheter's lumens.	Stopping the infusion of fluids or medications prevents these substances from interfering with the blood sample. Current guidelines do not specify a standard length of time for stopping the infusion, but it is associated with the internal volume of the specific CVAD.[20]
Choose the appropriate CVAD lumen for obtaining samples based on the largest lumen or the configuration of the lumen exit sites.	Blood draw requires a large lumen. For catheters with a staggered lumen exit at the tip, the sample should be drawn from the lumen exiting at the point farthest away from the heart and above other lumen exits used for infusion.[21] Follow CVAD manufacturer's instructions for these decisions.
Vigorously scrub the needless connector for at least 15 seconds with antiseptic scrub and let it dry completely.[22]	Scrubbing prevents microorganism contamination, and drying prevents contamination by substances.
Attach a prefilled 10-mL syringe of preservative-free normal saline to the needleless connector using ANTT. Unclamp the catheter and thoroughly flush the lumen with 10-20 mL of preservative-free 0.9% normal saline.[23] Aspirate slowly for blood, noting the characteristics of the whole blood.	A 10-mL syringe generates lower pressure within the catheter and prevents lumen rupture and/or occlusion.
Clear the dead space by using the push-pull method or discarding the aspirated blood according to agency policy. The discard method requires initial aspiration of 2 to 25 mL of blood (per internal volume of the CVAD, saline flushing prior to drawing the discard volume, and specific laboratory tests needed) and then discarding the syringe before performing the blood sampling.[24] The push-pull method utilizes the same syringe used when aspirating to test patency of the catheter. With the syringe still attached, 4 mL to 6 mL of blood is aspirated and then pushed back into the catheter. This aspiration and reinfusion sequence is repeated for four cycles. The blood and syringe are then discarded.[25]	Either method clears the CVAD catheter's dead space volume and removes any of the blood that becomes diluted with the flush solution. Performing the push-pull method for four cycles allows for an accurate blood sample and also reduces phlebotomy-associated blood loss, particularly when obtaining multiple blood samples. For the discard method, coagulation studies require the largest discard volume to produce accurate results, but this volume of discarded blood can lead to hospital-acquired anemia.

After obtaining the blood sample, thoroughly flush the CVAD lumen with 10-20 mL of preservative-free 0.9% normal saline.[26]	Flushing thoroughly prevents occlusion.

Evaluation

Daily evaluation for the necessity of continuing the CVAD is important and supported by the CLABSI prevention guidelines. Evaluating the client's cardio-respiratory status every shift and as needed per client condition prompts early recognition of potential complications.

Clients who are receiving infusion therapy and/or medication treatment require ongoing monitoring of laboratory values, intake/output, daily weights, and vital signs to evaluate their current fluid and electrolyte balances.

Nurses also evaluate the client's understanding of the CVAD. If the client will be discharged home with an IVAD, it is imperative they understand how to manage their device safely and when to notify the provider. They will also need referrals to a home health agency, as well as supplies to manage the device on an outpatient basis, such as extra dressings, flushes, and tubing.

20. Gorski, L. (2021). A look at 2021 infusion therapy standards of practice. *Home Healthcare Now, 39*(2), 62-71. https://www.nursingcenter.com/wkhlrp/Handlers/articleContent.pdf?key=pdf_01845097-202103000-00002
21. Gorski, L. (2021). A look at 2021 infusion therapy standards of practice. *Home Healthcare Now, 39*(2), 62-71. https://www.nursingcenter.com/wkhlrp/Handlers/articleContent.pdf?key=pdf_01845097-202103000-00002
22. The Joint Commission. (2023). *Central line-associated bloodstream infection toolkit and monograph*. https://www.jointcommission.org/resources/patient-safety-topics/infection-prevention-and-control/central-line-associated-bloodstream-infections-toolkit-and-monograph/
23. Gorski, L. (2021). A look at 2021 infusion therapy standards of practice. *Home Healthcare Now, 39*(2), 62-71. https://www.nursingcenter.com/wkhlrp/Handlers/articleContent.pdf?key=pdf_01845097-202103000-00002
24. Gorski, L. (2021). A look at 2021 infusion therapy standards of practice. *Home Healthcare Now, 39*(2), 62-71. https://www.nursingcenter.com/wkhlrp/Handlers/articleContent.pdf?key=pdf_01845097-202103000-00002
25. McBride, C., Miller-Hoover, S., & Proudfoot, J. A. (2018). A standard push-pull protocol for waste-free sampling in the pediatric intensive care unit. *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 41*(3), 189–197. https://doi.org/10.1097/NAN.0000000000000279
26. Gorski, L. (2021). A look at 2021 infusion therapy standards of practice. *Home Healthcare Now, 39*(2), 62-71. https://www.nursingcenter.com/wkhlrp/Handlers/articleContent.pdf?key=pdf_01845097-202103000-00002

4.4 Checklist: Change a CVAD Dressing and Needleless Connector

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Change a CVAD Dressing and Needleless Connector[1,2]

- Review the client's medical record for information related to the central venous access device and indications.
- Determine the date of the last dressing change.
- Gather the necessary equipment:
    - Antiseptic (chlorhexidine preferred)
    - Sterile transparent semipermeable dressing (may be chlorhexidine-impregnated) or sterile 4" × 4" (10-cm × 10-cm) gauze pad
    - Sterile tape
    - Sterile drape
    - Alcohol-free skin barrier solution
    - Sterile gloves
    - Gloves
    - Masks x 2 (one for nurse and one for the client)
    - Label
    - Sterile needless connectors
    - Sterile disinfectant caps
    - Sterile, preservative-free, prefilled syringes with 10 mL 0.9% normal saline (Number of syringes required based on number of lumens of the CVAD)
    - Stabilization device, if indicated, such as a Stat Lock or Stay Fix
    - Antimicrobial patch or biopatch for placement over the insertion site
    - *Many facilities have sterile pre-packaged CVAD dressing kits that contain the necessary supplies for a CVAD dressing change. Use of pre-packaged kits is recommended when available.

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com

- Perform hand hygiene.
- Confirm the client's identity using at least two patient identifiers and check allergies.
- Provide privacy.
- Explain the procedure to the client and family (if appropriate) and answer any questions. Family members should also wear a mask if present in the room during the dressing change.
- Raise the bed to the appropriate working height.
- Measure the external catheter length through the intact dressing.
- Put on a mask. Instruct the client to put on a mask and turn their head opposite from the CVAD site.
- Perform hand hygiene and put on gloves.
- Assemble the supplies on a sterile field.
- Remove the existing dressing by lifting the edge of the dressing at the catheter hub and gently pulling it perpendicular to the skin toward the insertion site. Discard the dressing in an appropriate receptacle. Remove the engineered stabilization device and discard it.
- Assess the catheter-skin junction and surrounding skin. Inspect the catheter integrity.
- Remove gloves and perform hand hygiene.
- Don sterile gloves.
- Follow manufacturer's recommendations for appropriate cleansing products, application, and dry times. Always allow the product to dry naturally without wiping, fanning, or blowing on the skin.[3] Cleansing products are typically applied using a back-and-forth motion while moving vertically and horizontally for at least 30 seconds. Apply a skin barrier solution, engineered stabilization device, and/or chlorhexidine-impregnated sponge according to the manufacturer's instructions.
- Apply a transparent semipermeable dressing over the catheter insertion site. Label the dressing with the date according to agency policy.
- Open the needleless connector package using sterile technique and

3. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharpe, E., & Alexander, M. (2021). Infusion therapy standards of practice (8th ed.). *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 44*(1S Suppl 1), S1–S224. https://doi.org/10.1097/NAN.0000000000000396

inspect the integrity of the device. Attach the prefilled 10-mL normal saline syringe and prime the connector.

- Ensure the clamp between the connector and the catheter is closed.
- Remove the existing needleless connector. Perform a vigorous scrub of the catheter hub per facility policy. Allow it to dry completely.
- Attach the new primed needleless connector to the catheter hub and rotate to tighten.
- Unclamp the catheter and aspirate for a blood return. If blood is aspirated, slowly inject the normal saline flush into the catheter using a pulsatile flushing technique.[4]
- Clamp the catheter and remove the syringe.
- Place a new antiseptic-impregnated sterile port cap on the needleless connector, if available.
- Dispose of used equipment in appropriate receptacles.
- Remove and discard gloves and other personal protective equipment, if worn.
- Perform hand hygiene.
- In an inpatient setting, help the client into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the client knows how to use the call light to summon assistance. To ensure the client's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Perform hand hygiene.
- Document the procedure and assessments.

Documentation Cues:

- Date/Time of procedure
- Condition and appearance of site, condition, and type of securement device, if used

4. Gorski, L. A., Hadaway, L., Hagle, M. E., Broadhurst, D., Clare, S., Kleidon, T., Meyer, B. M., Nickel, B., Rowley, S., Sharpe, E., & Alexander, M. (2021). Infusion therapy standards of practice (8th ed.). *Journal of Infusion Nursing: The Official Publication of the Infusion Nurses Society, 44*(1S Suppl 1), S1–S224. https://doi.org/10.1097/NAN.0000000000000396

- Measurement of catheter (if appropriate and performed)
- Number of lumens to the catheter
- Type of dressing applied with date/time
- ANTT technique and masking for the procedure were used
- Injection cap change and to which lumens and date/time of cap change
- Type of stabilization device used
- Client's tolerance of the procedure
- Teaching provided to the patient and family (if applicable), understanding, and follow-up teaching needed
- Any unexpected outcomes, if the health care provider was notified due to any complications, what interventions were provided to the client, and the client's response to treatment

View the following YouTube video[5] showing an instructor demonstration of changing a CVAD dressing and needless connectors.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=450#oembed-1

5. Chippewa Valley Technical College. (2023, January 5). *Changing a CVAD dressing and needleless connectors* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/AGhezALw_Aw

4.5 Checklist: Obtain a Blood Sample From a CVAD

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Obtain a Blood Sample From a CVAD[1,2]

- Verify the provider's order.
- Gather the necessary equipment:
  - Gloves
  - 10-mL prefilled syringes containing preservative-free normal saline flush solution (or syringes specifically designed to generate lower injection pressure)
  - Antiseptic pads or scrubs (chlorhexidine-based, povidone-iodine, or alcohol)
  - Appropriately sized syringes or needleless blood collection tube holder
  - Blood collection tubes
  - Labels
  - Laboratory biohazard transport bag
  - Puncture-resistant sharps disposal container
- Perform hand hygiene.
- Confirm the client's identity using at least two patient identifiers and check allergies.
- Provide privacy.
- Explain the procedure to the client and family (if appropriate) and answer any questions.
- Put on gloves and, if splashing is likely, put on a mask with a face shield or a mask and goggles.
- Raise the bed to waist level when providing care.
- Trace the tubing from the client to its point of origin.
- Stop any infusing IV fluids, including those running through another

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com

lumen of the catheter. Follow agency policy for how long the IV fluids must be stopped before the blood draw. Clamp the lumen, if appropriate. Detach the administration set from the needleless connector and place a sterile cap over the end of the administration set, if necessary.

- If no IV fluids are infusing and an antiseptic-impregnated sterile cap is covering the end of the needleless connector, replace it according to agency policy. For example, if drawing blood for blood cultures, agencies may require changing the cap before the blood draw to prevent contamination of blood culture results.
- Perform a vigorous mechanical scrub of the needleless connector for at least 15 seconds using an antiseptic pad. Allow it to air dry; do not fan or wave over it.
- While maintaining sterility of the syringe tip, attach a prefilled syringe containing preservative-free normal saline solution to the needleless connector. Unclamp the catheter and slowly aspirate for blood return. Troubleshoot if no blood return occurs; notify the practitioner if troubleshooting is ineffective.
- If blood return occurs, slowly inject the preservative-free normal saline solution into the catheter.
- Using the attached syringe used for flushing, aspirate the same volume of blood as amount of saline used to flush the catheter.
- Clamp the catheter and remove and discard the blood collection tube or syringe.
- Perform a vigorous mechanical scrub of the needleless connector for at least 15 seconds using an antiseptic pad, allow it to dry, connect an empty syringe to the catheter, release the clamp, and withdraw the blood sample.
- Clamp the catheter and remove the syringe.
- Change the needleless connector according to the manufacturer's instructions.
- Perform a vigorous mechanical scrub of the needleless connector for at least five seconds using an antiseptic pad; allow it to dry.
- While maintaining sterility of the syringe tip, attach the syringe containing preservative-free normal saline solution.

- Unclamp the catheter, slowly inject the preservative-free normal saline solution into the catheter, and then reclamp the catheter.
- Remove and discard the syringe.
- Continue the client's prescribed continuous IV infusion; if the client doesn't have a continuous infusion prescribed, proceed with locking the device if required by the facility. Discard the syringe.
- Place a new antiseptic-impregnated sterile cap, if available at the facility, on the needleless connector after locking it with saline.
- If blood was obtained using a syringe, use the blood transfer unit to transfer the blood into appropriate blood collection tubes.
- Label the samples in the presence of the client.
- Place all blood collection tubes in a laboratory biohazard transport bag and send them to the laboratory with a completed laboratory request form.
- Dispose of used equipment in appropriate receptacles.
- Remove and discard gloves and other personal protective equipment.
- Perform hand hygiene.
- In an inpatient setting, help the client into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the client knows how to use the call light to summon assistance. To ensure the client's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Perform hand hygiene.
- Document the procedure and assessments.

Documentation Cues:

- Date and time the blood sample was drawn
- Volume of blood withdrawn
- Lumen used if the client has a multi-lumen central venous access catheter
- Laboratory tests for which the sample was drawn
- Time the sample was sent to the laboratory
- Assessment of the catheter exit site and the patency of the catheter

- Absence of signs and symptoms of complications
- Presence of blood return on aspiration
- Lack of resistance when flushing
- Amount and types of flushes used
- Teaching provided to the client and family (if applicable), understanding, and follow-up teaching needed

View a YouTube video[3] showing an instructor demonstration of this skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=452#oembed-1

3. Chippewa Valley Technical College. (2023, January 5). *Obtaining a blood sample from a central venous access device (CVAD)* [Video]. YouTube. Video licensed under CC BY 4.0.

4.6 Checklist: Access an Implanted Venous Access Device

Checklist: Access an Implanted Venous Access Device[1,2]

- Review the client's medical record for information about the implanted venous access device. Determine if the device is "power injectable."
- Ensure confirmation of catheter tip placement.
- Verify the provider's order if required by the facility.
- Determine whether the client has a history of allergies or contraindications to the antiseptic, anesthetic, or prescribed solution.
- Gather the necessary equipment:
    - Gloves
    - Masks
    - Sterile gloves
    - Sterile drape
    - Safety-engineered noncoring needle (smallest gauge necessary to accommodate the prescribed therapy and length that allows external components to sit level with the skin and securely within the implanted venous access device) with attached extension set tubing
    - Antiseptic pad or applicator (chlorhexidine-based, povidone iodine, or alcohol)
    - Sterile 10-mL syringes (or syringes specifically designed to generate lower injection pressure) prefilled with preservative-free normal saline solution
    - Sterile transparent semipermeable dressing (may be chlorhexidine-impregnated)
    - Sterile needleless connector
    - Securement device (follow agency policy)
- Perform hand hygiene.
- Confirm the client's identity using at least two patient identifiers and check allergies.

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com

- Provide privacy.
- Explain the procedure to the client and family (if appropriate) and answer any questions.
- Assess the client's pain tolerance and discuss preferences for using local anesthetic. If warranted, prepare and administer EMLA cream or intradermal lidocaine prior to accessing the implanted venous access device, as prescribed.
- Raise the client's bed to working level.
- Perform hand hygiene.
- Put on gloves.
- Ask the client to put on a mask and then position them for comfort with their head turned toward the opposite side of the implanted venous access device.
- Assess the skin overlying and surrounding the implanted venous access device. Report abnormal findings to the provider.
- Palpate and locate the septum; assess for device rotation.
- Remove and discard gloves.
- Perform hand hygiene.
- Put on a mask.
- Perform hand hygiene.
- Open the supplies and prepare a sterile field using a sterile drape. Using sterile technique, place the supplies on the sterile field.
- Perform hand hygiene.
- Put on sterile gloves.
- Clean the site of the implanted venous access device with an antiseptic solution following the manufacturer's instructions.
- Attach a needleless connector to the extension set attached to the noncoring needle.
- Maintaining sterility of the syringe tip, attach a syringe containing preservative-free normal saline solution to the needleless connector and prime the extension set and noncoring needle with preservative-free normal saline solution. Clamp the extension set tubing.
- Palpate and stabilize the implanted venous access device with the nondominant hand.

- Grasp the noncoring needle with the dominant hand and insert the noncoring needle perpendicular to the skin through the septum of the implanted venous access device until the needle tip comes in contact with the back of the implanted venous access device.
- Unclamp the extension tubing and aspirate for blood return and then flush the implanted venous access device with preservative-free normal saline solution.
- Secure the noncoring needle with an engineered-stabilization device. Support the wings of the noncoring needle with sterile gauze; make sure that the gauze doesn't prevent visualization of the needle insertion site.
- If applicable, place a chlorhexidine-impregnated sponge dressing beneath the needle, following the manufacturer's directions.
- Apply a sterile semipermeable transparent dressing over the insertion site, noncoring needle, and upper portion of the extension tubing.
- Label the dressing with the current date or the date the dressing change is due as directed by the facility.
- Discard the used supplies. Dispose of used equipment and waste in an appropriate receptacle.
- Remove and discard gloves and mask.
- Perform hand hygiene.
- In an inpatient setting, help the client into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the client knows how to use the call light to summon assistance. To ensure the client's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Perform hand hygiene.
- Document procedure and assessments.

Documentation Cues:

- Date and time
- Location appearance of the site
- Needle gauge and length
- Number of attempts to access implanted venous access device

- Any unexpected outcomes and interventions
- Amount and type of flush solution used
- Patency of the catheter
- Presence of blood return
- Lack of resistance when flushing
- Client's tolerance of the procedure
- Teaching provided to the client and family (if applicable), understanding of that teaching, and any need for follow-up teaching

View a YouTube video[3] showing an instructor demonstration of this skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=454#oembed-1

3. Chippewa Valley Technical College. (2023, January 5). *Accessing an implantable port* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/BGOTSPZdFdE

4.7 Documentation

Sample Documentation for a CVAD Dressing Change:

11/19/20XX 0900

Double lumen PICC line dressing was changed to the right upper arm using a prepackaged CVAD dressing kit. Old dressing was removed and discarded. Site is without redness, swelling, exudate, or indication of complications. Client denies discomfort at the insertion site or along the vein track. Pre-procedure, catheter measured 4 cm external from insertion site to hub, which corresponds to the initial insertion external measurement. Upper arm circumference 10 cm above insertion site is 23 cm, which corresponds to the previous shift's measurement of 23 cm. No visible swelling or subcutaneous emphysema is observed. Nurse and client donned sterile masks. Per sterile technique, site area was cleansed with chlorhexidine scrub for 30 seconds and allowed to air dry. Device secured with Statlock followed by chlorhexidine gel impregnated sterile transparent dressing. Line flushed freely with 10mL of sterile, preservative-free 0.9% normal saline after obtaining brisk blood return. Needleless injection ports x2 were replaced and passive caps x2 were changed. Post-procedure, catheter measured 4 cm external from insertion site to hub, which corresponds to the initial insertion external measurement. Dressing dated and labeled. Client tolerated the procedure well without complications.

Jane Smith, RN

Exercises

(Answers to the exercises are located in the Answer Key at the back of the book).

Case Study #1

Autumn, age 32, has a history of Diabetes Mellitus Type II and has been admitted to the hospital with a left lower leg wound that developed cellulitis. She has been receiving antibiotic therapy in the hospital for the past two days through a right upper arm PICC line and is now ready for discharge. When at home, she will continue to receive cefazolin 500 mg IV every 8 hours for the next 14 days.

1. What will you provide for patient education for Autumn regarding her PICC line?

2. What are the maintenance care priorities for care of the PICC line?

3. Are there any specific concerns related to Autumn's need for a PICC line that should be monitored or addressed?

4. What is the purpose of the PICC line?

5. How often should a PICC line be assessed?

6. How does the dressing get changed for a PICC line?

7. What makes a PICC line different from a peripheral IV and from an implanted port?

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An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=458#h5p-11

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=458#h5p-12

Test your knowledge using a NCLEX Next Generation-style question. You may reset and resubmit your answers to this question an unlimited number of times.

IV Glossary

Air embolism: The result of a pressure gradient that allows air to enter the bloodstream when flushing the catheter.

Aseptic-impregnated catheter hub: A specific device or product that has an aseptic particulate embedded within it to prevent biological contaminants from entering a susceptible host. An example of an aseptic-impregnated device is a chlorhexidine impregnated CVAD dressing.

Aseptic nontouch technique (ANTT): A global standard used to prevent healthcare-acquired infections. ANTT identifies key parts and key sites throughout the preparation and implementation of the procedure. A key part is any sterile part of equipment used during an aseptic procedure, such as needle hubs and dressings. A key site is the insertion site, nonintact skin, or an access site for medical devices connected to clients. ANTT includes four underlying principles to keep in mind while performing invasive procedures:

- Always perform meticulous hand hygiene.
- Never contaminate key parts.
- Touch nonkey parts with confidence.
- Take appropriate infection control precautions.

Central line-associated bloodstream infection (CLABSI): A laboratory-confirmed bloodstream infection not related to an infection at another site that develops within 48 hours of a central line placement. Most CLABSI cases are preventable with proper aseptic techniques, surveillance, and management strategies.

Central venous access device (CVAD): A central line is a thin, flexible, large-bore tube inserted into a client's large vein.

Central venous pressure (CVP): Pressure observed within the central veins as the veins enter the right atrium. Central venous pressure is a good indicator of right heart function and is often monitored during fluid resuscitation.

Extravasation: Leakage of fluid into the tissues around the IV site causing tissue injury when the catheter has dislodged from the blood vessel but is still in the nearby tissue.

Fluid resuscitation: Infusing a large volume of fluid through the intravenous venous access to restore hemodynamics and optimize tissue perfusion and, ultimately, tissue oxygen delivery.

Fluoroscopy: A medical procedure that makes a real-time video of the movements inside a part of the body by passing X-rays through the body over a period of time.

Flushing: A manual injection of 0.9% sodium chloride to clean the catheter.

Hemodynamic monitoring: The assessment of a critically ill client's circulatory status and includes measurements of central venous pressure, cardiac output, and blood volume.

Locking: The injection of a limited volume of a liquid following the catheter flush, for the period of time when the catheter is not used, to prevent intraluminal clot formation and/or catheter colonization.

Reservoir pocket: A small pocket, either a plastic or metal cylinder, usually placed just below the collar bone and connected to a catheter that enters a large vein such as the subclavian.

Scrub hub: A scrubbing device with an embedded alcohol product such as chlorhexidine with alcohol or 70% alcohol to disinfect catheter hubs or needleless connectors.

Vesicant medications: Certain medications such as antineoplastic drugs, antibiotics, electrolytes, and vasopressors that can cause severe tissue injury or destruction.

PART V

CHAPTER 5 INSERT NASOGASTRIC AND FEEDING TUBES

5.1 Introduction

Learning Objectives

- Identify the indications for NG tube insertion
- Identify contraindications for NG tube insertion
- Outline essential safety principles related to the insertion of an NG tube, including evidence-based placement verification
- Outline nursing assessments and interventions related to the insertion of an NG tube
- Use clinical judgment to prevent, assess, manage, and document complications related to NG tubes
- Demonstrate the procedures for insertion and discontinuation of an NG tube
- Describe client care considerations prior to and following NG insertion

Enteral tubes are tubes placed in the gastrointestinal tract for stomach decompression, as well as an alternate route for feeding and/or medication administration. **Stomach decompression** is a medical term that refers to removing stomach contents by using suctioning. Stomach decompression is commonly used after surgery or trauma to reduce pressure from the buildup of fluids and gas that cause pain, nausea, and vomiting that can lead to potential aspiration of stomach contents into the lungs.

Insertion and post-insertion care of enteral nasogastric feeding (NG) tubes are common procedures in the United States, with more than 1.2 million temporary nasogastric feeding tubes inserted annually.[1] Clients in acute care

1. Bloom, L., & Seckel, M. A. (2022). Placement of nasogastric feeding tube and postinsertion care review. *AACN Advanced Critical Care, 33*(1), 68–84. https://doi.org/10.4037/aacnacc2022306

and community settings may have various types of enteral tubes to assist their recovery. Nurses are involved in the insertion, management, and removal of NG tubes, as well as the administration of feedings and medications through NG tubes. They must understand the manner in which these devices work, their purpose, and ways to prevent complications. Although inserting an NG tube is a commonly performed procedure, it can cause significant risk to the client if performed improperly.

Nursing responsibilities associated with caring for a client with an enteral tube include the following:

- Assessing tube placement and patency
- Assessing and cleansing the insertion site
- Administering tube feeding
- Administering medication via the enteral tube
- Irrigating/flushing the tube
- Managing gastric tube suctioning
- Monitoring and responding to potential complications

This chapter will discuss indications and contraindications for NG tubes, review the anatomy and physiology related to NG tubes, outline techniques to verify NG tube placement, and discuss potential complications. Checklists for inserting and removing NG tubes are also provided.

Review the "Enteral Tube Management" and "Administration of Enteral Medications" chapters in the Open RN *Nursing Skills* book for additional information about various types of enteral tubes and related nursing responsibilities.[2]

2. This work is a derivative of Nursing Skills by Open RN and is licensed under CC BY 4.0

5.2 Basic Concepts

A **nasogastric (NG) tube** is a flexible plastic tube inserted through a nostril, down the posterior oropharynx, and into the stomach or the upper portion of the small intestine. It is typically used for decompression of the stomach for clients with an intestinal obstruction or ileus or for administration of nutrition or medication to clients who are at risk for aspiration or unable to tolerate oral intake. Depending on the intended purpose of the tube, there are different types of NG tubes designed specifically for its use.[1]

Orogastric (OG) tubes have similar indications, monitoring, and care as NG tubes, but they are inserted through the mouth instead of the nose. OG tubes are often preferred for clients receiving mechanical ventilation.

Anatomy and Physiology

The nurse should be familiar with the anatomy and physiology of the nose, pharynx, esophagus, and stomach when caring for clients with NG tubes. See Figure 5.1[2] for an illustration of the nasal cavity and pharynx.

1. This work is a derivative of StatPearls by Sigmon and An and is licensed under CC BY 4.0
2. "Blausen_0872_UpperRespiratorySystem.png" by Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014" for WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436 is licensed under CC BY 3.0

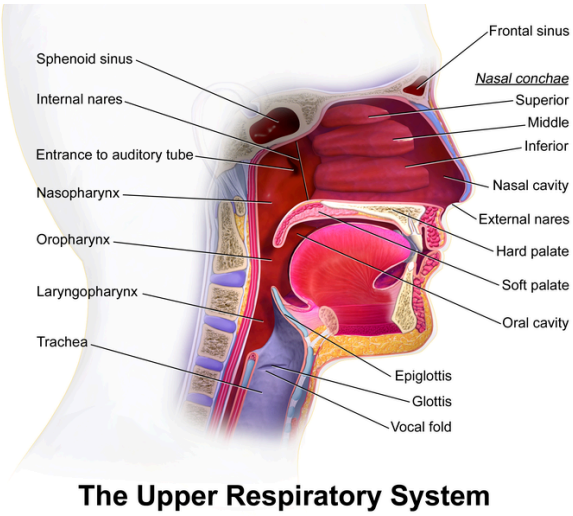

Figure 5.1 Nasal Cavity, Pharynx, and Epiglottis

The nares are the exterior openings to the nasal cavity. Usually, one nare is larger and more patent than the other. A septum, composed of bone and cartilage, divides the right and left nasal cavities. The nasal floor is parallel to the roof of the mouth. The end of the nasal cavity is narrow and ends at the juncture of several bones, including a portion of the cribriform plate, which is a very thin bone that, if fractured, could provide a direct portal into the brain. For this reason, NG tube placement in clients with suspected head trauma may be contraindicated.

The pharynx is a mucous membrane lined tube that begins at the nasal cavity and is divided into three major regions: the nasopharynx, the oropharynx, and the laryngopharynx.

- The nasopharynx serves only as an airway. It is a muscular passageway at the beginning of the pharynx, located behind the nasal cavity. It curves to extend behind the oral cavity to become the oropharynx.
- The oropharynx is a passageway for both air and food. The oropharynx is bordered superiorly by the nasopharynx and anteriorly by the oral cavity.
- The laryngopharynx is inferior to the oropharynx and posterior to the larynx. It continues the route for ingested material and air to the inferior end where the digestive and respiratory systems diverge. Anteriorly, the laryngopharynx opens into the larynx, and posteriorly it enters the esophagus that leads to the stomach. The larynx connects to the trachea and the lungs, so for this reason, great care must be taken when inserting

an NG tube to ensure it enters the posterior laryngopharynx and goes into the esophagus, not anteriorly into the trachea and the lungs.

The epiglottis is a cartilaginous flap of connective tissue located at the entrance to the larynx. During swallowing, the larynx moves upward, and the epiglottis closes over the glottis to prevent aspiration of food and fluid into the trachea. Many clinicians use this natural movement during NG tube insertion by asking clients to swallow ice chips or water once the NG tube passes beyond the oropharynx (i.e., the back of the oral cavity). As the client swallows, the rising and falling of the larynx and the opening and closing of the epiglottis can assist passage of the NG tube beyond the laryngopharynx toward the esophagus. The nurse can request the client to tuck their chin to ease this passage.

The esophagus starts at the upper esophageal sphincter and runs down through the diaphragm past the lower esophageal sphincter to the stomach. See Figure 5.2[3] for an illustration of the pharynx, trachea, esophagus, and stomach.

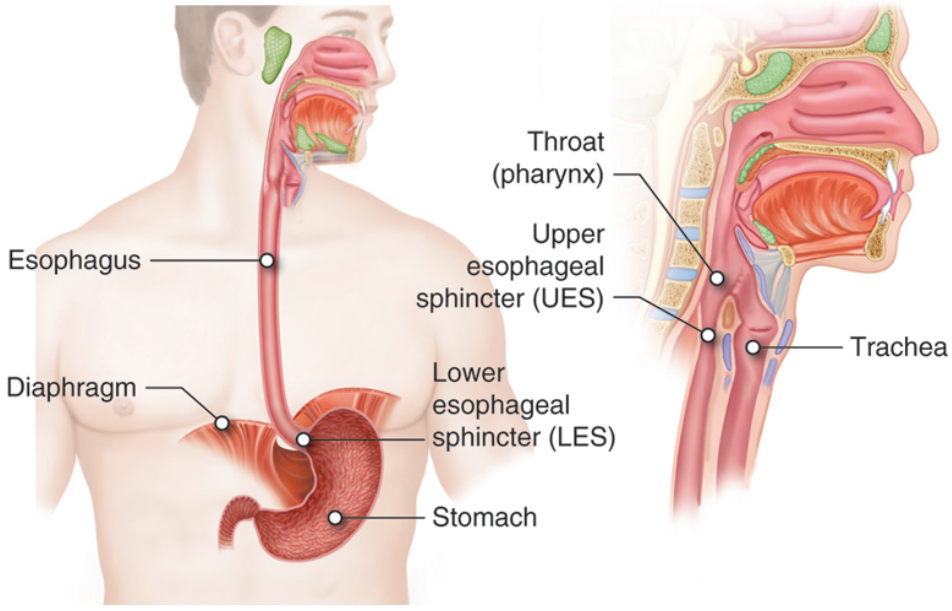

Figure 5.2 Pharynx, Trachea, Esophagus, and Stomach

3. "D_M3_24.jpg" by unknown Cenveo is licensed under CC BY 3.0. Access for free at https://pressbooks.ccconline.org/bio106/chapter/digestive-structures-and-functions/

Indications for NG Tubes

These are the indications for NG tubes[4]:

- To decompress the stomach and gastrointestinal (GI) tract (i.e., to relieve distention due to bowel obstruction, ileus, or atony)
- To administer nutrition and/or medication
- To empty the stomach to prevent aspiration (for example, NG tubes may be inserted in intubated clients to prevent aspiration)
- To remove blood from clients with GI bleeding[5]
- To obtain a sample of gastric contents to assess bleeding, volume, or acid content
- To remove ingested toxins
- To give antidotes such as activated charcoal
- To give oral radiopaque contrast agents
- To provide bowel rest

Bowel Obstruction and Ileus

The most common indication for placement of a nasogastric tube is to decompress the stomach of a client with a distal bowel obstruction or ileus. **Bowel obstruction** is a mechanical blockage of intestinal contents by a mass, adhesion, hernia, impacted stool, or other physical blockage such as volvulus (i.e., twisting of the stomach or intestine) or intussusception (i.e., one segment of intestine telescopes inside another). Bowel obstructions block the normal passage of bodily fluids such as salivary, gastric, hepatobiliary, and enteric secretions, causing the fluids to build up, resulting in abdominal distension, pain, and nausea. Eventually, the fluids will build up to a point that nausea will progress to emesis, putting the client at risk for aspiration.[6]

Ileus occurs when there is a nonmechanical decrease or stoppage of the flow of intestinal contents. Ileus is often an unavoidable consequence of

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abdominal or retroperitoneal surgery but can also be found in severely ill clients with septic shock or mechanical ventilation. An ileus usually manifests itself from the third to the fifth day after surgery and usually lasts 2 to 3 days with the small bowel being the quickest to return to function (0 to 24 hours), followed by the stomach (24 to 48 hours), and lastly the colon (48 to 72 hours). Other causes of ileus may include the following[7]:

- Prolonged abdominal/pelvic surgery
- Lower gastrointestinal (GI) surgery
- Opioid use
- Intra-abdominal inflammation (sepsis/peritonitis)
- Peritoneal carcinoma
- Perioperative complications (pneumonia or abscess)
- Bleeding (intraoperative or postoperative)
- Hypokalemia
- Delayed enteral nutrition or nasogastric (NG) tube placement

NG tube placement is a temporary intervention for bowel obstruction and ileus when normal peristalsis is temporarily altered. It serves to decompress the stomach and keep it empty until normal peristalsis returns. If decompression is needed for more than six weeks, then something more permanent like a jejunostomy tube may be inserted.

Nutrition and Medication Administration

Nasogastric tubes may be placed to administer nutrition or medications for a client who has a functional GI tract but is unable to ingest, chew, or swallow food safely or in adequate amounts. This indication is common for clients who have suffered a cerebrovascular accident (i.e., stroke) that has left them unable to swallow effectively. Nasogastric tubes may be placed for nutritional support while waiting to see how much function the client will recover. If the client does not adequately recover their swallowing ability or will otherwise

7. This work is a derivative of StatPearls by Beach and De Jesus and is licensed under CC BY 4.0

require long-term nutritional support, then a more permanent feeding tube is placed such as a gastrostomy or jejunostomy feeding tube.[8]

Other examples of conditions where clients have a functioning GI tract but cannot tolerate oral intake are as follows:

- Decreased level of consciousness, such as a coma or a sedated client on a ventilator
- Following upper gastrointestinal surgery where an **anastomosis** (i.e., a surgical connection between parts of the intestine) must be protected in the initial postoperative period
- During preoperative period to prepare malnourished clients for major abdominal surgery

For many of these indications for NG tubes, an orogastric tube (OG tube) can also be placed. Many of the principles used to manage an NG tube are the same for managing an OG tube, such as checking placement and monitoring for potential complications.

Contraindications for NG Tubes

There are two types of contraindications for any procedure or intervention and are referred to as absolute and relative. An absolute contraindication means the procedure or intervention may produce a life-threatening situation and should be avoided if possible. A relative contraindication means caution should be used because the possibility of an adverse event is possible; therefore, benefits must outweigh the risks.

Absolute contraindications to the placement of an NG tube include significant facial trauma; basilar skull fractures; or recent nasal, throat, or esophageal surgery where attempted placement of a tube via the nares may exacerbate the existing tissue trauma. In some cases of esophageal surgery, such as an esophagectomy, the surgeon will place the NG tube in the operating room and then remove it when indicated; the nurse should not manipulate the NG tube in this case. Esophageal obstruction, such as a

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neoplasm or foreign object, is also an absolute contraindication to nasogastric tube placement.[9]

Relative contraindications include esophageal trauma, especially if caustic substances were ingested. Coagulation abnormalities or anticoagulation therapy may cause bleeding from the tissue trauma from tube placement. For clients with previous gastric bypass surgery, hiatal hernia repair, or abnormal GI anatomy (such as esophageal varices or strictures), NG tubes should be placed by a provider under endoscopy.[10]

Types of NG Tubes

There are two basic types of NG tubes, those used for decompression and those used for feeding.

For decompression, a double-lumen, rigid tube is used with one large lumen used for suction and a smaller lumen to act as a sump. (A sump allows air to enter to prevent suctioning of the gastric mucosa into the eyelets at the distal tip of the tube or obstruction when the stomach is fully collapsed.) These tubes are often referred to as "Salem Sump." Their bore size ranges from 6 to 18 French, with those most commonly inserted being 14 to 16 French. A blue pigtail on this type of tube is the air vent, so it should never be clamped, connected to suction, or used for irrigation. See Figure 5.3[11] for an image of a Salem Sump.

9. This work is a derivative of StatPearls by Sigmon and An and is licensed under CC BY 4.0
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11. "11720205623covidien-salem-sump-nasogastric-suction-tube-P" by unknown author used on the basis of Fair Use. Access original image at https://www.healthproductsforyou.com/p-covidien-salem-sump-nasogastric-suction-tube.html?utm_source=google&utm_medium=surfaces&utm_campaign=shopping%20feed&utm_content=free%20google%20shopping%20clicks&gclid=Cj0KCQiAsdKbBhDHARIsANJ6-jcX4iGGwtT30nfQXurA9kiTlvlvBJQNj6BXyuGL4mGAnc40lL0tdCQaArZzEALw_wcB

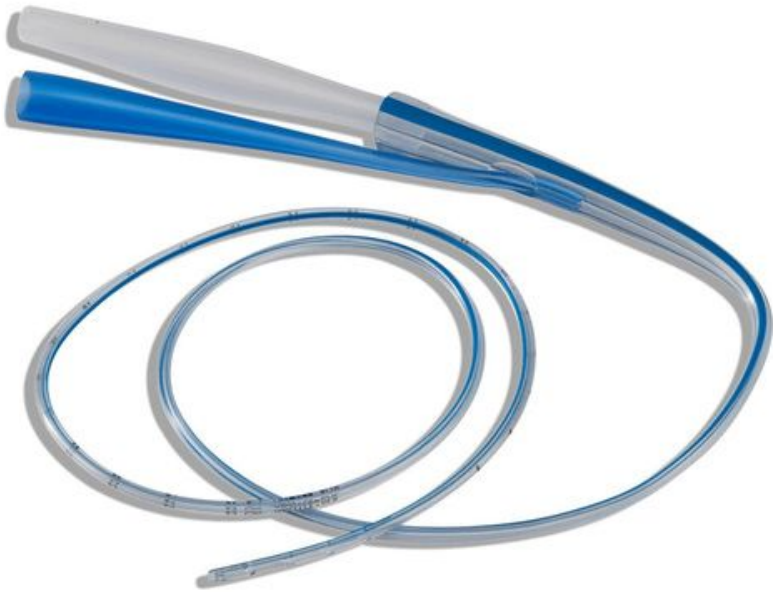

Figure 5.3 Salem Sump. Used under Fair Use.

NG tubes used for administration of medications or feeding are single lumen and are softer than those used for decompression. They have a smaller bore with a size ranging from 8 to 12 French. NG tubes placed for feeding or medication administration may be a Levin tube or a Dobhoff tube. A Levin tube is a simple small diameter NG tube. A Dobhoff tube is a special type of NG tube that is small-bore and flexible, so it is more comfortable for the client than a standard NG tube. The tube is inserted with the use of a guide wire, called a stylet, that is removed after correct tube placement is confirmed. A Dobhoff tube also has weight on the end to allow gravity and peristalsis to help advance the end of the tube past the pylorus, providing an additional barrier to reduce aspiration risk of nutrition or medications administered. See Figure 5.4[12] for an image of a Levin tube and Figure 5.5[13] for an image of a Dobhoff tube.

12. "2-Levin-Tube.jpg" by unknown author is used under Fair Use. Access original image at https://www.smd-medical.com/product-detail/levin-tube-stomach-tube/
13. "COV711006CN_PRI03.JPG" by unknown author is used under Fair Use. Access original image at https://punchout.medline.com/product/Kangaroo-Dobbhoff-Tip-Nasogastric-Feeding-Tube/Nasogastric-Tubes/Z05-PF10706

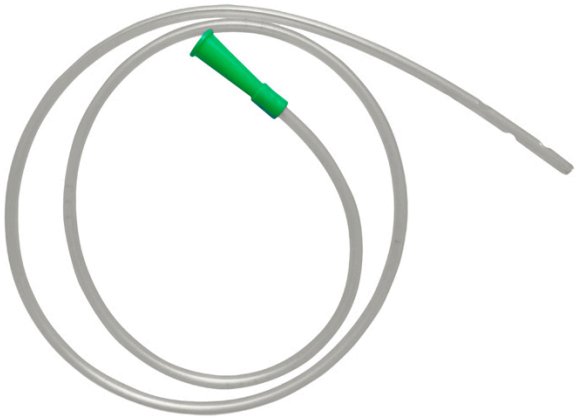

Figure 5.4 Levin Tube

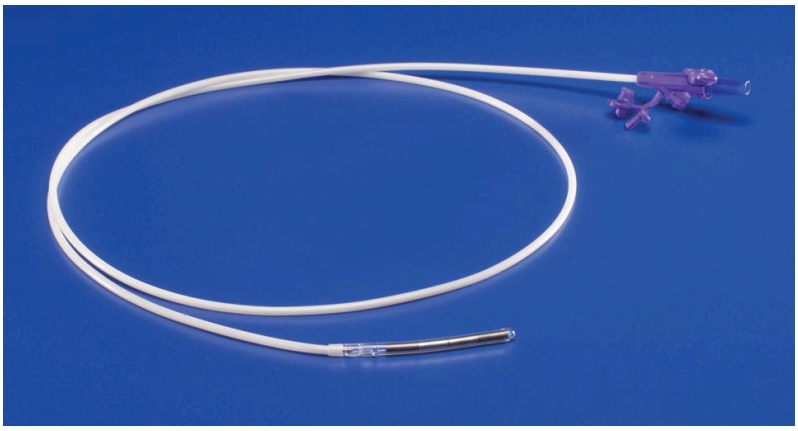

Figure 5.5 Dobhoff Tube With Weighted Tip

NG Tube Insertion

Insertion of an NGT is typically a clean (not sterile), "blind" procedure, meaning the person performing the procedure can't visualize where the tube is going in the client's body as they are inserting it. Insertion involves passing the tube through the nose, along the nasal floor, through the pharynx and down the esophagus until the proximal tip of the tube rests in the client's stomach. See "Checklist: Insert a Nasogastric Tube" for detailed procedural instructions.

NG tubes are inserted and removed by nurses and other health care providers. Due to the invasive nature of the placement process, privately ask the client if they desire visitors to leave the room during placement or removal of the NG tube. Nurses provide the daily care of NG tubes, as well as

the administration of nutritional formulas, medications, and other substances through the tube. Nursing management of NG tubes are further described in the "Applying the Nursing Process" section of this chapter. The nurse is also responsible for verifying the NG tube has been accurately placed prior to initial use and before each use thereafter.[14]

Estimating the Depth of NG Tube Placement

Five to seven centimeters posterior to the nares, the nasal sinus connects to the nasopharynx. The length of the pharynx from the base of the skull to the start of the esophagus is 12 to 14 centimeters. The esophagus, from the upper esophageal sphincter to the stomach, is approximately 25 centimeters. The stomach is a highly distensible structure and can vary in length, but the empty stomach is typically about 25 centimeters long. Thus, approximately 55 centimeters of the NG tube is typically inserted in an adult.[15]

There are several methods used to estimate the depth that an NG tube should be placed. A common preprocedural maneuver used to estimate the length of the tube that should be inserted is to measure the tube from the tip of the client's nose to the earlobe and then against the throat down to the xiphoid process, about 1/2 inch to 1 inch below the sternal notch.[16]

Special Circumstances

Insertion of weighted NG tubes used for feeding, as well as NG tubes for post-GI surgery clients, is performed by specially trained advanced practice nurses, physician assistants, or physicians.

The NG tube inserted for a post-GI surgery client should never be repositioned due to the risk of rupturing a suture line. If the NG tube becomes dislodged, the surgeon should be notified.

If a client is unconscious, gag reflex should be assessed before initiating the

14. Patient Safety Movement. (2020). *Actionable patient safety solutions (APSS) #15: Nasogastric tube (NGT) placement and verification.* https://patientsafetymovement.org/wp-content/uploads/2017/10/APSS-15-4.pdf
15. This work is a derivative of StatPearls by Sigmon and An and is licensed under CC BY 4.0
16. Nasogastric or orogastric tube insertion. (2021). Lippincott procedures. http://procedures.lww.com

procedure. Flex their head forward with your nondominant hand during the procedure as the tube is passed through the larynx. Extra precautions must be taken for clients with head injury to avoid misplacement of the NG tube.

Request assistance prior to starting the procedure based on the client condition. For example, clients who are confused, anxious, at risk for pulling out the tube as it is being inserted, and children often require assistance. Additionally, for pediatric clients it is often helpful to have their parents or caregivers at the bedside. For infants, sucrose may be administered to alleviate discomfort, based on agency policy.

Verifying NG Tube Placement

Insertion of NG tubes is considered a simple procedure, but incorrect placement can lead to client harm and possibly death. The risk of harm and death increases when misplaced tubes are not identified prior to their use. For this reason, placement must be verified immediately after insertion by an X-ray to ensure it has not been inadvertently placed into the trachea and into the bronchi. The nurse should monitor for signs and symptoms of incorrect placement during the procedure, such as coughing, decreased pulse oximetry readings, and cyanosis. If these signs occur, the tube should immediately be withdrawn until normal breathing resumes. See Figure 5.6[17] for an image of an X-ray demonstrating correct placement of an enteral tube in the stomach as indicated by the lower red arrow. (This X-ray also demonstrates an endotracheal tube correctly placed in the trachea as indicated by the top arrow.) After X-ray verification, the tube should be marked with adhesive tape and/or a permanent marker to indicate the measurement on the tube where the feeding tube enters the nares or penetrates the abdominal wall. This number on the tube at the entry point should be documented in the medical record and communicated during handoff reports. At the start of every shift, the nurse should evaluate if the incremental marking or external tube length has changed. If a change is observed, bedside tests such as visualization or pH testing of tube aspirate

17. "ETTubeandNGtubeMarked.png" by James Heilman, MD is licensed under CC BY-SA 4.0

can help determine if the tube has become dislodged. If in doubt, the provider should be notified and an X-ray repeated to confirm tube location.[18]

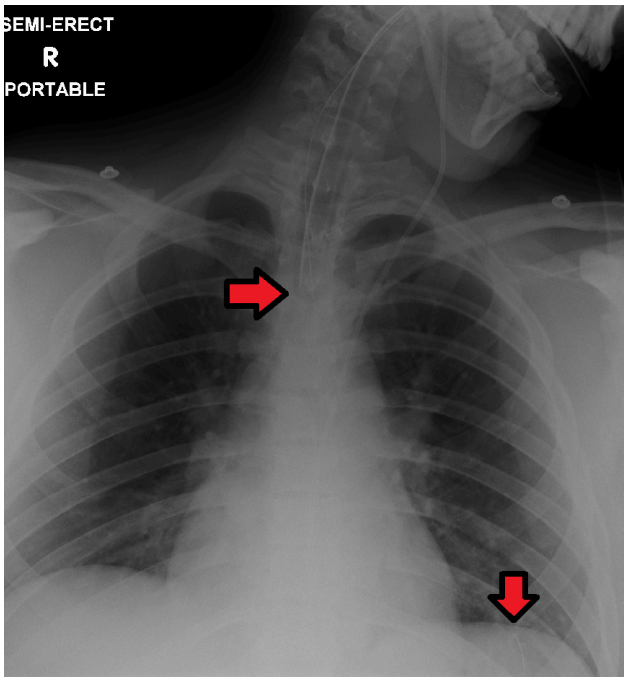

Figure 5.6 Placement Verification by X-Ray

After the tube placement is initially verified by X-ray, it is possible for the tube to migrate out of position due to the client coughing, vomiting, and moving. For this reason, the nurse must routinely check tube placement before every use. The American Association of Critical-Care Nursing recommends that the position of a feeding tube should be checked and documented every four hours and prior to the administration of enteral feedings and medications by

18. Boullata, J. I., Carrera, A. L., Harvey, L., Escuro, A. A., Hudson, L., Mays, A., McGinnis, C., Wessel, J. J., Bajpai, S., Beebe, M. L., Kinn, T. J., Klang, M. G., Lord, L., Martin, K., Pompeii-Wolfe, C., Sullivan, J., Wood, A., Malone, A., & Guenter, P. (2017). ASPEN safe practices for enteral nutrition therapy. *Journal of Parenteral and Enteral Nutrition, 41*(1), 15-103. https://doi.org/10.1177/0148607116673053

measuring the visible tube length and comparing it to the length documented during X-ray verification.[19,20,21]

Older methods of verifying tube placement included observing aspirated GI contents or administering air into the tube with a syringe while auscultating (commonly referred to as the "whoosh test"). However, research has determined these methods are unreliable and should no longer be used to verify placement.[22,23]

Assessing the pH of aspirated gastric contents is a method used to verify placement in some agencies. Gastric aspirate should have a pH of less than or equal to 5.5 using pH indicator paper that is marked for use with human aspirate. However, caution should be used with this method because enteral formula and some medications alter the gastric pH.[24]

Follow agency policy for assessing and documenting tube placement. Additionally, if the client develops respiratory symptoms that indicate potential aspiration, immediately notify the provider and withhold enteral feedings and medications until the placement is verified.

Potential Complications

The most common complications related to the placement of nasogastric tubes are discomfort, sinusitis, or epistaxis, all of which typically resolve

19. Boullata, J. I., Carrera, A. L., Harvey, L., Escuro, A. A., Hudson, L., Mays, A., McGinnis, C., Wessel, J. J., Bajpai, S., Beebe, M. L., Kinn, T. J., Klang, M. G., Lord, L., Martin, K., Pompeii-Wolfe, C., Sullivan, J., Wood, A., Malone, A., & Guenter, P. (2017). ASPEN safe practices for enteral nutrition therapy. *Journal of Parenteral and Enteral Nutrition, 41*(1), 15-103. https://doi.org/10.1177/0148607116673053
20. Lemyze, M. (2010). The placement of nasogastric tubes. *CMAJ: Canadian Medical Association Journal, 182*(8), 802. https://doi.org/10.1503/cmaj.091099
21. Simons, S. R., & Abdallah, L. M. (2012). Bedside assessment of enteral tube placement: Aligning practice with evidence. *American Journal of Nursing, 112*(2), 40-46. https://doi.org/10.1097/01.naj.0000411178.07179.68
22. Boullata, J. I., Carrera, A. L., Harvey, L., Escuro, A. A., Hudson, L., Mays, A., McGinnis, C., Wessel, J. J., Bajpai, S., Beebe, M. L., Kinn, T. J., Klang, M. G., Lord, L., Martin, K., Pompeii-Wolfe, C., Sullivan, J., Wood, A., Malone, A., & Guenter, P. (2017). ASPEN safe practices for enteral nutrition therapy. *Journal of Parenteral and Enteral Nutrition, 41*(1), 15-103. https://doi.org/10.1177/0148607116673053
23. Simons, S. R., & Abdallah, L. M. (2012). Bedside assessment of enteral tube placement: Aligning practice with evidence. *American Journal of Nursing, 112*(2), 40-46. https://doi.org/10.1097/01.naj.0000411178.07179.68
24. Best, C. (2019). Selection and management of commonly used enteral feeding tubes. *Nursing Times, 115*(3), 43-47. https://www.nursingtimes.net/clinical-archive/nutrition/selection-and-management-of-commonly-used-enteral-feeding-tubes-18-02-2019/

spontaneously with the removal of the nasogastric tube.[25] Other complications associated with use of an NG tube range from minor to more severe and may include the following conditions:

- Trauma to the nares, larynx, esophagus, and/or stomach during insertion.
- Trauma to or erosion of gastric mucosa, especially if gastric suctioning is prolonged.
- Mucosal pressure injury of the nares.
- Placement-related issues: Inadvertent placement in the trachea that can lead to pleural injury, pneumothorax, tracheobronchial aspiration, pneumonia, and death. Respiratory distress is a medical emergency, and emergency assistance must be obtained immediately.
- Esophageal perforation, evidenced by neck or chest pain, dysphagia, dyspnea, subcutaneous emphysema, or hematemesis.
- Inadvertent intracranial placement through a fractured cribriform plate.
- Knotting of the NG tube around an endotracheal tube or retrograde positioning (i.e., the proximal tip of the tube curves upward through the esophagus).

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Assessments and Interventions Prior to Insertion of an NG Tube

Prior to the insertion of an NG tube, the following nursing assessments and interventions should be performed:

- Review agency policy for inserting and verifying placement of an NG tube.
- Verify the provider's orders.
- Review laboratory results to check for coagulopathies or blood dyscrasias. If the client is on anticoagulation therapy, assess their most current INR before performing the procedure and notify the provider of any concerns.
- Ask the client if they have any allergies (e.g., to latex, medications, or other substances).
- Confirm client history for facial trauma, deviated septum, nasal fractures, or risk of increased intracranial pressure.
- Assess the client's level of consciousness and their ability to participate in the procedure. Request assistance from a colleague as indicated.
- Perform a focused abdominal assessment to identify the client's baseline status. Auscultate bowel sounds and palpate the abdomen for distention, pain, or rigidity.
- Assess the nares for obstructions and the surrounding skin. Select the nostril with the best airflow and skin condition.
- Provide patient education on the procedure and answer questions.
- Provide emotional support and comfort while being aware this is an uncomfortable procedure for the client. It is helpful to have an assistant nearby during this procedure; the assistant can also provide emotional support to the client as needed during the procedure.

Expected Outcomes of the Procedure

These are the expected outcomes related to insertion of an NG tube:

- The NG tube is placed without causing trauma.
- The correct placement of an NG tube is verified according to agency policy.
- The NG tube remains in place, patent, and functional for the duration of therapy.

Assessments and Interventions After Insertion of the NG Tube

Assessments and interventions immediately after insertion of an NG tube include the following[1]:

- Observe for signs of misplacement post-insertion, such as circumoral cyanosis, coughing, choking, dyspnea, decreased oxygen saturation level, or vomiting.
    - Respiratory distress is a medical emergency, and emergency assistance should be obtained.
    - Strongly consider removing the NG tube if these signs are present as the tube may be lodged in the airway or lungs.
- Do not administer fluids or medications via the NG tube until accurate placement has been verified with an X-ray.
- Document the following information in the client's medical record[2]:
    - Time and date of the procedure
    - Type and diameter of the NG tube
    - Number on the tube where it enters the nares and verification that number was communicated during handoff reports
    - Method(s) used to verify tube placement
    - Color and consistency of aspirate, including pH of aspirate if assessed
    - Client's tolerance of the procedure
    - Any unexpected client events or outcomes, interventions performed,

1. Lippincott procedures. http://procedures.lww.com
2. Walsh, K., & Schub, E. (2016). *Nasogastric tube: Inserting and verifying placement in the adult patient*. Cinahl Information Systems, Ebsco. https://www.ebscohost.com/assets-sample-content/Nasogastric_Tube_Insertion.pdf

and notification of the provider
- Patient/family education, including topics presented, response to education provided/discussed, and the plan for follow-up education

Routine Nursing Care of Clients with NG Tubes

Clients with NG tubes are at constant risk for developing adverse effects. While caring for clients with NG tubes, nurses monitor risks and adopt strategies for client safety and quality of care.

When working with clients who have NG tubes, nurses perform the following interventions[3]:

- **Keep the head of the bed 30 degrees or higher.**
  - Clients with NG tubes are at risk for aspiration, especially if they are receiving enteral nutrition. The head of the bed should always be raised 30 degrees or higher to prevent aspiration.
- **Prevent migration and/or dislodgement of the tube.**
  - The NG tube should be fastened to the client using a securement device and taped/pinned to the client's gown to prevent the tube from slipping from out of the stomach, migrating into the lungs, or being accidentally removed.
- **Maintain and promote comfort.**
  - The NG tube constantly irritates the client's nasal mucosa and can cause discomfort and potential skin breakdown. Ensure that the tube is securely anchored to the client's nose to prevent excess tube movement and is pinned to the gown in a manner that avoids excessive pulling or dragging. Routinely confirm the NG tube is not pressing against the client's nares or septum and regularly assess the skin around the tube and securement device for breakdown. The tube should be periodically repositioned in the nares to help prevent pressure injuries. Notify the provider of any concerns.

3. Lippincott procedures. http://procedures.lww.com

- If the client has abdominal distension or complains of abdominal pain, discomfort, or nausea or begins to vomit, perform the following actions:
    - If the client is receiving suctioning, verify suction settings are consistent with the provider order, including “continuous” versus “intermittent” suctioning and “low” versus “high” suction level. Check for kinking of the tube from the nare to the suction source.
    - Some NG tubes have valves that permit delivery of oral agents without disconnecting the tube. Ensure the valve is not turned in a direction that is blocking the tube.
- Assess the patency of a tube according to agency policy, typically by irrigating with a 60-mL syringe and 30 mL of tap water. NG tubes are prone to clogging for a variety of reasons. The risk of clogging may result from tube properties (such as narrow tube diameter), the tube tip location (stomach vs. small intestine), insufficient water flushes, aspiration for gastric residual volume, contaminated formula, and/or incorrect medication preparation and administration. To prevent clogging, NG tubes should be flushed a minimum of once per shift or according to provider orders/agency policy. Feeding tubes should be flushed immediately before and after intermittent feedings and medication administration and follow appropriate medication administration practices. Read more information about tube irrigation in the “Basic Concepts of Enteral Tubes” section in the Open RN *Nursing Skills* book.
- If the client is receiving enteral feedings, monitor for signs of tube feeding intolerance (i.e., abdominal bloating, nausea, vomiting, diarrhea, cramping, and constipation). If cramping occurs during bolus feedings, it can be helpful to administer the enteral nutritional formula at room temperature to minimize or help prevent symptoms.

- **Perform oral care.**

- Because one nostril is blocked, clients tend to breathe through their mouth, causing dehydration of the nasal and oral mucosa. Clients often complain of thirst, but they are typically NPO (nothing by mouth) when an NG tube is in place. Oral care keeps the oral mucous membranes moist and helps relieve dryness, as well as preventing infection. Oral care can include rinsing the mouth with cold water or mouthwash, as long as the client does not swallow. Some clients may be permitted to suck on ice chips per provider orders. Lubricant should be applied to the lips and the external nares.
- Clients may have throat discomfort. Some providers may prescribe a numbing throat spray but use with caution because it can hinder the gag reflex and increase the risk of aspiration.

◦ **Monitor input/output, electrolyte balances, and weight trend.**

- Because a client with an NG tube is typically NPO, it is important to closely monitor their fluid, electrolyte, and nutritional statuses. They are also at risk for acid/base imbalance. NG tubes used for suctioning place clients at risk for hypokalemia and metabolic alkalosis when large volumes of stomach acid contents are removed from the body.
- If the client is receiving suctioning, the drainage amount and color should be documented every shift.
- Fluid flushes and enteral feedings should be documented in the Input and Output (I & O) area in the medical record.
- Electrolyte and blood glucose levels should be monitored, as ordered, for signs of imbalances.
- Daily weights are typically ordered, and weight trends should be monitored by the nurse.

◦ **Monitor for potential complications.**

- Signs of tube dislodgement into the respiratory tract include coughing, shortness of breath, adventitious lung sounds, or decreasing oxygen saturation levels.

- Signs of esophageal perforation include neck or chest pain, dysphagia, dyspnea, subcutaneous emphysema, or hematemesis.

Life Span Considerations

When caring for older adults or children with NG tubes, there are additional factors to consider. For example, if the client wears dentures, remove them for the client's safety and comfort prior to inserting the NG tube.

For pediatric clients, irrigation of an NG tube requires a smaller fluid volume. Check agency policy, but typically the flushing volume is 2 to 5 mL in pediatric patients and 1 mL or less of water in neonates. For neonates, care should be taken to use the appropriate size and type of NG tube to prevent injury to the delicate nasal and gastrointestinal tissues.[4]

Delegation and Collaboration

The task of inserting and maintaining an NG tube cannot be delegated to unlicensed assistive personnel (UAP). However, the nurse can delegate the following actions to UAP under appropriate supervision:

- Measuring and recording drainage
- Providing oral and nasal hygiene
- Anchoring the NG tube to the client's gown during routine care to prevent displacement
- Immediately reporting to the nurse any signs of redness or irritation of the nares

Removal of NG Tube

See "Checklist: Remove an NG Tube" for procedural steps of removing an NG tube.

4. Institute of Safe Medication Practices. (2022). *Preventing errors when preparing and administering medications via enteral feeding tubes*. https://www.ismp.org/resources/preventing-errors-when-preparing-and-administering-medications-enteral-feeding-tubes.

Note that accidental removal of an NG tube is not a medical emergency. If accidental removal occurs, assess the client and notify the provider.

5.4 Checklist: Insert a Nasogastric Tube

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Insert a Nasogastric Tube[1,2]

Preparation Before Procedure

The following steps should be taken in preparation for the procedure[3]:

- The indication for the procedure, potential complications, and alternative to treatment should be explained to the client by the provider. If an informed consent form is required by agency policy, the nurse should ensure the informed consent form has been signed and is present in the client's medical record.
- Review the client's medical record for conditions that may contraindicate insertion of an NG tube (e.g., facial trauma or fractures, deviated or swollen nasal septum).
- If the nasogastric tube is to be connected to suction, attach the NG tube to the suction tubing and suction container before placement of the tube to minimize the risk of spillage of gastric contents.
- Perform a thorough gastrointestinal (GI) assessment.
- Gather and prepare equipment. All supplies should be close at hand to minimize unnecessary movement during the procedure. *Note: Topical use of local anesthetics such as lidocaine has not been shown to be useful for NG insertion, but the evidence does show that nebulized lidocaine relieves discomfort and allows for an increased chance of NG tube placement.
- Gather the necessary supplies:
    - Nasogastric tube per provider order
    - Antireflux valve
    - Stethoscope
    - Pulse oximeter

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com
3. This work is a derivative of StatPearls by Sigmon and An and is licensed under CC BY 4.0

    - Hypoallergenic tape or agency approved securement device
    - Cup of water and straw
    - Clean gloves
    - Suction equipment (if prescribed by provider)
    - Penlight
    - Tongue blade
    - Water-based lubricant
    - Oral hygiene supplies
    - Fluid-impermeable drape or towel
- Explain the procedure to the client and family members (if appropriate) according to their individual communication and learning needs. Assess client anxiety regarding insertion of the tube. Answer any questions and provide emotional support as necessary.

Procedure

- Verify the provider's orders for tube insertion and associated premedications.
- Perform hand hygiene.
- Confirm the client's identity using at least two patient identifiers and check allergies.
- Provide privacy.
- Assess the rigidity of the tube. If you need to increase the tube's flexibility to ease insertion, coil it around gloved fingers for a few seconds or dip it in warm water. If the tube is too flaccid, stiffen it by filling the tube with water and then freezing it or dipping the tube in ice water.
- Advise the client they may feel some discomfort as the tube moves through the nose but that the tube will be lubricated to ease its passage. Topical anesthetic and nasal vasoconstricting medications may be administered, as prescribed.
- Explain to the client they will be given water to sip once the tube reaches the pharynx. The swallowing action will facilitate passage of the tube and minimize the natural tendency to gag.
- Ask the client to identify a signal they will use to communicate with you if it is necessary to stop briefly during the insertion, such as raising their

hand.

- Raise the bed to waist level.
- Perform a focused gastrointestinal assessment.
- Because the dominant hand will be used to insert the tube, stand on the client's right side if right-handed or on the client's left side if left-handed.
- Position the client (in high Fowler's position) with the head of the bed elevated at least 30 degrees; if this position is contraindicated, consider the reverse Trendelenburg position. Assist the client in positioning their head in a neutral position, neither tilted forward nor backward.
- Perform hand hygiene.
- Put on nonsterile gloves and other personal protective equipment as indicated.
- Assess the client's nares to determine the best choice for insertion. Use a penlight to visualize nares as needed.
- Estimate the insertion length of the tube by measuring from the tip of the nose to the earlobe to the sternal notch of the xiphoid process. Mark this estimated exit point on the tube with a piece of tape or permanent marker.
- Drape a fluid-impermeable pad or towel over the client's chest. Place an emesis basin within reach because the client may gag or vomit during the procedure.
- Lubricate the proximal tip of the tube about 2 to 3 inches with water-soluble lubricant.
- Encourage the client to hold their head upright. You may wish to support the client's head with your nondominant hand while inserting the NG tube.
- Grasp the end of the tube with the distal end pointing downward, curve it if necessary, and carefully insert it into the most patent nare.
- Guide the tube at an angle parallel to the floor of the nasal canal and then gently downward as the tube advances through the nasal passage toward the distal pharynx.
- If resistance is met, try to gently rotate the tip until it advances past the nasal passage. If continued resistance is met, don't force the tube. Instead, withdraw the tube and allow the client to rest, relubricate the

tube, and retry or insert the tube in the other nare.

- After the tube reaches the oropharynx, have the client flex their head forward and tuck their chin down. Encourage them to sip water through a straw as you slowly advance the tube (unless contraindicated).
- As the tube is advanced, monitor the client for cues that might indicate that the tube entered the respiratory tract or the tube kinked or coiled in the oral cavity. If the client appears cyanotic or begins coughing severely during advancement of the tube, pull the NG tube backwards until normal breathing resumes. Severe coughing during tube insertion can indicate inadvertent placement in the trachea or bronchi. Reattempt advancement of the tube after the client begins breathing normally. However, never advance the NG tube against resistance because perforation may occur.
- Continue to advance the tube to the predetermined measured length.
- Following insertion, clean any excess lubricant from the client's skin.
- Secure the NG tube to the client's nose using a securement device, tape, or semipermeable transparent dressing. When securing the NG tube, use care to avoid applying undue pressure to tissue to reduce the risk of pressure injuries.
- Position the NG tube so the distal end is facing upwards and secure it to the client's gown according to agency policy. If using a rubber band, place it over the NG tube. Wrap one end of the rubber band behind the NG tube and up through the open half of the rubber band and then continue to pull the end so that the band is tightened around the tube. Use a safety pin to attach the rubber band and NG tube to the client's gown.
- Remove and discard the fluid-impermeable pad or towel.
- Discard used supplies in the appropriate receptacle.
- Remove and discard gloves and any personal protective equipment worn.
- Perform hand hygiene.
- Follow agency policy to verify correct placement of the NG tube. Do not instill anything through the NG tube or connect it to suction until correct placement has been confirmed.
- After correct placement is verified, document the length of the tube where it exits the nare. If a stylet is present, remove it at this point. Turn on

suction, if ordered, to intermittent or continuous suction and typically set it to 30 to 40 mmHg. Ensure the suctioning equipment is working properly.
- Provide oral care, discard any used supplies, and then perform hand hygiene.
- Keep the head of the bed elevated at least 30 degrees.
- In an inpatient setting, help the patient into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the patient knows how to use the call light to summon assistance. To ensure the patient's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Assess the client's status and comfort level; reposition as necessary.
- Update the client's plan of care, as appropriate.
- Perform hand hygiene.
- Document the procedure.

Documentation Cues:

- Pre-procedure assessments
- Type and size of tube placed
- Location of the distal tip of the tube (external measured length of the tube)
- Client's tolerance of the procedure
- Confirmation of the tube's position by X-ray examination
- Any unexpected outcome and related nursing interventions performed
- Pain assessment and management

View a YouTube video[4] showing an instructor demonstration of this skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=392#oembed-1

4. Chippewa Valley Technical College. (2023, January 5). *Inserting a nasogastric tube* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/_QA5lpxdbBQ

5.5 Checklist: Remove an NG Tube

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Remove an NG Tube[1,2]

Note: An NG tube should be removed if it is no longer required. The removal process is typically quick. Prior to removing an NG tube, verify the provider's orders for removal. If the NG tube was ordered to remove gastric content, the provider's order may include a "trial" clamping of the tube for a specified number of hours to verify the client can tolerate its removal. During the trial, the client should not experience any nausea, vomiting, or abdominal distension.[3]

- Verify the provider's orders to remove the NG tube.
- Gather the necessary supplies:
  - Fluid-impermeable pads
  - 20-60 mL syringe
  - Nonsterile gloves
  - Stethoscope
  - Oral hygiene supplies
  - Tissues
  - Garbage bag
- Verify the client using two patient identifiers.
- Explain the procedure to the client.
- Place the client in high Fowler's position.
- Perform hand hygiene.
- Assess the client's gastrointestinal function prior to removing the NG tube.
- Place a fluid impermeable pad on the client's chest.
- Disconnect the tube from feeding and suctioning if present.

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com
3. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0

- Remove the tape or securement device from the nose.
- Unclip the NG tube from the client's gown.
- Verify tube placement and then clear the NG tube by inserting 10 to 20 mL of air into the tube to prevent aspiration of any remaining gastric contents.
- Instruct the client to take a deep breath and hold it.
    - Holding one's breath closes the epiglottis and prevents aspiration.
- Kink the NG tube near the nare and gently pull out the tube in a swift, steady motion, wrapping it in your hand as it is being pulled out. Inspect the tube for intactness. Dispose of the tube in the garbage bag.
    - Kinking the tubing prevents any residual gastric contents from flowing out of the tube upon removal.
- Offer tissue and/or clean the nares for the client.
- Offer oral care for client comfort and to prevent transmission of microorganisms.
- Discard used supplies, remove gloves, and perform hand hygiene.
- In an inpatient setting, help the patient into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the patient knows how to use the call light to summon assistance. To ensure the patient's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Perform hand hygiene.
- Document the procedure and assessments.
- After tube removal, continue to monitor the client for signs of gastrointestinal (GI) dysfunction, including nausea, vomiting, abdominal distention or discomfort, and food intolerance. Notify the provider of GI dysfunction because reinsertion of the NG tube may be required.

Documentation Cues:

- Client's GI assessment and status before tube removal
- Date and time of NG tube removal; the color, consistency, and any amount of gastric drainage

- Visual inspection and intactness of the tube upon removal
- Client tolerance of the procedure
- Client and family (if applicable) education, their understanding of that teaching, and any need for follow-up teaching.
- Any type of unexpected outcome and the interventions performed

View a YouTube video[4] showing an instructor demonstration of this skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=394#oembed-1

4. Chippewa Valley Technical College. (2023, January 5). *Removing a nasogastric tube* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/BYM1nOdIzoM

5.6 Documentation

Sample Documentation:

11/17/20XX 1030

The NG tube insertion procedure was explained to the client. Prior to the NG tube insertion, hypoactive bowel sounds were present in all 4 quadrants, and the abdomen was slightly distended with no tenderness noted upon palpation. Client reported nausea and bloating. A 14 French, Salem NG tube was inserted via the left nostril at 1008 on 11/17/20XX. Placement was verified by X-ray and then the NG tube was attached to low intermittent suction as ordered. Tube was secured to the nose with exit point at 53 cm. Gastric drainage was pale green with pH of 4. Client tolerated the procedure without complication and reports decreased nausea. Client is resting comfortably in bed with no complaints of pain.

Jaimie Salvator, RN

Exercises

(Answers to the exercises are located in the Answer Key at the back of the book).

Case Study #1

Caroline, age 92, visits her health care provider for a follow-up visit with her son Brian. You take Caroline's vitals prior to the visit and find her to be hypotensive and bradycardic. She is slow to respond to questions, and Brian answers most of the questions you have for her. Brian says, "I'm worried about mom; that's why I asked for this appointment. I haven't seen her since Christmas two weeks ago, but she looks as if she has withered away to nothing in that time."

You note that since her last visit six months ago, she has had a 20-pound weight loss, and her BMI today is 16.2. Caroline lives alone in an apartment in an assisted living facility; her husband passed five years ago. Brian is her only child.

Brian states, "I thought she was doing so well. I haven't been told that she wasn't eating, but when I visited yesterday, she refused to eat any lunch or dinner, and only ate a half piece of toast at breakfast."

When you ask Caroline how she's feeling, she says, "I just don't feel like eating anymore. I know that I'm healthy, but my appetite is not there. I'm not ready to give up." She smiles, "I'm still a feisty 92 years young."

Caroline's health care provider admits her to the hospital to start NG tube feedings.

1. What can you provide for client education regarding the NG tube?

2. What are the maintenance care priorities for care of the NG tube?

3. Are there any specific concerns related to Caroline's need for an NG tube that should be monitored or addressed? What will you consider as you prepare for placement of the NG tube?

4. What is the purpose of the NG tube?

5. How often should an NG tube be assessed?

6. What cues would indicate further assessment of the NG tube and the client?

7. What type of technique is used to insert the NG tube?

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https://wtcs.pressbooks.pub/nursingadvancedskills/?p=399#h5p-13

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https://wtcs.pressbooks.pub/nursingadvancedskills/?p=399#h5p-14

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=399#h5p-15

Test your knowledge using a NCLEX Next Generation-style question. You may reset and resubmit your answers to this question an unlimited number of times.

V Glossary

Anastomosis: A surgical connection between parts of the intestine.

Bowel obstruction: A mechanical blockage of intestinal contents by a mass, adhesion, hernia, impacted stool, or other physical blockage such as volvulus (i.e., twisting of the stomach or intestine) or intussusception (i.e., one segment of intestine telescopes inside another). Bowel obstructions block the normal passage of bodily fluids such as salivary, gastric, hepatobiliary, and enteric secretions, causing the fluids to build up, resulting in abdominal distension, pain, and nausea.

Enteral tubes: Tubes placed in the gastrointestinal tract.

Ileus: A nonmechanical decrease or stoppage of the flow of intestinal contents that is often an unavoidable consequence of abdominal or retroperitoneal surgery.

Nasogastric (NG) tube: A flexible plastic tube inserted through a nostril, down the posterior oropharynx, and into the stomach or the upper portion of the small intestine. It is typically used for decompression of the stomach for clients with an intestinal obstruction or ileus or for administration of nutrition or medication to clients who are unable to tolerate oral intake.

Stomach decompression: A medical term that refers to removing stomach contents by using suctioning. Stomach decompression is commonly used after surgery or trauma to reduce pressure from the buildup of fluids and gas that cause pain, nausea, and vomiting and can lead to potential aspiration of stomach contents into the lungs.

PART VI

CHAPTER 6 MANAGE CHEST TUBE DRAINAGE SYSTEMS

6.1 Introduction

Learning Objectives

- Describe the physiology of breathing and the importance of negative pressure
- Identify indications for chest tube placement
- Differentiate the basic compartments of a chest tube drainage system
- Describe the safety principles essential for chest tube maintenance
- Prioritize methods for troubleshooting chest tube drainage systems
- Outline nursing assessments related to caring for a client with a chest tube
- Prioritize the nursing interventions when caring for a client with a chest tube
- Use clinical judgment to prevent, assess, manage, and document complications related to chest tubes

A **chest tube** is a catheter inserted into the pleural space in the chest cavity (also referred to as the thoracic cavity or thorax) to remove air, blood, and/or fluids. Chest tubes are inserted for a variety of reasons, ranging from emergent placement to routine use after cardiopulmonary surgery. Chest tubes are also often used to re-expand collapsed lungs by returning a negative pressure state within the chest cavity. The physiology of negative pressure is discussed in the “Basic Concepts” section of this chapter.

Safe management of patients with chest tube drainage systems requires an active role by the nurse. Nurses must comprehend the principles of

intrathoracic negative pressure, understand the reason a chest tube is indicated for a specific patient, and be knowledgeable of potential problems and/or complications that may occur. This chapter will review the principles of intrathoracic pressure, the indications for chest tubes, and the safe management of patients with chest tube drainage systems.

Review of Anatomy and Physiology

The lungs sit to the left and right of the heart within a space called the thoracic cavity. The cavity is protected by the rib cage. A sheet of muscle called the diaphragm sits at the bottom of the thoracic cavity and separates it from the abdominal cavity. For this reason, the thoracic cavity is a closed space with its own intrathoracic pressure.[1]

There are two membranes in the thoracic cavity. The visceral pleura membrane covers the outside of the lungs, and the parietal pleura membrane lines the interior chest wall. The space between these two membranes is called the pleural space (also referred to as the pleural cavity). The **pleural space** normally contains between 10 to 20 mL of pleural fluid that provides lubrication as the pleura continuously slide against each other during inspiration and expiration.[2] See Figure 6.1[3] for an illustration of the pleural cavity (i.e., pleural space).

1. A.D.A.M. Medical Encyclopedia [Internet]. Atlanta (GA): A.D.A.M., Inc.; c1997-2022. Breathing; [updated 2021, February 12]. https://medlineplus.gov/ency/anatomyvideos/000018.htm#:~:text=The%20second%20phase%20is%20called,and%20air%20is%20forced%20out
2. Merkle, A. (2022). *Care of a chest tube*. StatPearls. https://www.statpearls.com/ArticleLibrary/viewarticle/41781
3. "2313_The_Lung_Pleurea.jpg" by OpenStax College is licensed under CC BY 3.0

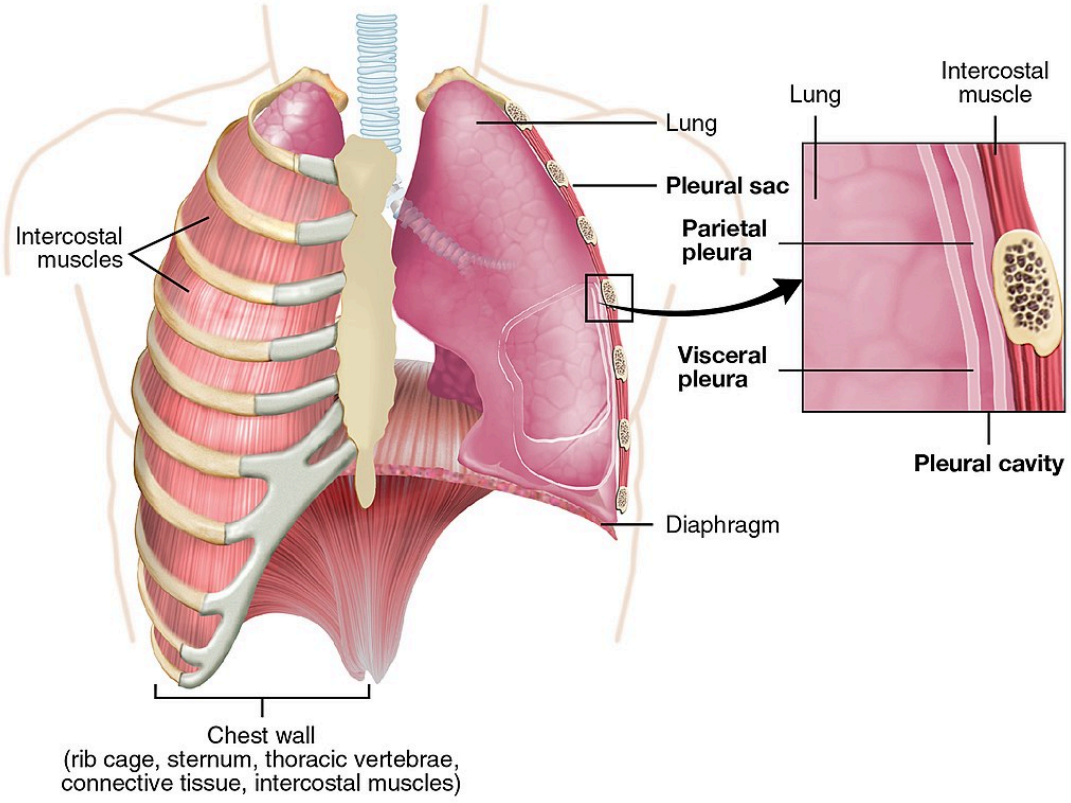

Figure 6.1 The Pleural Cavity

The process of breathing, known as ventilation, is divided into two distinct phases called inspiration and expiration. During inspiration (also called inhalation), the diaphragm contracts and pulls downward while the intercostal muscles between the ribs pull upward. This movement increases the size of the thoracic cavity, thus decreasing the intrathoracic pressure. This change in pressure on inspiration is referred to as **negative pressure**. As a result, pressure is lower inside the thoracic cavity than atmospheric pressure, creating a vacuum effect that causes air to rush into the lungs on inspiration.[4]

During expiration (also called exhalation), the diaphragm relaxes, and the volume of the thoracic cavity decreases as the chest recoils. As a result, the intrathoracic pressure increases and becomes higher than atmospheric pressure, causing air to be forced out or the lungs.

4. A.D.A.M. Medical Encyclopedia [Internet]. Atlanta (GA): A.D.A.M., Inc.; c1997-2022. Breathing; [updated 2021, February 12]. https://medlineplus.gov/ency/anatomyvideos/000018.htm#:~:text=The%20second%20phase%20is%20called,and%20air%20is%20forced%20out

View the following supplementary Medline Plus video[5] reviewing the physiology of breathing: *Breathing*

Pleural Disorders and Indications for Chest Tubes

An injury, inflammation, or infection can cause blood, fluid, or air to build up in the pleural space. The buildup of air or fluid can put pressure on the lung and cause all or part of it to collapse. Chest pain, shortness of breath, and coughing are common symptoms of pleural disorders, but the treatment for pleural disorders varies depending on the type of disorder and its seriousness. If left untreated, pleural disorders can lead to serious problems, including complete collapse of the lung, shock, or sepsis.[6]

When a lung collapses due to leaked air into the pleural space, it is called a **pneumothorax**, and when it collapses due to blood in the pleural space, it is called a **hemothorax**.[7] See Figure 6.2[8] for an illustration of a pneumothorax.

5. A.D.A.M. Inc. (2021, February 2). *Breathing* [Video]. Medline Plus. All rights reserved. https://medlineplus.gov/ency/anatomyvideos/000018.htm#:~:text=The%20second%20phase%20is%20called,and%20air%20is%20forced%20out
6. National Heart, Lung, and Blood Institute. (2022, March 24). *What are pleural disorders?* U.S. Department of Health & Human Services. https://www.nhlbi.nih.gov/health/pleural-disorders
7. National Heart, Lung, and Blood Institute. (2022, March 24). *What are pleural disorders?* U.S. Department of Health & Human Services. https://www.nhlbi.nih.gov/health/pleural-disorders
8. "Blausen_0742_Pneumothorax.png" by Blausen.com staff (2014) at Medical gallery of Blausen Medical 2014 is licensed under CC BY 3.0

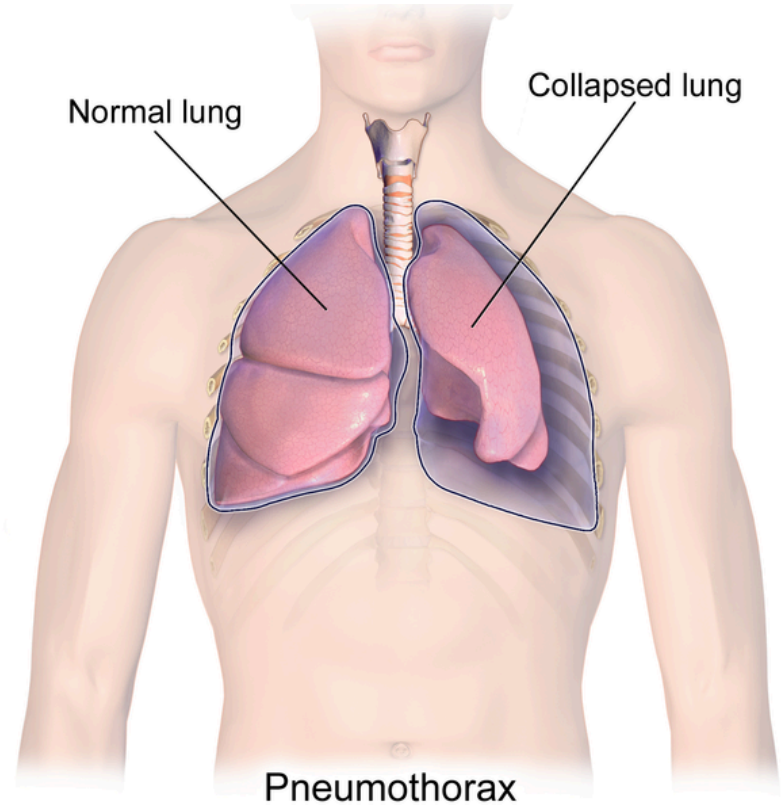

Figure 6.2 Pneumothorax

There are different types of a pneumothorax: spontaneous pneumothorax, traumatic pneumothorax, and tension pneumothorax. A **spontaneous pneumothorax** can happen suddenly without any known cause. It can also be caused by medical conditions that affect the lungs, such as chronic obstructive pulmonary disease (COPD). A **traumatic pneumothorax** is caused by a chest injury, such as a bullet wound that pierces the pleural membranes, causing air to rush into the thoracic cavity.

Tension pneumothorax is a medical emergency caused by large pneumothorax that impacts cardiovascular functioning. The increasing thoracic pressure interferes with blood flow through the inferior vena cava, superior vena cava, and right chambers of the heart, causing the patient's cardiac output and blood pressure to significantly drop. Due to increasing thoracic pressure, a tension pneumothorax causes the patient's trachea to shift to the unaffected side.[9]

9. National Heart, Lung, and Blood Institute. (2022, March 24). *What are pleural disorders?* U.S. Department of Health & Human Services. https://www.nhlbi.nih.gov/health/pleural-disorders

Other conditions that may require the placement of a chest tube include the following:

- **Pleural effusion**: Accumulation of fluid in the pleural space, often due to a medical condition such as cancer or heart, kidney, or liver failure
- **Chylothorax**: A collection of lymph in the pleural space
- **Empyema**: A pyogenic infection (pus) of the pleural space
- **Hydrothorax**: Accumulation of serous fluid in the pleural space

Chest tubes are indicated for these pleural disorders to remove air and/or fluid from the pleural space, reestablish negative pressure, and allow the lung to re-expand.

Chest Tube Placement Location

A chest tube is a sterile catheter that is inserted into the pleural space with small drainage holes at the proximal end of the tube to allow for drainage of air or fluid. See Figure 6.3[10] for an image of the proximal end of the chest tube that is inserted into the patient's pleural space.

10. "Chest_Tube_Drainage_Holes.jpg" by Bentplate84 is licensed under CC BY-SA 3.0

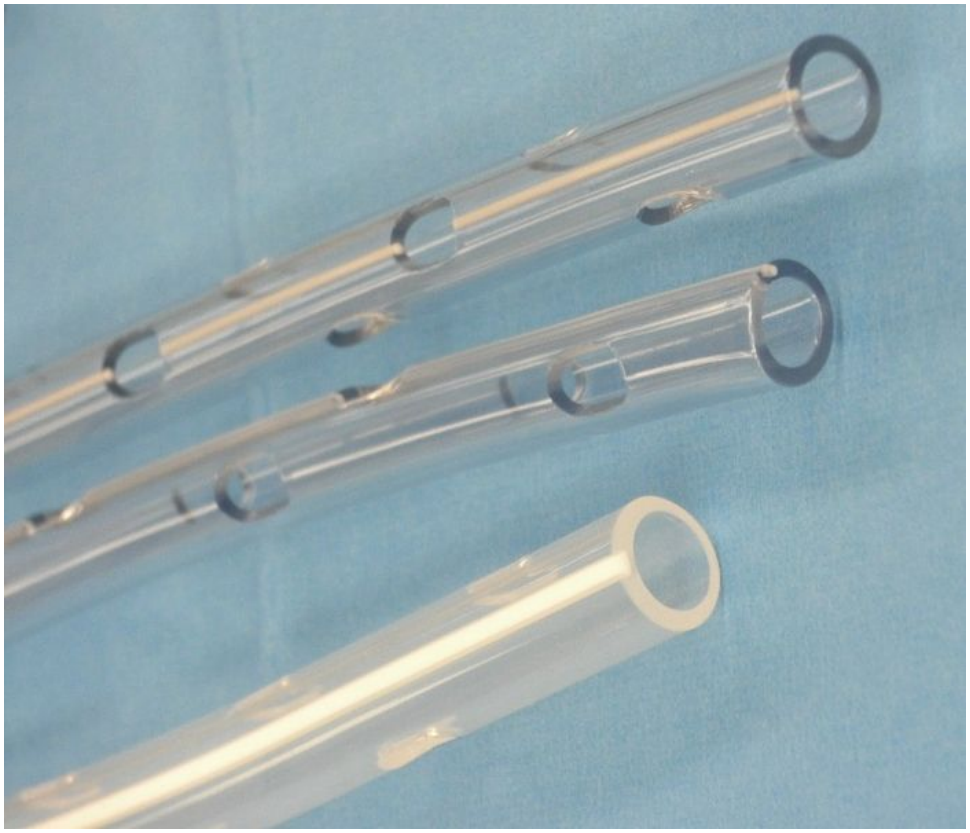

Figure 6.3 Chest Tube

The distal end of the chest tube is connected to a closed drainage system. See Figure 6.4[11] for an image of a closed chest tube drainage system connected to a mannikin. The closed system drains air and fluid from the patient's pleural space and prevents air or fluid from entering the pleural space. It is airtight and helps restore negative pressure in the thoracic cavity.[12] The chest tube drainage system must be maintained in an upright position below the patient's chest to facilitate drainage. It should be placed on a non-movable surface or hung on the bed to prevent accidental dislodgment.

11. "Book-pictures-2015-687-001.jpg" by British Columbia Institute of Technology (BCIT) is licensed under CC BY 4.0. Access for free at https://opentextbc.ca/clinicalskills/chapter/10-7-chest-drainage-systems/
12. This work is a derivative of StatPearls by Ravi & McKnight and is licensed under CC BY 4.0

Figure 6.4 Closed Chest Tube Drainage System

The location where the chest tube is inserted in the patient's chest is based on the medical condition and the contents that need to be drained from the pleural space. For example, if a patient has a pneumothorax and air needs to be removed from the pleural space, the chest tube is placed higher within the thoracic cavity because air rises. It is typically placed in the second or third intercostal space of the anterior chest. As the air is removed from the patient's pleural space, it disperses into the atmosphere, so there is little or no drainage collecting in the drainage system.[13]

Conversely, if fluid must be removed from the pleural space, it tends to settle in the lower portion of the lung cavity due to gravity. For this reason, chest tubes are often inserted in the lower posterior or lateral chest to drain blood and fluid. Suction is often applied to help promote the removal of the fluid. See Figure 6.5[14] for an illustration of common chest tube placement sites.

13. This work is a derivative of StatPearls by Ravi & McKnight and is licensed under CC BY 4.0
14. "Common-insertion-site-of-chest-tube-for-air-and-fluid" by unknown author is licensed under CC BY-NC-ND 4.0. Access for free at https://www.researchgate.net/figure/Common-insertion-site-of-chest-tube-for-air-and-fluid_fig2_279737006

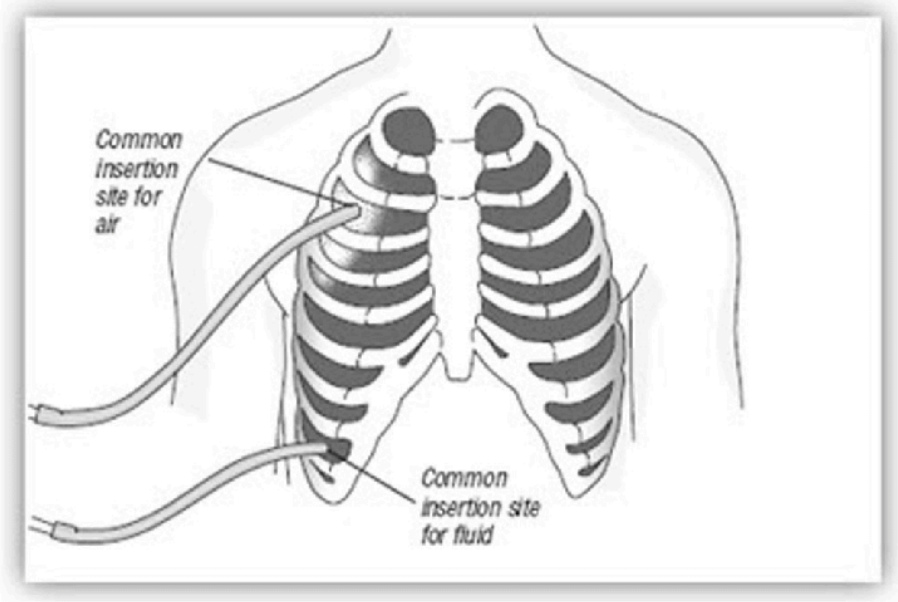

Figure 6.5 Common Chest Tubes Placement Sites

Chest tubes are also routinely placed postoperatively after cardiac surgery to eliminate mediastinal blood. They are typically placed through incisions near the inferior aspect of the sternotomy incision.

Chest Tube Drainage System Chambers

There is a wide range of chest tube drainage system models that have evolved over time with new technology. However, the basic design principles of these systems are the same: to prevent air from entering the pleural cavity during the various phases of the respiratory cycle and to allow for continuous drainage of air and/or fluid from the pleural cavity. To ensure successful and safe treatment of patients with chest tubes, nurses must have a good understanding of the functioning of the specific models of chest tube drainage systems used in their agency.[15] Always follow agency policy and manufacturer's directions for setup, monitoring, and use.

In general, traditional chest tube drainage systems have three chambers[16]:

- **Collection chamber:** The chest tube exits the incision from the patient's

15. "Chest Drainage Systems in Use" by Zisis, et al. is licensed under CC BY-NC-ND 4.0
16. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0

chest wall and connects directly to the collection chamber to collect drainage from the pleural space. The collection chamber is calibrated so that drainage can be directly measured in the device. The outer surface of the chamber has a surface that can be written on to document the date, time, and amount of fluid collected. This chamber is typically on the far right side of the system.[17]

- **Water seal chamber:** The water seal chamber has a one-way valve that allows air to exit the patient's pleural cavity during exhalation but does not allow it to reenter during inhalation. The water seal chamber is filled with sterile water and maintained at the 2 cm mark to ensure proper operation. This level should be checked regularly and filled with additional sterile water as needed. The water in the water seal chamber may rise with inhalation and fall with exhalation (referred to as **tidaling**). Tidaling indicates the chest tube is patent. However, continuous bubbling in the water seal chamber may indicate an air leak. Some chest drainage systems have a feature that allows for measurements of air leaks. Read more about this feature later in this section.[18]
- **Suction control chamber:** Not all patients require suction. If a patient has suction ordered, the amount of suction should be prescribed by the provider. There are two types of suction systems that may be used, referred to as a wet suction system or a dry suction system.
    - A **wet suction system** controls suction by the level of water in the suction control chamber and is typically set at -20 cm for adults. If there is less water in this chamber, there is less suction. There should be gentle bubbling in this chamber because it is directly attached to a suction device. However, excessive bubbling can cause rapid evaporation of the water. See Figure 6.6[19] for an image of a wet suction chest tube drainage system. In this image note the drainage in the collection chamber in the right compartment labeled "D," the

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18. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0
19. "Chest_drain_-_bedside_with_fluids.jpg" by Johntex is licensed under CC BY-SA 3.0

water seal chamber in the middle compartment labeled “C,” and -20 cm of water in the suction control chamber in the left compartment labeled “A.”

- A **dry suction system** uses a regulator to adjust the amount of suction and also responds to air leaks to deliver consistent suction for the patient.[20] See Figure 6.7[21] for an image of a dry suction chest tube system. Note the collection chamber on the right, the water seal chamber in the middle, and the dry suction regulator on the left.

Figure 6.6 Wet Suction Chest Tube Drainage System

20. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0
21. “Labelled_chest_tube_drainage_system.png” by British Columbia Institute of Technology (BCIT) is licensed under CC BY-SA 4.0

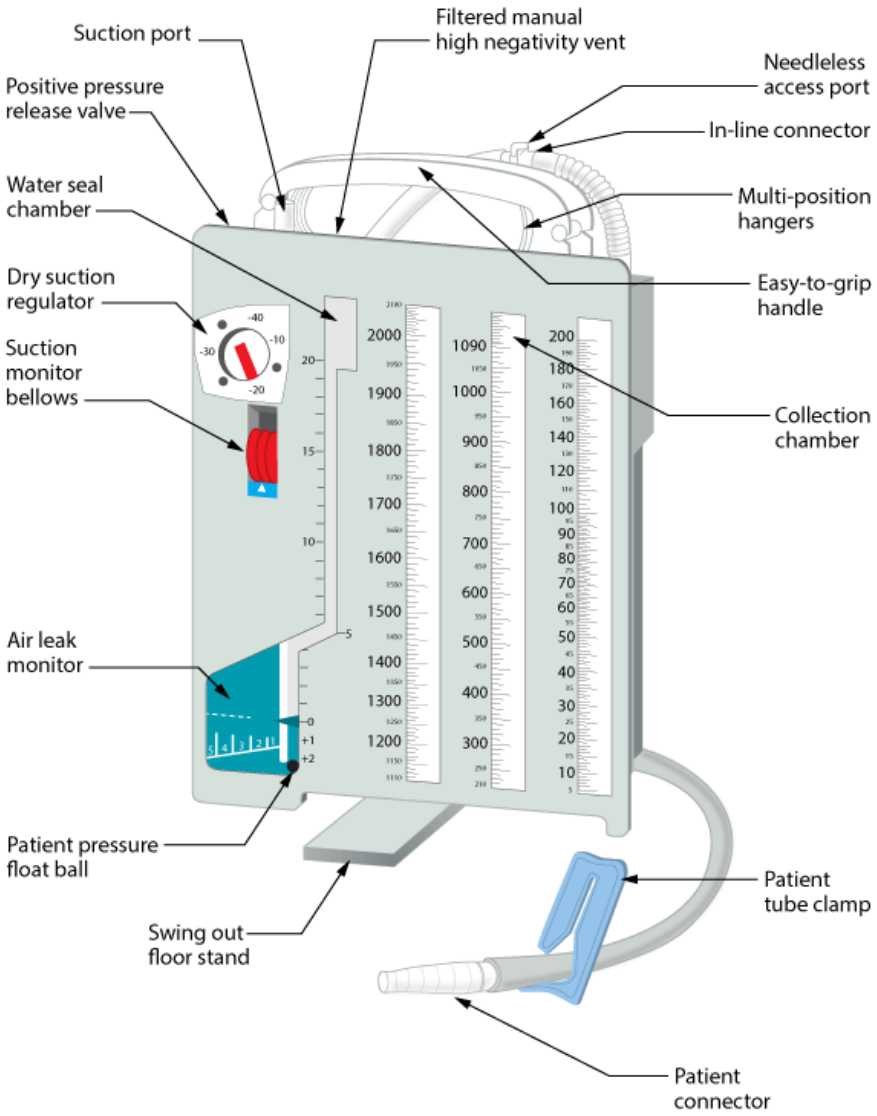

Figure 6.7 Dry Suction Chest Tube Drainage System

Air Leak Monitor

Chest tube drainage systems may include many safety features. For example, an air leak in the water seal chamber can indicate that air is reentering the patient's pleural space, which can indicate worsening of a pneumothorax. Some chest tube drainage systems contain a feature in the water seal chamber that facilitates the measurement of the degree of an air leak from the chest cavity. See Figure 6.8[22] for an image of an air leak meter. The meter is made up of numbered columns, labeled from 1 (low) to 5 (high). The higher

22. "atm-03-03-43-f2.jpg" by Charalambos Zisis, et al. for Annuals of Translational Medicine is used under Fair Use. Access for free at 10.3978/j.issn.2305-5839.2015.02.09

the numbered column through which bubbling occurs, the greater the degree of air leak. By documenting the numbered column through which bubbling is occurring, the nurse can monitor the increase or decrease of the air leak.

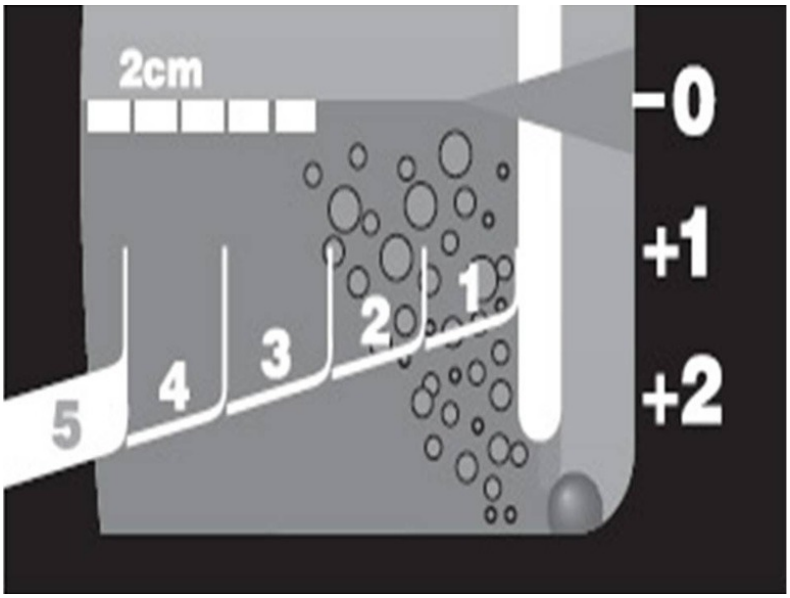

Figure 6.8 Air Leak Meter in the Water Seal Chamber. Used under Fair Use.

There are many different types and manufacturers of chest tube drainage systems. View a supplementary chest drain education video[23] by Gentinge that demonstrates the various components of their dry suction water seal chest drain: *Express Dry Suction Dry Seal Chest Drain.*

HEIMLICH VALVE

A Heimlich valve is an alternative to a chest tube drainage system. It is a small,

23. Gentinge. (n.d.) *Express dry suction dry seal chest drain* [Video]. Getinge. All rights reserved. https://www2.getinge.com/us/education/chest-drain-education/#

specially designed flutter valve that is portable and mobile, allowing a patient with a chest tube to ambulate with ease. The valve functions in any position, never needs to be clamped, and can be hooked up to suction if required. It can also be worn under clothing.[24] See Figure 6.9[25] for an image of a Heimlich valve.

Figure 6.9 Heimlich Valve

The blue end of the Heimlich valve attaches to the chest tube inserted into the patient's chest wall, and the other end can be left open to air or attached to a drainage bag. Air enters the inlet nozzle from the patient's pleural space and opens a rubber sleeve inside the Heimlich valve. The sleeve collapses near the inlet nozzle, preventing the backflow of air into the patient, and then reopens at the outlet nozzle and allows air to escape.[26] See Figure 6.10[27] for a visual demonstration of how the Heimlich valve works.

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25. "Book-pictures-2015-688.jpg" by unknown author is licensed under CC BY 4.0. Access for free at https://opentextbc.ca/clinicalskills/chapter/10-7-chest-drainage-systems/
26. This work is a derivative of Clinical Procedures for Safer Patient Care by British Columbia Institute of Technology and is licensed under CC BY 4.0
27. "Heimlich_valve.GIF" by Orinoco-w is licensed under CC BY-SA 3.0

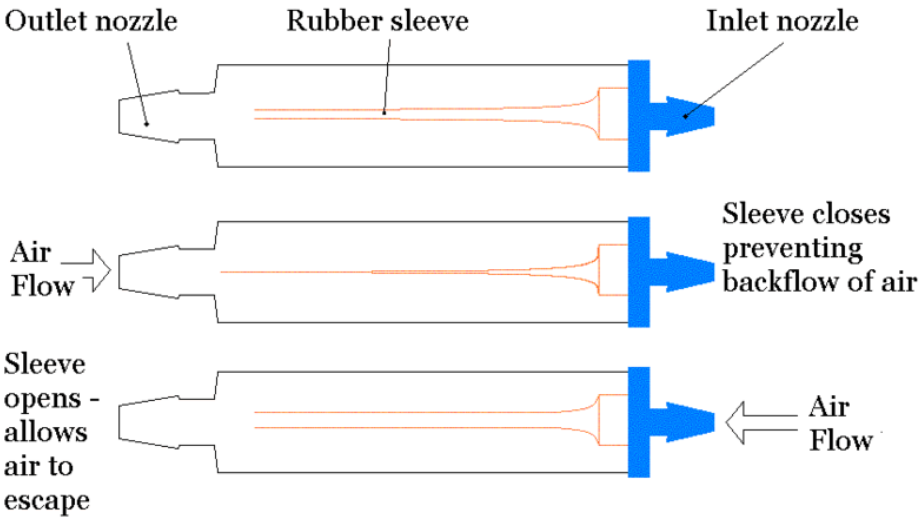

Figure 6.10 Heimlich Valve

6.3 Nursing Responsibilities for Clients With Chest Tube Drainage Systems

There are several nursing responsibilities related to caring for clients with chest tube drainage systems. Some assessments and interventions should occur at the start of the shift to ensure the client is stable and the chest tube drainage system is functioning appropriately, whereas other interventions and monitoring occur throughout the shift.

Assessments and Interventions at the Start of Shift

- Verify the provider's current orders regarding chest tube setting and care. Note the level of suction prescribed, if ordered, and verify the current wall suction setting.
- Obtain and document baseline vital signs (including oxygen saturation) and perform a focused respiratory assessment, including auscultation of lung sounds, current level of dyspnea, and trachea alignment. Gathering baseline data is important because changes that occur during the shift can indicate a malfunction in the chest tube drainage system and/or a change in patient condition.
- Continually monitor vital signs closely, watching for trends and changes in respiratory rate, oxygen saturation, and blood pressure that could indicate complications are occurring, such as a pneumothorax.
- Obtain a baseline pain assessment, especially regarding the chest tube insertion site. Based on findings, reposition the client, use other nonpharmacological interventions, and/or administer pain medications as prescribed.
- Assess the dressing over the chest tube insertion site to ensure it is dry and intact. Based on agency policy and provider orders, change soiled dressings or reinforce loose dressings.
- Assess the condition of the skin surrounding the insertion site for signs of infection (redness or purulent drainage) or bleeding. Palpate the area surrounding the dressing for **crepitus** (i.e., puffiness or crackling that indicates **subcutaneous emphysema**, the leakage of air into the subcutaneous tissues surrounding the insertion site).

- Assess the chest tube drainage system:
    - Ensure the system is upright and maintained below the client's chest to prevent fluid from flowing back into the client's chest. Some drainage systems have floor stands to prevent the unit from tipping over; if floor stands are present, ensure they are pulled out and perpendicular to the unit. If a stopcock is attached, ensure it is positioned to allow for drainage into the drainage system.
    - Ensure the tubing is not kinked so clots do not form. Any drainage present should be flowing freely into the collection chamber. However, do not "strip" the tubing (i.e., occlude the chest tube with one hand while quickly squeezing and moving the other hand down the tube to move fluid into the drainage chamber). Doing so can cause high intraluminal pressures that can cause a life-threatening pneumothorax.
    - Ensure the system remains closed (i.e., without air leaks) by verifying all tubing connections are taped and the chest tube is securely fastened to the client's chest wall.
    - Assess and document the amount, color, and characteristics of fluid in the collection chamber. Mark the drainage level with the time and date on the outside of the collection chamber for quick future reference during your shift.
    - Ensure the water seal chamber is filled with sterile water to the 2 cm mark (or as specified by the manufacturer). Tidaling should be seen in the water seal chamber. If tidaling is not occurring, the system may not be working properly, the tubing may not be patent, or the client's lung may have re-expanded.
        - There should not be continuous bubbling in the water seal chamber because this may indicate a leak. Immediately try to identify and correct causes of external leaks, such as loose tubing connections. Check the insertion site to ensure the tube has not become dislodged. Immediately notify the health care provider if the tube has become dislodged or you cannot identify or correct an external leak because an air leak can indicate a complication is occurring, such as a worsening pneumothorax.

    - If the chest tube drainage system is a wet suction device, ensure the suction control chamber is filled with sterile water to the -20 cm level or as prescribed. There should be constant, gentle bubbling in the suction control chamber if it is connected to suction.
    - If the chest tube drainage system is a dry suction device, ensure the rotary dry suction control dial is turned to the ordered suction mark (typically -20 cm water). Refer to the manufacturer's instructions regarding suction indicators. (In some systems, a ball or float appears in an indicator window to indicate the correct amount of suction, whereas other systems have a bellows that reaches a calibrated triangular mark.)
- Verify equipment and supplies are present in the room (in the event a malfunction occurs) according to agency policy and manufacturer recommendations, such as the following:
    - Two sets of rubber-tipped clamps. Chest tubes may be momentarily clamped (according to agency policy) when replacing the chest tube drainage unit, assessing for the location of an air leak, assessing the client's tolerance of chest tube removal, and during chest tube removal. However, routine clamping of the chest tube is not recommended because of the risk of a tension pneumothorax.
    - Sterile 4" x 4" gauze pads and/or petroleum gauze and tape. For example, if air can be heard leaking from the tube insertion site on the client's chest or the chest tube inadvertently becomes dislodged from the client's chest, follow agency policy. Typically, this includes immediately taping a dressing over the insertion site on three sides to allow air to escape and prevent a tension pneumothorax while the provider is notified.
    - Small container of sterile water or saline to use to create a temporary water seal if the tubing becomes disconnected from the drainage system.
- Instruct the client to do the following:
    - Immediately report any breathing difficulty. (Note: Notify the provider immediately if the client develops rapid or shallow breathing, decreased oxygenation saturation level, cyanosis, subcutaneous

emphysema, chest pain, or excessive bleeding.)
    - Sit upright to facilitate drainage of fluid and optimal lung expansion.
    - Splint the insertion site with a pillow while coughing to minimize pain.
    - Perform coughing and deep breathing exercises and/or incentive spirometry, change position, and ambulate as ordered, to facilitate lung expansion and drain fluid from the pleural space.

Monitoring and Interventions Throughout the Shift

- Assess the client's respiratory and pain status every 2 to 4 hours (or according to agency policy). Assess lung sounds, noting decreased or absent lung sounds, which can indicate a worsening pneumothorax or hemothorax and requires immediate notification of the provider. Monitor for new or worsening subcutaneous emphysema and notify the provider if present. Provide pain management according to the client's pain management goals. Obtain emergency assistance for sudden or increased intensity of dyspnea, oxygen saturation less than 90%, or tracheal deviation.
- Monitor for changes in vital signs. If the client develops tachycardia and/or hypotension, a tension pneumothorax could be occurring if there is increased pressure within the thoracic cavity.
- Assess the integrity of the drainage system and tubing every 1 to 4 hours per agency policy. Ensure the system remains intact, the tubing is patent, and there are no air leaks.
- If the chest tube was placed to remove drainage, monitor the amount, color, and consistency of drainage in the drainage tubing and in the collection chamber. Notify the provider if any of the following occur:
    - Drainage appears cloudy because this can be a sign of infection.
    - Drainage stops within the first 24 hours after the chest tube was inserted. This may indicate the tube has become displaced internally or is clotted. (However, be aware of the indication for chest tube placement because in cases addressing a pneumothorax, there may not be any drainage because only air is being removed.)

    - Drainage averages more than 200 mL/hour for 4 hours. This may indicate vascular injury that requires surgical repair.[1]
- Periodically check that the air vent in the drainage system is working properly (if applicable). Occlusion of the air vent results in a buildup of pressure in the system that could cause the patient to develop a tension pneumothorax.
- If the client requires transport out of the room, do not clamp the tubing. Instead, disconnect the suction connector tubing from the suction source. The system will continue to collect fluid (by gravity) and/or air (by water seal). Portable suction is also available if clients have an air leak and thus cannot tolerate water seal suction or if it is ordered by the provider.
- If a specimen collection is ordered, remove fluid using a sterile needle and syringe from the self-sealing portion of the chest tube drainage tubing (or a needless syringe from the needleless site of the drainage tubing after disinfecting the collection site).
- Change the chest tube drainage system if the collection chamber becomes filled with fluid, preventing drainage from overflowing back up the drainage tube.

View a supplementary YouTube video lecture on the nursing management of chest tubes[2]:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=179#oembed-1

1. Merkle, A. (2022). *Care of a chest tube*. StatPearls. https://www.statpearls.com/ArticleLibrary/viewarticle/41781
2. RegisteredNurseRN. (2016, August 3). *Chest tubes nursing care management assessment NCLEX review drainage system* [Video]. YouTube. Used with permission. https://youtu.be/JB-CqwMyrTM

6.4 Troubleshooting Problems and Complications

Several potential problems and complications can occur when managing a client with a chest tube drainage system. Table 6.4 outlines potential problems and complications, cues to detect a problem is occurring, and associated nursing interventions.

Table 6.4 Potential Problems, Complications, Cues, and Related Interventions[1,2]

1. *Chest tube and drainage system monitoring and care*. (2022). Lippincott procedures. http://procedures.lww.com
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Problems/ Complications	Cues and Interventions
Respiratory Distress	This is a priority concern for a patient with a chest tube drainage system and can be caused by a variety of conditions. Signs and symptoms may include oxygen saturation level less than 90%, decreased breath sounds from baseline, asymmetric chest movements, hypotension, tachycardia or bradycardia, subcutaneous emphysema around insertion site or neck, tracheal deviation, or patient complaints of chest pain or increased dyspnea. • Ensure the drainage system is intact with no leaks or blockages such as kinks or clamps. • Provide oxygen as indicated. • Immediately notify the provider. An urgent chest X-ray may be ordered to assess for a displaced tube, tension pneumothorax, or other complication. • Obtain emergency assistance as indicated.

Air Leak	An air leak may be indicated by continuous or intermittent bubbling in the water seal chamber or audible air leaking from the patient's chest. To determine the source of the leak (i.e., the patient, the tubing, or the drainage device), momentarily clamp the chest tube: • Using rubber-tipped clamps, begin at the dressing site and clamp the drainage tubing momentarily. Look at the water seal chamber. If bubbling stops, the air leak is from the chest tube site or inside the client's thorax. Unclamp the tube, reinforce the dressing, and notify the health care provider immediately. • If bubbling continues after clamping the tube near the chest wall, gradually move the clamp down the tubing toward the chest drainage system approximately every 10 to 12 inches. Each time the tubing is clamped, observe the water seal chamber. If the bubbling stops, the leak is located in that area of the tubing or the surrounding connections. Replace the tubing or secure the connections. Be sure to release the clamp. • If bubbling continues despite clamping near the drainage device, the leak is in the drainage system, and it requires replacement.

Dislodged Chest Tube From the Patient	Dislodgement of the chest tube from the insertion site in the patient's chest is an emergent situation, and agency policy must be followed. In general, the following actions may be performed: • Call for assistance and ask a colleague to immediately notify the provider and/or obtain supplies while you stay with the patient. • Immediately cover the chest tube insertion site with a sterile occlusive dressing and tape it on three sides, allowing air to escape on the fourth side to reduce the risk of a tension pneumothorax. • If a client develops respiratory distress or a sudden change in vital signs, call the rapid response team. • Prepare for the reinsertion of a chest tube.
Accidental Disconnection of Tubing or the Drainage System Cracks	Call for assistance in replacing the drainage system and notifying the provider. Momentarily clamp the tube close to the insertion site on the patient's chest wall or alternatively place the distal end of the chest tube in a bottle of sterile water.
Bleeding at the Insertion Site	Bleeding may occur after insertion of the chest tube. Apply pressure to the site, reinforce the dressing, and notify the provider.
Subcutaneous Emphysema	Subcutaneous emphysema can indicate a worsening air leak in the chest cavity or a tension pneumothorax as thoracic pressure increases and forces air from the chest cavity out of the tube insertion site and into the tissues. The provider should be notified if subcutaneous emphysema is new or worsening. It may be helpful to mark the area of subcutaneous emphysema to determine if it is extending and worsening.

Drainage Stops	If drainage suddenly stops in the first 24 hours after chest tube insertion, the tubing may be clogged by a blood clot or by a fluid blockage in a dependent loop: • Assess the drainage system and the client. • Inspect for kinks and straighten the tubing along its length to its connection with the collection device. • Reposition the client in an upright position. • Ensure the drainage system is below the level of the client's chest. • If interventions are not successful, notify the health care provider.
Sudden Increase in Bright Red Drainage	An increase of bright red drainage of more than 200 mL/hour may indicate vascular injury that requires surgical repair[3]: • Obtain vital signs and assess the client's cardiopulmonary status. • Notify the health care provider and report the amount and color of drainage.
Drainage Unit Tips Over	• Position the unit upright. • Immediately check the fluid level in the water seal for correct volume and replace lost fluid. • If all chambers are contaminated with blood, consider replacing the entire unit. • To prevent future tipping, use the attached floor stand that is a part of the drainage unit. If the client is mobile, consider securing the unit to an IV pole.

Overfilled Water Seal or Suction Control Chamber	• Press and hold the negative-pressure relief valve at the top of the chest drainage system to vent excess negative pressure in the water seal chamber. Release the valve when the level of the water returns to the 2-cm mark. • To remove excess water from the suction control chamber, insert a syringe and withdraw excess.
Suction Control Chamber Not Bubbling or Bubbling Too Much	The suction control chamber should have gentle bubbling. Vigorous bubbling can indicate wall suction is set too high and can cause faster evaporation, requiring water to be added. • Ensure the suction tubing is connected and the suction source is turned on and set to the prescribed suction amount.

3. Merkle, A. (2022). *Care of a chest tube*. StatPearls. https://www.statpearls.com/ArticleLibrary/viewarticle/41781

6.5 Checklist: Manage a Closed Chest Tube Drainage System

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Manage a Closed Chest Tube Drainage System[1,2]

- Verify the provider's order regarding chest tube care and management.
- Prior to managing a client with a chest tube, review the indication for the chest tube, the location of the chest tube, recent volume of drainage and characteristics of the drainage, the date of previous dressing change, and any previously recorded air leak measurements or presence of subcutaneous emphysema. Chest tube drainage systems are replaced only when the collection chamber is full or the system is contaminated or damaged.
- Review the client's medical record for allergies to antiseptic solutions and latex.
- Gather the appropriate equipment:
    - Vital signs monitoring equipment
    - Stethoscope
    - Pulse oximeter and probe
    - Disinfectant pad
    - Facility-approved disinfectant
    - Marker
- Perform hand hygiene.
- Confirm the client's identity using at least two patient identifiers.
- Provide privacy.
- Explain the procedure to the client (and family members, if present).
- Ensure safety/emergency equipment is always at the client's bedside and with the client during transportation to other departments. Safety equipment should include the following:
    - Two rubber-tipped clamps

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com

    - Sterile water
    - Petroleum-infused gauze
    - 4” × 4” sterile dressings
    - Occlusive dressing or waterproof tape
    - Small container of sterile water or saline
    - Alcohol swabs
- Wear appropriate personal protective equipment (PPE) based on the client’s medical condition.
- Complete a focused respiratory assessment and pain assessment and analyze vital signs. Place the client in semi-Fowler’s position.
- Assess the client. Assessment should be at a minimum of every 15 minutes for the first hour immediately following chest tube insertion. Continue assessing until the client is stable according to agency policy. Increase monitoring if the client’s condition worsens.
- Ensure the chest tube drainage system is below the level of the insertion site and upright to prevent backflow of fluid from the tubing into the chest cavity. Ensure the unit is secured to prevent it from being accidentally knocked over.
- Assess the sterile dressing over the chest tube insertion site to ensure it is dry and intact. Inspect and palpate the insertion site for subcutaneous emphysema.
- Assess the chest tube drainage system to ensure the system is intact and to prevent accidental tube removal or disruption of the drainage system. Ensure tubing is not kinked or bent under the client or in the bed rails or compressed by the bed.
- Coil the drainage system tubing and secure it to the edge of the client’s bed.
- Avoid creating dependent loops, kinks, or pressure in the tubing.
- Avoid lifting the drainage system above the client’s chest.
- Ensure the prescribed suction is set at the correct level.
- If the chest tube is ordered to “water seal” (i.e., suction is not ordered), ensure the suction port is left open to air.
- Check the water seal chamber to ensure the water level is at 2 cm at least once every shift. Add sterile water as necessary.

- Assess the water seal chamber for tidaling with respirations and ensure continuous bubbling is not occurring.
- If an air leak has been previously reported, assess the air leak meter according to the chest tube drainage system's feature. Document the level of air leak, if it is constant or intermittent, or if the air leak occurs at rest or with coughing.
- Write the date, time, and amount of drainage on the outside of the collection chamber at the end of each shift and as indicated. Record the amount and characteristics of the drainage on the fluid input/output flow sheet and chart.
- Observe the integrity of the drainage system tubing and chest tube every 1 to 4 hours according to agency policy and with any change in the client's condition.
- Promote oxygenation by encouraging the client to perform frequent position changes, deep breathing and coughing exercises, incentive spirometry, and ambulation as ordered.
- Discard used supplies, remove gloves, and perform hand hygiene.
- Help the patient into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the patient knows how to use the call light to summon assistance. To ensure the patient's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Perform hand hygiene.
- Document the procedure, assessments, and interventions.

View a YouTube video[3] showing an instructor demonstration of common chest tube systems:

3. Chippewa Valley Technical College. (2023, January 5). *Managing a chest tube system* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/dDMzp3yOGjo

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=192#oembed-1

Documentation Cues:

- Date and time that chest tube drainage system was initiated
- Type of chest tube drainage system used
- Location and size of chest tube inserted
- Amount of suction applied to the pleural cavity (if applicable)
- Presence or absence of bubbling or fluctuation in the water seal chamber (if applicable)
- Teaching provided to the client and family, understanding of education, and any need for follow-up teaching

6.6 Checklist: Set Up a Chest Tube Drainage System

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Set Up a Chest Tube Drainage System[1,2]

Note: Refer to agency policy and the manufacturer's guidelines before setting up a system.

- Verify the provider's order to determine the type of drainage system to use.
- Gather the necessary equipment and supplies:
  - Single-use, disposable, sterile chest drainage collection unit (water-seal–wet-suction system, water-seal–dry-suction system, or dry-seal–dry-suction system)
  - Sterile water
  - Nonsterile gloves
  - Tape
  - Sterile dressing
  - Optional: commercial securement device, zip tie, suction source with regulator, and suction connection tubing
- Perform hand hygiene.
- Put on clean gloves.
- Maintain a sterile no-touch technique of the drainage system, including the tubing throughout the procedure.
- Remove any protective wrappers and prepare for setup. Stand the system upright. Use the floor or hangers on the unit. Attach the unit to bed frame, keeping the unit below the level of the insertion site of the chest tube.
- Add sterile water or sterile normal saline to the appropriate compartments according to the manufacturer's instructions:
  - **For a Two-chamber System Without Suction:** Add sterile fluid to the

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com

water seal chamber to the required indicated level.
    - **For a Three-chamber System With Suction:** Add sterile fluid to the water seal chamber, typically to the 2 cm mark. Add sterile fluid to the suction control chamber, typically to the -20 cm mark. Connect the tubing from the suction control chamber to the suction delivery system (wall or portable).
    - **For a Dry Suction System:** Fill the water seal chamber with sterile solution, typically to the 2 cm mark. Adjust the suction control dial for the prescribed level of suction, typically between -10 to -40 cm. Connect the tubing from the suction control chamber to the suction delivery system (wall or portable). Do not occlude the suction control chamber when suction is used. On a dry suction system, do not occlude the positive-pressure relief valve because air will escape.
- Secure all tubing connections with tape or zip ties as indicated by agency policy.
- Discard used supplies, remove gloves, and perform hand hygiene.
- Help the patient into a comfortable position and place personal items, the tray table, and the call light within easy reach. Make sure the patient knows how to use the call light to summon assistance. To ensure the patient's safety, raise the appropriate number of side rails and lower the bed to the lowest position. Ensure the bed is locked.
- Perform hand hygiene.
- Document the procedure.

Documentation Cues:

- Date and time that chest tube drainage system was initiated
- Type of chest tube drainage system used
- Location and size of chest tube inserted
- Amount of suction applied to the pleural cavity (if applicable)
- Presence or absence of bubbling or fluctuation in the water seal chamber (if applicable)
- Teaching provided to the client and family, understanding of education, and any need for follow-up teaching

6.7 Assisting With Chest Tube Placement

Nurses may assist a provider with inserting a chest tube. Table 6.7 describes how to apply the nursing process before and after the chest tube is placed.

Table 6.7 Using the Nursing Process When Assisting With Chest Tube Placement

Nursing Process Phase	Nursing Actions
Assessment	• Obtain and analyze the client's vital signs and pulse oximetry. • Complete and document a focused respiratory assessment. • Verify client allergies, particularly allergies to latex or any substance applied to the skin. • Review client medications, noting the use of NSAIDs or prescribed anticoagulants, such as aspirin, ibuprofen, or warfarin, that increase the risk for bleeding. • Review any client lab results such as hemoglobin, hematocrit, and INR (if the client is taking warfarin). • Assess the client's knowledge and understanding of the procedure. • Assess the client's need for analgesia and antianxiety medication.
Diagnosis	• Determine nursing diagnoses based on the client's condition/needs at this time, such as impaired gas exchange, ineffective breathing pattern, acute pain, or anxiety.

Outcomes Identification/Planning	There are several expected outcomes after the insertion of a chest tube, such as the following: • Stable vital signs • Optimal oxygenation status indicated by oxygen saturation level • No chest pain • Baseline levels of alertness and orientation • Reduced level of anxiety, if present • Breath sounds present in all lung lobes with symmetric lung expansion • Unlabored respirations • Chest tube correctly placed • Chest tube drainage system functioning appropriately
Interventions Post-Procedure	• The tube will be connected to the chest drainage system and may be connected to suction based on provider orders. • In the trauma setting, notify the provider if initial output is over 1500 mL or there is 200 mL/hour because this may indicate vascular injury that may require surgical repair.[1] • Assess the client's respiratory status post-procedure, including lung sounds, chest expansion, and reported dyspnea. • Monitor vital signs, including oxygen saturation level. • Assess the client's comfort level and compare to baseline. Administer pain medications as indicated. • Confirm accurate placement of the chest tube has been verified by a chest X-ray.[2] • Inspect the dressing over the chest tube insertion site to ensure it is intact. (The tube is secured to the chest wall according to institutional preference with sutures, tape, or manufactured appliance.[3])

Evaluation	• Evaluate client response with anticipated decreased dyspnea and decreased pain. • Evaluate the client's ability to cough and deep breathe to promote lung expansion. • Evaluate for proper functioning and maintenance of the chest tube drainage system. • Evaluate for evidence of lung re-expansion.

1. Merkle, A. (2022). *Care of a chest tube*. StatPearls. https://www.statpearls.com/ArticleLibrary/viewarticle/41781
2. Merkle, A. (2022). *Care of a chest tube*. StatPearls. https://www.statpearls.com/ArticleLibrary/viewarticle/41781
3. Merkle, A. (2022). *Care of a chest tube*. StatPearls. https://www.statpearls.com/ArticleLibrary/viewarticle/41781

6.8 Assisting With Chest Tube Removal

The removal of a chest tube is performed by a health care provider such as a physician, physician's assistant, or nurse practitioner.

Indications for chest tube removal include the following[1]:

- Improved respiratory status
- Symmetrical rise and fall of the chest
- Bilateral breath sounds
- Decreased chest tube drainage
- Absence of bubbling in the water seal chamber during expiration
- Improved chest X-ray findings

Nursing Responsibilities

The information below summarizes nursing responsibilities before, during, and after the procedure. Expected outcomes after completing the procedure include re-expansion of the lung, client comfort, and healing of the chest tube insertion site without complications, such as infection.

Pre-Removal

- Prepare the client for removal of the chest tube:
  - Assess the need for analgesia.
  - Obtain required medication orders.
  - Instruct the client about the chest tube removal process and inform them that they may have to take a deep breath and hold when it is removed (Valsalva maneuver) to prevent air from reentering the pleural space.

- Assess the client's lungs for re-expansion:
  - Report the most recent chest X-ray results to the health care provider.
  - Examine the trend in the water seal fluctuation over the last 24 hours.

1. Bauman, M., & Handley, C. (2011). Chest-tube care: The more you know, the easier it gets. *American Nurse Today, 6*(9), 27-32. https://www.myamericannurse.com/chest-tube-care-the-more-you-know-the-easier-it-gets-2/

    - Note if bubbling is present.
    - Confirm decrease in drainage.

- Assess the client's understanding of the chest tube removal process.
- Do not clamp the tube before the removal.
- Administer prescribed pain medication 30 minutes before the procedure, if applicable.
- Identify the client using two patient identifiers as part of the "time out" process as the procedure begins.

During the Procedure

- Assess the client's level of comfort throughout the procedure.
- Perform hand hygiene and apply PPE, including gloves and face shield if needed.
- Assist the client to a seated, supine, or side-lying position (on the side without the chest tube). Apply a protective fluid impermeable pad under the chest tube.
- Provide physical and emotional support to the client during the procedure, especially as the provider removes dressings and sutures.
- After the health care provider removes the chest tube, applies a sterile occlusive dressing, and secures it, assist the client to an upright position supported with pillows.
- Remove equipment and dispose of supplies appropriately.
- Remove gloves and perform hand hygiene.

After the Procedure

- Auscultate lung sounds.
- Inspect and palpate over the area where the tube was inserted to detect any subcutaneous emphysema.
- Evaluate for any signs of respiratory distress immediately after removal and during the first hours after it is removed. Notify the health care provider if respiratory distress occurs.
- Evaluate vital signs, including oxygen saturation, respiratory status, pain

assessment, and level of anxiety.

- Review post-removal chest X-ray and report to the health care provider.
- After removal of a chest tube drainage system, assess the client at a minimum of every 15 minutes for at least an hour, according to agency policy. After the client is stable, monitoring may be less frequent.
- Frequently monitor the chest dressing for drainage. Change the dressing as prescribed, identifying any indications of infection or nonhealing at the insertion site.

6.9 Documentation

Documentation Tips:

Documentation should include all data described in the pre, during, and post-chest tube removal areas. Record the date/time of the chest tube removal, any drainage not recorded in the collection chamber, and the appearance of the dressing and wound if possible. Note the patient's response to the procedure. Include vital signs and respiratory assessment. Document patient teaching and patient's level of understanding.

Sample Documentation:

06/27/20xx 1430

Chest tube to right lateral lower chest wall intact. Water seal chest tube drainage system in upright position and below the level of the client's chest. Tubing is free of kinks and patent. Suction is set at prescribed -20 mmHg. Tidaling present in water seal system. No air leak identified. 50 mL of serosanguineous drainage noted in collection chamber over 8 hours without clots present. Respiratory rate 18 and pulse oximetry reading 96% on room air. Respirations are symmetrical and unlabored. Breath sounds are diminished in the posterior right lower lobe. No adventitious breath sounds or subcutaneous emphysema noted. Trachea is midline. Dressing is dry and intact. Client rates pain at 2/10 and at a tolerable level. Denies sputum. Continue to encourage deep breathing and coughing hourly. Two clamps and a bottle of sterile water are at the bedside.

Hector Ramos, RN

Exercises

(Answers to the exercises are located in the Answer Key at the back of the book).

1. A client is recovering from a thoracotomy and has a right pleural chest tube to drainage. Highlight or place an “X” next to the best indicators showing the client’s condition is resolving and ready for chest tube removal.

	Indicators
	Improved respiratory status
	Asymmetrical rise and fall of the chest
	Diminished breath sounds over right lower lobe
	Decreased chest tube drainage
	Absence of bubbling in the water seal chamber during expiration
	Improved chest X-ray findings

2. Managing chest tubes and drainage systems is essential for client safety. Place an “X” next to each nursing action to indicate whether it is likely to be effective in improving the client’s condition being treated with a chest tube or if it is ineffective.

Nursing Action	Effective	Ineffective
Promote oxygenation by encouraging frequent position changes, mobilization, and deep breathing and coughing exercises.		
Coil the drainage system tubing and secure it to the edge of the client's bed.		
Place the drainage system unit on the client's waist during transport.		
Immediately apply pressure to the chest tube insertion site and apply a sterile petroleum gauze dressing if the tube dislodges.		
Perform routine stripping of the chest tube to prevent blood clots from forming.		
Assess the amount, color, and consistency of drainage in the drainage tubing and in the collection chamber at regular intervals.		

3. The nurse is assessing a patient with a chest tube placed two days ago for a pneumothorax. The system is connected to suction. Which of the following findings indicate that there may be a problem with the chest tube drainage unit?

a. There is sanguineous drainage in the collection chamber.

b. There is continuous bubbling in the water seal chamber.

c. There is vigorous bubbling in the suction chamber.

d. The water level fluctuates in the water seal chamber with respirations.

Case Study #1

Scott, a 70-year-old male, arrived in the ED with increased shortness of breath and left-sided sharp chest pain. Upon arrival, he is hypertensive, tachycardic, tachypneic, and has an O2 sat of 76%. Lung sounds are absent on the left side. Scott's wife Sarah is

concerned. “I’ve never seen him like this. What is going on?” Scott rates his pain 7/10 but has difficulty speaking.

Scott has a history of COPD and a 50-year history of smoking two packs a day; he has had two exacerbations of COPD in the past year. Rapid COVID-19 test is negative.

The following stat orders are given by the ED provider:

- Attach ECG monitoring
- Obtain a portable chest X-ray STAT
- Provide client education about chest tube insertion
- Ensure informed consent for chest tube insertion
- Insert chest tube and chest tube drainage system

1. What client education should be provided regarding the chest tube?

2. What are the maintenance care priorities for care of the chest tube?

3. Are there any specific concerns related to Scott’s need for a chest tube that should be monitored or addressed?

4. What will you consider as you prepare for placement of the chest tube?

5. What is the purpose of the chest tube? What do you hypothesize is Scott’s primary diagnosis?

6. How often should a chest tube be assessed?

7. What cues would indicate further assessment of the chest tube and the client are needed?

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=202#h5p-16

Test your knowledge using a NCLEX Next Generation-style question. You may reset and resubmit your answers to this question an unlimited number of times.

VI Glossary

Chest tube: A catheter inserted into the pleural space in the chest cavity (also referred to as the thoracic cavity or thorax) to remove air, blood, and/or fluids.

Chylothorax: A collection of lymph in the pleural space.

Crepitus: Puffiness or crackling that indicates subcutaneous emphysema, the leakage of air into the subcutaneous tissues surrounding the insertion site.

Empyema: A pyogenic infection (pus) of the pleural space.

Hemothorax: A collection of blood in the space between the chest wall and the lung (called the pleural cavity).

Hydrothorax: Accumulation of serous fluid in the pleural space

Negative pressure: During inspiration (also called inhalation), the diaphragm contracts and pulls downward, while the intercostal muscles between the ribs pull upward. This movement increases the size of the thoracic cavity, thus decreasing the pressure inside. This change in pressure on inspiration is referred to as negative pressure. As a result, a vacuum effect is created and air rushes into the lungs.

Pleural effusion: Accumulation of fluid in the pleural space, often due to a medical condition such as cancer or heart, kidney, or liver failure.

Pleural space: Also referred to as the pleural cavity; the space between the membranes of the chest wall (i.e., visceral pleura membrane) and the lung (i.e., the parietal pleura membrane).

Pneumothorax: A collapsed lung that occurs when air leaks into the space between the lung and chest wall.

Spontaneous pneumothorax: Collapse of a lung that occurs suddenly without any known cause.

Subcutaneous emphysema: Air leakage into the subcutaneous tissues surrounding the chest tube insertion site.

Tension pneumothorax: A medical emergency caused by large pneumothorax that affects cardiovascular functioning.

Tidaling: When water in the water seal chamber rises with inhalation and falls with exhalation.

Traumatic pneumothorax: Lung collapse caused by a chest injury, such as

a bullet wound that pierces the pleural membranes, causing air to rush into the thoracic cavity.

PART VII

CHAPTER 7 INTERPRET BASIC ECG

7.1 Introduction

Learning Objectives

- Describe cardiac anatomy and physiology
- Apply leads for electrocardiograms (ECGs) and cardiac monitoring
- Identify basic cardiac rhythms
- Outline nursing interventions in response to the identified cardiac rhythm

Nurses assist with obtaining electrocardiograms (ECGs) and implementing cardiac monitoring to analyze the electrical activity of a client's heart. They must be able to interpret abnormal cardiac rhythms and quickly address them or obtain emergency assistance. This chapter will review the anatomy and physiology of the cardiovascular system and the electrical conduction system and then introduce the skills of obtaining an ECG and interpreting basic electrocardiogram patterns.

7.2 Basic Concepts

Before interpreting cardiac rhythms, it is vital to understand the anatomy and physiology of the heart. Let's begin with a basic review of the cardiovascular system. The heart is a fist-sized organ that pumps blood throughout the body. It is the primary organ of the circulatory system. The heart contains four main chambers made of muscle and powered by electrical impulses. The brain and nervous system direct the heart's function. The electrophysiology of the heart will determine the rate and rhythm. The blood pressure is maintained by the contractility of the heart muscle.[1] See Figure 7.1[2] for an illustration of the heart.

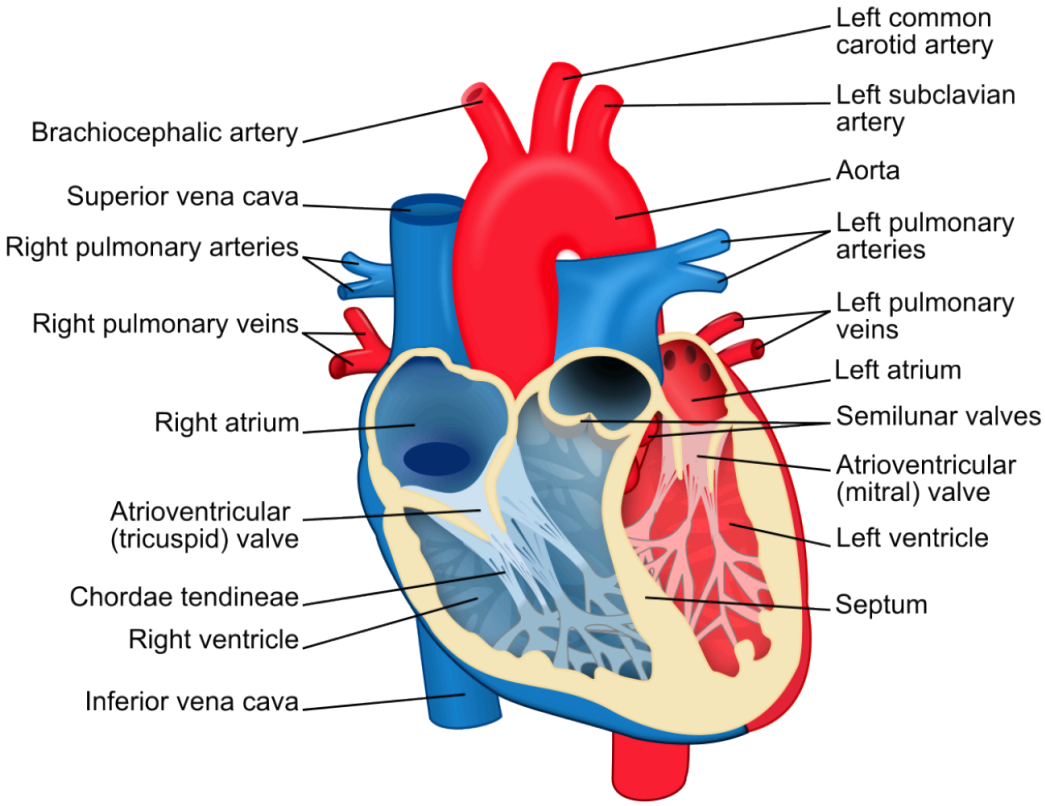

Figure 7.1 The Heart

The parts of the heart are similar to the parts of a house. Both the heart and a house have the following components[3]:

1. Cleveland Clinic. (2021, August 26). *Heart.* https://my.clevelandclinic.org/health/body/21704-heart
2. "Heart_diagram-en.svg" by ZooFari is licensed under CC BY-SA 3.0
3. Cleveland Clinic. (2021, August 26). *Heart.* https://my.clevelandclinic.org/health/body/21704-heart

- Walls
- Chambers (the rooms)
- Valves (the doors)
- Blood vessels (the plumbing)
- Electrical conduction system (the electricity)

Heart walls are muscles that contract (squeeze) and relax to send blood throughout the body. A layer of muscular tissue called the septum divides the heart walls into the left and right sides. Heart walls have three layers:

- **Endocardium**: The inner layer
- **Myocardium**: The muscular middle layer
- **Epicardium**: The protective outer layer

The epicardium is one layer of the pericardium. The **pericardium** is a protective sac that covers the entire heart. It produces fluid to lubricate the heart and keeps it from rubbing against other organs.[4]

The heart is divided into four chambers. There are two chambers on the top (called the left and right atria) and two chambers on the bottom (called the left and right ventricles). Blood flows through the chambers of the heart in the following order:

- **Right atrium**: Two large veins called the superior vena cava and the inferior vena cava deliver oxygen-poor blood to the upper right chamber of the heart called the right atrium. The **superior vena cava** carries deoxygenated blood from the upper body. The **inferior vena cava** carries deoxygenated blood from the lower body. The right atrium pumps this blood through the tricuspid valve into the right ventricle.
- **Right ventricle**: This lower right chamber of the heart pumps the oxygen-poor blood through the pulmonary valves and then through the **pulmonary arteries** to the lungs. (Note that arteries usually carry oxygenated blood, but pulmonary arteries carry deoxygenated blood to

4. Cleveland Clinic. (2021, August 26). *Heart.* https://my.clevelandclinic.org/health/body/21704-heart

the lungs.) The lungs reload blood with oxygen while removing carbon dioxide, and the **pulmonary veins** carry oxygenated blood back to the left atrium. (Note that veins usually carry deoxygenated blood, but pulmonary veins are the only veins in an adult that carry oxygenated blood.)

- **Left atrium**: The upper left chamber of the heart receives the oxygenated blood and pumps it through the mitral valve into the left ventricle.
- **Left ventricle**: The lower left chamber of the heart is called the left ventricle. It is slightly larger than the right ventricle because it pumps oxygen-rich blood through the aortic valve to the coronary arteries and out to the rest of the body.[5] See Figure 7.2[6] for an illustration of blood flow through the heart.

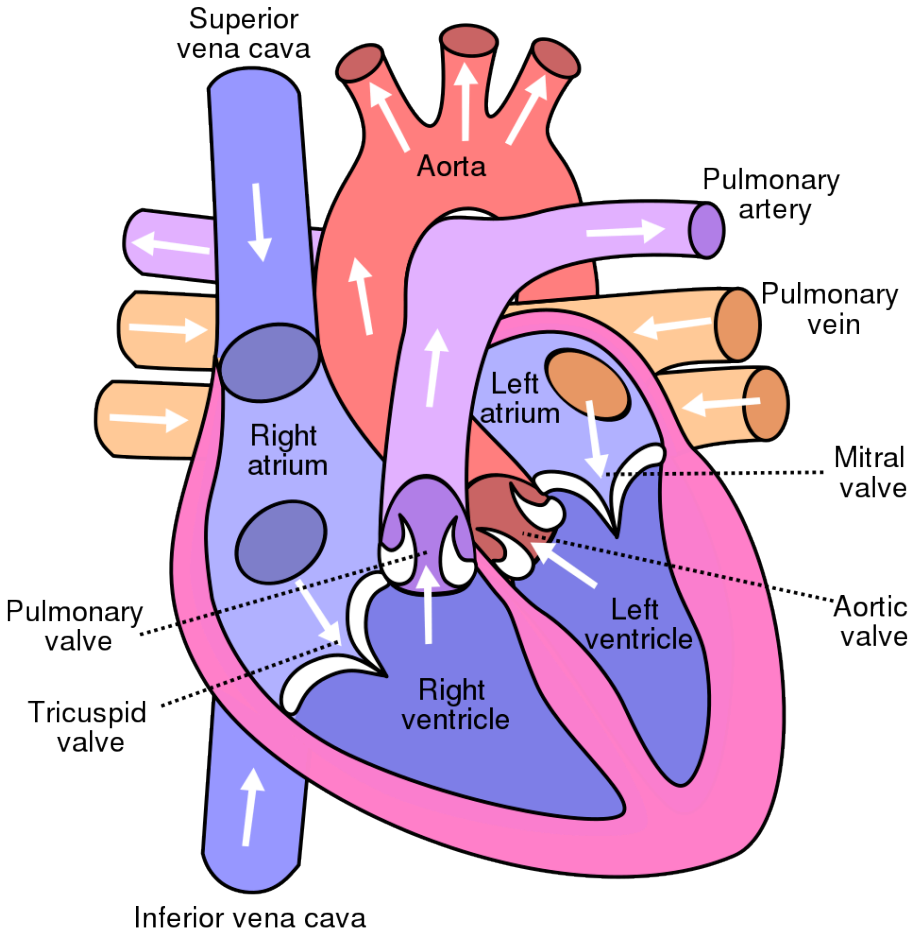

Figure 7.2 Blood Flow Through the Heart

5. Cleveland Clinic. (2021, August 26). *Heart.* https://my.clevelandclinic.org/health/body/21704-heart
6. "Diagram_of_the_human_heart.svg" by Wapcaplet, Yaddah is licensed under CC BY-SA 3.0

The heart valves are like doors between the four heart chambers that open and close to allow blood to flow through while preventing blood from moving backwards through the heart. The **atrioventricular (AV) valves** open between the atria and the ventricles (i.e., the upper and lower chambers of the heart). There are two AV valves[7]:

- **Tricuspid valve**: The valve between the right atrium and right ventricle
- **Mitral valve**: The valve between the left atrium and left ventricle

Semilunar (SL) valves open when blood flows out of the ventricles. SL valves include the following[8]:

- **Pulmonary valve**: The valve that opens when blood flows from the right ventricle into the pulmonary arteries (then to the lungs)
- **Aortic valve**: The valve that opens when blood flows out of the left ventricle to the aorta

The heart pumps blood through three types of blood vessels called arteries, veins, and capillaries[9]:

- **Arteries** carry oxygen-rich blood from the heart to the body's tissues. (As previously noted, the exception is the pulmonary arteries that carry deoxygenated blood to the lungs.) The **aorta** is a large artery that carries oxygen-rich blood from the heart to the rest of the body. The heart itself receives oxygen and nutrients through a network of **coronary arteries** that run along the heart's surface.
- **Veins** carry oxygen-poor blood back to the heart. (As previously noted, the exception is the pulmonary veins that carry oxygenated blood from the lungs to the heart.)
- **Capillaries** are small blood vessels where the body exchanges oxygen and carbon dioxide in the blood at the cellular level.

7. Cleveland Clinic. (2021, August 26). *Heart.* https://my.clevelandclinic.org/health/body/21704-heart
8. Cleveland Clinic. (2021, August 26). *Heart.* https://my.clevelandclinic.org/health/body/21704-heart
9. Cleveland Clinic. (2021, August 26). *Heart*. https://my.clevelandclinic.org/health/body/21704-heart

View a supplementary YouTube video[10] on the anatomy and physiology of the heart in a virtual reality lab: *Heart Anatomy and Flow by Dr. Nick Slamon.*

The electrical conduction system of the heart is similar to the electrical wiring of a house. The heart has a network of electrical bundles and fibers that control the rhythm and pace of the heartbeat. The electrical conduction system includes these components[11]:

- **Sinoatrial (SA) node**: The SA node is located in the upper part of the right atrium and is a major element of the conduction system. The SA node is often referred to as the heart's natural pacemaker. The natural pacemaker rate for the SA node is 60-100 beats per minute. It sends the signals that make the heart beat with a normal rate and rhythm.
- **Atrioventricular (AV) node**: The AV node is located in the lower part of the right atrium. The AV node carries electrical signals from the SA node to the ventricles. If the SA node fails to send signals, the AV node takes over. The AV node is the "backup" pacemaker if the SA node fails. The AV node will pace the heart at a rate of 40-60 beats per minute.
- **Bundle of His**: A collection of cardiac cells found along the septum between the ventricles that sends electrical impulses from the AV node to the left and right bundle branches.
- **Left bundle branch**: Offshoots from the bundle of His that send electrical impulses to the left ventricle.
- **Right bundle branch**: Offshoots from the bundle of His that send electrical impulses to the right ventricle.
- **Purkinje fibers**: A network of thin filaments that carry electrical impulses that cause the ventricles to contract and pump blood out of the heart. If

10. Acadicus. (2021, January 21). Heart anatomy and flow by Dr. Nick Slamon [Video]. YouTube. All rights reserved. https://youtu.be/SE9MFFjJW8A
11. Cleveland Clinic. (2021, August 26). *Heart.* https://my.clevelandclinic.org/health/body/21704-heart

all other “backup” pacemakers in the heart fail, the Purkinje fibers will pace the heart at 20-40 beats per minute. See Figure 7.3[12] for an illustration of the electrical conduction system of the heart.

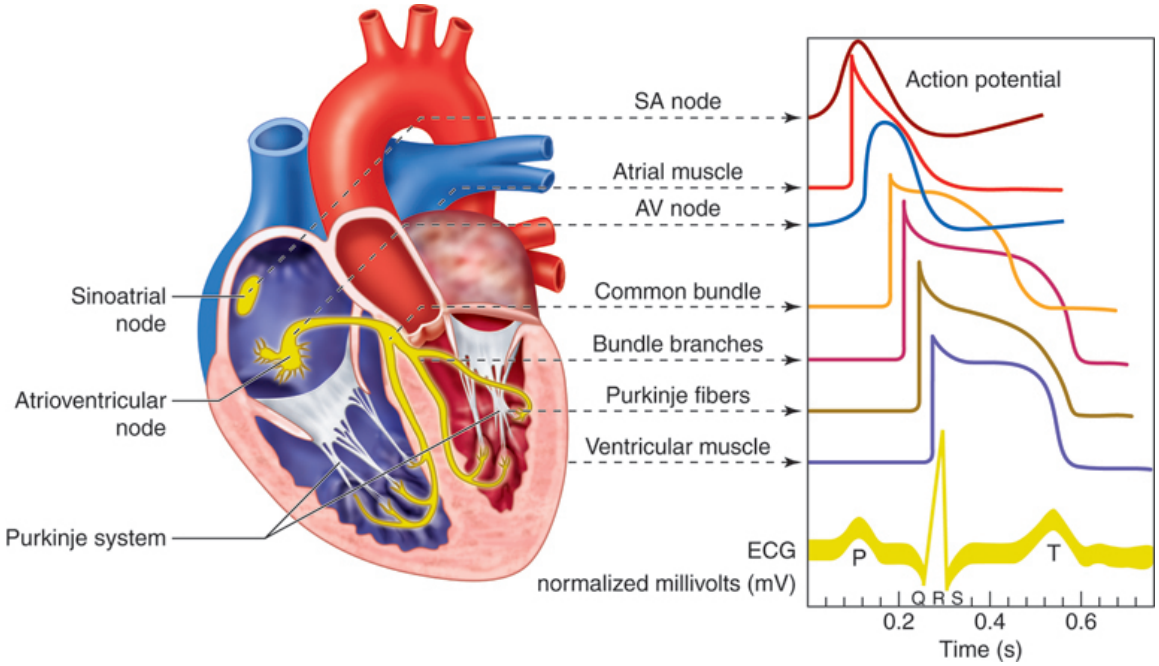

Figure 7.3 Electrical Conduction System of the Heart

View the following YouTube video[13] explaining the electrical conduction system of the heart: *Electrical Conduction System of the Heart: Cardiac SA Node, AV Node, Bundle of His.*

Dysrhythmias

Occasionally, an area of the heart other than the SA node will initiate an

12. “C_M3_37.jpg” by CCCOnline is licensed under CC BY-SA 4.0. Access for free at https://pressbooks.ccconline.org/bio106/chapter/cardiovascular-levels-of-organization/
13. RegisteredNurseRN. (2015, May 20). *Electrical conduction system of the heart cardiac | SA node, AV node, bundle of His* [Video]. YouTube. All rights reserved. https://www.youtube.com/watch?v=-X9rYD8zSQg

impulse that will be followed by a premature contraction. Premature contractions simply mean these impulses happen too soon and may originate from a different place than a regular beat. These premature contractions can happen in the atrium (premature atrial contraction), ventricle (premature ventricular contraction), or AV junction (premature junctional contractions). Such a contraction is known as an ectopic beat, and the premature contraction causes an irregular heart rate and rhythm during that beat. The underlying heart rate and rhythm can be either regular or irregular. An ectopic focus may be stimulated by localized ischemia, exposure to certain drugs, abnormal electrolytes or acid-base balance, hypoxia, elevated stimulation by both sympathetic or parasympathetic divisions of the autonomic nervous system, or several diseases or pathological conditions. Occasional occurrences of dysrhythmias are generally transitory and not life-threatening. However, if the condition becomes a chronic deviation from the normal pattern of impulse conduction and contraction, it is referred to as **dysrhythmia** or **arrhythmia**. Severe arrhythmias can lead to cardiac arrest, which is fatal if not treated within a few minutes.

Electrocardiograms

Electrocardiograms (ECGs) use leads with electrodes attached to the client's body to record the electrical activity of the heart on special graph paper or on a cardiac monitor. These electrodes detect the small electrical changes of cardiac muscle depolarization followed by repolarization during each cardiac cycle (heartbeat).

A paper rhythm strip is at least a 6-second tracing printed out on special graph paper that shows activity from one or two leads. See Figure 7.4[14] for an example of an ECG rhythm strip. When interpreting a paper ECG, the vertical lines indicate voltage of a given waveform. The thin lines, thick lines, and boxes along the horizontal axis represent various amounts of time as the electrical signal is conducted through the heart tissue:

- Thin lines or small box (1 mm intervals): 0.04 seconds

14. "Normal_Sinus_Rhythm_Unlabeled.jpg" by Andrewmeyerson is licensed under CC BY-SA 3.0

- Thick lines or big box (5 mm intervals): 0.2 seconds

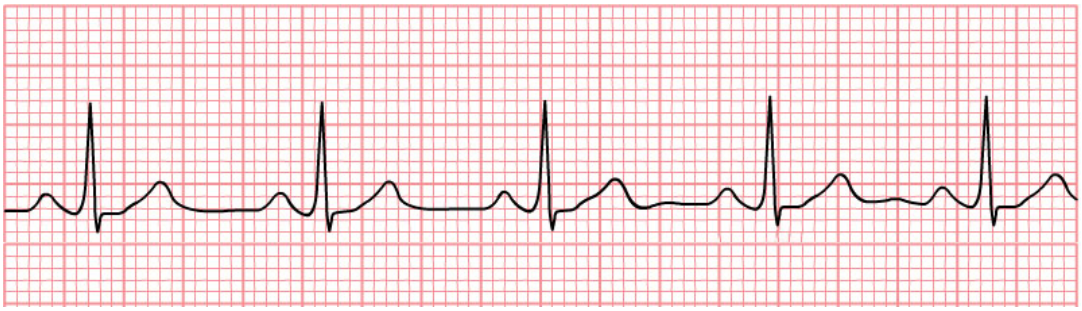

Figure 7.4 ECG Rhythm Strip

12-Lead ECG

A **12-lead electrocardiogram** is a diagnostic test that uses 12 leads to record information through 12 different perspectives of the heart to display a complete picture of its electrical activity. Electrodes are placed on the surface of the client's chest (i.e., leads V1, V2, V3, V4, V5, and V6), and four are placed bilaterally on their upper and lower extremities (i.e., RA, LA, RL, LL). In this manner, the heart's electrical activity is measured from twelve different angles (referred to as "leads") to capture each moment throughout the cardiac cycle. Accurate placement of leads to obtain a 12-lead ECG is further described in "Checklist: Obtain a 12-Lead ECG."

A standard 12-lead ECG report displays a 2.5 second tracing of each of the twelve leads. The tracings are most commonly arranged in a grid of four columns and three rows. The first column is the limb leads (I, II, and III), the second column is the augmented limb leads (aVR, aVL, and aVF), and the last two columns are the precordial leads (V1 to V6). See Figure 7.5[15] for an image of a 12-lead ECG with the various waveforms.

15. "Sinustachy.JPG" by James Heilman, MD is licensed under CC BY-SA 3.0

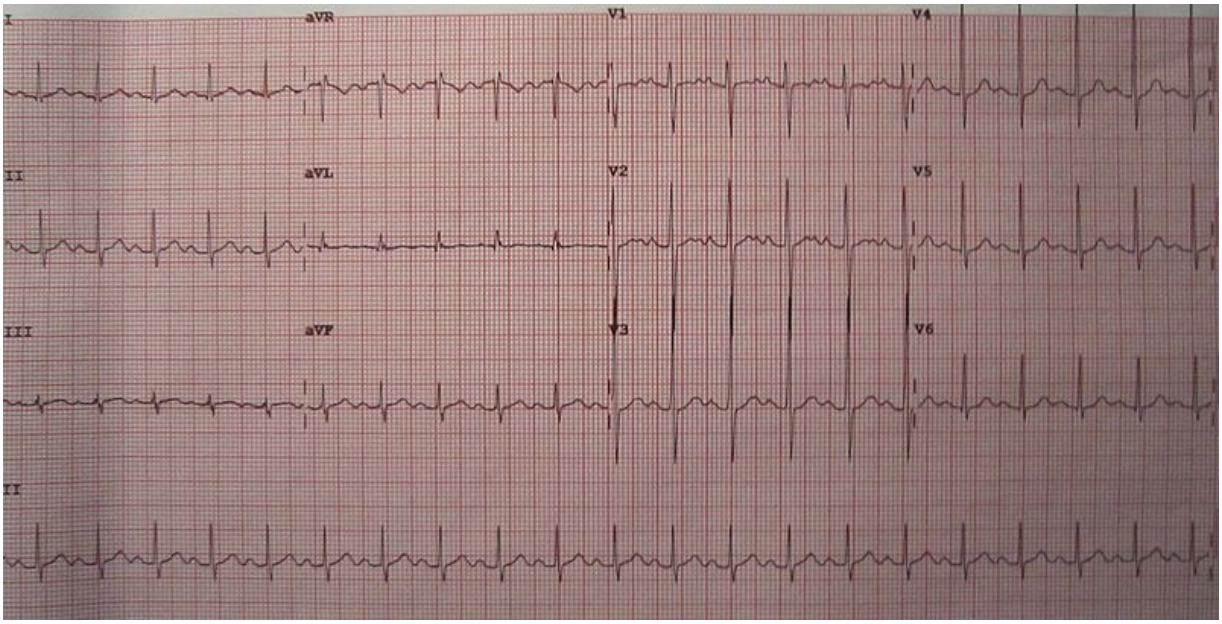

Figure 7.5 12-Lead ECG

Each of the 12 ECG leads records the electrical activity of the heart from a different angle and, therefore, aligns with different anatomical areas of the heart:

- Inferior leads (II, III, and aVF): Inferior surface of the heart
- Lateral leads (I, aVL, V5, and V6): Lateral wall of the left ventricle
- Septal leads (V1 and V2): Septal surface of the heart
- Anterior leads (V3 and V4): Anterior wall of the right and left ventricles

When administered and interpreted accurately, an ECG can detect and monitor several types of heart conditions such as dysrhythmias, heart attacks (myocardial infarction), and electrolyte imbalances.

Telemetry

Telemetry refers to a portable device used to continuously monitor clients' heart rhythms. While a client is on telemetry (also referred to as cardiac monitoring), their heart's electrical patterns are displayed on a monitor. The patterns are continuously monitored by specially trained technicians and nurses who interpret the heart's electrical activity. Nurses must be able to identify normal and abnormal heart rhythms displayed on a cardiac monitor. Health care agencies provide specialized training to nurses who

work on units with clients on telemetry. See Figure 7.6[16] for an image of a client on telemetry.

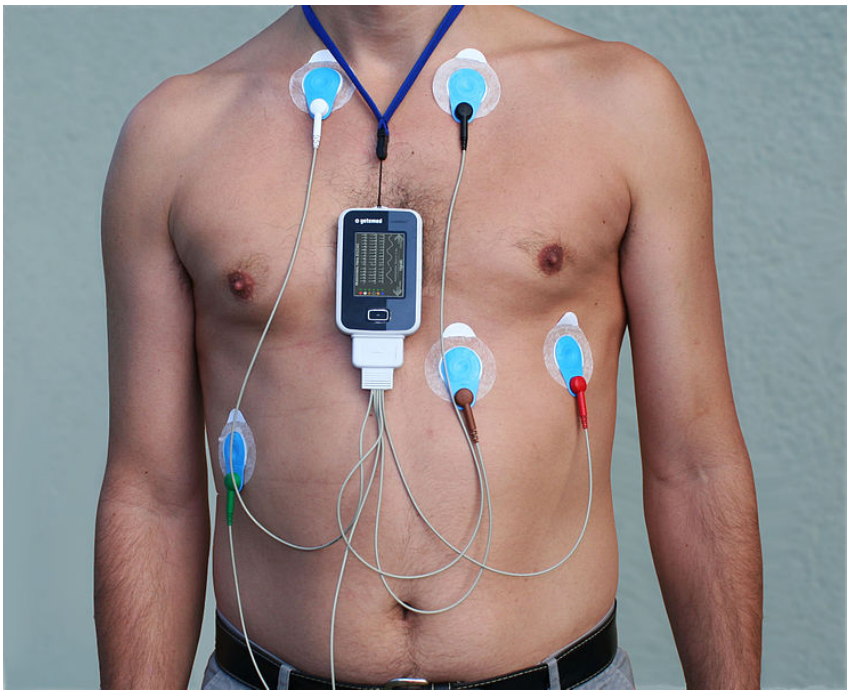

Figure 7.6 Telemetry

Artifact

The monitor or ECG strip typically displays the name of the cardiac rhythm the client is experiencing, but this display is not always correct due to artifact. **Artifact** occurs when the electrodes are not making good contact with the skin and/or if the client moves during the tracing. See an image of artifact on an ECG strip in Figure 7.7[17]. Artifact may be interpreted by the monitor as ventricular beats or other abnormal cardiac patterns when, in reality, there are no cardiac abnormalities occurring. For this reason, it is important for nurses to observe the client to ensure what is displayed on the monitor is accurate according to the client's condition.

16. "Alex_CM4000.jpg" by Misscurry is licensed under CC BY-SA 3.0
17. "Sinus Rhythm with Artifact" by Deanna Hoyord is licensed under CC BY 4.0

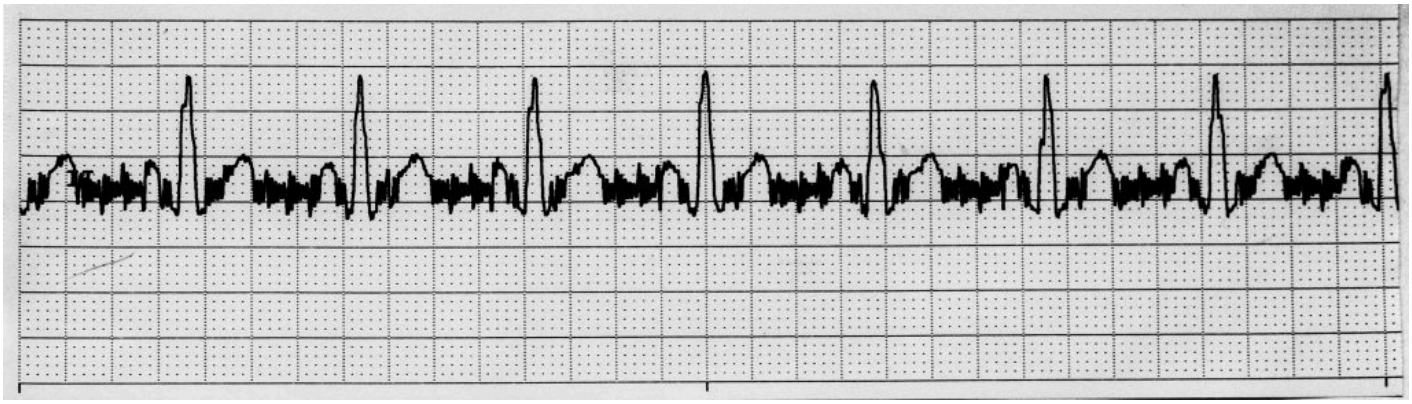

FIgure 7.7 Artifact

Components of ECG Waveforms

There are five prominent components on an ECG waveform: the P wave; the Q, R, and S components (often referred to as the QRS complex); and the T wave. Each wave represents a specific electrical impulse in the heart with a specific appearance and normal ranges of measurements on the ECG graph paper. See Figure 7.8[18] for an image of these components.

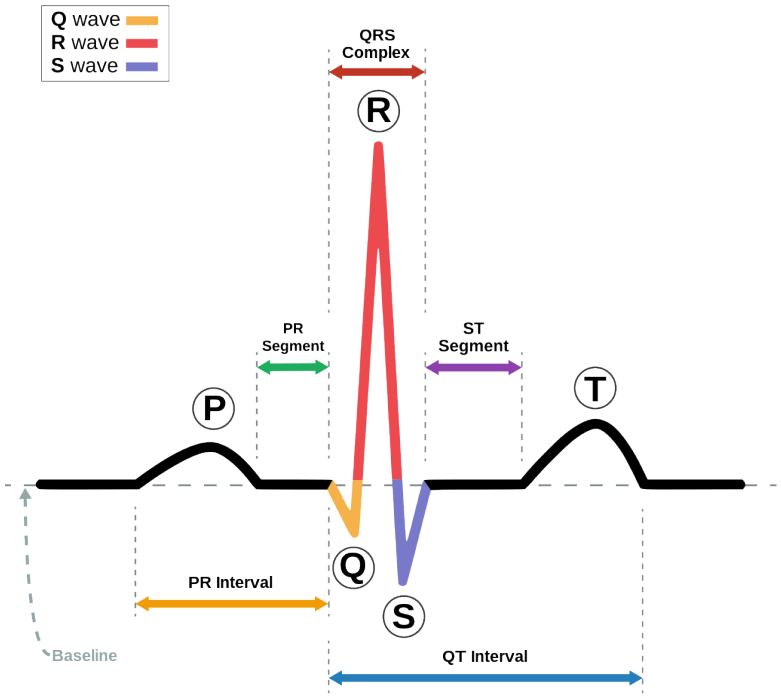

Figure 7.8 Waveforms on an ECG

18. "SinusRhythmLabels.svg" by Agateller (Anthony Atkielski) is licensed in the Public Domain.

The small **P wave** represents the depolarization of the atria. The large **QRS complex** represents the depolarization of the ventricles, which requires a much stronger impulse because of the larger size of the ventricular cardiac muscle. The ventricles begin to contract as the QRS reaches the peak of the R wave, causing a "heartbeat" that is felt when assessing a client's pulse. Lastly, the **T wave** represents the repolarization of the ventricle.[19]

Intervals between waveforms are assessed on an ECG. The **P-P interval** represents the duration between atrial heartbeats. The **R-R interval** represents the duration between the ventricular heartbeats. Both of these intervals should be consistent if the heart rhythm is regular. However, the P-P interval and the R-R interval may not be the same if a client has a dysrhythmia with different atrial and ventricular heart rates. For example, in atrial flutter the atrial rate will be much faster than the ventricular rate.

The **isometric line** (also known as isoelectric line) is used to measure intervals. It is an imaginary line that can be drawn horizontally through the telemetry strip. This is also called the baseline and is used to determine where each component of the heartbeat starts and ends. It also helps to determine if the component has a positive or negative deflection. See Figure 7.9[20] for an illustration of the isoelectric line.

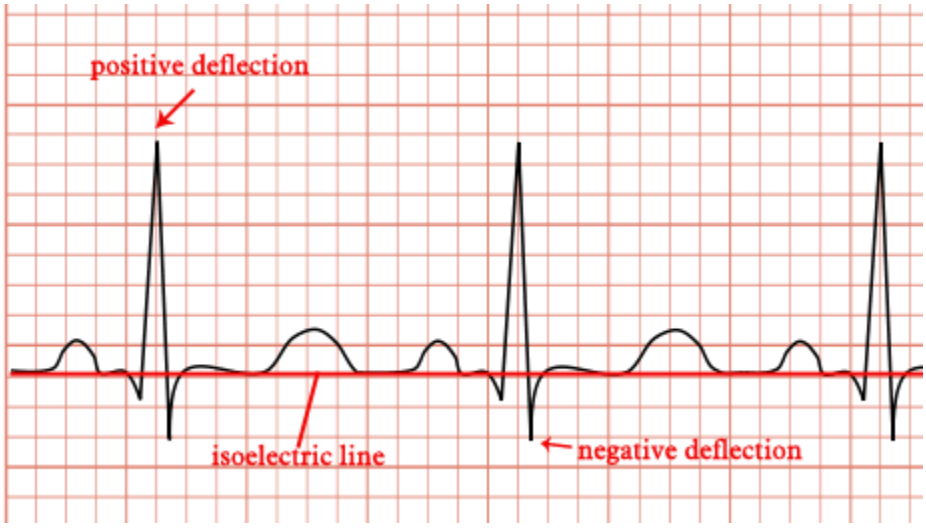

Figure 7.9 Isoelectric Line

19. Physical Therapy Reviewer. (n.d.). *How to read an ECG.* https://ptreviewer.com/electrocardiogram-ecg-2/reading-an-ecg/
20. "ECG deflection.gif" is a derivative of Tachycardia_ECG_paper.svg by Madhero88 and licensed under CC BY-SA 3.0. Access for free at http://simple-cardio.blogspot.com/2012/12/ecg-ekg-paper.html

The **PR interval** is measured from the start of the P wave to the start of the QRS complex. This is where the P wave starts to have a positive deflection off the isometric line to the first negative deflection. The **QRS complex** is measured from the first negative deflection (Q) through the upward spike (R) to the second negative deflection (S) once it returns to the isometric line. The **QT interval** is measured from the first negative deflection (Q) to the end of the T wave or where the T wave returns to the isometric line.

Table 7.2a reviews the characteristics of ECG components and intervals.

Table 7.2a Components and Intervals on an ECG Waveform

	Representation	Duration	Amplitude	Shape	Notes
P wave	Atrial depolarization by the SA node	Less than 0.12 seconds	Less than 2.5 mm	Upward, rounded, and similar appearance	P wave may be inverted or biphasic (i.e., 2 phases) based on the lead being observed, but is typically upward and rounded.
PR interval	Conduction from the atria through the AV node into the ventricles	0.12-0.20 seconds			Can be shortened or lengthened depending on heart rate. Lengthened past 0.2 seconds is referred to as a “heart block” dysrhythmia.

QRS complex	Atrial repolarization and relaxation and ventricular depolarization and contraction	0.06-0.12 seconds	1.0-3.0 mm	Q: Downward deflection R: Upward spike; represents electrical stimulus passing through ventricles on depolarization S: Downward deflection; reflects final depolarization of Purkinje fibers	All 3 waves may not be visible depending on which lead is being observed. A Q wave duration greater than 0.04 seconds, depth greater than 1 mm, or size greater than 25% of the QRS complex amplitude is a sign of a previous myocardial infarction (commonly referred to as a pathological Q wave).

QT interval	Ventricular depolarization and repolarization	0.36-0.44 seconds			Normal QT interval varies based on gender and heart rate. It may be lengthened (bradycardia) or shortened (tachycardia) depending on heart rate. Corrected QT interval (QTc) is typically monitored because it takes heart rate and gender into consideration. A side effect of many medications is a prolonged QTc interval.
T wave	Ventricular repolarization		Less than 10 mm	Upward, rounded, and similar in appearance; should have a higher amplitude than P wave	Size should be between one eighth and two thirds of the size of the R wave.
ST segment	Isoelectric period when the ventricles are in between depolarization and repolarization	0.005 – 0.150 seconds	Less than 1 mm	Flat, isoelectric section of the ECG between the end of the S wave (often referred to as the J point) and the beginning of the T wave	Depressed ST segments may indicate coronary ischemia; ST elevation may indicate myocardial infarction. ST elevation is typically seen in leads V1 and V2.

7.3 A Systematic Approach to Interpreting an ECG

A systematic approach to interpreting an ECG improves the speed and reliability of the assessment, especially if a dysrhythmia is present. This section outlines a systematic approach to interpreting an ECG, as well as common findings in ECG waveforms that occur during dysrhythmias. Review basic information about ECG waveforms and intervals in Table 7.2a in the "Basic Concepts" section of this chapter. Supplementary videos demonstrating how to interpret an ECG are provided at the end of this section, and an online cardiac rhythm game in the "Learning Activities" section provides practice in interpreting ECG strips.

Calculate the Rate

Calculate the ventricular and atrial rates.

There are several methods to calculate the rate. The simplest method to obtain a ventricular rate is to count the number of R waves in a 6-second strip (i.e., over 30 large boxes) and multiply this number by 10. See Figure 7.10[1] for an image of counting the R waves on a 6-second strip for a ventricular heart rate of 80.

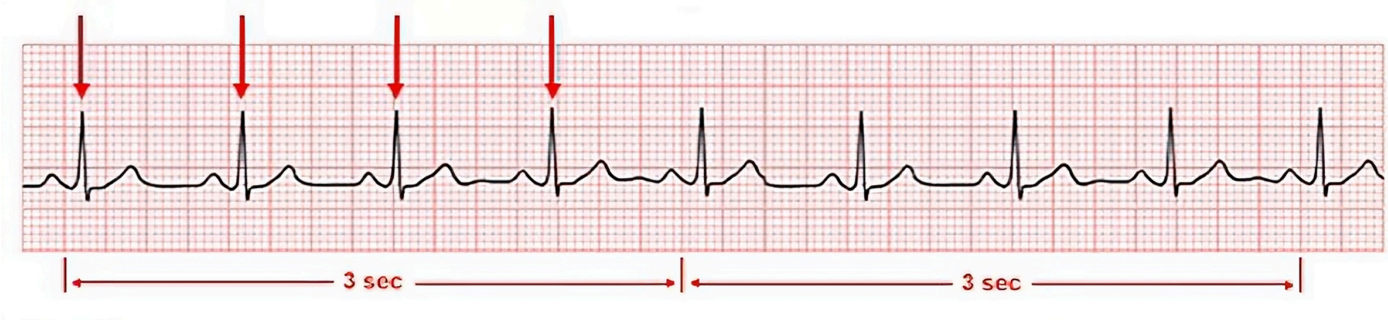

Figure 7.10 Calculating the Ventricular Rate by Counting the R Waves in a 6-Second Strip

In a similar manner, the atrial rate can be calculated (if P waves are present) by counting the number of P waves in a 6-second strip and multiplying this number by 10. In order to ensure accuracy of this method, please make sure that the rhythm strip that is used is a 6-second strip.

1. "Counting the R Waves" by Chippewa Valley Technical College is licensed by CC BY 4.0

Determine the Regularity of the Rhythm

Determine if the rhythm is regular or irregular.

View leads I, II, aVF, and V1 for the most accurate interpretation of the rhythm.[2] Assess the distances between the R waves to determine the regularity of the rhythm using a caliper or ruler. It is important to assess the distances across the whole strip to account for any potential abnormality. See Figure 7.11[3] for an image depicting the R to R distance on an ECG strip. Cardiac rhythms are categorized into four types of rhythms:

- **Regular Rhythm:** The R to R distances are always equal distance apart. For example, normal sinus rhythm is a regular rhythm.
- **Irregularly Irregular Rhythm:** The R to R distances are never equal distances apart. For example, atrial fibrillation is an irregularly irregular rhythm.
- **Regularly Irregular:** The R to R distances are unequal, but there is a repetitive pattern to the unequal distances. For example, second-degree heart block type II may have a regularly irregular rhythm.
- **Occasionally Irregular:** The R to R distances are equal except for an occasional out of place R. For example, sporadic premature ventricular contractions (PVCs) are an occasionally irregular rhythm.

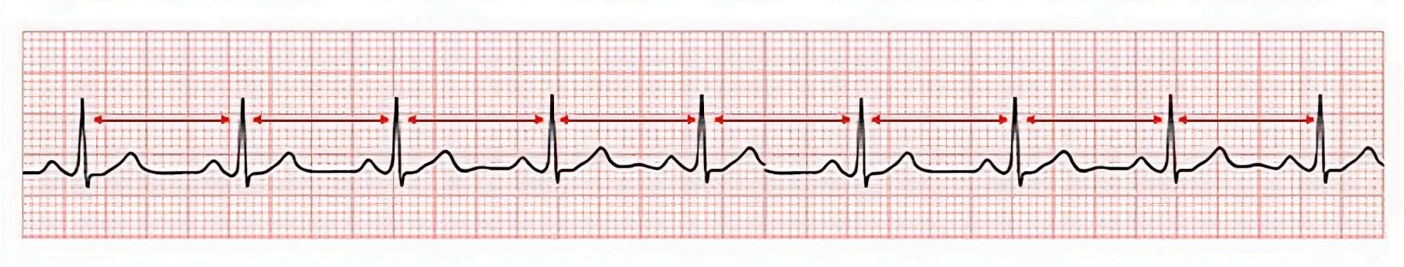

Figure 7.11 Assessing the R to R Distance

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3. "Assessing Distance Between R Waves" by Chippewa Valley Technical College is licensed by CC BY 4.0

Assess the P Waves

The P waves are critical to determining the origin of a heartbeat. Assess the following characteristics related to the P waves:

- **Are P waves present?** The absence of P waves indicates the heartbeat did not originate in the SA node.
- **Do all of the P waves look the same?** When a heartbeat originates somewhere other than the SA node, the contour of the P wave changes.
- **Do the P waves occur at a regular rate?** Using a caliper or ruler, assess the distance from "P to P" waves. If this distance varies, there is an issue in conduction from the SA node to the AV node. See Figure 7.12[4] for an image of assessing the distance between P waves.
- **Is there one P wave with every QRS complex?** This helps to further assess conduction. Is the electrical communication between the atria and the ventricles working correctly?

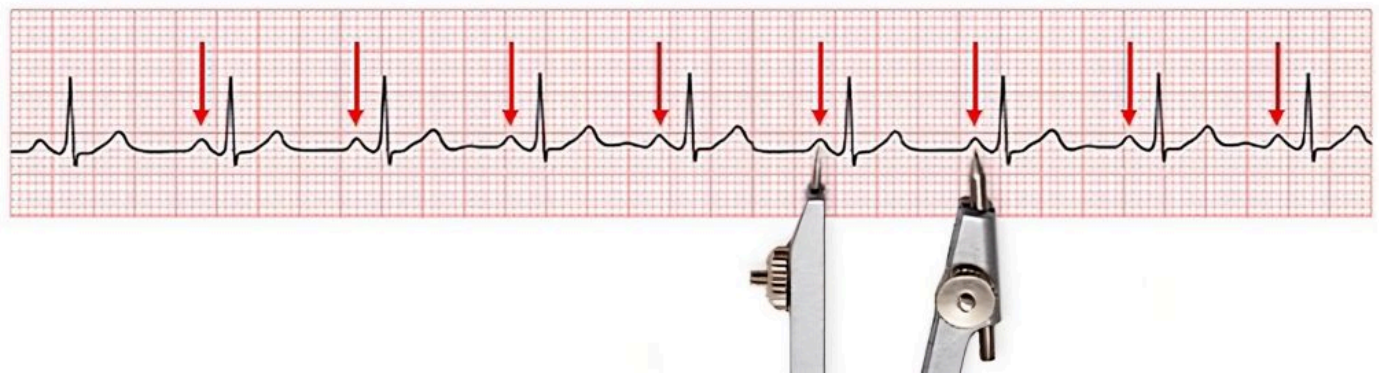

Figure 7.12 Assessing the P to P Distance

An example of a dysrhythmia that lacks P waves is atrial fibrillation. The presence of "irregularly irregular" narrow QRS complexes with no distinct P waves or a wavy baseline is the hallmark feature in the identification of atrial fibrillation.[5]

4. "Assessing Distance Between P Waves" by Chippewa Valley Technical College is licensed by CC BY 4.0
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Determine the PR Interval

Measure the distance from the beginning of the P wave to the beginning of the QRS complex.

Recall that the normal PR interval is 0.12 to 0.2 seconds (i.e., 3-5 small boxes). When the PR interval is too long, there is a problem with conduction from the SA node to the AV node. A delay in SA to AV node conduction is representative of a heart block. See Figure 7.13[6] for an image of measuring the PR interval.

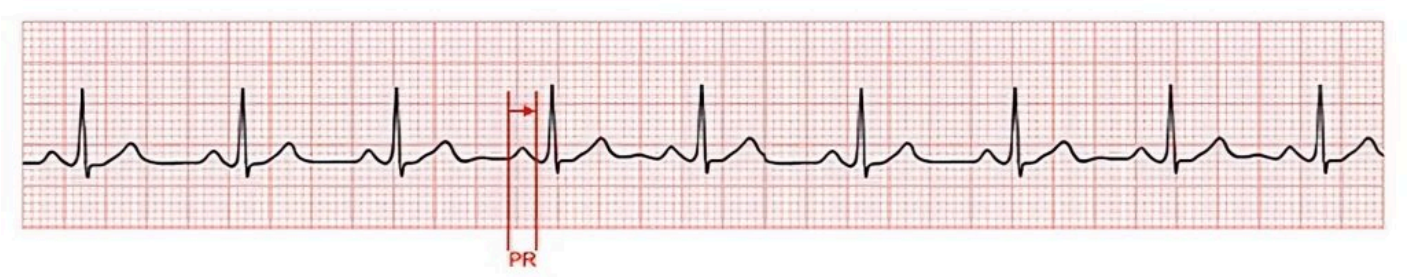

Figure 7.13 Measuring the PR Interval

The PR interval represents the time from the beginning of atrial depolarization to the start of ventricular depolarization and includes the delay at the AV node. Variations in the PR interval can be seen in various disorders. For example, a long PR interval may indicate first-degree AV block. Short PR intervals are present in conditions with accelerated AV conduction, such as Wolf-Parkinson-White syndrome, a disorder that is present at birth.[7]

Determine the QRS Duration

Measure the distance from the beginning to the end of the QRS complex.

Recall that normal QRS duration is 0.04 to 0.12 seconds (i.e., 1-3 small boxes). When the QRS complex is too wide, it indicates the heartbeat did not originate in the atria. See Figure 7.14[8] for an image of measuring the QRS duration.

6. "Measuring the PR Interval" by Chippewa Valley Technical College is licensed by CC BY 4.0
7. This work is a derivative of StatPearls by Sattar and Chhabra and is licensed under CC BY 4.0
8. "Measuring the QRS Duration" by Chippewa Valley Technical College is licensed by CC BY 4.0

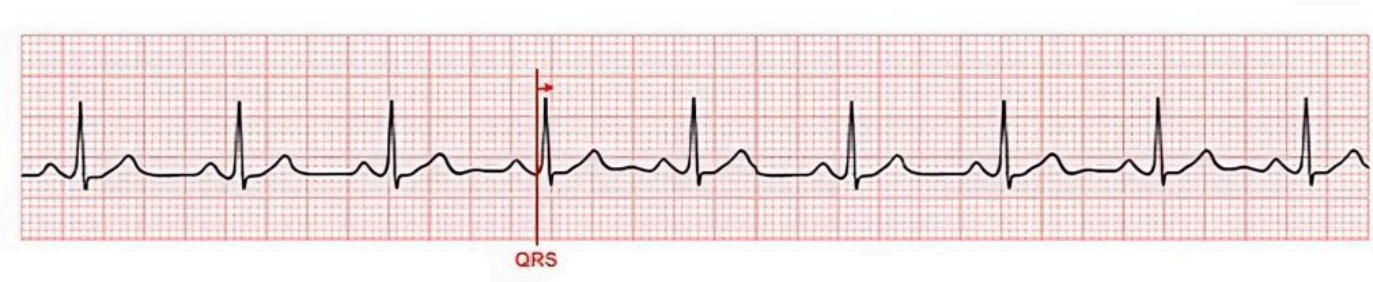

Figure 7.14 Measuring the QRS Duration

The QRS complex represents ventricular depolarization as the electrical signal passes down from the AV node. A prolonged QRS may indicate hyperkalemia or bundle branch block. A premature ventricular contraction, intraventricular conduction delay (bundle branch block), or other ventricular dysrhythmias are associated with a wide QRS.[9]

Evaluate the T Waves

Evaluate the T waves. Do they follow the QRS complex? Are they upright and rounded?

Recall the T wave represents ventricular repolarization. Its morphology is highly susceptible to cardiac and noncardiac influences such as hormonal and neurological factors. The size of a typical T wave is between one eighth and two thirds of the size of the R wave and a height of less than 10 mm.

Abnormalities in the T wave morphology include inverted, flat, biphasic, or tall tented or peaked T waves. T wave changes can occur with a variety of conditions. Tall T waves in an anterior chest lead III, aVR, and V1 with a negative QRS complex may suggest acute myocardial ischemia. Other causes of T wave abnormalities are caused by temporary physiological factors (for example, after eating a high carbohydrate meal), endocrine or electrolyte imbalances, myocarditis, pericarditis, cardiomyopathy, post-cardiac surgery state, pulmonary embolism, fever, infection, anemia, acid-base disorders,

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drugs, endogenous catecholamines, metabolic changes, acute abdominal processes, and intracranial pathology.[10]

Evaluate the ST Segment

What is the appearance of the S-T segment? Is it isoelectric (i.e., is it on the same level of the PR segment)?

Recall the ST segment depicts the interval between the end of ventricular depolarization and the beginning of ventricular repolarization. A normal ST segment falls along the isoelectric line and lies at the same level as the PR interval. See Figure 7.15[11] to review an illustration of ST segments, waves, and other intervals discussed in this section.

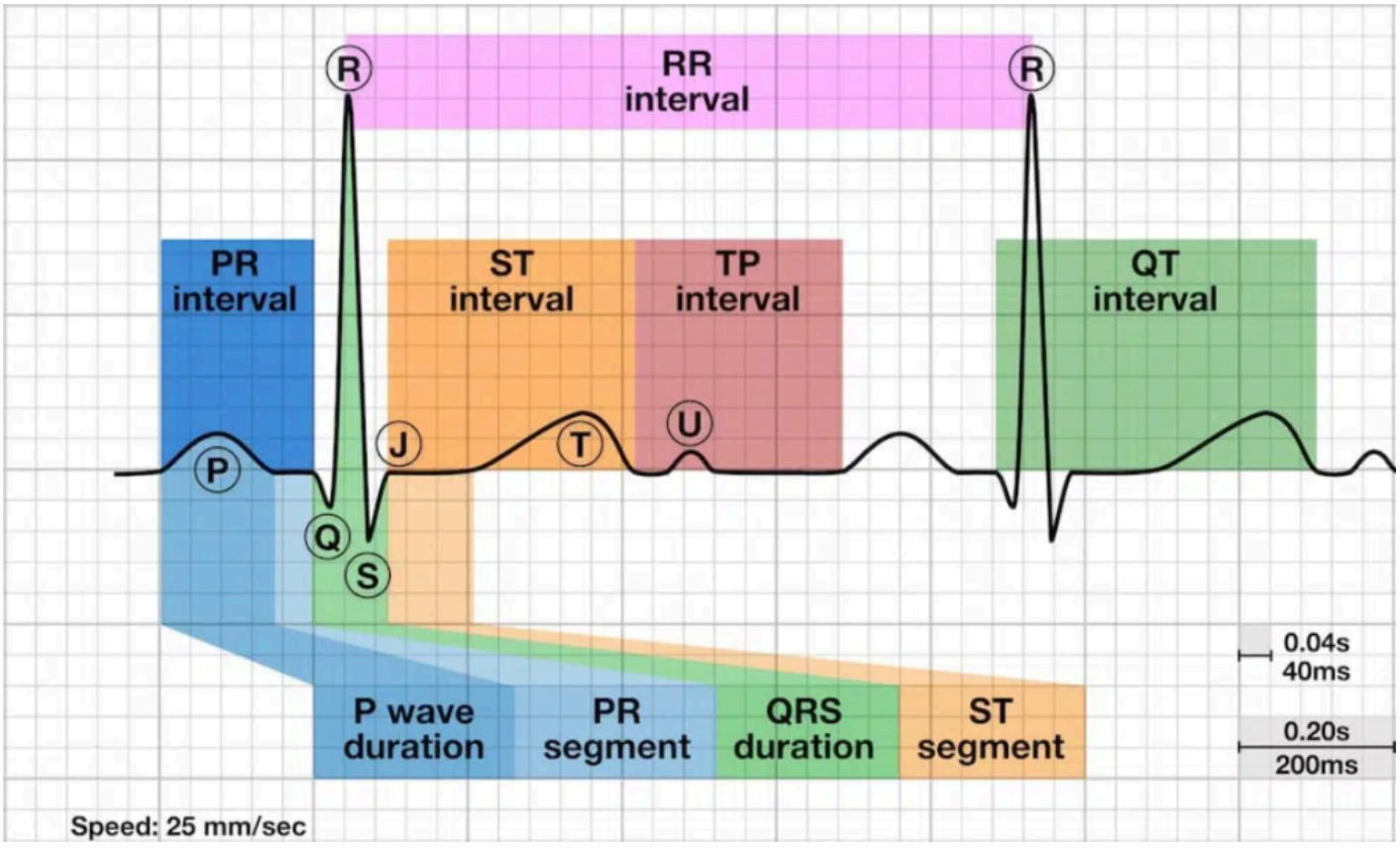

Figure 7.15 ST Segment and Other Intervals

10. This work is a derivative of StatPearls by Sattar and Chhabra and is licensed under CC BY 4.0
11. "ECG-waves-segments-and-intervals-LITFL-ECG-library-3.jpg" by unknown author at LITFL is licensed under CC BY-NC-SA 4.0. Access the original image at https://litfl.com/st-segment-ecg-library/

Elevation or depression of the ST segment by 1 mm or more, measured at the J point, is abnormal. The J point is a region between the QRS complex and the ST segment. ST elevation is highly specific if present in two or more contiguous leads in the setting of an acute myocardial infarction and usually indicates a complete blockage of the coronary artery. If ST elevation on the ECG tracing above the baseline after the J point is at least 1 mm in a limb lead or 2 mm in a precordial lead, it is clinically significant for diagnosing acute myocardial infarction. ST depression greater than 1 mm below the baseline is often a sign of myocardial ischemia or angina. It can appear as a downsloping, upsloping, or a horizontal segment on the ECG. ST depressions are also associated with nonischemic causes, including digoxin toxicity, hypokalemia, hypothermia, and tachycardia.[12]

Determine the QT Interval Duration

Is the QT (or QTc) interval duration within normal limits?

Recall the QT interval, measured from the Q wave to the end of the T wave, represents the start of depolarization to the end of the repolarization of the ventricles. Generally, the normal QT interval is less than 0.4 to 0.44 seconds. Women usually have a slightly longer QT interval than men, and heart rate also impacts the QT interval, so typically the corrected QT interval (QTc) is monitored.

A short QTc (less than 0.36 seconds) may be associated with hypercalcemia, acidosis, hyperkalemia, hyperthermia, or short QT syndrome.[13] A prolonged QTc presents an imminent risk for serious ventricular arrhythmias, including torsades de pointes, ventricular tachycardia, and ventricular fibrillation. Common causes of QTc prolongation include side effects of medications, electrolyte abnormalities such as hypocalcemia and hypomagnesemia, and congenital long QT syndrome.[14]

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13. This work is a derivative of StatPearls by Sattar and Chhabra and is licensed under CC BY 4.0
14. This work is a derivative of StatPearls by Sattar and Chhabra and is licensed under CC BY 4.0

Evaluate Other ECG Components

Are there extra beats on the waveform? Is anything else abnormal?

The U wave is a small wave that can follow the T wave, though it is not always visible. It represents the delayed repolarization of the papillary muscles or Purkinje fibers and is commonly associated with hypokalemia.[15]

The J wave is an abnormal finding typically found during hypothermia. It appears as an extra deflection on an ECG at the QRS complex and ST segment junction.[16]

Clinically Observe the Client

When analyzing an ECG strip, it is vital to clinically observe the client for signs and symptoms that determine the significance of the dysrhythmia. For example, the more abnormal a rhythm becomes, the less blood the heart pumps, causing symptoms due to low blood pressure such as dizziness, confusion, and loss of consciousness.[17]

View a supplementary YouTube video[18] on ECG interpretation basics:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=301#oembed-1

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16. This work is a derivative of StatPearls by Sattar and Chhabra and is licensed under CC BY 4.0
17. Physical Therapy Reviewer. (n.d.). *How to read an ECG*. https://ptreviewer.com/electrocardiogram-ecg-2/reading-an-ecg/
18. RegisteredNurseRN. (2022, March 7). *EKG/ECG interpretation basics nursing NCLEX | QRS complex, P wave, T wave, PR interval* [Video]. YouTube. All rights reserved. https://youtu.be/bUF12VIgzP0

View a supplementary YouTube video[19] on PQRST EKG rhythm:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=301#oembed-2

19. RegisteredNurseRN. (2015, May 21). *How to memorize the PQRST EKG rhythm strip wave for anatomy & pathophysiology* [Video]. YouTube. All rights reserved. https://youtu.be/QAQiK-zRtl0

7.4 ECG Patterns and Dysrhythmias

Abnormal ECG waveforms indicate dysrhythmias (also referred to as arrhythmias). Some dysrhythmias can significantly affect the client's clinical status and require rapid nurse response. Early and accurate identification of ECG patterns, assessment of the client's clinical presentation, and knowledge of the agency's policies and procedures regarding treatment will ensure clients receive optimal care.

Recall that the electrical conduction system stimulates the mechanical pumping action of the heart. If the ventricles become unable to effectively pump blood to the rest of the body due to altered electrical signals, signs and symptoms of **decreased cardiac output** occur, such as decreased blood pressure and pulses, prolonged capillary refill, chest pain, shortness of breath, dizziness, confusion, or loss of consciousness. When an ECG demonstrates new abnormal findings, the nurse must immediately assess the client for signs of decreased cardiac output and respond appropriately.

Some dysrhythmias can quickly lead to cardiac arrest, such as ventricular tachycardia, ventricular fibrillation, and third-degree heart block. The nurse must be aware of which rhythms require emergency assistance.

Medical treatments for symptomatic dysrhythmias can include antidysrhythmic medications, cardioversion, defibrillation, and/or implantation of medical devices such as pacemakers and implantable cardioverter defibrillators (ICDs). Cardioversion and defibrillation are further discussed in the "Cardioversion and Defibrillation" section of this chapter.

ECG patterns are generally classified into three categories depending on whether the signal originates from the SA node (i.e, sinus rhythms), the atria (i.e., atrial rhythms), or the ventricles (i.e., ventricular rhythms). Additionally, heart blocks refer to blocks in the normal pathway of electrical conduction through the heart and can be categorized as sinus node, atrioventricular (AV) node, or bundle branch blocks. The characteristics of each of these types of rhythms and blocks are further discussed in the following sections. A table summarizing the ECG images discussed in this chapter can be found in the "Appendix of Rhythm Strips."

Sinus Rhythms

Sinus rhythm is a regular rhythm, but the rate varies depending on autonomic nervous system regulation of the sinus node. When the rhythm is regular but there is an abnormal rate, it is called “sinus arrhythmia.” Sinus arrhythmias include sinus tachycardia and sinus bradycardia. Characteristics and treatment of sinus rhythms are summarized in Table 7.4a at the end of this subsection.

Normal sinus rhythm (NSR) originates from the sinus node and describes the characteristic rhythm of a healthy human heart. All components of the ECG waveform are within normal limits. See Figure 7.16[1] for an image of normal sinus rhythm.

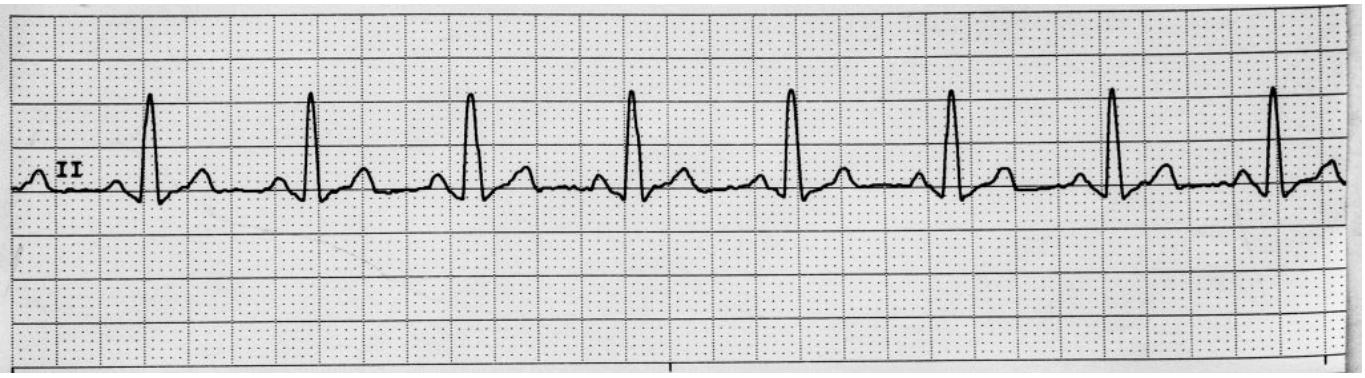

Figure 7.16 Normal Sinus Rhythm

A sinus rhythm faster than a normal rate (i.e., greater than 100 in adults) is called a **sinus tachycardia**. Sinus tachycardia is commonly caused by stress, exercise, alcohol, caffeine, and tobacco and can be resolved by addressing these causes. However, sinus tachycardia can also be caused by conditions such as hypovolemia, anemia, fever/infection, decreased oxygenation, cardiac conditions, and some medications, requiring nursing action depending upon the cause. See Figure 7.17[2] for an image of sinus tachycardia.

1. “Normal Sinus Rhythm” by Deanna Hoyord is licensed under CC BY 4.0
2. “Sinus Tachycardia.jpg” by Deanna Hoyord is licensed under CC BY 4.0

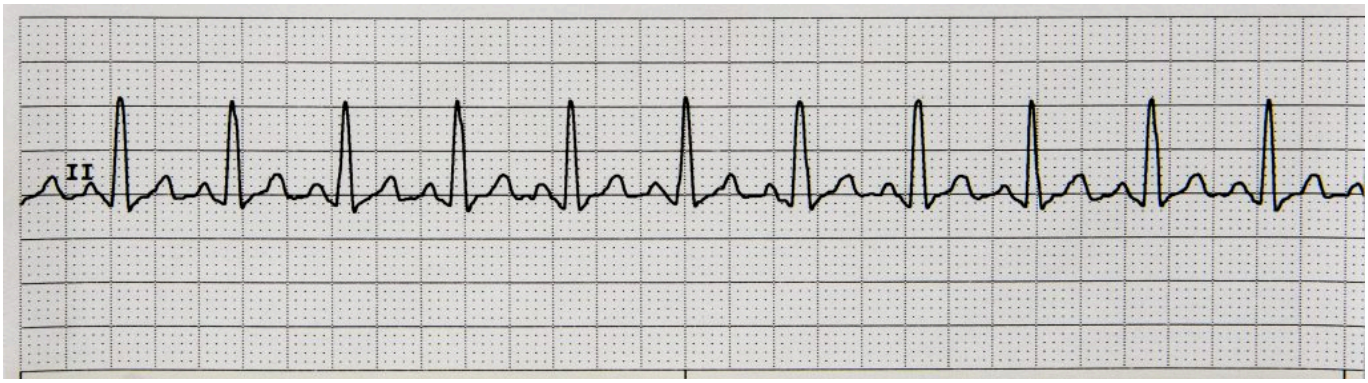

Figure 7.17 Sinus Tachycardia

A sinus rhythm with a slower rate than normal range (i.e., less than 60 in an adult) is called a **sinus bradycardia**. Sinus bradycardia may be asymptomatic and normally occur in athletes due to a well-conditioned heart. However, it can also be symptomatic and signify a new cardiac condition or side effect of cardiac medications, requiring nursing action. See Figure 7.18[3] for an image of sinus bradycardia.

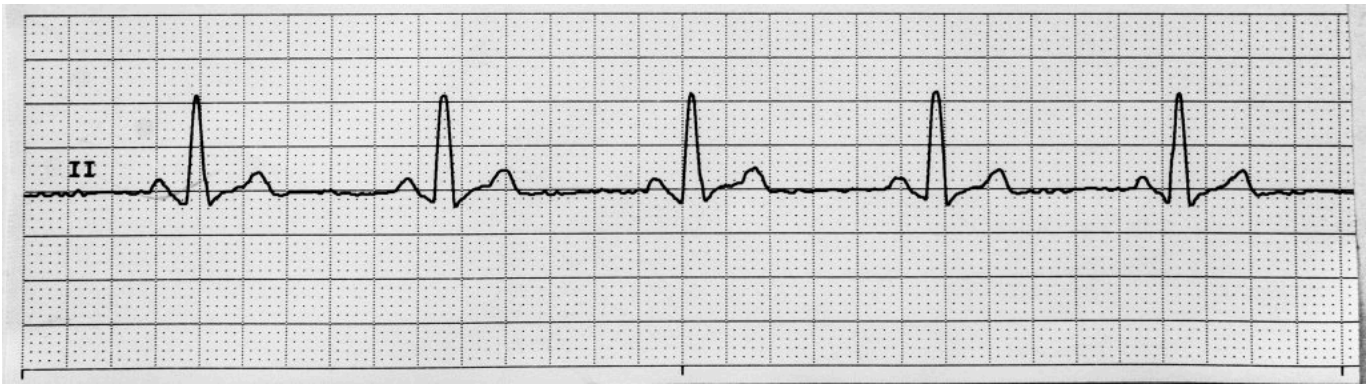

Figure 7.18 Sinus Bradycardia

Respiratory sinus arrhythmia is typically a normal finding in young, healthy adults where the heart rhythm correlates to the respiratory cycle. As the client breathes in, the heart rate increases and then the rate slows as they breathe out.

Table 7.4a Characteristics of Normal Sinus Rhythm and Common Sinus Dysrhythmias

3. "Sinus Bradycardia" by Deanna Hoyord is licensed under CC BY 4.0

Sinus Rhythms	Patho-physiology	Causes	Identification	Symptoms	Nursing Interventions	Medical Treatment	Patient Education
Normal Sinus Rhythm (NSR)	Normal conduction of the heart.	N/A	All components are within normal limits.	N/A	N/A	N/A	N/A
Sinus Bradycardia[4]	Slowed electrical conduction in the heart.	May occur in well-conditioned athletes. Can also signify a cardiac condition or side effects of cardiac medications requiring nursing action.	All components are within normal limits except the heart rate is less than 60 beats per minute.	Many clients are asymptomatic, but if signs and symptoms occur, they are related to decreased cardiac output.	Assess for adequate cardiac output. Withhold cardiac medications if indicated and notify the provider.	If symptomatic, the cause is treated. Atropine, transcutaneous pacemaker, and placement of a permanent pacemaker may be required for chronic bradycardia.	Seek medical care for symptoms such as chest pain, shortness of breath, dizziness, confusion, or fainting.
Sinus Tachycardia[5]	Fast electrical conduction through the heart, causing lack of filling between each beat.	Often caused by stress, exercise, alcohol, caffeine, and tobacco. Can also be caused by hypovolemia, anemia, fever/infection, decreased oxygenation, cardiac conditions, and some medications.	All components are within normal limits except the heart rate is above 100 beats per minute.	Some clients are asymptomatic. Other clients have palpitations or symptoms of decreased cardiac output.	Assess for adequate cardiac output and notify the provider if indicated. Educate about lifestyle changes that could cause the rhythm.	If symptomatic, the underlying cause is treated. Beta-blockers, calcium channel blockers, or sinus ablation may be used to slow the rate.	Eliminate the cause of the rhythm. Seek medical treatment for symptoms of chest pain, shortness of breath, dizziness, confusion, or loss of consciousness.
Respiratory Sinus Arrhythmia[6]	Rhythm correlates to the respiratory cycle; the rate increases when the client breathes in and slows when they breathe out.	Very common in young healthy adults.	All components are within normal limits except the rhythm is irregular and corresponds to the respiratory cycle. If the client holds their breath, the rhythm reverts to NSR.	Rare.	Notify the provider if symptomatic.	Typically, no treatment is needed.	This is a sign of a normal functioning heart.

4. Cleveland Clinic. (2022, March 7). *Sinus bradycardia.* https://my.clevelandclinic.org/health/diseases/22473-sinus-bradycardia
5. Cleveland Clinic. (2022, October 3). *Tachycardia.* https://my.clevelandclinic.org/health/diseases/22108-tachycardia
6. Cleveland Clinic. (2022, March 21). *Sinus arrhythmia.* http://my.clevelandclinic.org/health/diseases/21666-sinus-arrhythmia

Atrial Rhythms

Atrial rhythms originate in the atria rather than in the SA node. The P wave is positive, but its shape can be different from a normal sinus rhythm because the electrical impulse follows a different path to the AV (atrioventricular) node. Common atrial arrhythmias include premature atrial contractions, atrial fibrillation, and atrial flutter. Characteristics and treatment of common atrial dysrhythmias are summarized in Table 7.4b at the end of this subsection.

Premature atrial contractions (PAC) are common in older adults and are caused by ectopic beats that originate in the atria. They are not typically treated unless the client becomes symptomatic.

Atrial fibrillation (A-fib) is categorized as an "irregularly irregular rhythm." It is characterized by atrial quivering, resulting in a lack of P waves. Clients may develop signs and symptoms of decreased cardiac output because the ventricles are not able to fill and pump the appropriate amount of blood with each beat. Nurses should assess for signs of decreased cardiac output, including fatigue, dizziness, syncope, chest pain, and shortness of breath, as well as for new signs of stroke. Clients with A-fib are at risk of stroke due to blood pooling in the atria. See Figure 7.19[7] for an image of atrial fibrillation.

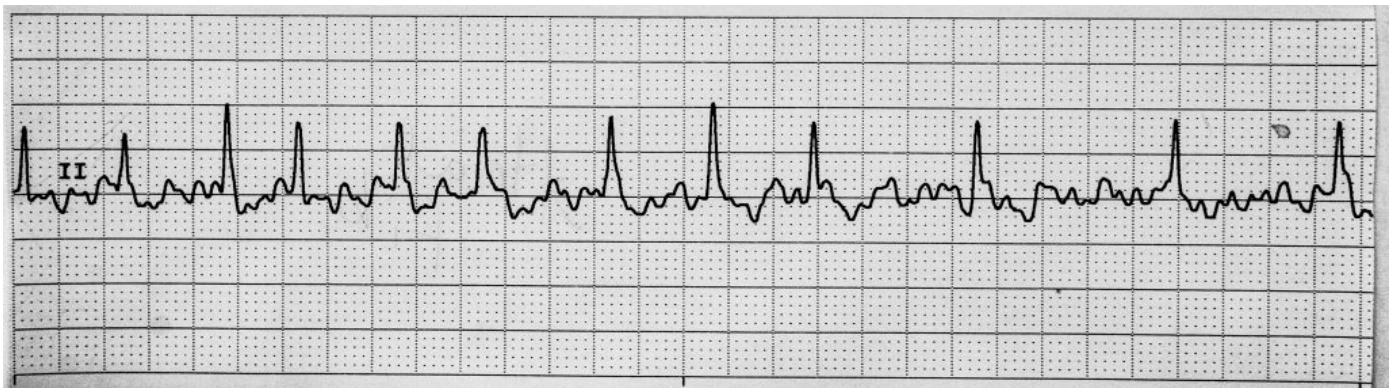

Figure 7.19 Atrial Fibrillation

Atrial flutter (A flutter) displays the atrial beats as sawtooth beats, and the PR interval is not measurable. Atrial impulses are fast and regular, with rates between 250-300, and the ventricular rate is not the same as the atrial rate. As a result, the client's cardiac output decreases because the heart is not able to

7. "Atrial Fibrillation" by Deanna Hoyord is licensed under CC BY 4.0

fill and pump the appropriate amount of blood with each beat. Clients with atrial flutter are also at risk for stroke. See Figure 7.20[8] for an image of atrial flutter.

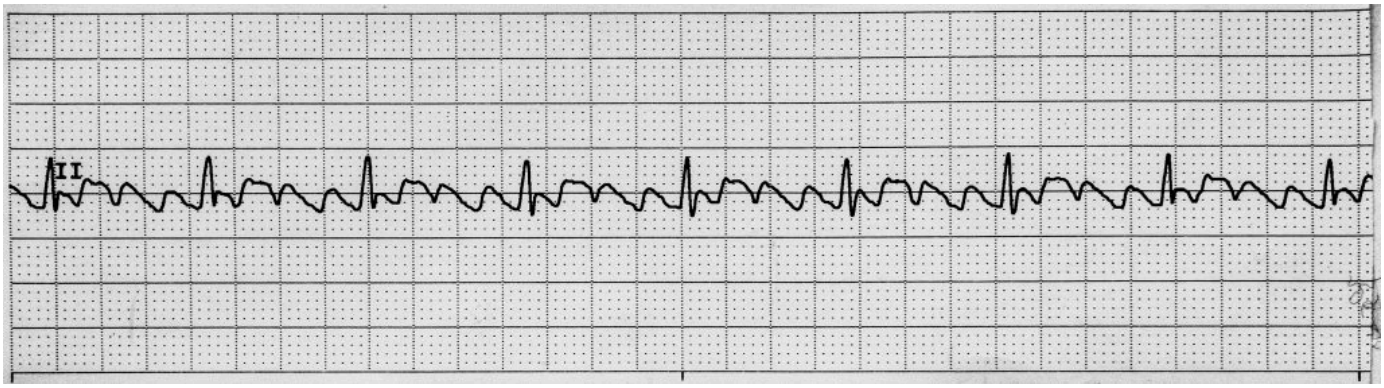

Figure 7.20 Atrial Flutter

Table 7.4b Characteristics of Common Atrial Dysrhythmias

8. "Atrial Flutter" by Deanna Hoyord is licensed under CC BY 4.0

Atrial Rhythms	Pathophysiology	Causes	Identification	Symptoms	Nursing Interventions	Treatment	Patient Education
Premature Atrial Contractions (PAC)[9]	An ectopic beat that originates in the atria.	Common in older adults; often caused by caffeine, tobacco, anxiety, and electrolyte imbalances.	Early P waves that may be closer than normal to the previous T wave.	Feelings of a skipped beat or palpitations.	Encourage lifestyle changes, such as decreased caffeine, tobacco, and alcohol intake, as well as improved stress management.	If symptomatic, then treatments are prescribed to eliminate the cause.	Seek medical treatment for symptoms of chest pain, shortness of breath, dizziness, confusion, or fainting.
Atrial Fibrillation (A-fib)[10]	An irregular heart rhythm originating in the atria characterized by atrial quivering. This rhythm is categorized as an "irregularly irregular rhythm." Clients are at increased risk for a stroke due to blood pooling in the atria.	Coronary artery disease, heart failure, high blood pressure, and cardiac irritability due to ischemia or electrolyte imbalances.	Irregular heart rate with lack of clear P waves and a wavy baseline because they are quivering. PR interval is not measurable.	Irregular heartbeat and possible palpitations. May have signs and symptoms of decreased cardiac output, including fatigue, dizziness, syncope, chest pain, and shortness of breath.	Be aware that atrial and ventricular rates are different and may affect the accuracy of blood pressure readings on automatic monitors. Immediately report signs of decreased cardiac output or signs of stroke.	Medications for stable A-fib include those to control rate and/or rhythm, as well as anticoagulation to prevent strokes. Treatments of unstable A-fib include cardioversion and/or ablation. A pacemaker may be implanted if bradycardia is present.	Seek medical care for symptoms of a stroke, such as one-sided weakness or paralysis, slurred speech, or facial drooping. Seek medical treatment for chest pain, shortness of breath, dizziness, confusion, or fainting.
Atrial Flutter (A flutter)[11]	Fast, regular atrial impulses with rates between 250-300. As a result, the heart is not able to fill and pump the appropriate amount of blood with each beat. Clients are at increased risk for stroke.	Coronary artery disease, hypertension, obesity, and heart failure.	Atrial beats appear as sawtooth beats. PR interval is not measurable. QRS may be regular or irregular.	Shortness of breath, syncope, palpitations, and dizziness.	Be aware atrial and ventricular rates will be different. Monitor for signs of decreased cardiac output and stroke.	If stable, medications are prescribed for rate and/or rhythm control, as well as for anticoagulation to prevent strokes. If unstable, cardioversion, ablation, and/or a pacemaker may be performed.	Seek medical care for symptoms of a stroke, such as one-sided weakness or paralysis, slurred speech, or facial drooping. Seek medical treatment for chest pain, shortness of breath, dizziness, confusion, or fainting.

9. Cleveland Clinic. (2021, July 27). *Premature atrial contractions.* https://my.clevelandclinic.org/health/diseases/21700-premature-atrial-contractions
10. Cleveland Clinic. (2022, May 1). *Atrial fibrillation (Afib).* https://my.clevelandclinic.org/health/diseases/16765-atrial-fibrillation-afib
11. Cleveland Clinic. (2022, September 21). *Atrial flutter.* https://my.clevelandclinic.org/health/diseases/22885-atrial-flutter

Ventricular Rhythms

Ventricular rhythms originate in the ventricles (rather than the SA node) and typically cause the heart to beat faster (i.e., ventricular tachycardia) or quiver (i.e., ventricular fibrillation). There are several different types of ventricular dysrhythmias. Many ventricular dysrhythmias are life-threatening and require immediate emergency response. Common ventricular dysrhythmias include premature ventricular tachycardia (PVC), supraventricular tachycardia, torsades de pointes, ventricular tachycardia (V-tach), and ventricular fibrillation (V-fib). Characteristics and treatment of common ventricular dysrhythmias are summarized in Table 7.4c at the end of this subsection.

Some ventricular dysrhythmias may be unifocal or multifocal. **Unifocal** dysrhythmias causes the waveforms to look the same because the signal is originating from the same area in the heart, whereas **multifocal** dysrhythmias cause the waveforms to look different because the impulse is originating from different areas of the heart. Multifocal rhythms are harder to treat and are more dangerous because the impulse is not predictable and multiple areas of the heart are involved.

Premature ventricular contractions (PVC) are caused by ectopic beats that originate in the ventricle, resulting in the appearance of wide, bizarre QRS complexes within an otherwise normal sinus rhythm. Although occasional PVCs are common in healthy adults with no symptoms other than occasional palpitations, increased frequency of PVCs per minute can signal a more serious condition. **Bigeminy** is a PVC every other beat. **Trigeminy** is a PVC every third beat. **Couplets** refer to PVCs occurring in pairs. See Figure 7.21[12] for an image of unifocal PVCs in an otherwise normal sinus rhythm. See Figure 7.22[13] for an image of PVCs occurring in couplets.

R on T phenomenon occurs when a PVC occurs on a T wave and can trigger ventricular tachycardia. Medications or diseases that cause prolonged QT interval can result in R on T phenomenon.

12. "Sinus Rhythm with Unifocal PVCs" by Deanna Hoyord is licensed under CC BY 4.0
13. "Bigeminy PVCs" by Deanna Hoyord is licensed under CC BY 4.0

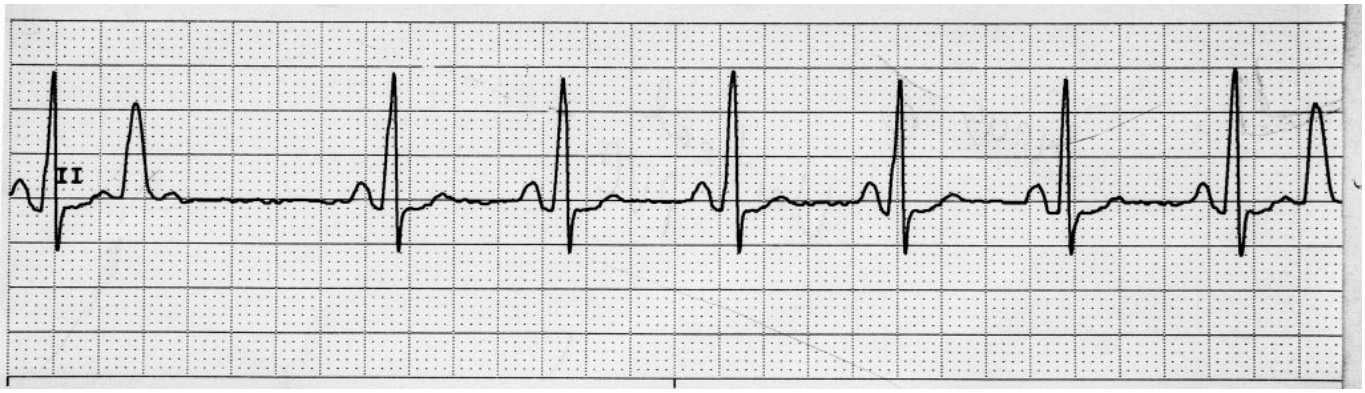

Figure 7.21 Sinus Rhythm With Unifocal PVCs

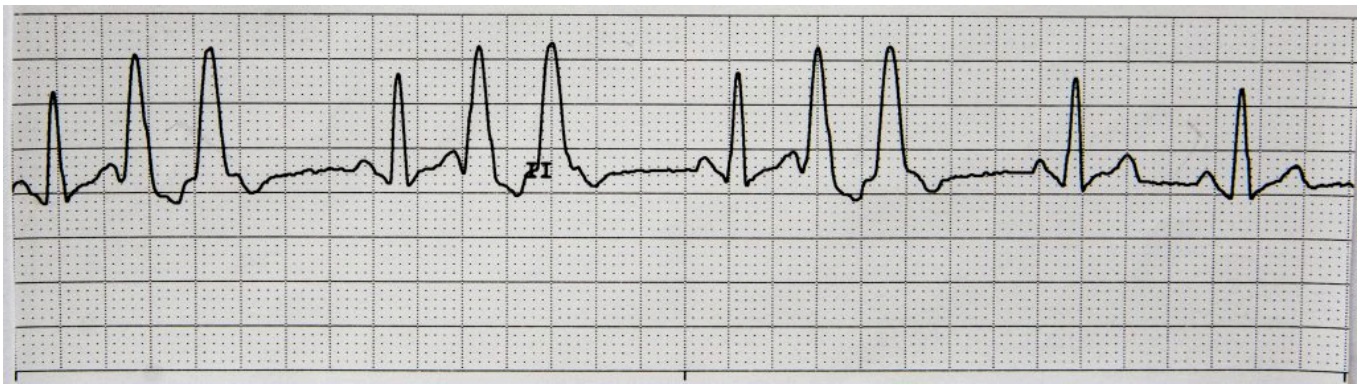

Figure 7.22 Premature Ventricular Contractions (PVCs) – Couplets

Supraventricular tachycardia (SVT) is characterized by a narrow QRS interval of 0.1 second or less and rapid heart rates over 160 beats per minute. P waves often cannot be identified due to fast rate, and cardiac output may decrease due to the inability of the ventricles to fill and pump blood. See Figure 7.23[14] for an image of supraventricular tachycardia.

14. "Supraventricular Tachycardia" by Deanna Hoyord is licensed under CC BY 4.0

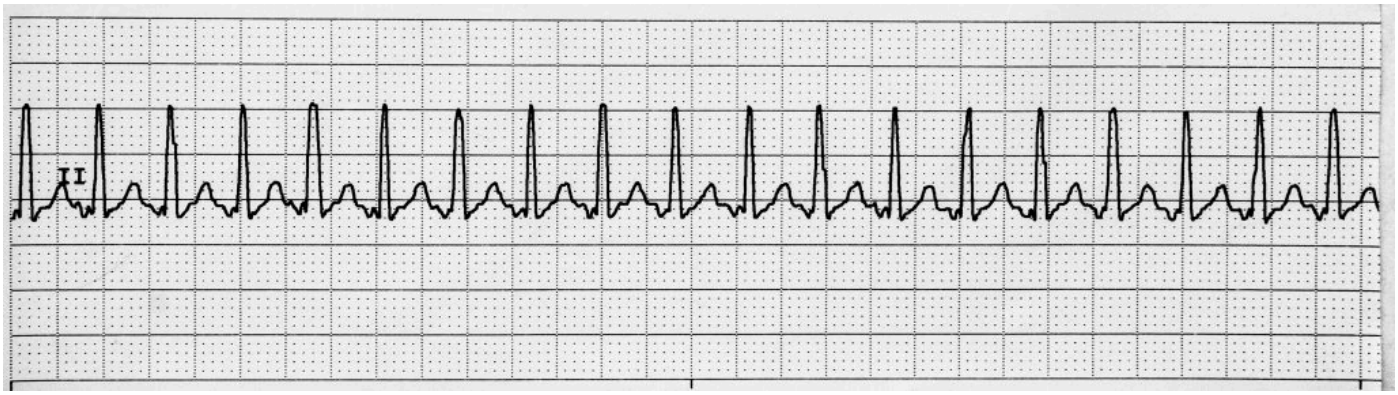

Figure 7.23 Supraventricular Tachycardia

Ventricular tachycardia (V-tach) is characterized by wide QRS complexes without visible P and T waves. The ventricular rate is often over 120 beats per minute, resulting in rapidly worsening cardiac output. The client is only able to tolerate this rapid ventricular rhythm for a short period of time before losing consciousness. V-tach requires emergency response. If the client has a pulse, synchronized cardioversion and/or intravenous antidysrhythmic medications are administered. If the client does not have a pulse, defibrillation is administered. Read details about synchronized cardioversion and defibrillation in the "Cardioversion and Defibrillation" section of this chapter. Read more information about antidysrhythmic medications in the "Antiarrhythmics" section of the "Cardiac and Renal" chapter of Open RN *Nursing Pharmacology*. See Figure 7.24[15] for an image of ventricular tachycardia.

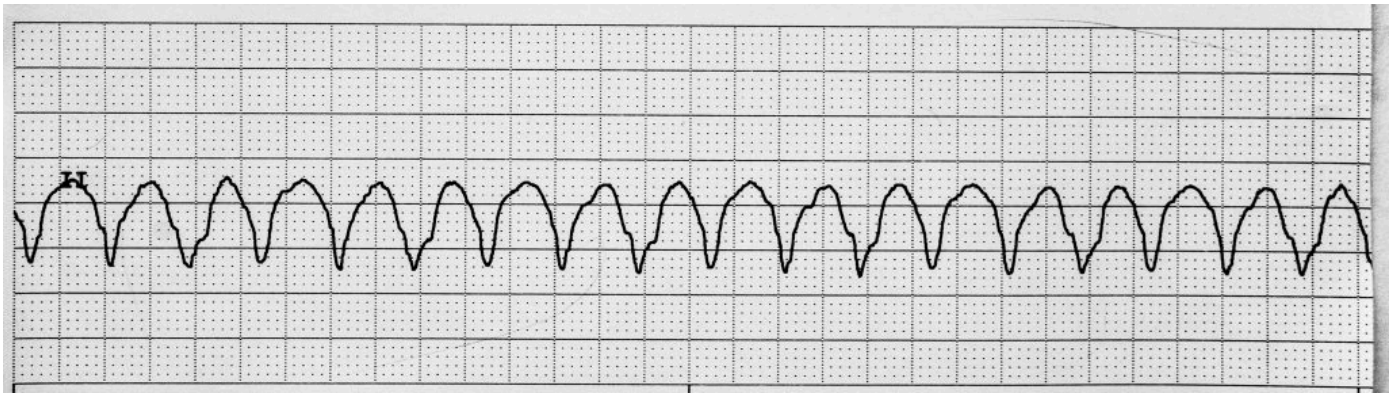

Figure 7.24 Ventricular Tachycardia

15. "Ventricular Tachycardia" by Deanna Hoyord is licensed under CC BY 4.0

Torsades de pointes is a type of V-tach that occurs when there is a long QT interval, and a beat occurs during the QT interval. It resembles ventricular tachycardia but has a pattern of twisting points or peaks. This rhythm can rapidly develop into ventricular fibrillation and requires emergency response. See Figure 7.25[16] for an image of torsades de pointes.

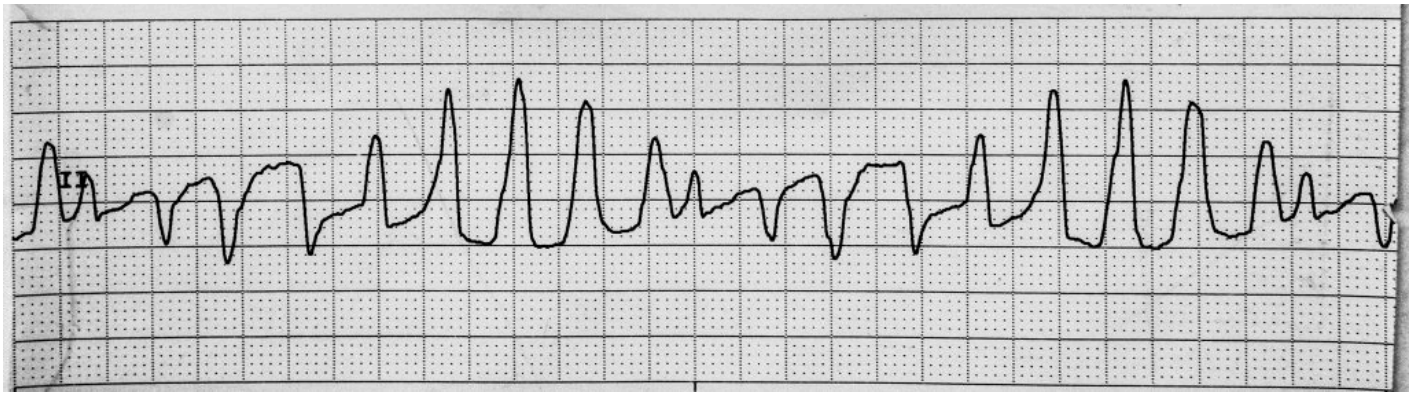

Figure 7.25 Torsades de Pointes

Ventricular fibrillation is characterized by quivering ventricles with no patterns to the waveforms, so nothing can be measured on the ECG. As a result, there are no effective contractions and no cardiac output. This is the most dangerous arrhythmia because of lack of cardiac output and requires immediate initiation of CPR and emergency response. Defibrillation is administered, along with IV antidysrhythmic medications. Read details about defibrillation in the "Cardioversion and Defibrillation" section of this chapter. Read more information about antidysrhythmic medications in the "Antiarrhythmics" section of the "Cardiac and Renal" chapter of Open RN *Nursing Pharmacology 2e*. See Figure 7.26[17] for an image of ventricular fibrillation.

16. "Torsades de Pointes" by Deanna Hoyord is licensed under CC BY 4.0
17. "Ventricular Fibrillation" by Deanna Hoyord is licensed under CC BY 4.0

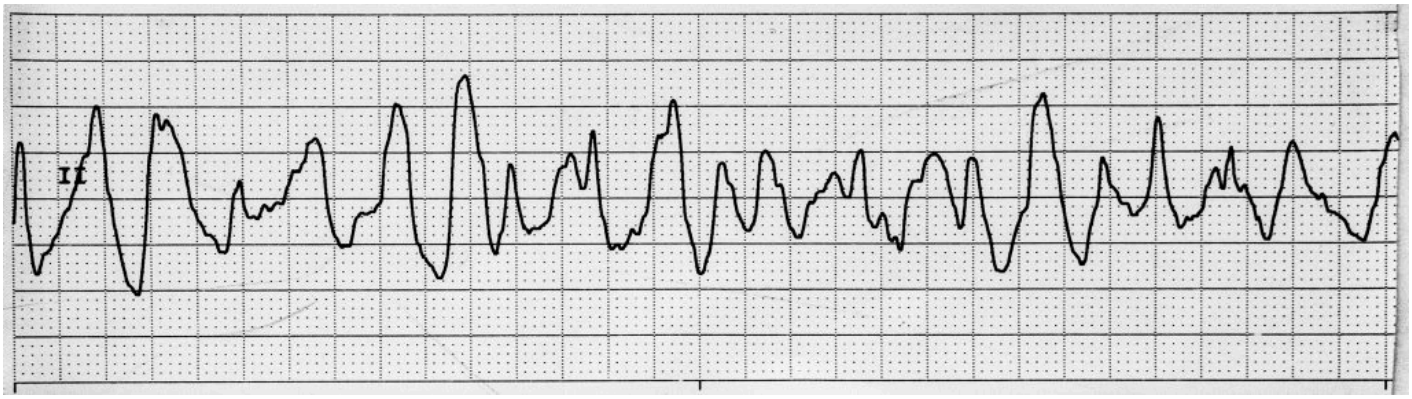

Figure 7.26 Ventricular Fibrillation

Some dysrhythmias, such as asystole and pulseless electrical activity, have no electrical conduction through the ventricles, resulting in no contractions and no pulse.

In **asystole** there are no electrical impulses, and a flat line appears on the ECG. CPR and emergency treatment are instituted, but asystole is not a shockable rhythm because there are no existing electrical impulses. See Figure 7.27[18] for an image of asystole.

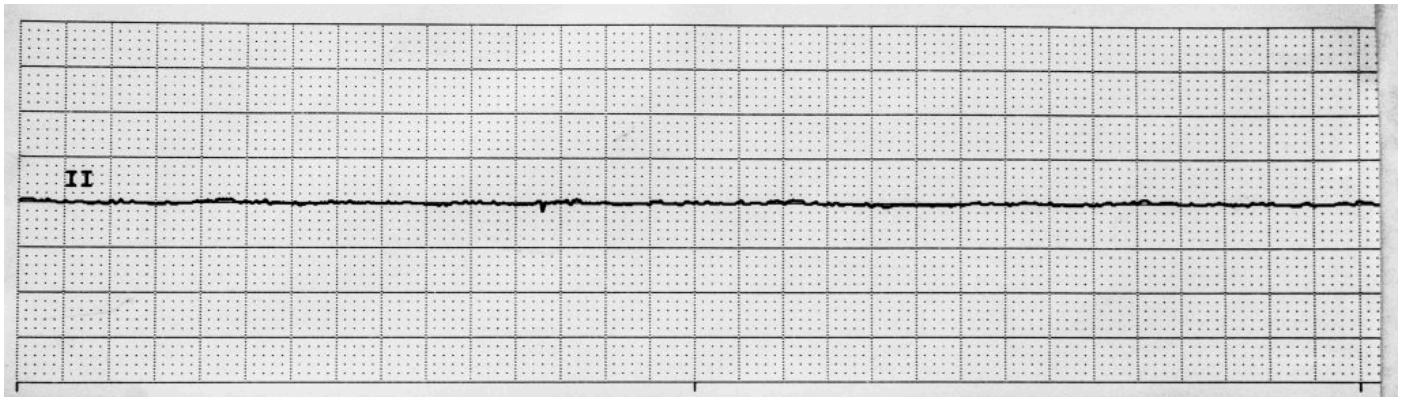

Figure 7.27 Asystole

Pulseless electrical activity (PEA) is similar to asystole because although electrical activity appears on the ECG, it is not strong enough to stimulate a ventricular contraction or a pulse. CPR and emergency treatment are initiated, but PEA is not a shockable rhythm.

Table 7.4c Characteristics of Common Ventricular Dysrhythmias, Asystole, and PEA

18. "Asystole" by Deanna Hoyord is licensed under CC BY 4.0

Ventricular Rhythms	Pathophysiology	Causes	Identification	Symptoms	Nursing Interventions	Treatment	Patient Education
Premature Ventricular Contraction (PVC)[19]	Ectopic beats that originate in the ventricle. Common in healthy adults with no symptoms other than occasional palpitation.	Heart failure, high blood pressure, electrolyte imbalance, stress, alcohol, and excessive caffeine or energy drink consumption.	Wide bizarre QRS complexes within a normal underlying rhythm. May be single or multiple PVCs.	Palpitations and signs of decreased cardiac output depending on how frequent they are occurring.	Monitor for signs of decreased cardiac output.	If PVCs are infrequent or asymptomatic, no treatment is needed. Treatment for symptomatic PVCs include correcting the underlying cause and may include ablation and antiarrhythmic medication.	Educate about potential causes and lifestyle changes such as decreased caffeine and alcohol and improved stress management. Seek medical care for signs of decreased cardiac output.
Supraventricular Tachycardia (SVT)[20]	The impulse to the ventricle is fast with ventricular rates often over 160 beats per minute.	Stress, caffeine, alcohol, infection, or sepsis.	Narrow-complex tachycardias with a QRS interval of 0.1 second or less. P waves cannot be identified due to the fast ventricular rate.	Chest pain, fast heartbeat, palpitations, shortness of breath, and syncope.	Prepare to administer medications to slow the heart rate.	Valsalva maneuvers and medications are used to slow the heart rate.	Seek medical care when the heart feels like it is racing or for symptoms of chest pain, shortness of breath, dizziness, confusion, or fainting.
Ventricular Tachycardia (V-tach[21]	Ventricular rate over 120 beats per minute, causing rapidly worsening cardiac output.	Coronary artery disease, heart failure, myocarditis, heart surgery, previous damage to the heart, recreational drugs, alcohol, medications, and electrolyte imbalances.	Wide QRS complexes are the only components that are measurable. P and T waves are not visible.	Chest pain, shortness of breath, syncope, palpitations, and cardiac arrest. Client can only tolerate this rhythm for a short period of time before losing consciousness.	Notify the provider and obtain emergency assistance. Prepare to administer IV antidysrhythmic medications, cardioversion, or defibrillation.	Reversible causes are treated. If the client is stable, synchronized cardioversion and IV antidysrhythmic medications are administered. If the client is unstable, defibrillation and CPR are administered, along with IV antidysrhythmic medications.	Call 911 for chest pain, shortness of breath, or fainting.

19. Cleveland Clinic. (2022, July 29). *Premature ventricular contractions.* https://my.clevelandclinic.org/health/diseases/17381-premature-ventricular-contractions
20. Cleveland Clinic. (2021, December 1). *SVT (supraventricular tachycardia).* https://my.clevelandclinic.org/health/diseases/22152-svt-supraventricular-tachycardia
21. Cleveland Clinic. (2022, June 12). *Ventricular tachycardia*. https://my.clevelandclinic.org/health/diseases/17616-ventricular-tachycardia

Torsades de Pointes[22]	A type of V-tach.	Long QT interval syndrome, certain congenital syndromes, and medications that can prolong the QT interval.	Resembles ventricular tachycardia but looks like twisting points or peaks. Review the first beat to determine if it started in the QT interval.	Chest pain, shortness of breath, syncope, palpitations, and cardiac arrest. Client can only tolerate this rhythm for a short period of time before losing consciousness.	Notify the provider and obtain emergency assistance. Be aware if the client is taking medications that prolong the QT interval. Prepare to administer IV antidysrhythmic medications, cardioversion, or defibrillation.	Reversible causes are treated. Synchronized cardioversion, IV magnesium, and/or IV antiarrhythmic medications are administered. An implantable cardiac defibrillator may be required.	Seek medical care for feelings of the heart racing or palpitations.
Ventricular Fibrillation (V-fib)[23]	The ventricles are quivering with no effective contractions and no cardiac output. This is the most dangerous arrhythmia.	Heart disease, heart attack, heart surgery, untreated arrhythmias, electrolyte imbalances, and electrical shock.	Nothing can be measured because there is just a fibrillatory line. Can be coarse or fine fibrillatory waves. Coarse waves are taller than fine. Fine V-fib is harder to treat and convert to a sustaining rhythm.	Pulselessness and loss of consciousness.	Obtain emergency assistance and initiate CPR. Prepare to administer IV antidysrhythmic medications and defibrillation.	Reversible causes are treated. Defibrillation and IV antiarrhythmic medications administered according to ACLS algorithm.	Not applicable because the client is unconscious.
Asystole[24]	There are no electrical impulses occurring in the heart.	Shock, heart attack, untreated arrhythmia, trauma, and toxins.	A flat line appears on the ECG. There is no impulse occurring, so nothing is measurable.	Client is unconscious and does not have a pulse.	Initiate CPR and obtain emergency assistance. Be aware systole is not a shockable rhythm.	CPR and IV epinephrine are administered, and the underlying cause is treated.	Not applicable because the client is unconscious.
Pulseless Electrical Activity (PEA)[25]	There is electrical activity, but it is not strong enough to cause a contraction or a pulse.	Cardiac arrest, shock, untreated dysrhythmias, hypothermia, and trauma.	ECG components may be present, but the client does not have a pulse.	Client is unconscious and does not have a pulse.	Initiate CPR and obtain emergency assistance. Be aware PEA is not a shockable rhythm.	PEA is not a shockable rhythm. CPR and IV epinephrine are administered, and the underlying cause is treated.	Not applicable because the client is unconscious.

22. Cleveland Clinic. (2021, August 13). *Torsades de pointes.* https://my.clevelandclinic.org/health/diseases/21915-torsades-de-pointes
23. Cleveland Clinic. (2021, September 20). *Ventricular fibrillation.* https://my.clevelandclinic.org/health/diseases/21878-ventricular-fibrillation
24. Cleveland Clinic. (2022, May 3). *Asystole*. https://my.clevelandclinic.org/health/symptoms/22920-asystole
25. Cleveland Clinic. (2022, June 3). *Pulseless electrical activity*. https://my.clevelandclinic.org/health/symptoms/23213-pulseless-electrical-activity

Heart Block

A **heart block** is an obstruction in the normal pathway of electrical conduction through the heart that can occur in many anatomical locations. The anatomical location of a heart block can be categorized as in the sinus node, atrioventricular (A/V) node, or bundle branches.[26]

Sinus node blocks (also referred to as sinoatrial exit blocks) occur due to failed conduction of the impulses beyond the SA node, resulting in prolonger PR intervals or dropped P waves on the ECG. Common causes of sinus node blocks include sick sinus syndrome, increased vagal tone, inferior wall MI, vagal stimulation, myocarditis, and drugs (including digoxin and beta-blockers).[27]

Atrioventricular (AV) blocks are conduction blocks that can occur anywhere between the SA node and Purkinje fibers. There are three variants of AV blocks: first-degree, second-degree, and third-degree. Diagnosing AV blocks requires careful measuring of the PR interval and examining the relationship of the P waves to QRS complexes.[28] Certain medications, such as beta-blockers, can contribute to or worsen AV blocks and may need adjustments per the health care provider. First-degree, second-degree, third-degree, and bundle branch blocks are further described in the following subsections. Characteristics and treatments of common heart blocks are summarized in Table 7.4d at the end of this section.

First-Degree Heart Block

First-degree AV block is defined as a prolonged PR interval more than 0.2 seconds. A single P wave precedes every QRS complex by a consistent length. It may be a normal finding in some individuals. Conversely, it can be an early sign of degenerative disease of the conduction system or a transient manifestation of myocarditis, drug toxicity, hypokalemia, and acute rheumatic

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27. This work is a derivative of StatPearls by Sattar and Chhabra and is licensed under CC BY 4.0
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fever. It usually does not require any treatment.[29] See Figure 7.28[30] for an image of first-degree heart block.

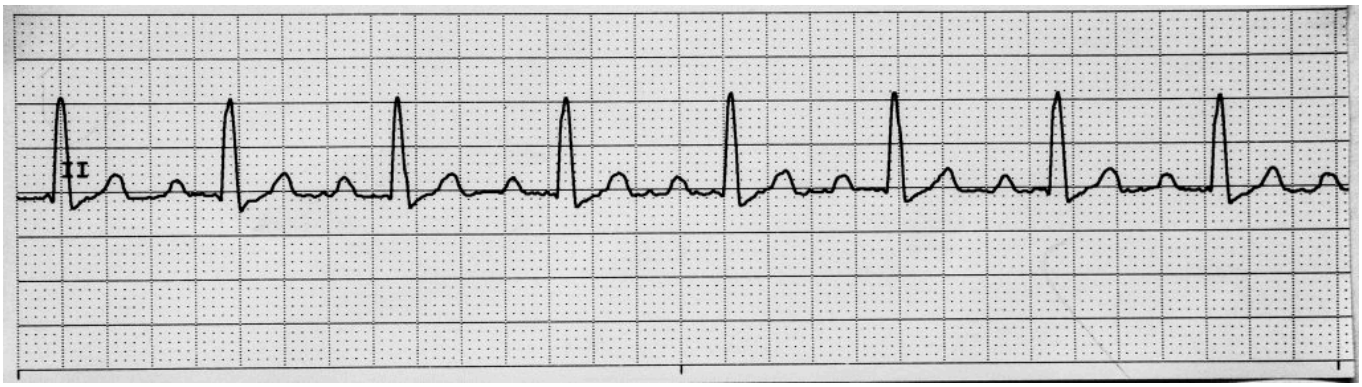

Figure 7.28 First-Degree Heart Block

Second-Degree Heart Block

There are two types of second-degree heart blocks: Type I and Type II.

TYPE I

Second-degree Type 1 AV block is also known as Wenckebach block. The block across the AV node or bundle of His is variable and increases with each ensuing impulse, ultimately resulting in a drop of the impulse. On an ECG, it shows a progressive prolongation of the PR interval, and then suddenly, a P wave is not followed by the QRS complex. This sequence regularly repeats itself. Most clients with Mobitz Type I second-degree AV block are asymptomatic. Mobitz Type I AV block may occur in the setting of acute myocardial ischemia or myocarditis. It may also result in clinical deterioration if the resulting ventricular rate is inadequate to maintain cardiac output. Most clients with Mobitz Type I second-degree AV block are asymptomatic and do not require specific intervention. Occasionally, clients with Mobitz Type I block are symptomatic, demonstrate hemodynamic instability, and require treatment with either atropine or cardiac pacing.[31]

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30. "1st Degree Heart Block" by Deanna Hoyord is licensed under CC BY 4.0
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TYPE II

Second-degree Type 2 AV block has a consistent PR interval and the duration may be normal, but there are dropped ventricular beats, or QRS complexes, periodically. There can be one or more dropped QRS complexes, which can result in several P waves in a row without QRS complexes following them. This is significant because when ventricular beats are dropped, there is no ventricular output, meaning there is no cardiac output for the preceding P waves. It usually occurs below the AV node at the level of the bundle of His. It clinically signifies a severe underlying heart disease that can progress to third-degree heart block. When diagnosed, it usually requires prompt treatment with a permanent pacemaker.[32] See Figure 7.29[33] for an image of second-degree heart block, Type II.

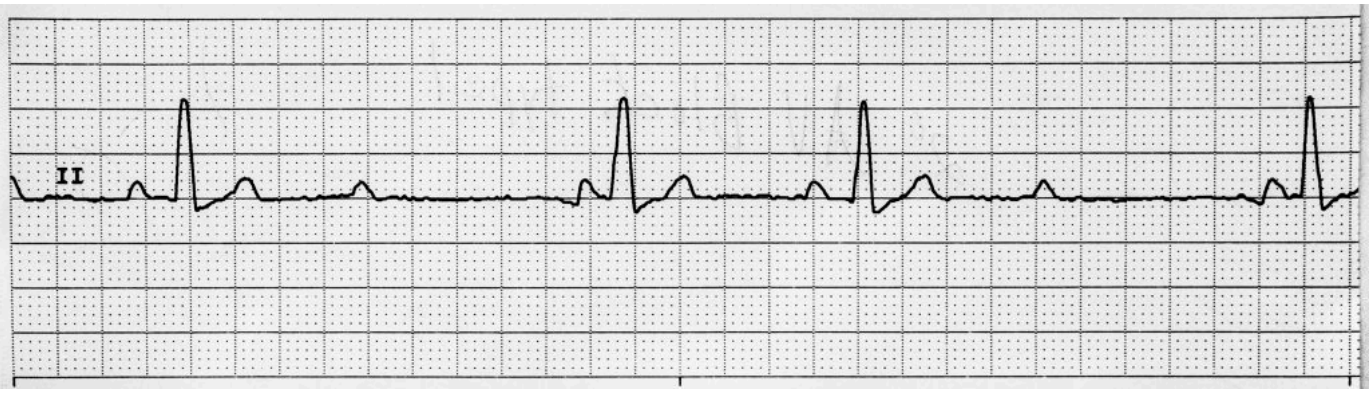

Figure 7.29 Second-Degree Heart Block Type II

Third-Degree Heart Block

Third-degree AV block, also called complete heart block, is characterized by a complete electrical dissociation between the atria and ventricles, resulting in the atria and the ventricles beating at their intrinsic rates irrespective of how the other is beating. Degenerative disease of the conduction system is the leading cause of third-degree heart block. A complete heart block may present in acute myocardial infarction. Complete heart block may be reversible with prompt revascularization, especially in inferior myocardial

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33. "2nd Degree Type II AV Block.jpg" by Deanna Hoyord is licensed under CC BY 4.0

infarction. Elevated magnesium levels can also cause third-degree heart block. Lyme disease may be associated with a complete heart block and is potentially reversible with antibiotic therapy. In the case of irreversible or permanent complete heart block, a permanent pacemaker remains the standard treatment.[34] See Figure 7.30[35] for an image of third-degree heart block.

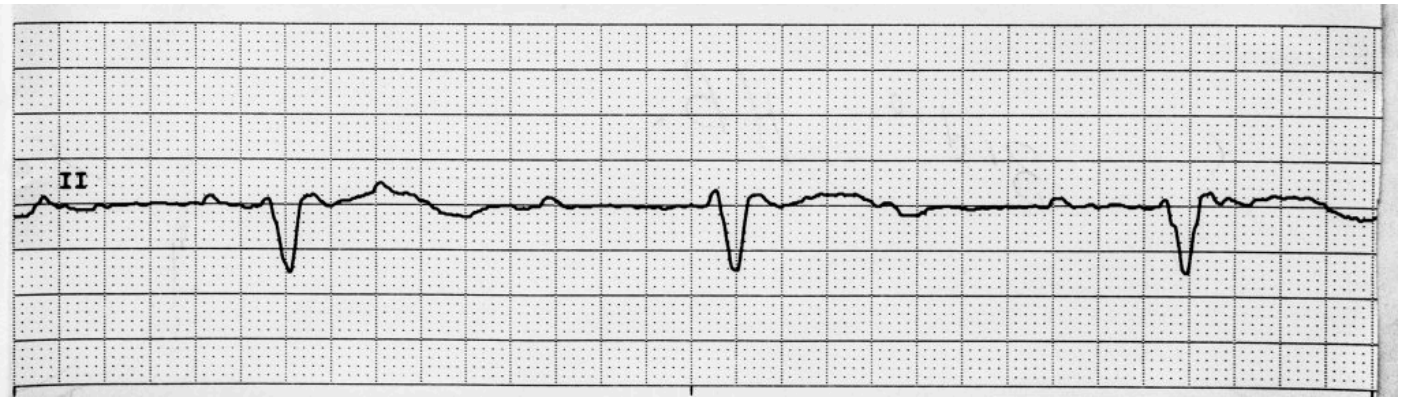

Figure 7.30 Third-Degree Heart Block

Bundle Branch Blocks

Bundle branch blocks (i.e., intraventricular conduction delays) result from the conduction block of either left or right bundle branches and occur within the ventricles. They are diagnosed by examining the width and configuration of the QRS complexes.[36] A generic bundle branch block is characterized by a widened QRS complex greater than 0.12 mm. To determine if it is a right or left bundle branch block, additional 12-lead EKG interpretation is necessary and is beyond the scope of this text.

Table 7.4d Characteristics of Common AV Blocks

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35. "Third Degree Heart Block.jpg" by Deanna Hoyord is licensed under CC BY 4.0
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AV Blocks	Pathophysiology	Causes	Identification	Symptoms	Nursing Interventions	Treatment	Patient Education
1st-Degree AV Block	There is a slowed impulse from the AV node to the ventricles.	Heart attack, heart muscle disease, heart surgery, medications, toxins, and genetics.	The PR interval is greater than 0.20 seconds and consistent. There is one P wave for each QRS.	Typically, no symptoms.	Typically, none because asymptomatic.	Reverse underlying causes.	This is the least dangerous form of a heart block, but there is a chance it could progress to worse types of heart blocks.
2nd-Degree Type 1 AV Block	The impulse from the AV node to the ventricles gets slower and slower with each beat until there is a dropped beat. The pattern then repeats itself.	Same as 1st-degree block.	The PR interval will become more prolonged with each beat until there is a missing beat.	Syncope, chest pain, shortness of breath, palpitations, shortness of breath, and nausea.	Treat the cause of the block if it is reversible. Monitor for signs of worsening decreased cardiac output.	Reverse underlying causes. If symptomatic, medications prescribed to improve cardiac output until a permanent pacemaker can be placed.	Be aware this type of block can progress to worsening blocks. Seek medical treatment for chest pain, shortness of breath, dizziness, confusion, or fainting.
2nd-Degree Type 2 AV Block	The impulse from the AV node to the ventricles is variable. Some beats will be normal, and other beats will be dropped.	Same as 1st-degree block.	PR interval is consistent. It may be normal or prolonged until the QRS is dropped, resulting in only P waves for those heartbeats.	Syncope, chest pain, shortness of breath, palpitations, shortness of breath, and nausea.	Treat the cause of the block if it is reversible. Monitor for signs of worsening decreased cardiac output.	Reverse underlying causes. Symptomatic: Medications are prescribed to improve cardiac output until a permanent pacemaker can be placed.	Be aware this type of block can progress to worsening blocks. Seek medical treatment for chest pain, shortness of breath, dizziness, confusion, or fainting.
3rd-Degree AV Block	The impulse from the AV node to the ventricles is blocked. The atria and ventricles beat independently of each other.	Same as 1st-degree block.	There is no correlation between the P and the QRS complex, but the P waves march out consistently and the QRS march out consistently. The QRS complex is the only thing that is able to be measured.	Syncope, chest pain, fatigue, and shortness of breath.	Client may have reduced cardiac output due to poor ventricular filling and slow heart rate. Prepare the client for a pacemaker (temporary or permanent).	Reverse underlying causes. A temporary pacemaker may be initiated until a permanent pacemaker can be placed.	Client will need a pacemaker. Be aware of pre-surgical treatment.

Paced Rhythms

Clients with pacemakers have a set heart rate with unique characteristics on their ECGs referred to as **paced rhythms**. If their heart is atrial paced (A paced), a pacer spike appears before the P wave. If their heart is ventricular paced (V paced), a pacer spike appears before the QRS complex, and the QRS complex will be wide. If their heart is atrial-ventricular (AV) paced, there will

be pacer spikes before the P wave and the QRS complex, and the QRS complex will be wide. See Figure 7.31[37] for an image of a ventricular-paced rhythm with pacer spikes appearing before the QRS complex. Characteristics of paced rhythms are summarized in Table 7.4e.

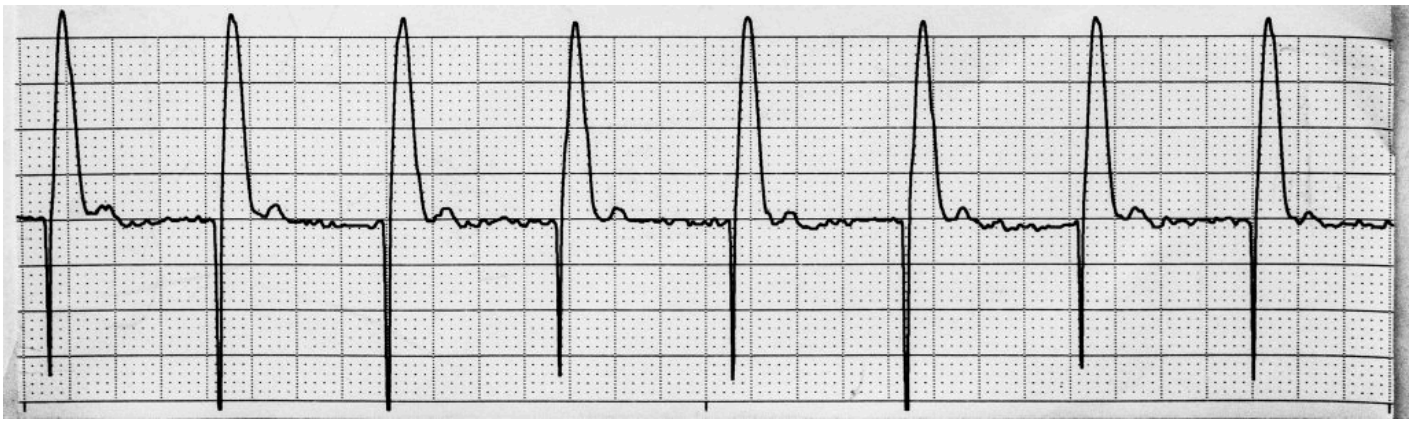


Figure 7.31 Ventricular Paced Rhythm

Table 7.4e Characteristics of Paced Rhythms

Other Rhythms	Pathophysiology	Causes	Identification	Symptoms	Nursing Interventions	Treatment	Patient Education
Paced Rhythms[38]	A client who has a pacemaker will have a set rate.	Permanent pacemakers are placed for symptomatic bradycardia, heart blocks, or other dysrhythmias.	If it is atrial paced (A paced), there is a pacer spike before the P wave. If it is ventricular paced (V paced), there is a pacer spike before the QRS complex. The QRS complex will be wide. If it is AV paced, there will be a pacer spike before the P wave and the QRS complex. The QRS complex will be wide.	No symptoms as long as the pacemaker is working appropriately.	Interpret rhythm strip; report inappropriate pacing and pacing abnormalities to the provider.	None.	Take medications as prescribed; call the provider for symptoms such as unexplained edema, shortness of breath, dizziness, hiccups or muscle twitching, or signs of infection around the insertion site. Complete pacer checks as prescribed.

37. "Ventricular Paced Rhythm" by Deanna Hoyord is licensed under CC BY 4.0
38. Cleveland Clinic. (2022, February 28). *Permanent pacemaker.* https://my.clevelandclinic.org/health/symptoms/23213-pulseless-electrical-activity

ST Segment Abnormality

ST segment abnormality (elevation or depression) indicates myocardial ischemia or myocardial infarction and requires rapid emergency response. Discussion of medical treatment is beyond the scope of this text, but nurses should recognize ST abnormalities on ECGs and seek immediate emergency assistance. See Figure 7.32[39] for an image of ST elevation.

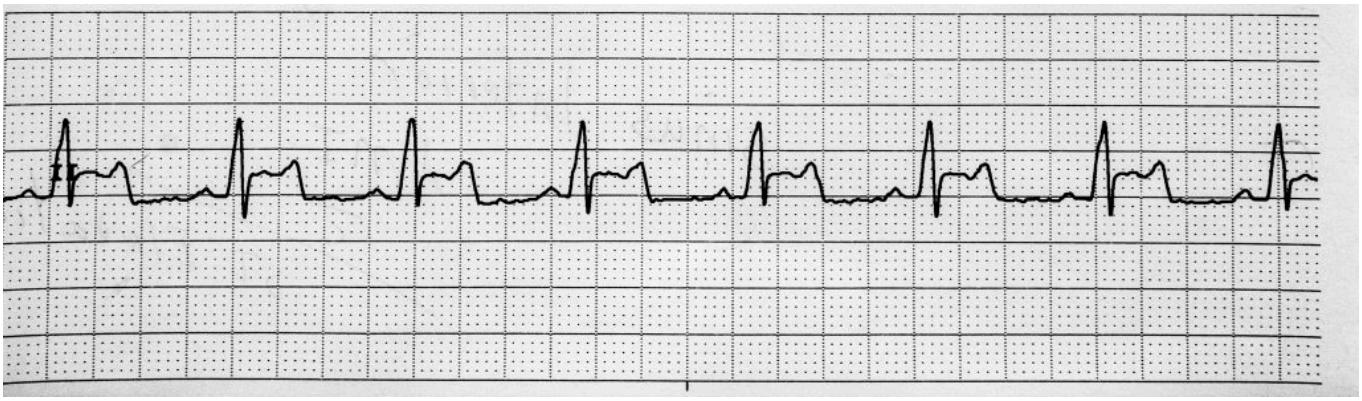


Figure 7.32 ST Elevation

39. "Sinus Inferior AMI with ST Elevation.jpg" by Deanna Hoyord is licensed under CC BY 4.0

7.5 Cardioversion and Defibrillation

As a nurse becomes familiar with the various types of heart rhythms, it is important to recognize that some rhythms will require immediate intervention and an attempt to restore normal electrical activity within the heart. Without prompt intervention for certain arrhythmias, the client is at risk for cardiac arrest. With any rhythm interpretation, the nurse is responsible for assessing rhythm, identifying the rhythm, and treating the rhythm in collaboration with the medical team.

The purpose of prompt rhythm identification and intervention is to reorganize the electrical conduction within the heart before significant damage can occur. In order to understand how the reorganization of electrical pathways occurs, it is important to recall the normal cardiac conduction pathways. The normal cardiac conduction pathway begins with an electrical impulse from the sinoatrial node (SA) located in the right atrium, to the atrial-ventricle node (AV) located between the atrium and ventricles, down the bundle of His branches located within the ventricular septum, to the Purkinje fibers that deliver the electrical impulses to the ventricular myocardium. As the impulses are transmitted through the ventricular myocardium, they activate the contractions of the right and left ventricles.

When a client is experiencing a serious dysrhythmia, the conduction of the electrical impuse has become altered and the SA node is no longer initiating the rhythm. Cardioversion and defibrillation are used to attempt to reset the heart's normal electrical conduction pathway and put the SA node back in charge.

Cardioversion

Cardioversion involves the use of low-energy electrical shocks to resume the heart's normal electrical rhythm. It is important to remember that cardioversion is only used for dysrhythmia in which the client has a pulse. The typical rhythms that require cardioversion are paroxysmal supraventricular tachycardia (PSVT), supraventricular or narrow complex tachycardia, rapid atrial fibrillation/flutter, torsades de pointes (with a pulse), and ventricular tachycardia (with a pulse). If the client is hemodynamically stable, a provider

may first attempt to convert the rhythm with the use of medications. However, if the client is unstable, immediate cardioversion may be required.

When a client has a heart dysrhythmia but is hemodynamically stable, such as new onset atrial fibrillation or atrial flutter, cardioversion may be a scheduled procedure. In these cases, clients will typically have a transesophageal echocardiogram (TEE) prior to the cardioversion to assess for potential blood clots within the heart, particularly if the rhythm has persisted for greater than 48 hours or the time of rhythm onset is unknown. The TEE procedure involves the use of an ultrasound transducer inserted down into the client's esophagus via endoscope to examine blood flow within the heart. If there is no sign of clot present, the provider can proceed to cardioversion. If a clot is present, the client may require anticoagulation or a different medical treatment to manage the arrhythmia.

As with any invasive medical procedure, the client must complete informed consent prior to proceeding. The nurse ensures that a signed consent in present in the client's medical record and the provider has explained the procedure. The nurse provides patient education about the procedure, including reminding the client they will receive sedation during the procedure, which will limit their memory of the cardioversion.

When preparing the client for cardioversion, electrode patches are placed on the chest in addition to the cardioversion pads. A cardiac monitor is used to monitor the heart rhythm then synchronizes the shock to the existing electrical activity within the client's heart. When the monitor is "synced," it

identifies the client's R waves and administers the electrical shock during the peak of the R wave. See Figure 7.33[1] for an image of a defibrillator monitor displaying triangles above the R waves of the client's cardiac rhythm, which indicate the monitor has been synced. This synchronization ensures the shock is delivered at the appropriate time in the electrical cycle and minimizes the risk of developing ventricular fibrillation or asystole.

Figure 7.33 Synchronizing the Shock With the R Wave

The majority of cardiac monitors, including automated external defibrillators (AEDs), are biphasic. **Biphasic** monitors deliver current to the client in two directions. In the first phase, current moves from one paddle to the other. In

1. "LIFEPAK_20e_Defibrillator_and_Monitor_displaying_synchronization_with_QRS_complexes._(arrowheads).jpg" by StudentDoctorDG is licensed under CC BY-SA 4.0

the second phase, it reverses direction.[2] The electrical energy levels are determined by the provider and may be as low as 100 to 200 joules. To maintain a safe environment, everyone must remain clear of the client when delivering the electrical shock. No one should touch the client, and the hospital bed and oxygen equipment should be moved away from the client when the shock is delivered. Because the synced cardiac monitor will deliver the electrical shock at the optimal moment of the client's existing cardiac electrical activity, there may be a few second delay from the time the shock is implemented to when it is actually delivered.

Defibrillation

Defibrillation is the immediate administration of an electrical current to help restore normal cardiac function. Defibrillation is administered when the client does not have a pulse. The typical rhythms for defibrillation are ventricular fibrillation, torsades de pointes (without a pulse), and ventricular tachycardia (without a pulse).[3] Automated external defibrillators (AEDs) search for these rhythms to determine if a client is experiencing a "shockable rhythm" that may be responsive to an electrical shock.

If a client has a dysrhythmia requiring defibrillation, the nurse must understand that blood is not circulating in the client. Therefore, in addition to the shock, the client requires cardiopulmonary resuscitation (CPR) to circulate blood throughout the body. Because these dysrhythmias are life-threatening and require emergency treatment, informed consent is not obtained. It is imperative for the client to receive the defibrillation shock as rapidly as possible, but high-quality compressions must be administered to maintain perfusion of vital organs until the defibrillator is connected to the client, the rhythm interpreted by the monitor, and shock is advised.

After the defibrillation monitor has arrived near the client, the pads must be placed on the client's chest as quickly as possible to allow the monitor to

2. Li, W., Li, J., Wei, L., Wang, J., Peng, L., Wang, J., Yin, C., & Li, Y. (2021). A framework of current based defibrillation improves defibrillation efficacy of biphasic truncated exponential waveform in rabbits. *Scientific Reports, 11*(1), 1586-1586. https://doi.org/10.1038/s41598-020-80521-9
3. Choi, H. J., & Noh, H. (2021). Successful defibrillation using double sequence defibrillation: Case reports. *Medicine, 100*(10), e24992-e24992. https://doi.org/10.1097/MD.0000000000024992

analyze the rhythm. During the rhythm analysis process, is important that no one touches or moves the client. Once the monitor determines if a shock is advised, the staff should continue compressions until the monitor is charged and ready to administer shock at the required joules.

The goal of rapid defibrillation is to stop the disorganized rhythm promptly so the heart's natural pacemaker can hopefully take over with an organized rhythm. Because disorganized rhythms use a tremendous amount of oxygen in already depleted heart tissue, continuing chest compressions for at least two minutes after defibrillation is required to reoxygenate the heart tissue and decrease the risk of the heart going back into ventricular tachycardia or ventricular defibrillation.

Defibrillation does not resolve asystole because an underlying electrical rhythm must be present. During asystole, the heart is in constant polarization and no electrical conduction is occurring.

7.6 Checklist: Initiate Telemetry

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Initiate Telemetry[1,2]

- Verify the provider's order.
- Gather supplies: electrodes.
- Introduce yourself and your role to the client.
- Perform hand hygiene.
- Identify the client using two identifiers and check allergies.
- Provide privacy.
- Explain the procedure to the client regarding the purpose of telemetry, what to expect with lead placement, and telemetry monitoring.
- Prior to applying the electrodes, assess the skin and ensure it is free of excess hair and sweat. Apply the electrodes to clean, dry skin, ensuring good adherence according to manufacturer instructions. The electrodes must make contact with the skin for a clear picture of the heart's electrical activity on the monitor.[3] Apply the electrodes to the skin. See Figure 7.34[4] for an illustration of electrode placement.[5]
    - White – Right arm (RA): Infraclavicular fossa close to the right shoulder
    - Black – Left arm (LA): Infraclavicular fossa close to the left shoulder
    - Red – Left leg (LL): Below the rib cage on the left upper quadrant of

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com
3. Drew, B. J., Califf, R. M., Funk, M., Kaufman, E. S., Krucoff, M. W., Laks, M. M., Macfarlane, P. W., Sommargren, C., Swiryn, S., & Van Hare, G. F. (2004). Practice standards for electrocardiographic monitoring in hospital settings. *Circulation, 110*(17), 2721-2746. https://www.ahajournals.org/doi/10.1161/01.cir.0000145144.56673.59
4. This image is a derivative of "Patient-monitoring-ECG-lead-configuration-A-5-electrode-lead-configuration-was-used-in.png" by Barbara Drew et al., and is licensed under CC BY 4.0. Access for free at https://www.researchgate.net/publication/267740230_Insights_into_the_Problem_of_Alarm_Fatigue_with_Physiologic_Monitor_Devices_A_Comprehensive_Observational_Study_of_Consecutive_Intensive_Care_Unit_Patients
5. Drew, B. J., Califf, R. M., Funk, M., Kaufman, E. S., Krucoff, M. W., Laks, M. M., Macfarlane, P. W., Sommargren, C., Swiryn, S., & Van Hare, G. F. (2004). Practice standards for electrocardiographic monitoring in hospital settings. *Circulation, 110*(17), 2721-2746. https://www.ahajournals.org/doi/10.1161/01.cir.0000145144.56673.59

the abdomen
    - Green – Right leg (RL): Below the rib cage on the right upper quadrant of the abdomen
    - Brown – (V1): Fourth intercostal space on the right sternal border
- Attach the lead wires to the electrodes.
- Observe the rhythm and print a six-second strip.
- Interpret the rhythm.

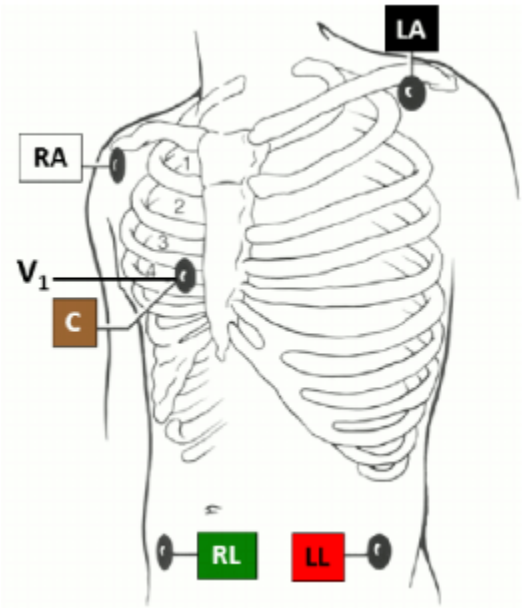


Figure 7.34 Electrode Placement for Telemetry

View a YouTube video[6] showing an instructor demonstration of this skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=320#oembed-1

6. Chippewa Valley Technical College. (2023, January 5). *Initiating telemetry* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/LvE4NrlcuE0

7.7 Checklist: Obtain a 12-Lead ECG

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Obtain a 12-Lead ECG[1,2]

- Verify the provider's order.
- Obtain data related to age, gender, cardiac medications, recent blood pressure, and pain level.
- Introduce self and your role.
- Perform hand hygiene.
- Verify the client with two identifiers and check allergies.
- Explain the procedure to the client.
- Provide privacy.
- Enter demographic data as required.
- Remove oil, moisture, and/or excess hair at lead placement points.
- Open the electrode package. Check the expiration date to ensure electrodes are not expired.
- Attach four electrodes to the extremities as indicated on the electrodes.
- Attach the six chest leads in the locations described below.[3] View Figure 7.35[4] for an illustration of ECG lead placement.
    - V1 – Fourth intercostal space on the right sternal border
    - V2 – Fourth intercostal space at the left sternal border
    - V3 – Midway between placement of V2 and V4
    - V4 – Fifth intercostal space at the midclavicular line
    - V5 – Left anterior axillary line on the same horizontal level as V4
    - V6 – Mid-axillary line on the same horizontal level as V4 and V5
- Press the auto button and record the ECG. Ask the client to hold still while

1. *Clinical skills: Essentials collection* (1st ed.). (2021). Elsevier.
2. Lippincott procedures. http://procedures.lww.com
3. Drew, B. J., Califf, R. M., Funk, M., Kaufman, E. S., Krucoff, M. W., Laks, M. M., Macfarlane, P. W., Sommargren, C., Swiryn, S., & Van Hare, G. F. (2004). Practice standards for electrocardiographic monitoring in hospital settings. *Circulation, 110*(17), 2721-2746. https://www.ahajournals.org/doi/10.1161/01.cir.0000145144.56673.59
4. "Ecg-lead-placement.jpg" by unknown author is used under Fair Use. Access the original at https://nurseyourownway.com/2016/04/20/demystifying-the-12-lead-ecg/

the machine is capturing the electrical activity of the heart to ensure a clear and accurate depiction of the heart's electrical pattern.

- Inspect the tracing printout for quality. The ECG machine will provide an interpretation of the electrical activity, but a health care provider will evaluate the findings.
- If the client has an abnormal cardiac pattern, assess their level of consciousness, carotid pulse, and for complaints of chest pain or shortness of breath. Request emergency assistance if indicated.
- Remove the electrodes and clean the skin. Assess the area for redness and irritation.
- Remove gloves and perform hand hygiene.
- Provide for client comfort and safety.
- Notify the health care provider of abnormalities.

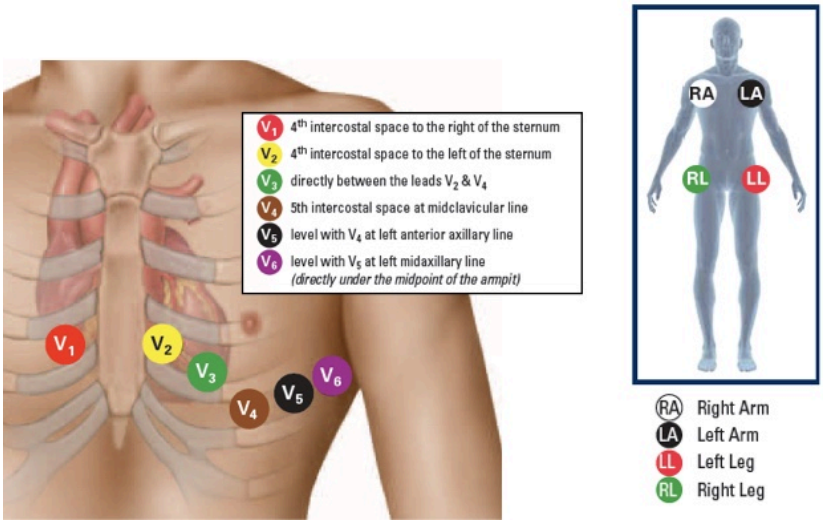


Figure 7.35 12-Lead ECG Placement

View a YouTube video[5] showing an instructor demonstration of this skill:

5. Chippewa Valley Technical College. (2023, January 5). *Obtaining a 12-lead ECG* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/Ud6nr-hxA80

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=322#oembed-1

Sample Documentation:

11/25/20XX 1030

Obtained a routine 12-lead ECG for a client scheduled for surgery in the morning. Explained the procedure to the client. Performed the 12-lead ECG and assessed the quality of the tracing. Removed the electrodes and no signs of redness or irritation present on skin. The client tolerated the procedure well. ECG results were provided to the health care provider.

Michael Jones, RN

7.8 Checklist: Interpret an ECG

**Disclaimer: Always follow agency policy and manufacturer recommendations*

Checklist: Interpret an ECG

- Accurately calculate the ventricular rate.
- Accurately determine whether the rhythm is regular or irregular.
- Accurately assess the P waves.
- Accurately measure the PR interval.
- Accurately measure the QRS complex.
- Accurately evaluate the T waves.
- Accurately determine the QT interval.
- Accurately evaluate for other components.
- Accurately identify the type of rhythm represented.

View a YouTube video[1] showing an instructor demonstration of this skill:

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/nursingadvancedskills/?p=324#oembed-1

1. Chippewa Valley Technical College. (2023, January 5). *Interpreting an ECG* [Video]. YouTube. Video licensed under CC BY 4.0. https://youtu.be/lMSi4LOZ7Yg

7.9 Spotlight Application

A 65-year-old male client with no past cardiac medical history comes into the Emergency Department complaining of palpitations and shortness of breath. He tells the triage nurse it started about two hours ago. He states he has felt these palpitations before, but they always went away after about ten minutes. The nurse attaches the ECG leads and connects the monitor. The rhythm in Figure 7.36[1] appears on the monitor.

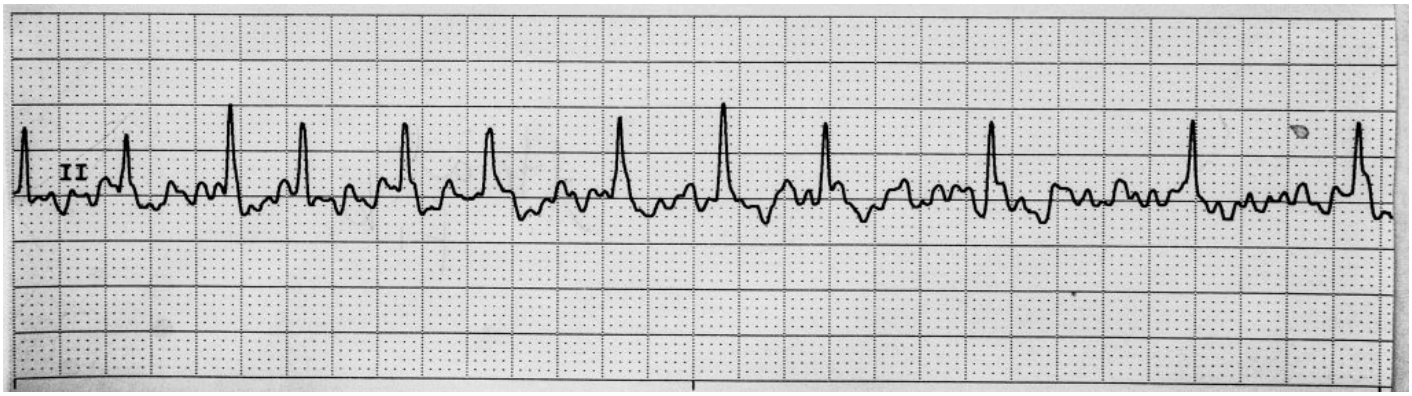


Figure 7.36 Rhythm

Reflection Questions:

1. Interpret this cardiac rhythm.
2. Does this rhythm require emergency assistance?
3. Is this client a candidate for defibrillation or synchronized cardioversion?

Answers:

Here are the steps the nurse took to interpret this rhythm:

1. The nurse calculates the ventricular rate of 120 beats per minute by counting 12 R waves in the 6-second strip (i.e., over 30 large boxes) and multiplies this by 10 to reach 120. The atrial rate cannot be calculated because there are no discernible P waves.
2. The nurse classifies this rhythm as an irregularly irregular rhythm because

1. "Rhythm.jpg" by Deanna Hoyord is licensed under CC BY 4.0

the R waves are not equal distances apart.
3. The nurse assesses the P waves. There are no P waves present, so these heartbeats are not originating in the SA node.
4. The PR interval cannot be calculated because there are no P waves.
5. The QRS duration ranges between 0.04 to 0.12 seconds (1 – 3 small boxes).
6. The T waves cannot be evaluated in this lead because the quivering atria (i.e., P waves) obscure them.
7. The ST segment cannot be evaluated in this lead because of the lack of discernible T waves.
8. The QT interval cannot be evaluated in this lead because of the lack of discernible T waves.
9. The quivering waves on the ECG strip between the R waves indicate the atria are quivering, which is a characteristic of atrial fibrillation.
10. The nurse assesses the client for signs and symptoms of decreased cardiac output such as decreased blood pressure, decreased peripheral pulses, prolonged capillary refill, dizziness, chest pain, confusion, and loss of consciousness. The client is stable without signs of decreased cardiac output at this time.

The client is diagnosed by the provider with new onset, stable atrial fibrillation. Because the client presented to the hospital within 48 hours of onset, he is a candidate for a synchronized cardioversion. The nurse anticipates an order for administration of anticoagulant medication and to set up for a cardioversion procedure by the cardiologist.

The Rest of the Story:

Cardioversion is completed, and the client successfully returns to a normal sinus rhythm. He is discharged the next day with a follow-up outpatient appointment with cardiology services to ensure he remains in normal sinus rhythm with prescribed medications.

7.10 Learning Activities

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://wtcs.pressbooks.pub/nursingadvancedskills/?p=330#h5p-17

- Cardiac Rhythm Flashcard Identification: Cardiac Rhythm Flashcards

- Cardiac Rhythm Interpretation Game: Rhythm Interpretation

Test your knowledge using a NCLEX Next Generation-style question. You may reset and resubmit your answers to this question an unlimited number of times.

VII Glossary

12-lead electrocardiogram: A diagnostic test (referred to as an ECG or EKG) that uses leads attached to the client's body to record the electrical activity of the heart on special graph paper.

Aorta: A large artery that carries oxygen-rich blood to the rest of the body.

Aortic valve: The valve that opens when blood flows out of the left ventricle to the aorta.

Arrhythmia: Also referred to as a dysrhythmia; a chronic deviation from the normal pattern of impulse conduction and contraction.

Arteries: Vessels that carry oxygen-rich blood from the heart to the body's tissues.

Artifact: Interference with the tracing of the cardiac pattern on an ECG.

Asystole: No cardiac pattern on the ECG and the client does not have a pulse.

Atrial fibrillation (A-fib): An irregular heart rhythm originating in the heart's upper chambers (atria) characterized by atrial quivering, lack of clear P waves, and a wavy baseline on the ECG tracing.

Atrial flutter: A condition where the heart's upper chambers (atria) beat too quickly. This causes the heart to beat in a fast, but usually regular, rhythm and is characterized by a sawtooth pattern on the ECG tracing.

Atrial rhythms: Rhythms that originate in the atria rather than in the SA node.

Atrioventricular (AV) blocks: Conduction blocks that can occur anywhere between the SA node and Purkinje fibers.

Atrioventricular (AV) node: Node located in the lower part of the right atrium, which carries electrical signals from the SA node to the ventricles.

Atrioventricular (AV) valves: The valves located between the atria and ventricles within the heart.

Bigeminy: An abnormal heart rhythm where a premature ventricular contraction (PVC) occurs every other beat.

Biphasic: Two phases.

Bradycardia: Heart rate less than 60 beats per minute.

Bundle branch blocks: Conduction block of either left or right bundle branches and occur within the ventricles.

Bundle of His: A collection of cardiac cells found along the septum between the ventricles that sends electrical impulses from the AV node to the left and right bundle branches.

Capillaries: Small blood vessels where the body exchanges oxygen and carbon dioxide in the blood at the cellular level.

Cardioversion: The use of low-energy shocks to resume the heart's normal electrical rhythm.

Coronary arteries: Blood vessels that run along the heart's surface and carry oxygenated blood to heart tissue.

Couplets: Premature Ventricular Contractions (PVCs) occurring in pairs.

Decreased cardiac output: Lack of blood being pumped out of the heart by the ventricles causing signs and symptoms of decreased blood pressure, decreased pulses, increased capillary refill, dizziness, light-headedness, fainting, chest pain, or shortness of breath.

Defibrillation: The use of an electrical current administered immediately to a patient to help restore normal cardiac function.

Dysrhythmia: Also referred to as an arrhythmia; a chronic deviation from the normal pattern of impulse conduction and contraction.

Electrocardiograms (ECGs): Electrodes are attached to a client's body to record the electrical activity of the heart on special graph paper or on a cardiac monitor.

Endocardium: The inner layer of the heart.

Epicardium: The protective outer layer of the heart.

First-degree AV block: There is a slowed impulse from the AV node to the ventricles.

Heart block: A conduction block that can occur due to any obstruction in the normal pathway of electrical conduction through the heart. The anatomical location of the block can be categorized as in the sinus node, atrioventricular node, or bundle branches.

Inferior vena cava: Carries deoxygenated blood from the lower body.

Isoelectric line: The baseline of the ECG tracing.

Left atrium: The upper left chamber of the heart receives the oxygenated blood and pumps it through the mitral valve into the left ventricle.

Left bundle branch: Offshoots from the bundle of His that send electrical impulses to the left ventricle.

Left ventricle: The lower left chamber of the heart.

Mitral valve: The valve between the left atrium and left ventricle.

Multifocal: Dysrhythmias cause the waveforms to look different because the impulse is originating from different areas of the heart

Myocardial infarction (MI): An emergency medical condition caused by a lack of blood flow to the heart muscle.

Myocardium: The muscular middle layer of the heart.

Normal sinus rhythm (NSR): Originates from the sinus node and describes the characteristic rhythm of the healthy human heart.

Paced rhythms: A client who has a pacemaker with a set heart rate.

P-P interval: The interval that represents the duration between atrial heartbeats.

Pericardium: The protective sac that covers the entire heart.

Premature atrial contractions (PAC): An ectopic beat that originates in the atria.

Premature ventricular contractions (PVCs): A random ventricular contraction stimulated by an area of the heart other than the SA node and characterized by a wide, bizarre QRS complex.

Pulmonary arteries: Arteries that carry deoxygenated blood to the lungs.

Pulmonary valve: The valve that opens when blood flows from the right ventricle into the pulmonary arteries (then to the lungs).

Pulmonary veins: Arteries that carry oxygenated blood back to the left atrium.

Pulseless electrical activity (PEA): There is electrical activity in the heart, but it is not strong enough to cause a contraction or a pulse.

Purkinje fibers: A network of thin filaments that carry electrical impulses that cause the ventricles to contract and pump blood out of the heart.

R-R interval: The interval that represents the duration between the ventricular heartbeats.

R on T phenomenon: When a PVC occurs on the T wave.

Respiratory sinus arrhythmia: Rhythm correlates to the respiratory cycle;

the rate increases when the client breathes in and slows when they breathe out.

Right atrium: Two large veins called the superior vena cava and the inferior vena cava deliver oxygen-poor blood to the upper right chamber of the heart.

Right bundle branch: Offshoots from the bundle of His that send electrical impulses to the right ventricle.

Right ventricle: This lower right chamber of the heart pumps the oxygen-poor blood through the pulmonary valves and then through the pulmonary arteries to the lungs.

Second-degree Type 1 AV block: The impulse from the AV node to the ventricles gets slower and slower with each beat until there is a dropped beat. The pattern then repeats itself.

Second-degree Type 2 AV block: The impulse from the AV node to the ventricles is variable. Some beats will be normal, and other beats will be dropped.

Semilunar (SL) valves: Values that open when blood flows out of the ventricles.

Sinoatrial blocks: Failed conduction of the impulses beyond the SA node, resulting in prolonger PR intervals or dropped P waves on the ECG

Sinoatrial (SA) node: Node located in the upper part of the right atrium and a major element of the conduction system.

Sinus bradycardia: A sinus rhythm that is a slower rate than normal (i.e., less than 60 beats per minute in an adult).

ST elevation: An elevation of the ST segment on an ECG that can indicate myocardial infarction.

Superior vena cava: Carries deoxygenated blood from the upper body.

Supraventricular tachycardia (SVT): An irregularly fast but regular heart rhythm that affects the heart's upper chambers. SVT is also called paroxysmal supraventricular tachycardia.

Tachycardia: Heart rate greater than 100 bpm.

Telemetry: A portable device used to continuously monitor clients' heart rhythms.

Third-degree AV block: The impulse from the AV node to the ventricles is blocked. The atriums and ventricles beat independently of each other.

Torsades de pointes: A life-threatening ventricular tachycardia that can be caused from long QT intervals or magnesium deficiency.

Tricuspid valve: The valve between the right atrium and right ventricle.

Trigeminy: An abnormal heart rhythm where a premature ventricular contraction (PVC) occurs every third beat.

Unifocal: Dysrhythmias causes the waveforms to look the same because the signal is originating from the same area in the heart

Veins: Carry oxygen-poor blood back to the heart.

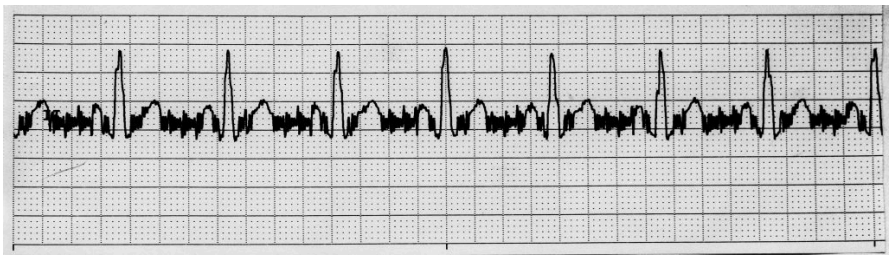
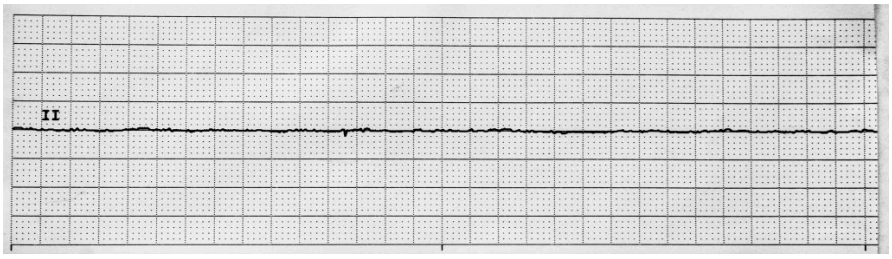
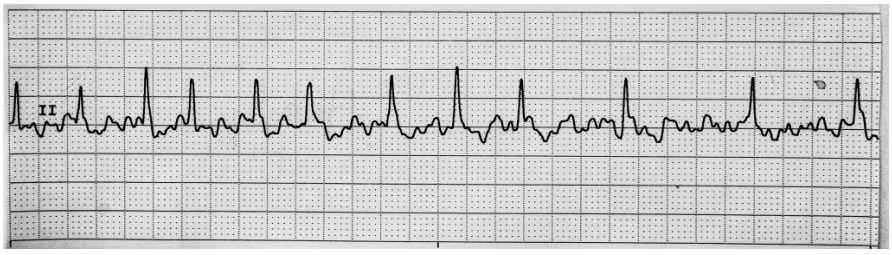
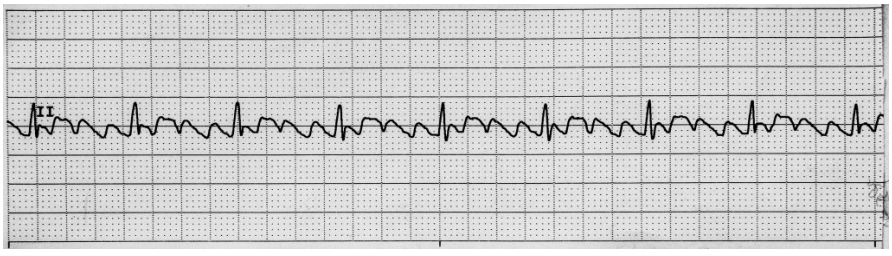
Ventricular fibrillation: An abnormal heart rhythm with disorganized electrical conduction signals causing the lower chambers of the heart (ventricles) to twitch (quiver) uselessly and not pump blood to the rest of the body.

Ventricular rhythms: Rhythms that originate in the ventricles (rather than the SA node) and cause the heart to beat faster.

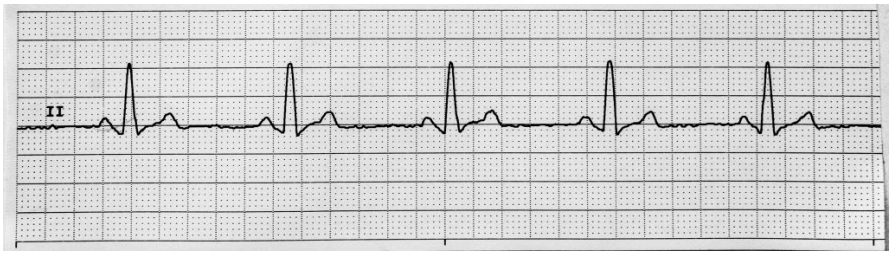
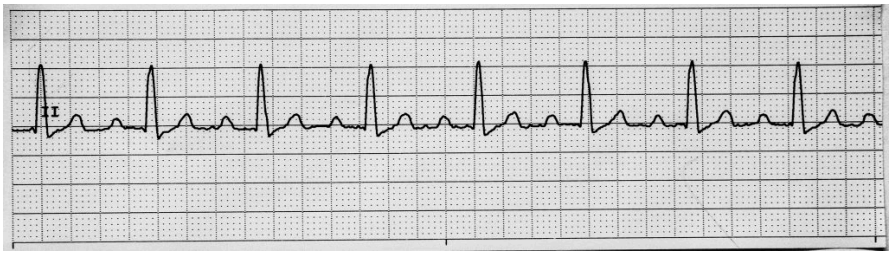
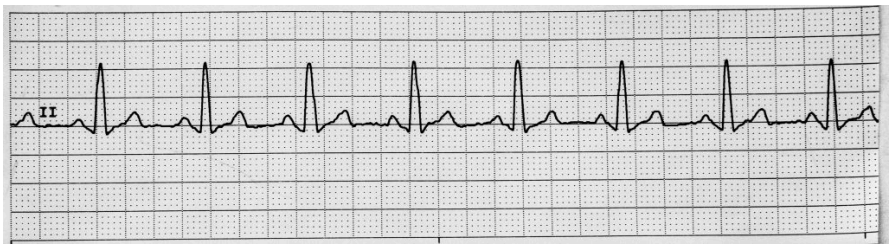
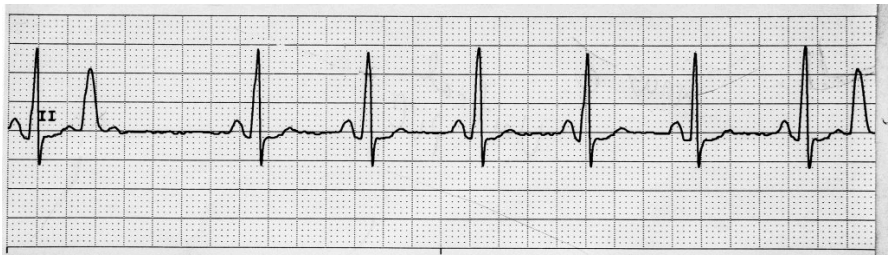
Ventricular tachycardia: An abnormal heart rhythm originating in the lower chambers of the heart (ventricles) characterized by regular, wide QRS complexes, no P waves, and a rate of 150-300 per minute with or without a pulse.

Appendix of Rhythm Strips

Alphabetized List of Selected ECG Patterns

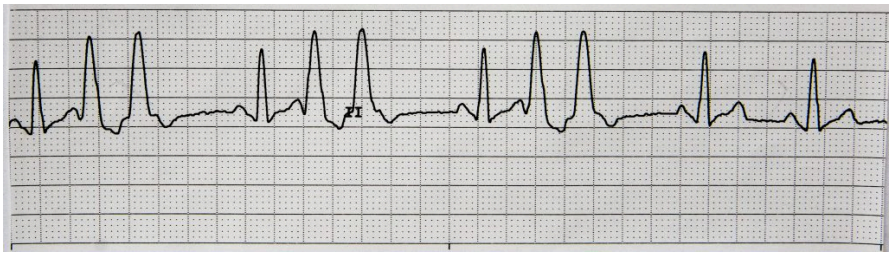
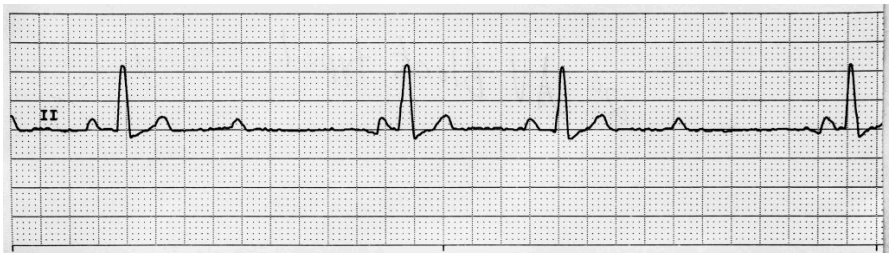
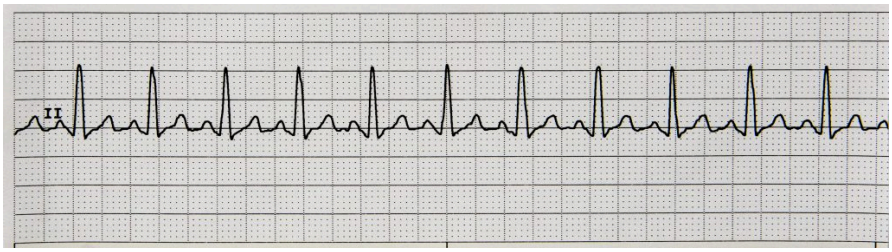
ECG Pattern	Image of Pattern
Figure 7.37 Artifact[1]	 *Figure 7.37 Artifact*
Figure 7.38 Asystole[2]	 *Figure 7.38 Asystole*
Figure 7.39 Atrial Fibrillation[3]	 *Figure 7.39 Atrial Fibrillation*
Figure 7.40 Atrial Flutter[4]	 *Figure 7.40 Atrial Flutter*

1. “Sinus Rhythm with Artifact” by Deanna Hoyord is licensed under CC BY 4.0
2. “Asystole” by Deanna Hoyord is licensed under CC BY 4.0
3. “Atrial Fibrillation” by Deanna Hoyord is licensed under CC BY 4.0
4. “Atrial Flutter” by Deanna Hoyord is licensed under CC BY 4.0

Figure 7.41 Bradycardia[5]	 *Figure 7.41 Bradycardia*
Figure 7.42 First-Degree Heart Block[6]	 *Figure 7.42 First-Degree Heart Block*
Figure 7.43 Normal Sinus Rhythm[7]	 *Figure 7.43 Normal Sinus Rhythm*
Figure 7.44 Premature Ventricular Contraction (PVC) – Unifocal[8]	 *Figure 7.44 Premature Ventricular Contraction (PVC) – Unifocal*

5. "Sinus Bradycardia" by Deanna Hoyord is licensed under CC BY 4.0

6. “1st Degree Heart Block” by Deanna Hoyord is licensed under CC BY 4.0
7. “Normal Sinus Rhythm” by Deanna Hoyord is licensed under CC BY 4.0
8. “Sinus Rhythm with Unifocal PVCs” by Deanna Hoyord is licensed under CC BY 4.0

Figure 7.45 Premature Ventricular Contractions (PVCs) – Couplet[9]	 *Figure 7.45 Premature Ventricular Contractions (PVCs) – Couplets*
Figure 7.46 Second-Degree Heart Block Type II[10]	 *Figure 7.46 Second-Degree Heart Block Type II*
Figure 7.47 Sinus Tachycardia[11]	 *Figure 7.47 Sinus Tachycardia*

9. "Bigeminy PVCs" by Deanna Hoyord is licensed under CC BY 4.0
10. "2nd Degree Type II AV Block.jpg" by Deanna Hoyord is licensed under CC BY 4.0
11. "Sinus Tachycardia.jpg" by Deanna Hoyord is licensed under CC BY 4.0

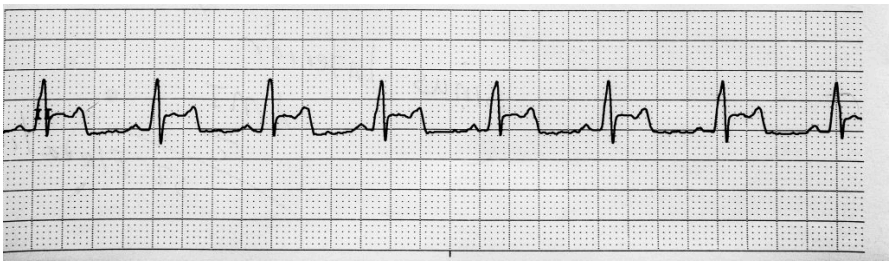
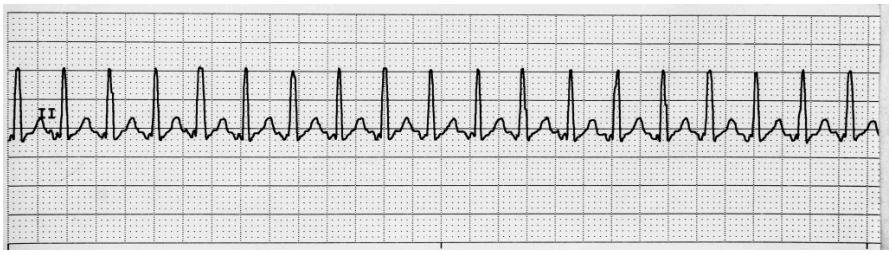
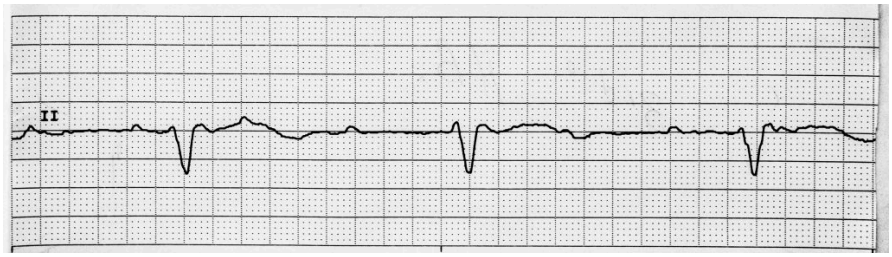
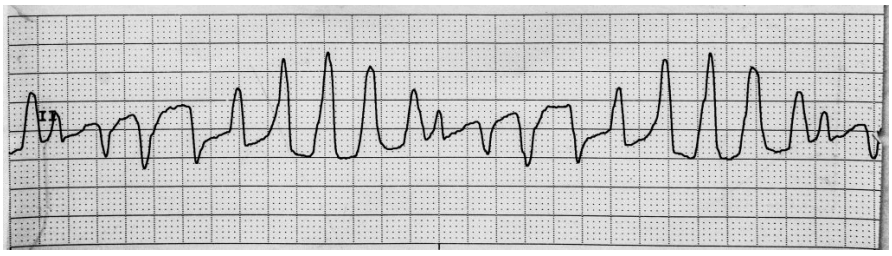
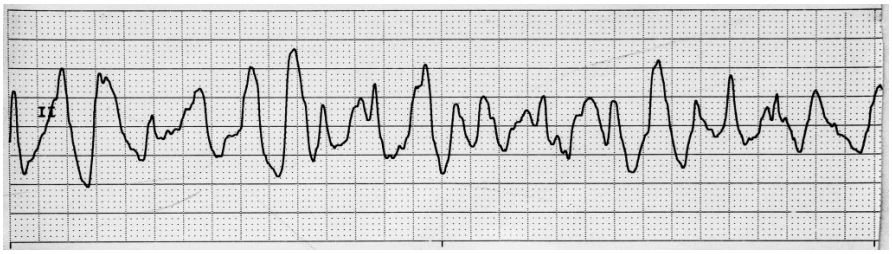
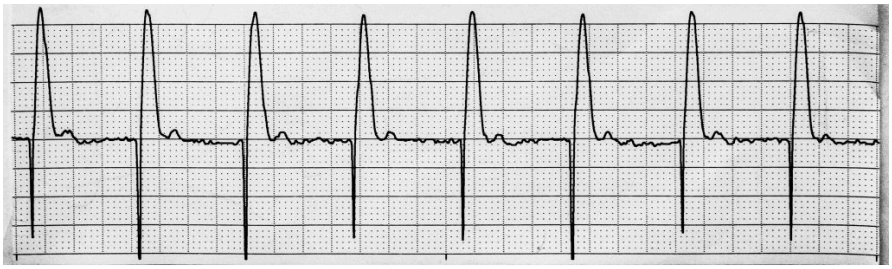
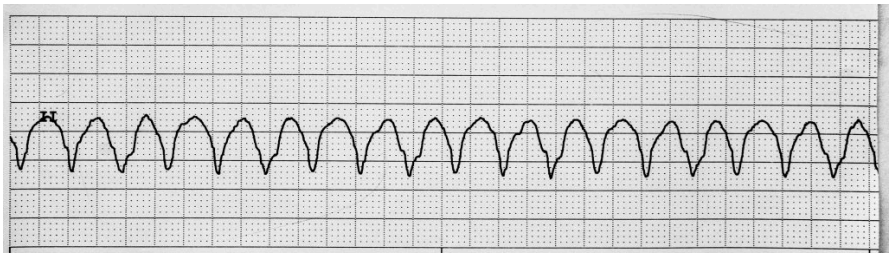
Figure 7.48 ST Elevation[12]	 *Figure 7.48 ST Elevation*
Figure 7.49 Supraventricular Tachycardia (SVT)[13]	 *Figure 7.49 Supraventricular Tachycardia*
Figure 7.50 Third-Degree Heart Block[14]	 *Figure 7.50 Third-Degree Heart Block*
Figure 7.51 Torsades de Pointes[15]	 *Figure 7.51 Torsades de Pointes*

Figure 7.52 Ventricular Fibrillation[16]	 *Figure 7.52 Ventricular Fibrillation*
Figure 7.53 Ventricular Paced Rhythm[17]	 *Figure 7.53 Ventricular Paced Rhythm*
Figure 7.54 Ventricular Tachycardia[18]	 *Figure 7.54 Ventricular Tachycardia*

12. "Sinus Inferior AMI with ST Elevation.jpg" by Deanna Hoyord is licensed under CC BY 4.0
13. "Supraventricular Tachycardia" by Deanna Hoyord is licensed under CC BY 4.0
14. "Third Degree Heart Block.jpg" by Deanna Hoyord is licensed under CC BY 4.0
15. "Torsades de Pointes" by Deanna Hoyord is licensed under CC BY 4.0
16. "Ventricular Fibrillation" by Deanna Hoyord is licensed under CC BY 4.0
17. "Ventricular Paced Rhythm" by Deanna Hoyord is licensed under CC BY 4.0
18. "Ventricular Tachycardia" by Deanna Hoyord is licensed under CC BY 4.0

PART VIII

ANSWER KEYS

Chapter 1

Case Study #1

1. When initiating an IV for Eli, you will consider the following:

- Client assessment: Check Eli's vital signs, hydration status, and any underlying medical conditions.
- Site selection: Choose the best IV site, taking into consideration the age of the client, access, and current skin condition.
- Equipment and supplies: Ensure you have all necessary equipment, such as an IV catheter, tubing, and a sterile dressing. The catheter size for a child will be smaller, and a 22-gauge or 24-gauge catheter may be appropriate.
- Safety measures: Follow standard infection control procedures to prevent transmission of infectious diseases.
- Client comfort: Explain the procedure to Eli in age-appropriate terms. Include his grandmother and ensure that they understand the process. Offer comfort measures such as a blanket or a favorite toy to minimize stress and anxiety.
- Proper technique: Follow the proper technique for inserting an IV catheter and document the insertion site.
- Monitoring: Monitor Eli for any adverse reactions and make note of any changes in his condition.
- Medication administration: Administer the diphenhydramine as ordered, following proper medication administration guidelines.

All of the answers to the interactive element are found within the element.

Chapter 2

Case Study #1

1) When initiating an IV for Gary, consider the following:

- Age
- Health history (including hypertension, diabetes, and colon cancer)
- Current symptoms and the need for PIV access to administer and deliver the medication
- Location of a vein for IV access
- Infection control measures and sterile technique for IV insertion

2) Based on the supplied metoprolol of 10 mg/10 mL, each dose of metoprolol for Gary will be 5 mg. To administer this dose, you would need to draw 5 mL of the medication into the syringe.

The rate of administration will depend on the administration method. If it is given as a rapid IV push, you would administer the 5 mL dose over 1-2 minutes and then wait 2 minutes and repeat up to three doses as ordered by the MD.

3) Medication Information

Indication and action of medication:

- Metoprolol is indicated for the treatment of hypertension, angina, and heart failure. It works by blocking the effect of certain hormones (epinephrine and norepinephrine) on the heart and blood vessels, which reduces the heart rate, blood pressure, and workload on the heart.

Onset, peak, and duration of the medication:

- Intravenous (IV) metoprolol has an onset time of approximately 5 minutes, a peak effect within 15 to 30 minutes, and a duration of 3 to 6 hours.

Nursing considerations or special instructions for use:

- Monitoring vital signs: Metoprolol can cause bradycardia and

hypotension, so the client's heart rate, blood pressure, and electrocardiogram should be monitored closely.

Assessments pre-, post-, and during administration:

- Pre-administration: Assess blood pressure and heart rate. Also, assess for any known allergies or adverse reactions to beta-blockers.
- During administration: Monitor blood pressure, heart rate, and respiratory rate. Assess for any signs of adverse reactions, such as chest pain, shortness of breath, or swelling of the legs or ankles.
- Post-administration: Monitor blood pressure and heart rate and assess for any changes in symptoms.

Patient education:

- Explain the purpose and action of metoprolol.
- Inform Gary that the medication will be given as a rapid injection into a vein. He may experience the following common side effects:
    - Decreased heart rate
    - Low blood pressure
    - Dizziness
    - Fatigue

- It is important that Gary communicates immediately to the health care provider if he notes any worsening of symptoms or side effects.

Case Study #2

1) When initiating an IV for Karen, consider the following:

- Assess Karen's veins for IV placement, ensuring that the veins are large enough to accommodate the IV catheter. Note the presence of a client's IV fistula, or location of hemodialysis access site, and take care to restrict IV placement to a non-fistula arm.
- Consider the type and amount of fluids Karen requires, taking into

account her chronic kidney disease and biweekly dialysis.

2) Based upon the supply of medication 16mg/8mL, you will administer 4mL of medication IV push.

The IV push should be administered slowly between 2-5 minutes.

3) Medication Information

Indication and action of medication:

- Ondansetron is indicated for the treatment of nausea and vomiting. It acts by blocking the action of serotonin in the brain and gut, which reduces the stimulation of the vomiting center.

Onset, peak, and duration:

The onset of ondansetron is within 15 minutes, with a peak effect within 30 minutes, and a duration of 4 to 8 hours.

Nursing considerations or special instructions for use:

- Assess for potential allergies or adverse reactions to ondansetron before administering.
- Monitor Karen's vital signs and level of consciousness during and after administration.
- Administer the medication slowly to avoid extravasation, which can cause tissue damage.

Assessments pre-, post-, and during administration:

- Pre-administration: Assess Karen's level of nausea, vomiting, and hydration status.
- During administration: Monitor Karen's vital signs and level of consciousness and check for any adverse reactions or extravasation.
- Post-administration: Assess Karen's level of nausea and vomiting and document any adverse reactions or improvement.

Patient education:

- Explain to Karen the purpose and action of the medication and how it may help with her nausea and vomiting.
- Advise Karen to inform the health care provider if she experiences any adverse reactions, such as difficulty breathing, chest pain, or severe headache.
- Explain the importance of proper hydration and encourage Karen to drink clear fluids to prevent dehydration.

All of the answers to the interactive element are found within the element.

Chapter 3

Case Study #1

1. Indications for a blood transfusion for Helen:

- Anemia (Hgb of 6.5 g/dL)
- Fatigue and exhaustion
- Pale appearance

2) Considerations for starting an IV for the blood transfusion:

- Client assessment: Check Helen's vital signs, hydration status, and any underlying medical conditions.
- Site selection: Choose the best IV site, taking into consideration the age of the client, access, and current skin condition. Consider the size of catheter, optimally a 20-gauge catheter or larger for blood administration.
- Equipment and supplies: Ensure you have all necessary equipment, such as an IV catheter, blood tubing, sterile dressing, and saline.
- Safety measures: Follow standard infection control procedures to prevent transmission of infectious diseases.
- Client comfort: Explain the procedure to Helen.

3) Steps to prepare for the administration of blood for Helen:

- Ensure Helen has signed the consent for blood transfusion
- Verify the correct patient with 2 identifiers, blood type, and cross-match
- Check the compatibility of the blood with the client's blood type and cross-match
- Check for any allergies or sensitivities to components of the blood
- Ensure that the blood is labeled

4) Precautions or nursing considerations:

- Monitor for adverse reactions, such as fever, chills, itching, or hives
- Observe for signs of anaphylaxis

- Check the IV site regularly for any signs of infiltration or infection
- Monitor vital signs and fluid status
- Monitor for signs of fluid volume overload; administer transfusion at an appropriate rate to not overload the client

5) Assessments to be completed prior to the blood transfusion:

- Vital signs
- Lung sounds
- Allergies or sensitivities to components of the blood
- Blood type and cross-match

Assessments to be completed during the blood transfusion:

- Vital signs
- Lung sounds
- Fluid status
- IV site
- Any adverse reactions

6) Blood type O- is compatible with O- and O+ blood types.

7) Steps to ensure safety for the client during blood transfusion:

- Verify the correct client and blood type
- Check the compatibility of the blood with the clent
- Check for any allergies or sensitivities to components of the blood
- Monitor vital signs, lung sounds, and fluid status
- Observe for signs of adverse reactions

8) Steps for the procedure of administering the blood transfusion:

- Administer furosemide 20 mg IV as ordered
- Complete checks with a second RN
- Attach the transfusion set to the IV tubing
- Begin the transfusion at a slow rate and monitor vital signs

- Observe the client for adverse reactions and adjust the rate as needed
- Document the transfusion, including the amount and rate of transfusion, any adverse reactions, and any changes in the client's condition
- Administer furosemide 20 mg IV between units
- Administer second unit of PRBCs
- Discontinue the transfusion and remove the IV catheter once the transfusion is complete

All of the answers to the interactive element are found within the element.

Chapter 4

Case Study #1

1. Patient education for Autumn regarding her PICC line:

- Explanation of the PICC line: A peripherally inserted central catheter (PICC) line is a long, thin tube inserted into a vein in the arm and passed through the vein until the tip lies in a larger vein near the heart.
- Importance of hand hygiene.
- Avoidance of heavy lifting and vigorous activities that may put pressure on the PICC line or dislodge it.
- Signs and symptoms of PICC line complications such as redness, swelling, pain, and drainage.
- Promptly reporting any concerns or changes to the health care provider.

2. Maintenance care priorities for a PICC line:

- Monitoring for signs of infection at the insertion site.
- Keeping the PICC line and dressing dry and secure. Monitor length of catheter visible at insertion site and arm circumference.
- Changing the dressing as directed.
- Avoiding tugging or pulling the PICC line.

3. Specific concerns related to Autumn's need for a PICC line:

- Assessing for phlebitis (inflammation of the vein) related to the PICC line.
- Monitoring for complications related to the cellulitis.

4. Purpose of the PICC line: The PICC line is used to provide long-term, continuous access to the bloodstream for administering medications or drawing blood.

5. Frequency of PICC line assessment: The PICC line should be assessed every shift or as directed by the health care provider.

6. Changing the dressing for a PICC line: The dressing should be changed every 48-72 hours or as directed by the health care provider. A sterile dressing

should be used, and aseptic technique should be followed to minimize the risk of infection.

7. Difference between PICC line and a peripheral IV: A peripheral intravenous (IV) line is a short-term solution for administering medications or fluids, whereas a PICC line is a long-term solution. A peripheral IV is inserted into a vein in the hand or arm, whereas a PICC line is inserted into a vein in the arm and passed through a large central vein until the tip lies near the heart.

Difference between PICC line and an implanted port: A port is a device similar to a PICC line that is surgically implanted under the skin and has a small reservoir that can be accessed with a needle. Unlike a PICC line, a port does not need to be reinserted, as the port can remain in place for months or years.

All of the answers to the interactive element are found within the element.

Case Study #1

1. For client education regarding the NG tube, you can explain the purpose of the tube, which is to provide nutrition to the client when they are unable to eat or drink by mouth. You can also explain how the tube will be inserted, the type of food that will be provided through the tube, and any possible side effects or discomfort that may occur during the procedure.
2. Maintenance care priorities for the NG tube include checking the tube's placement, making sure the tube is secure and not kinked, monitoring the client's vital signs, and checking the amount and appearance of drainage from the tube.
3. Specific concerns related to Caroline's need for an NG tube that should be monitored include infection, tube dislodgement, and blockage. You should also consider the client's age, health status, and any prior experience with NG tubes when preparing for placement.
4. The purpose of the NG tube is to provide nutrition and hydration to the client.
5. An NG tube should be assessed regularly, at least once every shift; prior to any instillation of medication, fluids, or substances into the tube; or as needed based on the client's condition.
6. Cues that indicate a further assessment of the NG tube and the client include changes in the client's vital signs, discomfort or pain, and changes in the amount or appearance of drainage from the tube.
7. The technique used to insert the NG tube is typically the nasal method, which involves passing the tube through the client's nose and down into the stomach.

All of the answers to the interactive element are found within the element.

Chapter 6

1. A client is recovering from a thoracotomy and has a right pleural chest tube to drainage. Highlight or place an “X” next to the best indicators showing the client’s condition is resolving and ready for chest tube removal.

	Indicators
X	Improved respiratory status
	Asymmetrical rise and fall of the chest
	Diminished breath sounds over right lower lobe
X	Decreased chest tube drainage
X	Absence of bubbling in the water seal chamber during expiration
X	Improved chest X-ray findings

2. Managing chest tubes and drainage systems is essential for client safety. Place an “X” next to each nursing action to indicate whether it is likely to be effective in improving the client’s condition being treated with a chest tube or if it is ineffective.

Nursing Action	Effective	Ineffective
Promote oxygenation by encouraging frequent position changes, mobilization, and deep breathing and coughing exercises.	X	
Coil the drainage system tubing and secure it to the edge of the client's bed.	X	
Place the drainage system unit on the client's waist during transport.		X
Immediately apply pressure to the chest tube insertion site and apply a sterile petroleum gauze dressing if the tube dislodges.	X	
Perform routine stripping of the chest tube to prevent blood clots from forming.		X
Assess the amount, color, and consistency of drainage in the drainage tubing and in the collection chamber at regular intervals.	X	

3. B

Case Study # 1

1. For client education regarding the chest tube, the following information can be provided:

- Explain that the purpose of the chest tube is to remove excess air, fluid, or blood that may have accumulated in the pleural cavity (the space between the lung and the chest wall) in order to relieve pressure and improve breathing.
- Discuss the procedure and any potential risks, such as infection, bleeding, and pain.
- Emphasize the importance of keeping the chest tube site clean and avoiding physical activities that may cause trauma to the site.

2. Maintenance care priorities for the chest tube include the following:

- Keeping the chest tube site and surrounding area clean and dry.
- Making sure the chest tube is secured in place and not kinked or obstructed.

- Monitoring the chest tube drainage for any changes (amount, color, consistency).
- Assessing the client's vital signs, lung sounds, and breathing patterns regularly.
- Administering pain medication as prescribed.

3. Specific concerns related to Scott's need for a chest tube that should be monitored or addressed are as follows:

- Pain management, especially around the chest tube site.
- Prevention of infection at the chest tube site.
- Potential complications such as re-accumulation of fluid or air in the pleural cavity, displacement of the chest tube, and injury to surrounding structures.
- Proper functioning of the chest tube and chest tube drainage system.

4. When preparing for placement of the chest tube, the following should be considered:

- Obtaining informed consent from the client or their representative.
- Assess the client's airway, breathing, and circulation (ABCs) to ensure that they are stable.
- Checking for allergies or adverse reactions to medications, including local anesthetics.
- Administering pain control measures, such as local anesthesia, as indicated.
- Properly positioning the client to facilitate chest tube placement and minimize discomfort.
- Making sure the necessary equipment and supplies are readily available, such as sterile gloves, gowns, drapes, chest tube insertion tray, sterile solution, dressing materials, and suture materials.

5. Purpose of chest tube:

- The purpose of a chest tube is to relieve pressure in the chest caused by

fluid or air buildup and to help re-expand collapsed lungs.
- Scott's primary diagnosis is likely a pneumothorax or pleural effusion, based on his history of COPD and smoking, as well as his presentation of increased shortness of breath and left-sided chest pain.

6. The chest tube should be assessed every hour after initial placement and with each client assessment, minimally every four hours or more frequently based on client condition.

7. Further assessment for the chest tube would be indicated further by the following:

- Sudden changes in the amount or color of the drainage from the chest tube.
- Increased pain or discomfort at the chest tube site.
- Signs of infection, such as redness, swelling, or discharge.
- Changes in the client's breathing pattern or oxygen saturation level.

All of the answers to the interactive element are found within the element.

Chapter 7

All of the answers to the interactive element are found within the element.

A

Air embolism: The presence of air in the vascular system that occurs when air is introduced into the venous system and travels to the right ventricle and/or pulmonary circulation. (Chapter 1.3, Chapter 4.2)

Allogeneic blood products: Blood products donated by other people. (Chapter 3.2)

Ampules: Glass containers in 1 mL to 10 mL sizes that hold a single dose of medication in liquid form. (Chapter 2.3)

Anastomosis: A surgical connection between parts of the intestine. (Chapter 5.2)

Anemia: A hematological condition where there is a lack of healthy red blood cells and/or hemoglobin to carry adequate oxygen to the body's tissues. (Chapter 3.2)

Aorta: A large artery that carries oxygen-rich blood to the rest of the body. (Chapter 7.2)

Aortic valve: The valve that opens when blood flows out of the left ventricle to the aorta. (Chapter 7.2)

Arrhythmia: Also referred to as a dysrhythmia; a chronic deviation from the normal pattern of impulse conduction and contraction. (Chapter 7.2)

Arterial blood sampling: Blood is obtained via venipuncture into an artery. (Chapter 1.2)

Arteries: Vessels that carry oxygen-rich blood from the heart to the body's tissues. (Chapter 7.2)

Artifact: Interference with the tracing of the cardiac pattern on an ECG. (Chapter 7.2)

Aseptic-impregnated catheter hub: A specific device or product that has an aseptic particulate embedded within it to prevent biological contaminants from entering a susceptible host. An example of an aseptic-impregnated device is a chlorhexidine impregnated CVAD dressing. (Chapter 4.3)

Aseptic nontouch technique (ANTT): A global standard used to prevent healthcare-acquired infections. ANTT identifies key parts and key sites throughout the preparation and implementation of the procedure. A key part is any sterile part of equipment used during an aseptic procedure, such as needle hubs and dressings. A key site is the insertion site, nonintact skin, or an access site for medical devices connected to clients. ANTT includes four underlying principles to keep in mind while performing invasive procedures:

- Always perform meticulous hand hygiene.
- Never contaminate key parts.
- Touch nonkey parts with confidence.
- Take appropriate infection control precautions. (Chapter 4.3)

Asystole: No cardiac pattern on the ECG and the client does not have a pulse. (Chapter 7.4)

Atrial fibrillation (A-fib): An irregular heart rhythm originating in the heart's upper chambers (atria) characterized by atrial quivering, lack of clear P waves, and a wavy baseline on the ECG tracing. (Chapter 7.4)

Atrial flutter: A condition where the heart's upper chambers (atria) beat too quickly. This causes the heart to beat in a fast, but usually regular, rhythm and is characterized by a sawtooth pattern on the ECG tracing. (Chapter 7.4)

Atrioventricular (AV) blocks: Conduction blocks that can occur anywhere between the SA node and Purkinje fibers. (Chapter 7.4)

Atrioventricular (AV) node: Node located in the lower part of the right atrium, which carries electrical signals from the SA node to the ventricles. (Chapter 7.2)

Atrioventricular (AV) valves: The valves located between the atria and ventricles within the heart. (Chapter 7.2)

Autologous blood transfusion: A procedure in which blood is removed from the patient and returned to their circulation at a later time, instead of relying on blood donated by others (i.e., allogeneic blood). (Chapter 3.2)

B

Basal infusion: Continuous rate of medication administration, regardless of demand attempts. (Chapter 1.7)

Biphasic: Two phases. (Chapter 7.5)

Blood product: Any therapeutic substance derived from human blood, including whole blood and other blood components for transfusion, as well as plasma-derived medicinal products. (Chapter 3.1)

Blown vein: A ruptured vein that is leaking blood. (Chapter 1.3)

Blunt needles: Needleless access devices. (Chapter 2.3)

Bowel obstruction: A mechanical blockage of intestinal contents by a mass, adhesion, hernia, impacted stool, or other physical blockage such as volvulus (i.e., twisting of the stomach or intestine) or intussusception (i.e., one segment of intestine telescopes inside another). Bowel obstructions block the normal passage of bodily fluids such as salivary, gastric, hepatobiliary, and enteric secretions, causing the fluids to build up, resulting in abdominal distension, pain, and nausea. (Chapter 5.2)

Bradycardia: Heart rate less than 60 beats per minute. (Chapter 7.2)

Breakthrough bolus dose: A dose of opioid or non-opioid medication administered by the nurse for breakthrough pain when a patient is receiving patient-controlled analgesia. (Chapter 1.7)

Bundle of His: A collection of cardiac cells found along the septum between the ventricles that sends electrical impulses from the AV node to the left and right bundle branches. (Chapter 7.2)

C

Capillaries: Small blood vessels where the body exchanges oxygen and carbon dioxide in the blood at the cellular level. (Chapter 7.2)

Capillary blood testing: A blood sample collected from the capillary blood

vessels (i.e., tiny blood vessels located near the surface of the skin). (Chapter 1.2)

Catheter embolism: An embolism that occurs when a small part of the cannula breaks off and flows into the vascular system. (Chapter 1.3)

Catheter-related bloodstream infection (CR-BSI): An infection caused by microorganisms introduced into the bloodstream through the puncture site, the hub, or contaminated IV tubing or IV solution, leading to bacteremia or sepsis. A CR-BSI is a hospital-acquired preventable infection and considered an adverse event. (Chapter 1.3)

Central line-associated bloodstream infection (CLABSI): A laboratory-confirmed bloodstream infection not related to an infection at another site that develops within 48 hours of a central line placement. Most CLABSI cases are preventable with proper aseptic techniques, surveillance, and management strategies. (Chapter 4.2)

Central venous access device (CVAD): A type of vascular access that involves the insertion of a tube into a vein in the neck, chest, or groin and threaded into a central vein (most commonly the internal jugular, subclavian, or femoral) and advanced until the terminal lumen resides within the inferior vena cava, superior vena cava, or right atrium. (Chapter 1.2, Chapter 4.1)

Central venous pressure (CVP): Pressure observed within the central veins as the veins enter the right atrium. Central venous pressure is a good indicator of right heart function and is often monitored during fluid resuscitation. (Chapter 4.2)

Chest tube: A catheter inserted into the pleural space in the chest cavity (also referred to as the thoracic cavity or thorax) to remove air, blood, and/or fluids. (Chapter 6.1)

Chylothorax: A collection of lymph in the pleural space. (Chapter 6.2)

Coronary arteries: Blood vessels that run along the heart's surface and carry oxygenated blood to heart tissue. (Chapter 7.2)

Crepitus: Puffiness or crackling that indicates subcutaneous emphysema, the leakage of air into the subcutaneous tissues surrounding the insertion site. (Chapter 6.3)

D

Decreased cardiac output: Lack of blood being pumped out of the heart by the ventricles causing signs and symptoms of decreased blood pressure, decreased pulses, increased capillary refill, dizziness, light-headedness, fainting, chest pain, or shortness of breath. (Chapter 7.4)

Demand dose: Medication dose given on activation of demand (pressing the demand button). (Chapter 1.7)

Dysfibrinogenemia: A coagulation (clotting) disorder characterized by abnormal fibrinogen. (Chapter 3.2)

Dysrhythmia: Also referred to as an arrhythmia; a chronic deviation from the normal pattern of impulse conduction and contraction. (Chapter 7.2)

E

Empyema: A pyogenic infection (pus) of the pleural space. (Chapter 6.2)

Endocardium: The inner layer of the heart. (Chapter 7.2)

Enteral tubes: Tubes placed in the gastrointestinal tract. (Chapter 5.1)

Epicardium: The protective outer layer of the heart. (Chapter 7.2)

Epidural: Administration of analgesics and anesthetics into the spinal fluid via an epidural catheter for severe pain management associated with surgical procedures or during labor and delivery. (Chapter 1.7)

Extravasation: A condition that occurs when vesicant solution (medication) is administered and inadvertently leaks into surrounding tissue, causing damage to surrounding tissue. It is characterized by the same signs and symptoms as infiltration but also includes burning, stinging, redness, blistering, or necrosis of the tissue. (Chapter 1.3, Chapter 2.2, Chapter 4.2)

F

First-pass effect: The action that occurs when a medication must be first metabolized or broken down prior to entering the blood. (Chapter 2.2)

Fluid resuscitation: Infusing a large volume of fluid through the intravenous venous access to restore hemodynamics and optimize tissue perfusion and, ultimately, tissue oxygen delivery. (Chapter 4.2)

Fluoroscopy: A medical procedure that makes a real-time video of the movements inside a part of the body by passing X-rays through the body over a period of time. (Chapter 4.2)

Flushing: A manual injection of 0.9% sodium chloride to clean the catheter. (Chapter 4.3)

H

Heart block: A conduction block that can occur due to any obstruction in the normal pathway of electrical conduction through the heart. The anatomical location of the block can be categorized as in the sinus node, atrioventricular node, or bundle branches. (Chapter 7.4)

Hemodynamic monitoring: The assessment of a critically ill client's circulatory status and includes measurements of central venous pressure, cardiac output, and blood volume. (Chapter 4.2)

Hemolysis: Red blood cell destruction. (Chapter 3.2)

Hemothorax: A collection of blood in the space between the chest wall and the lung (called the pleural cavity). (Chapter 6.2)

Hydrothorax: Accumulation of serous fluid in the pleural space (Chapter 6.2)

Hypertonic solutions: IV fluids with a higher concentration of dissolved particles than blood. (Chapter 1.2)

Hypofibrinogenemia: A rare, autosomal dominant condition characterized

by bleeding and obstetric problems such as abruption, postpartum hemorrhage, and recurrent pregnancy loss. (Chapter 3.2)

Hypotonic solutions: IV fluids with a lower concentration of dissolved solutes than blood. (Chapter 1.2)

I

Ileus: A nonmechanical decrease or stoppage of the flow of intestinal contents that is often an unavoidable consequence of abdominal or retroperitoneal surgery. (Chapter 5.2)

Inferior vena cava: Carries deoxygenated blood from the lower body. (Chapter 7.2)

Infiltration: A condition that occurs when a nonvesicant solution (IV solution) is inadvertently administered into surrounding tissue. Signs and symptoms include pain, swelling, redness, the skin surrounding the insertion site is cool to touch, there is a change in the quality or flow of IV, the skin is tight around the IV site, IV fluid is leaking from IV site, or there are frequent alarms on the IV pump. (Chapter 1.3)

Intravenous push (IV push): Process of introducing a medication or fluid substance directly into the bloodstream via the venous system. (Chapter 2.2)

Intravenous therapy (IV therapy): Administration of a substance directly into a person's vein. (Chapter 1.2)

Isoelectric line: The baseline of the ECG tracing. (Chapter 7.2)

Isotonic solutions: IV fluids with a similar concentration of dissolved particles as blood. (Chapter 1.2)

IV lock: An IV cannula that has been inserted into a vein and saline locked or clamped. (Chapter 2.2)

L

Left atrium: The upper left chamber of the heart receives the oxygenated blood and pumps it through the mitral valve into the left ventricle. (Chapter 7.2)

Left bundle branch: Offshoots from the bundle of His that send electrical impulses to the left ventricle. (Chapter 7.2)

Left ventricle: The lower left chamber of the heart. (Chapter 7.2)

Loading dose: Ordered amount of medication administered at the time of PCA initiation. (Chapter 1.7)

Locking: The injection of a limited volume of a liquid following the catheter flush, for the period of time when the catheter is not used, to prevent intraluminal clot formation and/or catheter colonization. (Chapter 4.3)

Lockout interval: Time period in which no follow-up demand dose may be administered (even if demand button is activated). (Chapter 1.7)

Lockout maximum: The maximum dose of medication that can be administered within a certain period, commonly prescribed to 1 hour limit. (Chapter 1.7)

M

Microaggregate filter: A second-generation blood filter with a pore size of 20–40 µm that removes 75–90% of white cells, which is used to transfuse packed red cells. (Chapter 3.3)

Midline peripheral catheters: Larger peripheral catheters (i.e., 16-18 gauge) that allow for rapid infusions and blood sampling and can be used for longer duration that traditional peripheral catheters. They are ultrasound-guided and can be inserted by RNs with additional training or other trained professionals. (Chapter 1.2)

Mitral valve: The valve between the left atrium and left ventricle. (Chapter 7.2)

Multifocal: Dysrhythmias cause the waveforms to look different because the impulse is originating from different areas of the heart. (Chapter 7.4)

Myocardial infarction (MI): An emergency medical condition caused by a lack of blood flow to the heart muscle. (Chapter 7.2)

Myocardium: The muscular middle layer of the heart. (Chapter 7.2)

N

Nasogastric (NG) tube: A flexible plastic tube inserted through a nostril, down the posterior oropharynx, and into the stomach or the upper portion of the small intestine. It is typically used for decompression of the stomach for clients with an intestinal obstruction or ileus or for administration of nutrition or medication to clients who are unable to tolerate oral intake. (Chapter 5.2)

Negative pressure: During inspiration (also called inhalation), the diaphragm contracts and pulls downward, while the intercostal muscles between the ribs pull upward. This movement increases the size of the thoracic cavity, thus decreasing the pressure inside. This change in pressure on inspiration is referred to as negative pressure. As a result, a vacuum effect is created and air rushes into the lungs. (Chapter 6.2)

Normal sinus rhythm (NSR): Originates from the sinus node and describes the characteristic rhythm of the healthy human heart. (Chapter 7.4)

P

Patient-controlled analgesia (PCA): A method of pain management that allows hospitalized patients with severe pain to safely self-administer opioid

medications using a programmed pump according to their level of discomfort. (Chapter 1.7)

Pericardium: The protective sac that covers the entire heart. (Chapter 7.2)

Peripheral IV (PIV): A short intravenous catheter inserted by percutaneous venipuncture into a peripheral vein and held in place with a sterile transparent dressing. (Chapter 1.2)

Phlebitis: The inflammation of the vein's inner lining, the tunica intima. Clinical indications are localized redness, pain, heat, and swelling that can track up the vein leading to a palpable venous cord. (Chapter 1.3, Chapter 2.2)

Pleural effusion: Accumulation of fluid in the pleural space, often due to a medical condition such as cancer or heart, kidney, or liver failure. (Chapter 6.2)

Pleural space: Also referred to as the pleural cavity; the space between the membranes of the chest wall (i.e., visceral pleura membrane) and the lung (i.e., the parietal pleura membrane). (Chapter 6.2)

Pneumothorax: A collapsed lung that occurs when air leaks into the space between the lung and chest wall. (Chapter 6.2)

P-P interval: The interval that represents the duration between atrial heartbeats. (Chapter 7.2)

Precipitate: Formation of small crystals as the incompatible substances come into contact with one another. (Chapter 2.2)

Prefilled syringe: Syringes that contain prefilled volumes of medication within the device. (Chapter 2.3)

Premature ventricular contractions (PVCs): A random ventricular contraction stimulated by an area of the heart other than the SA node and characterized by a wide, bizarre QRS complex. (Chapter 7.4)

Pulmonary arteries: Arteries that carry deoxygenated blood to the lungs. (Chapter 7.2)

Pulmonary edema: A condition caused by excess fluid accumulation in the lungs due to excessive fluid in the circulatory system. It is characterized by decreased oxygen saturation; increased respiratory rate; fine or coarse crackles in the lung bases; restlessness; breathlessness; dyspnea; and coughing up pink, frothy sputum. Pulmonary edema requires prompt medical attention and treatment. (Chapter 1.3)

Pulmonary valve: The valve that opens when blood flows from the right ventricle into the pulmonary arteries (then to the lungs). (Chapter 7.2)

Pulmonary veins: Arteries that carry oxygenated blood back to the left atrium. (Chapter 7.2)

Purkinje fibers: A network of thin filaments that carry electrical impulses that cause the ventricles to contract and pump blood out of the heart. (Chapter 7.2)

R

Reservoir pocket: A small pocket, either a plastic or metal cylinder, usually placed just below the collar bone and connected to a catheter that enters a large vein such as the subclavian. (Chapter 4.2)

Right atrium: Two large veins called the superior vena cava and the inferior vena cava deliver oxygen-poor blood to the upper right chamber of the heart. (Chapter 7.2)

Right bundle branch: Offshoots from the bundle of His that send electrical impulses to the right ventricle. (Chapter 7.2)

Right ventricle: This lower right chamber of the heart pumps the oxygen-poor blood through the pulmonary valves and then through the pulmonary arteries to the lungs. (Chapter 7.2)

R on T phenomenon: When a PVC occurs on the T wave. (Chapter 7.4)

R-R interval: The interval that represents the duration between the ventricular heartbeats. (Chapter 7.2)

S

Saline locks: A short extension set that allows intermittent IV access without ongoing infusion. (Chapter 1.2)

Scrub hub: A scrubbing device with an embedded alcohol product such as chlorhexidine with alcohol or 70% alcohol to disinfect catheter hubs or needleless connectors. (Chapter 4.3)

Semilunar (SL) valves: Values that open when blood flows out of the ventricles. (Chapter 7.2)

Sinoatrial blocks: Failed conduction of the impulses beyond the SA node, resulting in prolonger PR intervals or dropped P waves on the ECG. (Chapter 7.4)

Sinoatrial (SA) node: Node located in the upper part of the right atrium and a major element of the conduction system. (Chapter 7.2)

Speed shock: An adverse systemic reaction when a foreign substance is introduced into the bloodstream. (Chapter 2.2)

Spontaneous pneumothorax: Collapse of a lung that occurs suddenly without any known cause. (Chapter 6.2)

ST elevation: An elevation of the ST segment on an ECG that can indicate myocardial infarction. (Chapter 7.2)

Stomach decompression: A medical term that refers to removing stomach contents by using suctioning. Stomach decompression is commonly used after surgery or trauma to reduce pressure from the buildup of fluids and gas that cause pain, nausea, and vomiting and can lead to potential aspiration of stomach contents into the lungs. (Chapter 5.1)

Subcutaneous emphysema: Air leakage into the subcutaneous tissues surrounding the chest tube insertion site. (Chapter 6.3)

Superior vena cava: Carries deoxygenated blood from the upper body. (Chapter 7.2)

Supraventricular tachycardia (SVT): An irregularly fast but regular heart rhythm that affects the heart's upper chambers. SVT is also called paroxysmal supraventricular tachycardia. (Chapter 7.4)

T

Tachycardia: Heart rate greater than 100 bpm. (Chapter 7.2)

Telemetry: A portable device used to continuously monitor clients' heart rhythms. (Chapter 7.2)

Tension pneumothorax: A medical emergency caused by large pneumothorax that affects cardiovascular functioning. (Chapter 6.2)

Thrombocytopenia: Platelet deficiency causing bleeding, bruising, and slow blood clotting after injury. (Chapter 3.2)

Tidaling: When water in the water seal chamber rises with inhalation and falls with exhalation. (Chapter 6.2)

Torsades de pointes: A life-threatening ventricular tachycardia that can be caused from long QT intervals or magnesium deficiency. (Chapter 7.4)

Transfusion reactions: Adverse events that are directly related to the transfusion of blood products and may range from mild to severe with life-threatening effects. Transfusion reactions may be acute or delayed (i.e., up to days or weeks after the transfusion). Immune-related reactions are often due to a mismatch or incompatibility of the transfused blood product and the recipient's blood type or Rh factor. Non-immunologic reactions are typically caused by the physical effects of the blood component or the transmission of a disease. (Chapter 3.2)

Traumatic pneumothorax: Lung collapse caused by a chest injury, such as a bullet wound that pierces the pleural membranes, causing air to rush into the thoracic cavity. (Chapter 6.2)

Tricuspid valve: The valve between the right atrium and right ventricle. (Chapter 7.2)

12-lead electrocardiogram: A diagnostic test (referred to as an ECG or EKG) that uses leads attached to the client's body to record the electrical activity of the heart on special graph paper. (Chapter 7.2)

U

Unifocal: Dysrhythmias causes the waveforms to look the same because the signal is originating from the same area in the heart. (Chapter 7.4)

V

Veins: Blood vessels that typically carry oxygen-deficient blood back to the heart. (Chapter 7.2)

Venipuncture: The process of introducing a needle into a patient's vein to collect a blood sample or insert an IV catheter. (Chapter 1.2)

Ventricular fibrillation: An abnormal heart rhythm with disorganized electrical conduction signals causing the lower chambers of the heart (ventricles) to twitch (quiver) uselessly and not pump blood to the rest of the body. (Chapter 7.4)

Ventricular tachycardia: An abnormal heart rhythm originating in the lower chambers of the heart (ventricles) characterized by regular, wide QRS complexes, no P waves, and a rate of 150-300 per minute with or without a pulse. (Chapter 7.4)

Vesicant medications: Certain medications such as antineoplastic drugs, antibiotics, electrolytes, and vasopressors that can cause severe tissue injury or destruction. (Chapter 4.2)

Vial: A single- or multi-dose plastic container with a rubber seal and covered by a metal or plastic cap. (Chapter 2.3)