Chapter 1: Care of the Circulatory System

Overview

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lock

Needleless systems and safer medical devices

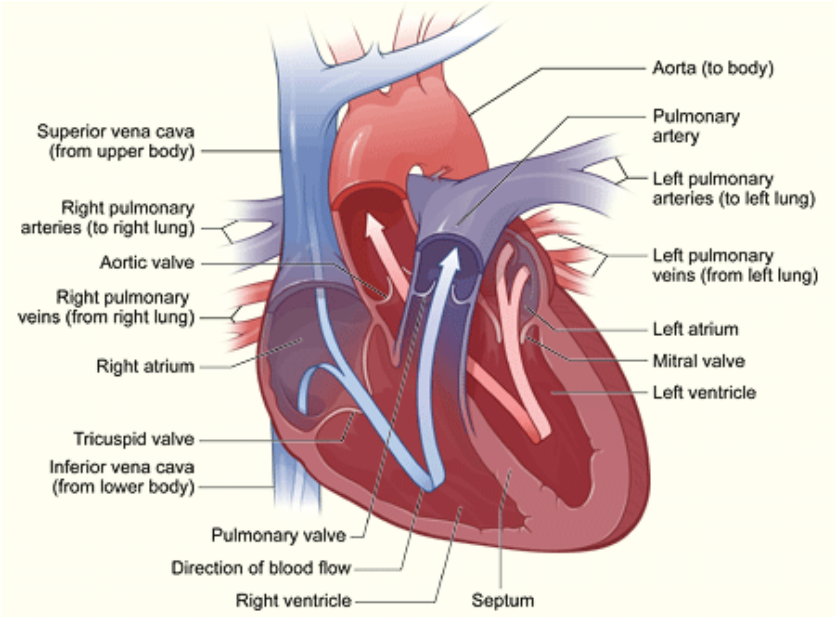
One-handed needle recapping

Circulatory System

Overview

The circulatory system is composed of the heart and the blood vessels. The heart acts as a pump to transport blood via blood vessels throughout the body. The blood delivers oxygen and nutrients to all parts of the body and returns carbon dioxide and waste products to the lungs and kidneys to be eliminated. Each day the average heart beats 100,000 times and pumps about 2,000 gallons of blood.

The *heart* is a muscular pump with four chambers and valves that open and close to let blood flow in only one direction. The *right atrium* receives deoxygenated blood from the body. Blood flows through the *tricuspid valve* into the right ventricle. The *right ventricle* then contracts and pumps blood through the *pulmonary valve* into the *pulmonary artery* leading to the lungs.



In the lungs, carbon dioxide is released and oxygen is picked up by the blood. The oxygen-rich blood returns to the heart via the *pulmonary vein* into the *left atrium*. From there, it passes through the *mitral valve* into the left ventricle. The *left ventricle* has the strongest pump because it must pump this oxygenated blood through the *aortic valve* with enough force to push it through the *aorta* to all parts of the body.

The blood is transported to the body through a complex network of one way vessels, which if laid end to end, would extend for 60,000 miles. The *arteries* carry oxygen-rich blood away from the heart to the body. These arteries branch into smaller vessels called *arterioles*, which branch into the tiny *capillaries* where cells of the body can exchange their carbon dioxide and wastes for the oxygen and nutrients.

Veins take deoxygenated blood from the capillaries and return it to the heart. Veins are thinner than arteries with some having one-way valves to prevent blood from pooling in the extremities. The veins get larger in size as they return closer to the heart. The large veins inside the chest and abdomen are called *central veins*.

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Illustration Source:

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Central Venous Access Devices

Overview

A central venous access device (CVAD) is a sterile intravenous catheter (tube) inserted into a large “central” vein (e.g., subclavian vein). It may also be called a "central line" or central venous catheter (CVC). A student may receive a CVAD if there is need for long-term intravenous access, such as the need for chemotherapy, extended antibiotic therapy, total parenteral nutrition (TPN), or frequent venipuncture (blood drawing).

There are several types of CVADs. The *tunneled catheter* is often called by its manufacturer’s name---Hickman, Broviac, Leonard, or Groshong. It is inserted surgically into the central vein, tunneled under the skin, and has a separate exit site, typically located in the upper chest. The portion of the catheter that is tunneled under the skin contains a Dacron cuff, which helps to hold the catheter in place while it heals and helps prevent infections by stopping bacteria from entering the tunnel and traveling up the vein. You may also find an antimicrobial cuff (trade name VitaCuff) which significantly reduces incident of catheter-related infection. The tunneled catheter may have one, two, or three ports (entrance lines), which will normally need to be flushed with heparin each day. Such flushing is usually done at home. (Catheters with a Groshong valve prevent backflow of blood unless negative pressure is applied. There is usually no need for heparin flushes and external clamps are not used on Groshong catheters). The tunneled catheter will also have a sterile dressing covering it to prevent it from becoming infected. This dressing should be changed according to a schedule, as specified by the health care provider, and whenever it becomes wet, soiled, or the edges are no longer intact. Routine dressing changes are done at home, but dressing changes may need to be done at school if the dressing becomes wet, soiled, or loose.

The *non-tunneled catheter* is similar to the tunneled catheter in appearance except that it is inserted directly into a central vein. It is usually a temporary CVAD and not seen in the school setting because it is not secured as well under the skin. Care for the non-tunneled catheter is the same as that for the tunneled except that extreme care must be taken not to dislodge it. If the student has a non-tunneled catheter, consideration should be given to homebound instruction where there would be less risk for harm to the catheter.

Another type of CVAD is the *totally implanted device* (TID) such as the Port-A-Cath, Mediport, PowerPort, or BardPort. They may also be called a *totally implanted venous access device* (TIVAD). This CVAD consists of a small reservoir that is totally implanted under the skin. When it is not being used, it has no tubing on the outside of the skin, does not need a dressing, and has a lower risk of becoming infected. However, when it needs to be used, the child must be stuck with a needle. Only **non-coring** Huber needles can be used to access the totally implanted CVAD to prevent damage to the port. When the TID is being

used for intravenous therapy it may also need to be flushed and have its dressing changed, but flushes and dressing changes are not routinely done in schools.

A fourth type of central line is a peripherally inserted central catheter (PICC), which is inserted into a peripheral vein and threaded to a large, central vein. See section on Management of PICC lines.

Follow manufacturer recommendations for size of syringe for the specific type of line when flushing CVADs. Generally, smaller syringes exert too much pressure and can cause a rupture in the catheter or reservoir. Therefore, 10-milliter (10 cc) syringes should be used, unless specified otherwise in student's individualized health care plan (IHP). All connections should be luer-locked.

Settings and Staff

Due to the risk for infection and the need for privacy, most CVAD dressing changes are done at home. CVAD dressing may be reinforced at school, which should take place in a clean, private room such as the health room or clinic area. Privacy regarding the student's medical condition and need for a CVAD should also be maintained unless the family chooses to disclose it. The student can participate in school activities, but participation in physical education activities must be determined on an individual basis by the student's health care provider.

Due to the risk of infection and/or injury, reinforcement of central line dressing should be performed by a registered nurse or licensed practical nurse (LPN) using sterile technique. A LPN under the supervision of a RN should be trained and have current competencies on file per the policies of each district and the Oklahoma Nurse Practice Act. Administering medications through intravenous lines and central line dressing changes are not usually responsibilities of a school nurse, but protecting the tubing and dressing from injury is. Non-medical school staff should not perform any procedures with central lines. Any school personnel who has regular contact with a student who has a CVAD must receive general training from a health care personnel covering the student's specific needs, potential problems, and implementation of the established emergency plan. Most importantly, they should be instructed what to do if the CVAD is damaged or becomes dislodged, wet, or damp.

Individualized Health care Plan (IHP)

Each student's IHP must be tailored to the individual's needs. A sample plan is included in Appendix A. When preparing an IHP for a student with a central venous access device, the following items should be considered:

- The student's underlying condition and potential problems associated with the condition or treatment
- Type of CVAD—tunneled, non-tunneled, implanted, or peripherally inserted

- Specific orders from student's health care provider for care at school
- The need for readily-available additional dressing supplies including a spare clamp
- Informing school staff who have regular contact with the student about the CVAD and general safety guidelines
- Reporting any fever or site changes to the school nurse, family and/or health care provider
- Determination of when, and under what conditions, the tubing or the dressing should be handled
- Never use scissors near the catheter
- Steps to be taken if a complication occurs
- Latex allergy precautions
- Standard precautions

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Possible Problems with Central Venous Access Devices

Equipment to be Available at all times for Emergencies (family supplies equipment):

- Sterile gauze
- Tape included in sterile dressing kit packaging
- Alcohol swabs
- Biopatch, if ordered
- Statlock device, if ordered
- Gloves (both sterile and clean)
- Sterile clear adhesive bandage
- Mask
- Additional unused caps

Problems

- **Temperature elevation; redness, swelling, or drainage at the CVAD site; chills, increased fatigue, irritability or headache**
  Notify the school nurse, family, and/or health care provider immediately as these are possible indications of infection. Swelling may indicate infiltration.

- **Arm, shoulder, or neck pain**
  Infiltration or thrombosis could be developing. Also, if implanted Dacron cuff has not fully healed, excessive sneezing, coughing, or vomiting may cause catheter migration. Notify school nurse, family and/or health care provider immediately.

- **Difficulty breathing; chest pain**
  Clamp the line and lay student on left side to help prevent an air bubble from entering the heart.

  Do not let the student walk!
  Initiate the school emergency plan. The student should be transported as soon as possible to the appropriate hospital emergency room. If the school nurse is not available, pinch the tubing with a clamp or fingers and call the emergency medical team. Notify the school nurse, family, and/or health care provider immediately.

- **Blood in the tubing or bleeding from the end of the tubing**
  Put on sterile gloves. If blood is noted in the line or coming from the end of the line, **check to see if the clamp is open or if the cap is off.** If so, close the clamp or replace cap. Notify the school nurse and the family. If the clamp is not functioning properly, the tubing should be firmly pinched closed and the school nurse, family, and health care provider notified immediately according to the student's emergency plan.

- **CVAC is pulled or falls out**
  Inspect the exterior of the dressing. If the dressing is intact and the tape still holds the

looped catheter, it is probable that no significant trauma to the student or the line has occurred. The school nurse, family, and the health care provider should be notified. If the tape or dressing has been disrupted, the dressing should be reinforced by the school nurse and the family and health care provider notified.

If the catheter has fallen out, stay calm. Reassure the student. The CVAD exit site should immediately be covered with sterile gauze or a clean dressing if a sterile one is not readily available. Apply firm pressure to the exit site (bleeding should be minimal). **Notify the school nurse, health care provider and family immediately. Activate the school emergency plan.**

- **Catheter tubing breaks**
  Clamp the catheter above the break (closest to the skin) or pinch it off by folding catheter onto itself and wrap the broken end with sterile gauze. **Notify the school nurse, family and health care provider immediately. Initiate the emergency action plan.** The catheter can sometimes be repaired by the health care provider at the hospital.

Sources:

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General Information for Students with Central Venous Access Devices

Date: _____

To: _____
(Teachers, Instructional assistants, Bus drivers, etc.)

Name of Student: _____

This student has a central venous access device (CVAD), a plastic tube that has been placed into a large vein close to the heart. The tube may be used for nutritional support or medications.

The tubing, located on the chest (sometimes on the arm for peripherally inserted central catheters), may or may not be visible and is covered by a bandage to protect the site. No one should routinely touch the tubing or dressing. The CVAD should not cause any discomfort if it is secured properly.

The CVAD usually is clamped or capped during school or during transport. However, some students may have the tubing connected to an intravenous fluid solution. Usually routine CVAD care is done at home or in the school clinic.

Most students with CVADs are able to participate in school activities. The student's health care provider and family need to determine, in writing, any physical activity restrictions. Basically, the CVAD should not be bumped during activity and the tubing should not be pulled. The dressing should not get soiled or wet. If it does, the school nurse and family should be notified.

This student should have an Emergency Action Care Plan and **all staff** that has contact with this student should be familiar with how to initiate the plan.

Contact_____at_____(phone number/pager) for additional information or if the student experiences any problems with the CVAD.

Source: Adapted from: Porter, S, Haynie, M, Bierle, T, Caldwell, TH, & Palfrey, JS (Eds.). (1997). *Children and Youth Assisted by Medical Technology in Educational Settings: Guidelines for Care*. (2nd ed.). Baltimore: Paul H. Brookes Publishing.

PICC Line Management

Overview

A peripherally inserted central catheter (PICC) is a long intravenous (IV) line which is inserted into a peripheral vein and threaded (often with a guide wire) to a large, central vein. It is usually used for IV therapy of short to moderate length, but has been used longer. It is frequently used for outpatient IV medication therapy lasting 1-6 weeks because it has fewer problems with infiltration and phlebitis than peripheral IVs, yet it costs less (does not need to be inserted in the operating room) and has fewer complications than other central venous access devices.

PICC lines are most often inserted into the antecubital fossa (inner aspect of the elbow) and threaded through the basilic or cephalic vein to the superior vena cava (which flows into the heart). PICC lines may have a single or double lumen. For short-term therapy not requiring total parenteral nutrition, they may be trimmed before insertion and only inserted "midline," ending near the axillary vein. The site of the PICC line is covered with a sterile dressing, which should be treated like other CVAD dressings.

Precautions

PICC lines are generally treated like central venous catheters in catheter care. Dressing changes are usually done of a prescribed schedule and heparin flushes are done at home daily. Dressing changes should be done using sterile technique, but should not be done at school. If the dressing becomes soiled or damp, the registered school nurse should reinforce the dressing and call the parent.

It is important to remember that **most PICC lines are not sutured into place**. Extra care must be taken not to pull the catheter out of the insertion site. **PICC lines cannot be removed in the same manner as other peripherally inserted catheters or heparin locks**. In general, treat them like central lines. **If problems occur with a PICC line, the school nurse, family and health care provider must be notified.**

Due to their location (usually the arm), PICC sites may not be covered by clothing. If not, a wrap or mesh may provide added protection at school if ordered by the health care provider. If the PICC line is in the arm, there should be no heavy lifting, push-ups, or pull-ups. Orders regarding activity level and restrictions should be provided by the health care provider.

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Heparin/Saline Lock--Intermittent Venous Access Device

Overview

Students who do not need continuous intravenous (IV) infusion, yet still require peripheral IV access for intermittent medication or fluids, may have a heparin or saline lock. An intermittent intravenous device such as this permits the student to move around more easily. These IV catheters are used for short-term courses of medication or fluids.

Heparin prevents blood from clotting in the catheter. Heparin or saline in the intermittent device is replaced on a regular basis by injecting a prescribed amount of heparin or saline into the hub or cap. Caps must be scrubbed with alcohol using a twisting friction motion for 10-15 seconds before injecting a flush or medication. Studies indicate either heparin or saline are effective flushes if the IV catheter is larger than 24 gauge. Some studies indicate heparin is more effective in catheters as small as 24 gauge. Heparin flushes may cause more discomfort than saline for some students. Saline and heparin flushes must be ordered by a physician and include dose specific to the student for Heparin flushes.

Settings and Staff

Procedures such as flushes and dressing changes should be done at home. The student's activity may need to be limited to prevent dislodging the IV catheter. Catheter insertion sites affected by the motion of a joint should be supported (e.g., using an arm board or hand board) to avoid risk of infiltration or mechanical phlebitis from motion of the catheter inside the vein.

Due to the risk of infection, reinforcement of the IV catheter dressing should be performed by a registered school nurse using sterile technique. Non-medical school staff should not perform this procedure. Any school personnel who have regular contact with a student with a heparin/saline lock or venous access device should receive training that covers potential problems and implementation of the student emergency care plan.

Individualized Health Plan (IHP)

Each student's IHP must be tailored to the individual's needs. A sample plan is included in Appendix A. When preparing an IHP for a student with a peripheral heparin/saline lock, the following items should be considered:

- Health care provider's order for an intermittent venous access device
- Protection of the IV site from bumping or injury
- Activity level restrictions
- Whether catheter tubing stays clamped
- Signs of IV site infiltration or infection

- Symptoms which require notification of school nurse, family, and/or health care provider
- Safe storage and disposal of supplies
- Latex allergy precautions
- Standard precautions

Sources:

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Possible Problems with a Heparin/Saline Lock

Signs of possible problems include:

- **Tender, red, swollen, or warm IV site**
  IV catheter may be displaced or infiltrated, causing the intravenous fluid to enter the tissue, or the vein may be inflamed. Notify the school nurse and call the family immediately.

- **Wet or bloody IV dressing**
  Male adaptor (cap) may be dislodged. IV catheter itself may have slipped out of the vein or IV site may be infiltrated. Reinforce with dry dressing and call family.

- **Red streak noted above IV site**
  Vein may be inflamed (phlebitis). Notify school nurse, family and/or health care provider.

Sources:

Bowden, V., & Greenberg, C. (2012). *Pediatric nursing procedures* (Third ed.). Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins, 324-327; 634-637.

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General Information for Students with Heparin/Saline Locks

Date: _____

To: _____
(Teachers, Instructional assistants, Bus drivers, etc.)

Name of Student: _____

This student has an intravenous (IV) catheter (tube) in a vein in his or her arm or hand. The tubing is held in place with tape. This IV tube is used to give the student medication or fluids.

When the student is not receiving medications or fluids, the IV tube is closed with a heparin or saline lock. The student may have activity restrictions.

The student should not dislodge the tubing or get it soiled or wet.

Contact_____at_____(phone number/pager) for additional information or if the student experiences any problems with the IV tubing.

Source: Adapted from: Porter, S, Haynie, M, Bierle, T, Caldwell, TH, & Palfrey, JS (Eds.). (1997). *Children and Youth Assisted by Medical Technology in Educational Settings: Guidelines for Care*. (2nd ed.). Baltimore: Paul H. Brookes Publishing.

Use of Needleless Systems and Safer Medical Devices

Overview

Injuries from contaminated needles expose health care workers to a number of diseases, including human immunodeficiency virus (HIV), Hepatitis-B virus, and Hepatitis-C virus. According to the Centers for Disease Control and Prevention (CDC), approximately 600,000-800,000 needlestick accidents occurred each year prior to 2000.

The Needlestick Safety and Prevention Act of 2000 was passed in an effort to reduce the risks of disease transmission and injury from needles and other sharps. During 2001, the Occupational Safety and Health Administration (OSHA) revised the Bloodborne Pathogens standard to comply with the new law. As a result, **facilities are *required* to utilize safer medical devices as they become available**. These "safer medical devices" replace sharps with non-needle devices or incorporate safety features designed to reduce the likelihood of injury and have greatly decreased such injuries.

Any facility or organization that employs individuals who might reasonably experience occupational exposure to blood or other potentially infectious materials must comply with the regulation, even if the facility has never had a needlestick injury. In schools, the presence of large numbers of children, as well as the safety of nurses and other health care workers, make the use of needleless systems and safer medical devices a high priority.

A variety of products have been developed to reduce accidental needlesticks. Some safety products are "passive" and automatically engage the safety mechanism whenever they are used, while "active" products require the user to activate the safety component. There are so many new products available and being developed that it would be impossible to describe the procedure for using each one. Users are directed to follow manufacturer's specific instructions for each device.

Types of Safer Medical Devices

Below is an outline and brief description of some of the types of safer medical devices:

A. Injection Equipment
- Needle guards—after injection:
  - user pushes safety cover/sheath forward until it locks
  - user grasps sleeve and twists flanges to loosen sleeve and pull down over retracting needle
- Needle guards—hinged recap
  - Needle has a pre-attached sheath. After injection, user presses sheath against a hard surface, locking it in place over needle.
- Retractable needles
  - When user fully depresses plunger, the needle automatically retracts from patient and is encapsulated within the syringe
  - Safety sheath covers needle when user pushes button on the syringe

- User rotates plunger to release needle and pull plunger back so needle retracts and becomes encapsulated
- Needleless jet injection
  - Needle-free delivery of intramuscular or subcutaneous injections using CO_2 as a power source to eject medication, which then penetrates the skin
- Pre-Filled syringes
  - Syringes pre-filled with common medications and various needle safety devices

B. IV Medication Delivery Systems (not usually done at school)
- Needleless IV access—blunted cannula
  - Blunt plastic cannula with pre-slit, resealing synthetic injection sites
- Needleless IV access—valve/access ports and connectors
  - Two-way reflux valve activated by standard male luer lock; valve closes automatically when luer is removed
  - Capless valve activated by standard male luer lock
  - Capless valve which uses positive displacement to expel fluid when the luer lock taper is removed, preventing any backflow—becoming increasingly popular because it prevents the retrograde return of blood, thus reducing clotting and contamination risks; this tubing should usually <u>not</u> be clamped until luer lock is removed;
- Prefilled medication cartridge with safety needles/guards—often part of a specific IV product system line
- Recessed/protected needles
  - Recessed needles which lock onto injection ports, usually at Y-sites
- Medication vial adapters

C. IV Insertion Equipment
- Shielded or retracting peripheral IV catheters
  - Needle retracts automatically into a needle shield when the needle is withdrawn from catheter
  - Push button shielding retracts needle into needle shield
  - Telescoping needle shield that covers stylet as it is withdrawn
  - Safety clip automatically engages and covers needle tip as it is withdrawn
- Shielded midline catheters
- Guidewire introducers

D. Lancets
- Laser lancets
- Retracting lancets
- Strip lancets

E. Sharps Disposal Containers

F. Other Safer Medical Devices not often used in school settings
    a. Blood collection equipment
    b. Laboratory devices
    c. Blood bank devices
    d. Nuclear medicine devices
    e. Surgical scalpels
    f. Blunted suture needles
    g. Alternative skin closure devices
    h. Other surgical sharps protection
    i. Hemodialysis and apheresis devices
    j. Fluid sampling devices
    k. Bone marrow collection system
    l. Other miscellaneous products

Sources:

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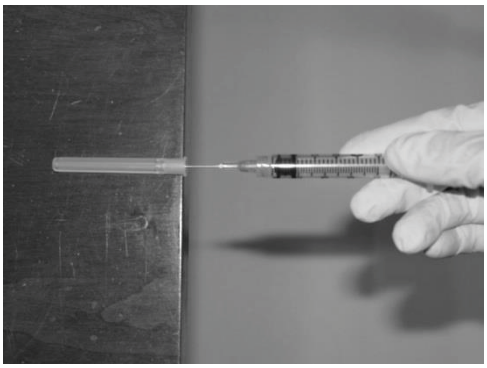
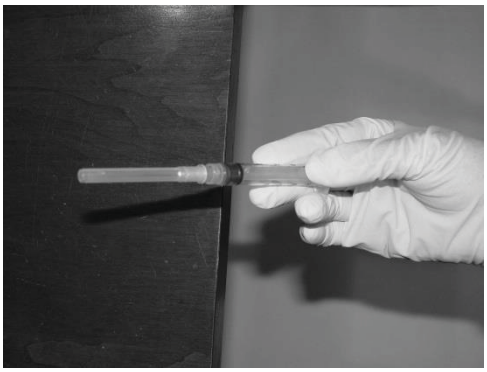
Procedure for One-Handed Needle Recapping

Due to the risk of injury, needles should rarely ever be recapped. Use this procedure only when a sharps disposal box is unavailable or when the needle is used in such a way that it has had **no** chance of becoming contaminated. Needlestick injuries place workers at risk for bloodborne pathogens. After a needle has been used, it should be disposed of in the nearest sharps container. It should **never** be placed (capped or uncapped) in regular trash.

1. Wash hands and apply gloves.
2. Before using the needle, place the needle cover on a flat, solid, immovable object such as the edge of a table. The open end of the needle cap should face the worker and be within reach of the dominant hand.
3. Give the injection, or use the needle and syringe to draw up solution.
4. Place the tip of the needle inside the open end of the needle cap and gently slide the needle into the cap.



5. Once the needle is inside the cap, gently lift the syringe just off the table with the needle cap pointed upwards.



6. Carefully point the capped needle against the table and use the table's resistance to completely cap the needle.
7. At the first opportunity, dispose of the needle and syringe in an appropriate container.
8. Remove gloves and wash hands.

Sources:

U.S. Food and Drug Administration. (2014). *What to do if you can't find a sharps disposal container*. Available online at http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/HomeHealthandConsumer/ConsumerProducts/Sharps/ucm263259.htm

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Illustration Source: Vickie H. Southall.