MODULE 6:

Hemodialysis Procedures and Complications

Fourth edition authors:
Lynda Ball, BSN, RN, CNN
Susan Hossli, MSN, RN
Elmer Lee, BSN, RN
Debra McDillon, MSN, RN, CNN
Eileen Peacock, MSN, RN, CNN, CIC, CPHQ, CLNC
Lyle Smith, BSN, RN, CNN, CPDN
Donna Swartzendruber, MSN, RN, CNN

Objectives

After completing this module, the learner will be able to:

1. Describe the predialysis set-up of the hemodialysis machine and extracorporeal circuit.
2. Explain the start, monitoring, and end of a routine treatment.
3. Identify the vital signs that should be monitored before, during, and after treatments.
4. Discuss the basics of infection control.
5. Explain how to draw up and give intravenous medications.
6. Describe how to draw a blood sample.
7. Discuss the importance of documenting patient care.
8. Identify causes, signs and symptoms, and prevention of clinical and technical complications that may occur during dialysis.

Introduction

Cleaning a patient's blood with dialysis is a complex process with many steps—and each step may be crucial to keeping patients safe and maintaining their comfort. Dialysis treatments can only be uncomplicated and routine when staff pay close attention.

This module covers the types of patient care tasks, technical tasks, and skills you will need to learn to deliver safe and effective treatment. It goes over the processes of dialysis, from set-up through clean-up. Your actions at each step—from setting up the machine, to washing your hands, to putting in needles, to monitoring the treatment—affect your patients.

The authors wrote this module assuming that you will work with a preceptor, or teacher, who will show you each step. We do not provide step-by-step checklists, but rather descriptions of processes and the reasons for key procedures. Each step may be done in various ways. Your center will have its own policies and procedures that you will need to learn and follow.

This module is a general review of procedures and complications you may encounter. The exact tasks that you can do will vary with the Nurse Practice Acts, regulations, and laws in each state; and with your center's policy. A team of technicians, nurses, nephrologists, social workers, dietitians, pharmacists, and others cares for dialysis patients. The authors assume that patient assessment is the job of registered nurses, but that you can help by gathering data, noting and reporting unexpected findings, and providing input into the care plan.

Patient and Staff Safety

BODY MECHANICS

You will use your musculoskeletal system on the job to stand, walk, sit, or squat to carry, lift, push, or pull objects. These tasks can injure your muscles and back. When you use good body mechanics (moving your body to prevent injury), you can avoid muscle strain and fatigue (see Figure 1). Awkward postures, repetitive motion, and heavy lifting are the three main risk factors in musculoskeletal injury. To move effectively, you need to make friction, leverage, and gravity work for you. Your teacher will

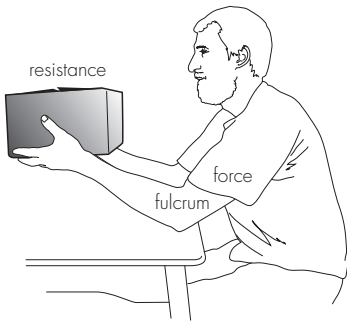


Figure 1: Good body mechanics

show you the basics of good body mechanics. Use what you learn in your day-to-day work.

Lifting and Carrying

The proper way to lift objects—like supply boxes—is to stand with your feet shoulder-width apart and bend from your hips and knees. ***Never bend at the waist or turn your body when you lift, push, or pull an object.*** Put your hands around the object and pick it up, holding it close to your body. Bend your knees and keep your back straight; you want to use your arm and leg muscles—*not* your back. If the object is too heavy for you to lift by yourself, don't try it—get help instead.[1]

TRANSFERRING PATIENTS

Many dialysis patients need help to transfer (move from place to place). The Occupational Safety & Health Administration (OSHA) publication *Ergonomics for the Prevention of Musculoskeletal Disorders* has techniques for safe transfers in any healthcare setting.[3] In the center, you will learn to do several types of patient transfers. Use the steps you learn to prevent injuries to yourself, other staff, and patients.

Which technique you use will vary with how well a patient can stand up and bear his/her own weight. Patients who can bear their own weight can transfer alone, but a staff member should stand by in case the patient needs help—especially after a treatment when he or she may be dizzy. You may need more than one staff member or a lift device if a patient can't bear his or her full weight.[4]

Before you move a patient, check his or her general condition. If possible, *do not* move a patient who has unusual fatigue, nausea, or unstable pulse or blood pressure; an unstable patient may fall. Learn how to minimize a fall: if a patient stands up and is unsteady, help him or her to sit back on the edge of the chair/bed that he or she started from. If you can't prevent a fall, try to slowly ease the patient down to the floor, then call for help.

Back-saving Tips[2]

- Think before you lift.
- Lift with your legs and hold the object close to your body.
- Stay at your ideal body weight.
- Strengthen your leg and stomach muscles.
- Exercise for 30 minutes, at least 3–4 times a week.
- Improve your flexibility; do gentle stretches every day.
- Never twist and lift at the same time. Keep your feet, knees, and torso pointed in the same direction.
- Test the weight of the object or patient before you lift. If something is too heavy, get help from a coworker or a mechanical aid.
- Push, don't pull. You'll have twice as much power and less chance of injury.
- Slow, smooth movements are safer than fast, jerky ones.
- If you develop back pain, stop what you are doing!

Patients Who Use Walkers

You may need to help patients who use walkers to be sure they can balance and will not fall. Even though it may be faster for you to put a patient in a wheelchair, it is physically better for the patient to use the walker.

Chair-to-Chair Transfers

Some patients transfer from a wheelchair to the dialysis chair and back to a wheelchair after treatment. Patients who use wheelchairs

need help to transfer to the dialysis chair (see Figure 2).

Lock the wheelchair and apply the brakes any time you move a patient to or from a wheelchair. Even with the brakes on, hold the wheelchair in place or put one foot against a wheel during a transfer to keep it from slipping or tipping over.

Stand and pivot technique

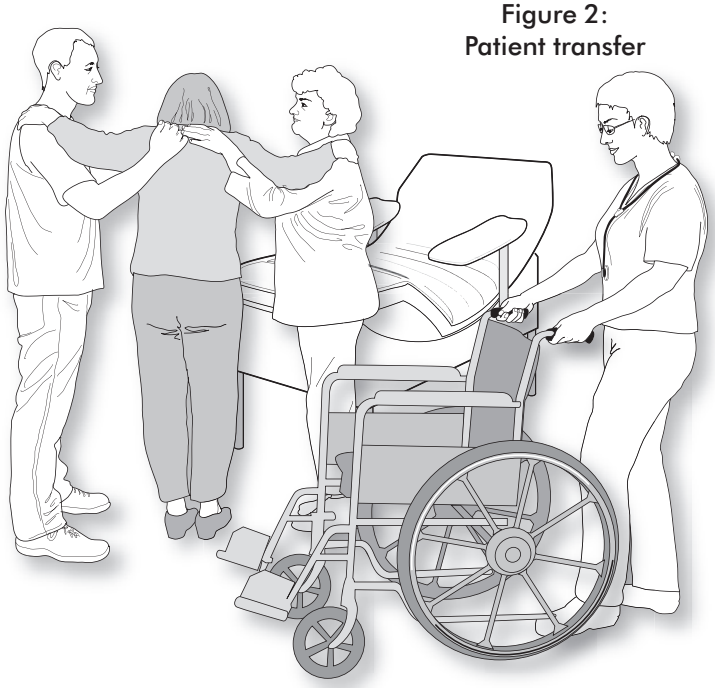
If a patient can bear enough weight to stand, you may be able to transfer him or her by yourself, using the stand and pivot technique. Following your center's procedure, help the patient sit on the edge of the chair. Put a gait belt (heavy canvas belt) around the patient's waist to provide stability and control during the transfer. Stand in front of the patient and help him or her to stand by pulling the belt to bring the patient toward you. Then, slowly pivot with the patient until you can lower the patient into another chair and then remove the belt. Use good body mechanics to prevent back injury.[4]

Using a slide board

You can do a chair-to-chair lateral (sideways) transfer from the sitting position using a slide board (smooth, shiny board) to reduce friction. When you use a slide board:

- Hold the board steady during the transfer.
- Lock the wheelchair and hold onto it during the transfer.
- Have a "spotter" standing by—someone who can help the patient to the floor if he or she slips or the board moves.
- Ask a staff person to hold the dialysis chair to keep it from moving during the transfer.

Figure 2: Patient transfer



Portable lift devices

Portable lift devices like Hoyer™ lifts or sling lifts are usually used for patients who can't bear weight, are very heavy, or can't help with their own transfers. Make sure the device will hold the weight of the patient you are moving before you try a transfer (the weight limit will be in the owner's manual). Patient transfers using portable lift devices require at least two staff members:[4] one to move the lift and one to pull the patient to the correct part of the chair. When you use a portable lift device:

- Make sure the sling is under the patient's body from shoulders to hips.
- Check that the hooks are all in the correct slots on the sling holder.
- Raise the patient up just enough to clear the chair.
- Be sure the patient's fingers are clear of any hooks that could pinch.

- Release the patient down into the chair gently.
- Reposition the patient as needed.

Stretcher-to-Chair Transfers

Some patients, often those from nursing homes, come to dialysis on stretchers. If a patient can bear some weight, follow your center's procedure to place the stretcher in a low position and use the stand and pivot technique. If the patient can't bear any weight, use a portable lift device, as previously described.[4]

Stretcher-to-Bed (Lateral) Transfers

Lateral transfers are used for bed-bound patients. You can use assist devices, like sheets or boards with rollers, to help push and pull a patient from a stretcher to a bed. You will need several staff members, but these devices avoid the need for a complete lift, which reduces the risk of injury. For all lateral moves, the surface to which the patient is being transferred should be a half inch lower then the surface the patient is on.[4] Using an assist device, some of the staff members will push and the others will pull the patient onto the new surface.

EMERGENCY PREPAREDNESS

An emergency is an unexpected event, like a fire, tornado, hurricane, flood, blizzard, ice storm, or earthquake, that requires help or immediate action. In an emergency, patients and staff may have to evacuate the center, and you need to know how to help. Your center must have an emergency action plan.[5] Key points of emergency preparedness include:

- Follow your center's plan to notify staff and emergency services personnel.
- Know where to find all exit doors, how to locate and use fire extinguishers, and your role if there is an emergency.
- In case of fire, remember **R.A.C.E.**:
  - **R**escue
  - **A**ctivate the alarm
  - **C**ontain the fire (only if small)
  - **E**vacuate
- To use a fire extinguisher, remember **P.A.S.S.**:
  - **P**ull the pin
  - **A**im the nozzle at the base of the flames
  - **S**queeze the handle
  - **S**pray from side to side at the base of the flames
- Disconnect patients from the machine to evacuate in this order:
  1. Patients who can walk without help
  2. Patients who can walk, but will need some staff help to do so
  3. Patients who cannot walk and will need staff help to evacuate
- Evacuate the premises using the safest and closest exit.

INFECTION CONTROL

Pathogens (agents that cause disease, like bacteria, viruses, or fungi) that invade the body can cause infection. Infectious disease is the

second most common cause of death in dialysis patients.[6] The most common pathogens normally live on the skin and on mucous membranes (e.g., the lining of the nose, mouth, and bowels). Others are found in the soil, in water, on clothing, and on all surfaces.

Some pathogens cause more severe disease than others, and some are more communicable (easy to spread) than others. Nosocomial infections are picked up in a hospital or other healthcare setting. Your goal is to prevent infections in your center for patients and staff.

Communicable disease can be spread in several ways:

1. **Direct contact**: touching an infected person, such as shaking hands or kissing
2. **Indirect contact**: touching contaminated objects such as clothing, towels, cups, water faucets, telephones, doorknobs, and equipment
3. **Droplet spread**: breathing in sneezed or coughed droplets from the nose, mouth, throat, or lungs of an infected person

Infection can also occur when contaminated fluids enter the body, such as through a needle stick. A bite by an insect or animal can cause disease. Some diseases are caused by breathing in airborne fungi, bacteria, or viruses in dust or lint. In a dialysis center, pathogens can be spread by patients, staff, visitors, equipment, water, dialysate, and air.

Aseptic Technique

Aseptic (free from infection) technique is used to keep an object or area sterile (free from all germs). Other terms that relate to aseptic technique are:

- **Clean**: not free of germs, but disinfected and usable for some steps in the treatment
- **Contaminated**: an object that was sterile, but then was touched by a non-sterile object (germs could now be on the object)
- **Dirty**: neither clean nor sterile; cannot be used for dialysis steps that require an object to be clean or sterile

Learn aseptic technique, understand it, watch closely, and practice it with supervision.

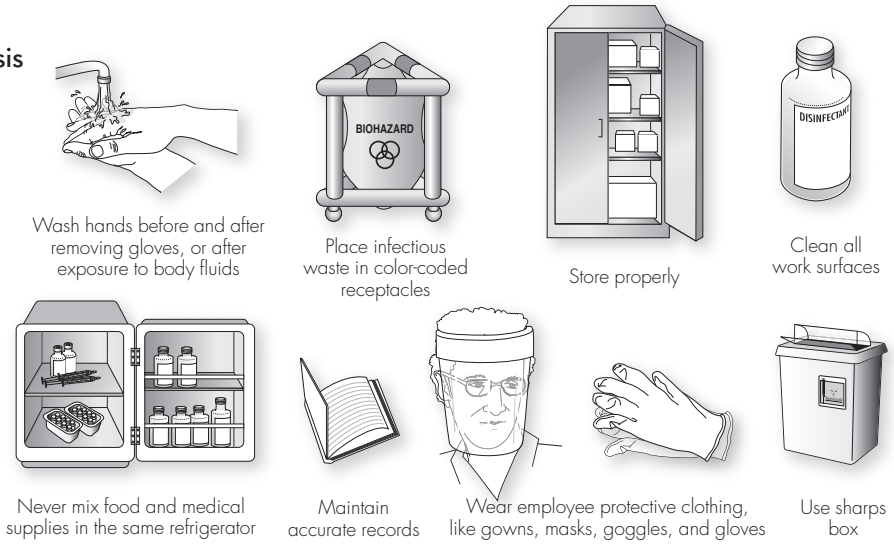
Guidelines for Aseptic Technique

- Prepackaged sterile items are sterile only if the package is closed and intact. Open sterile solutions or supplies only when you need them. Once open, they are exposed to airborne pathogens.
- Wash your hands before you touch a package that contains a sterile item. This will help keep you from getting germs on the item. Packages that contain sterile items should not be allowed to get wet—moisture allows pathogens to pass through the wrapper and contaminate the object.
- A contaminated object contaminates a sterile object. For example, when you spike a bag of saline, take care to insert the spike directly into the port. If the spike touches the outside of the bag or any other unsterile object, it becomes contaminated itself, and you cannot use it.
- Before you use a multidose vial, scrub the rubber stopper with disinfectant. Mark the vial with the date and time of first use.
- All fistula needles, syringe tips, and needles used to give medications or draw blood must be sterile, because they enter the bloodlines or the patient's body. When you start a treatment, do not touch the fistula needle or ends of the bloodlines to the patient or dialyzer. When you attach a heparin syringe to the heparin line, do not touch the syringe tip or the end of the heparin line.

Hemodialysis Infection Control Precautions

In 2001, the Centers for Disease Control and Prevention (CDC) recommended ways to

Figure 3:
Components of dialysis precautions



prevent bloodborne infections in hemodialysis patients (see Figure 3).[7] The CDC's guidelines are more strict than the standard precautions often used in hospitals. Using the CDC infection control steps will reduce the chances for disease to transfer from patient to patient, directly or indirectly, through contaminated equipment, supplies, surfaces, or staff's hands. Use these steps for *all* patients in your center.[7]

When to Wash Your Hands[8]

Wash your hands:

- *Between contact with all patients*
- Before and after you do any invasive procedure—like putting in dialysis needles—even if you wear sterile gloves
- Before you touch a wound, whether it is surgical, due to trauma, or caused by an invasive device—like a dialysis needle
- Before you touch patients who have diseases that make them more susceptible to infection
- After you touch any body substance or mucous membrane
- After you take off your gloves
- Between tasks and between procedures on the same patient to prevent cross contamination of different body sites
- When you enter and leave the center, to reduce the chance of spreading germs to your family, the patients, and other staff

Handwashing

Washing your hands correctly is the single most important thing you can do to prevent the spread of infection. It protects you as well as the patient. The goal is to remove pathogens that might be transferred to patients, visitors, or other staff. Research shows that handwashing can reduce infection rates, stop an outbreak of disease, and reduce the spread of drug-resistant bacteria.[8]

The CDC recommends that when you wash your hands with soap and water, wet your hands first with water. Apply the amount of soap recommended by the manufacturer, and rub hands together briskly for at least 15 seconds, covering all surfaces of the hands and fingers. Rinse your hands with water and dry thoroughly with a paper towel. Use a paper towel to turn off the faucet. The CDC also recommends that healthcare personnel who have direct contact with high risk patients—which includes

dialysis patients—avoid wearing artificial nails. Keep your nails less than one quarter of an inch long.[8]

If your hands are *not* visibly dirty, you can use an alcohol-based handrub. Apply the product to the palm of one hand and rub your hands together to cover all surfaces until your hands are dry. Always wash your hands with either soap or an alcohol-based handrub if your hands are *not* visibly dirty; after you take off gloves; each time you work with a different patient; and after you touch blood, body fluids, and contaminated items. Due to frequent handwashing, your hands may become dry and/or chapped. Use hand lotion or cream after washing your hands to prevent dryness and chapping.[8]

Protective equipment

During a treatment, you can be exposed to blood and contaminated items. ***You must wear gloves when you care for a patient or touch the equipment.*** You must also change your gloves between patients—failing to change gloves is a common error made in healthcare settings. Follow these steps to properly remove gloves:

1. With both hands gloved, peel one glove off from the top (wrist) to the bottom (fingers) and hold it in the gloved hand.
2. With the exposed hand, peel the second glove off from the inside, tucking the first glove inside the second.
3. Do not "snap" the gloves when you take them off.
4. Throw out the soiled gloves promptly.

Wear a gown, face shield, eyewear, or mask to protect yourself and keep your clothes clean when you do tasks that put you in possible contact with blood (e.g., start and end of treatment, cleaning dialyzers). Throw out any disposable protective equipment that is soiled with blood or other body fluids. Wash any contaminated non-disposable protective equipment per your center policy.

When to Use Protective Equipment[7]

Change your gloves:

- After each patient contact
- When they are bloodstained
- After you handle infectious waste containers
- After starting a treatment
- Before you touch any surface such as machine dials, charts, and phones

Wear a gown:

- When you do tasks that may cause blood or body fluid to splash or spray (e.g., start and end of a treatment, injecting into a bloodline, putting in needles)
- When you handle patient care equipment that is soiled with blood or body fluids, to prevent contamination of clothing or skin

Wear a face shield and protective eyewear:

- During tasks that may cause droplets of blood or body fluids
- At the start or end of a treatment
- When troubleshooting the vascular access
- When you inject into the bloodlines or change the transducer protector

To avoid sticking yourself with sharps (needles):

- ***Never recap needles if at all possible.*** If, for some reason, you must recap, use a mechanical recapping device or a one-handed method. Learn your center's policy and recapping devices, if used.
- Do not bend, shear, or break contaminated needles.
- Dispose of needles in puncture-resistant, color-coded boxes.
- Always point needles away from yourself.

Protection from contamination

Items used in dialysis can be contaminated with blood and body fluids by patients or staff. Any items used in the treatment—even those placed on top of the machine—should be thrown out, assigned to one patient, or cleaned and disinfected before going back to a clean area (storage space for sterile and clean items).[7] Your center will have policies and procedures about how to handle supplies after treatment. Learn about the "clean" and "dirty" areas in your center.

Guidelines for Preventing Contamination[7]

In your personal hygiene:

- Follow your center's policy for washing your hands.
- Never eat, smoke, apply cosmetics or lip balm, or handle contact lenses in treatment areas.
- If you have a cold or a cough, wear a mask to prevent spreading germs to patients.

To avoid environmental contamination:

- After each treatment, clean surfaces at the station, including the bed or chair, counters, and outside of the machine.
- Promptly clean up blood spills.
- Do not use common carts in the patient treatment area to prepare or give out medications. If trays are used to give out medications, clean them before using them for a different patient.
- Use a separate room if possible, a dedicated machine, and avoid dialyzer reuse for patients who test positive for hepatitis B surface antigen (see *Hepatitis B* section).
- Never store food and drink in refrigerators, freezers, shelves, cabinets, or counters where blood or other body fluids may be present.
- Use fresh external venous and arterial pressure transducer protectors for each treatment. These keep the machine's pressure monitors free from blood. Change protectors between each patient; do not reuse them.
- Cap dialyzer ports and clamp tubing on dialyzers and blood tubing that will be reprocessed. Place all used dialyzers and tubing in leakproof containers for transport from the station to the reprocessing or disposal area.

Cleaning and disinfecting

You can help prevent the spread of disease in your center. One way is to remove all (or nearly all) pathogens by sterilizing and disinfecting equipment, and keeping shared equipment to a minimum. Your center has policies and procedures on how to clean and disinfect surfaces and equipment after each treatment.[7] Learn which products your center uses and how to use them correctly.

Disposing of Infectious Wastes

There are rules and laws in each county and state for how to identify, handle, package, and transport infectious waste. Throw out needles in leak-proof, puncture-resistant boxes. Label sharps containers and do not allow them to overfill. Disposable material such as gloves, gauze, and aprons that are contaminated with body fluids need to be thrown out in "red" or color-coded garbage bags. Laundry contaminated with blood or other pathogens must be placed in labeled or color-coded, leak-proof bags; some centers double-bag all contaminated laundry. Learn your center's policies and procedures, which are based on your local and state regulations.

Bloodborne Diseases

Three primary bloodborne pathogens pose a risk to dialysis patients, and are therefore a risk in the center: hepatitis B (HBV), hepatitis C (HCV), and human immunodeficiency virus (HIV).

Hepatitis B

Hepatitis B (HBV) is a highly contagious virus. It can be transmitted through infected blood

and body fluids. The virus is hardy and can live for 7 days or more on surfaces. You can destroy the virus by cleaning with disinfectants and germicides. Most HBV outbreaks in hemodialysis patients are due to cross-contamination of patients via:

- Surfaces, supplies (e.g., hemostats, clamps), or equipment that did not get disinfected after each use
- Multidose drug vials and IV solutions used for more than one patient
- Drugs drawn up for injection near areas where blood samples are handled
- Staff members who care for both HBV-infected and susceptible patients at the same time

The most common ways that HBV is spread in dialysis centers are:

- A sharp object—such as a needle, scalpel, or broken blood tube breaks the skin
- Broken skin or mucous membranes of the eyes, mouth, or nose come in contact with blood

Hepatitis C

Like HBV, Hepatitis C (HCV) is spread by contact with infected blood and can be killed by disinfectants and germicides. HCV is not nearly as easy to transmit as HBV, so patients do not need to be in separate rooms, and their dialyzers can be reused.

Outbreaks of HCV in dialysis centers have been linked to these types of cross-contamination among patients:

- Equipment, machine surfaces, and supplies that were not disinfected between uses
- Use of common carts to prepare and give out medications

Precautions to Prevent Transmission of HBV

Centers can help avoid the spread of HBV if they:

- Follow hemodialysis infection control precautions with *all* patients.
- Dialyze HBV positive patients in a separate room with separate machines, equipment, instruments, and supplies.
- Keep staff who care for HBV positive patients away from patients who may be susceptible (e.g., on the same shift or during a shift change).
- Test patients for HBV per CDC guidelines.
- Do not reuse dialyzers of HBV positive patients.
- Vaccinate staff and patients against HBV.

- Sharing of multidose drug vials which were placed on top of machines
- Contaminated priming buckets that were not changed or cleaned and disinfected between patients
- Blood spills that were not cleaned up promptly
- Supply carts that were moved from one station to another with both clean supplies and blood-contaminated items, including small biohazard containers, sharps disposal boxes, and used vacutainers with patients' blood

Hemodialysis infection control precautions must be taken with *all* patients, whether or not they have HCV.

Human Immunodeficiency Virus (HIV)

HIV is a virus that attacks the immune system. HIV is the cause of AIDS (acquired immunodeficiency syndrome). HIV is transmitted by blood and other body fluids

Precautions to Prevent Transmission of HIV

Centers can help avoid the spread of HIV if they:

- Follow hemodialysis infection control precautions with *all* patients.
- Ask patients with risk factors for HIV to be tested; if infected, they can get proper care and counseling to prevent spreading the virus.

that contain blood. In the general public, HIV is most often spread through sexual contact and shared IV drug needles.[9]

Infection control precautions recommended for all hemodialysis patients are sufficient to prevent HIV transmission between patients. HIV-infected patients do not have to be isolated from other patients or dialyzed separately on dedicated machines. They can also take part in dialyzer reuse programs. HIV is not transmitted efficiently through occupational exposures, so reprocessing dialyzers from HIV-positive patients should not place staff at a higher risk for infection.[7]

Antibiotic-resistant Bacteria

Dialysis patients and staff could be exposed to drug-resistant bacteria that can cause infection. The two most common are methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant *Enterococcus*.

Methicillin-resistant Staphylococcus Aureus (MRSA)

Staphylococcus (staph) *aureus* is a bacterium that lives on skin and mucous membranes and in the respiratory, gastrointestinal, and urinary tracts. MRSA is a type of staph that has become resistant to certain antibiotics. It is most common in wounds, exit sites, and access sites, and can also cause sepsis (blood infections) and pneumonia. Sepsis caused by MRSA can be severe. Entry of MRSA into the bloodstream of a dialysis patient is most often through the vascular access or dialysis catheter.[7]

MRSA causes many nosocomial (hospital-related) infections in the United States. Certain people (especially those with weak immune systems—like dialysis patients) may be more likely to become infected with pathogens like MRSA. MRSA can be spread by healthcare staff's hands. MRSA may also be present on equipment,[7] and can live for a long time on surfaces.

Vancomycin-resistant Enterococcus (VRE)

Vancomycin-resistant *Enterococcus* (VRE) has also become a common nosocomial infection in U.S. hospitals. *Enterococcus* bacteria live in the intestines and are harmless to healthy people. VRE can cause severe infections in people with weak immune systems. Hemodialysis patients have played a key role in the growth of vancomycin resistance. One of the first cases of VRE was reported in 1988 by a dialysis center in London, England. CDC data have shown that from 12–22% of hospital patients who had VRE were on hemodialysis.[7]

Outbreaks due to enterococci, including VRE, have shown that it can spread from patient to patient. This transmission can be through direct contact, or indirectly through staff's hands or contaminated equipment or surfaces.[7]

Antibiotic-resistant Bacteria Precautions

Using infection control precautions (dialysis precautions) for all of your patients will help prevent the spread of drug-resistant bacteria, too.

Your center may use extra precautions to treat patients who may be at a higher risk for transmitting pathogenic bacteria, such as patients who have:

- An infected skin wound with drainage that seeps out of dressings
- Fecal incontinence or uncontrolled diarrhea

For these patients, extra precautions may mean that you:

- Wear a gown over your clothing and remove the gown when you're done caring for that patient
- Dialyze the patient at a station with as few stations next to it as possible (e.g., at the end or corner of the center)
- Use a dedicated blood pressure cuff and stethoscope

Tuberculosis (TB)

Tuberculosis (TB) is an infectious disease that spreads from person to person on airborne droplets. The droplets are formed when someone with pulmonary (lung) TB coughs, sneezes, or speaks. Anyone who is exposed may contract TB.[10]

TB infection can be active or latent (inactive). Someone with latent TB will have a positive skin test, but no outward signs of TB. Latent TB is not contagious, but without treatment the TB may become active and contagious. Active TB can cause a persistent cough, fever, weakness, weight loss, and night sweats. The number of cases of TB has risen in the United States, and some outbreaks have been reported in dialysis centers.[10]

MEDICATIONS AND SOLUTIONS

Each state regulates dialysis technician practice and what drugs and solutions you can or can't give.

Precautions to Prevent Transmission of TB[10]

Centers can help avoid the spread of TB if they:

- Require an annual TB skin test for patients and staff.
- Dialyze patients with infectious TB in an acute care setting or isolation room with negative air flow (air is pulled into the room).
- Require patients to take medication to prevent or treat infectious TB, and take all of the prescribed pills to prevent relapse and development of drug-resistant TB.

Some states allow patient care technicians to draw up and administer heparin and/or normal saline. In other states the patient care technicians are not allowed to draw up or administer *any* medication.[11] Learn the policies and procedures in your center, and the right equipment and techniques to give drugs and solutions correctly.

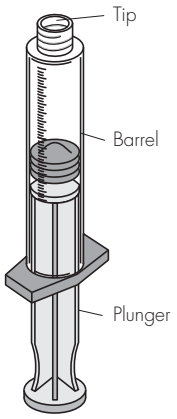
Needles

Needles are made of stainless steel and are thrown out after one use. The slanted part of a needle's tip is called the bevel. The diameter of the needle is called the gauge. Needles come in different bevel and gauge sizes. Needles must be used with aseptic technique (method of using equipment without contamination). Throw away contaminated needles in a sharps container.

Syringes

Syringes are made of plastic, and are packaged in sterile paper or plastic containers. They come in different sizes, and have three parts (see Figure 4 on page 176). The top of the syringe is the tip. A needle connects to a syringe at the tip, so the tip must be sterile at all times. The outside of the syringe is the barrel, which has scales printed on it to indicate the

Figure 4: Syringe



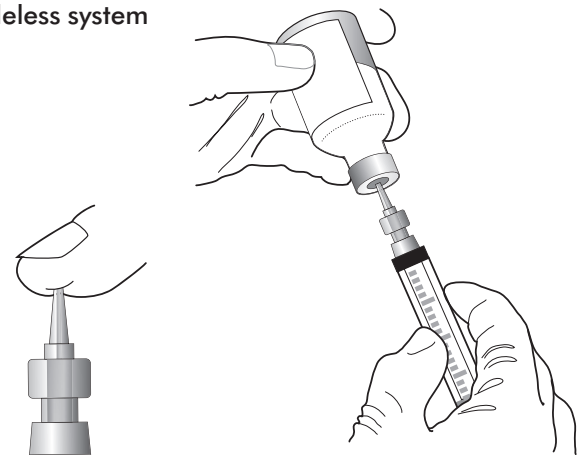
dose. The plunger fits into the barrel to push the medication out through the needle.

Using Syringes and Needles Safely

Wash your hands before you use a syringe and needle. Use only sterile syringes and needles to avoid contamination. Throw out used needles and syringes in a sharps container without cutting or recapping them, to prevent accidental needle sticks.

In 2001, the Occupational Safety Health Administration (OSHA) passed the Needlestick Safety and Prevention Act. This act requires safety devices to reduce exposure to bloodborne diseases, like sharps disposal containers, self-sheathing needles, and needleless systems (see Figure 5). Devices to prevent needle stick injuries are required in all dialysis centers.[12]

Figure 5: Needleless system



Drawing Up Medication

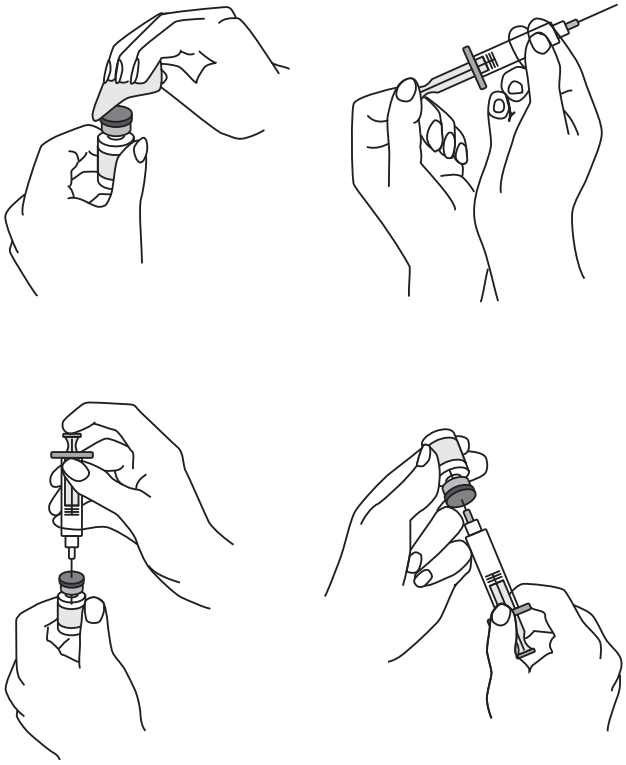
Vials are small plastic or glass bottles that have sealed rubber caps, usually covered by protective metal or plastic caps. Vials come in different sizes and can contain one or more doses of medication. If your role includes drawing up medications, learn how to draw up the right amount of a medication without contamination (see Figure 6). The basic steps to drawing up solutions and medications are:

1. Read the drug name on the vial before, during, and after drawing up a solution to make sure you have the right one.
2. Check the expiration date on the vial.
3. Clean the vial's rubber cap with a disinfectant to remove any contaminants.
4. Use a single dose vial only once.
5. Write your initials and the date on a multidose vial if you are the first one to use it.
6. Draw air into the syringe and inject as much air into the vial as solution you want to draw up. This will prevent a vacuum from forming, which would make it hard for you to draw up the solution.
7. Expel any air bubbles once you have withdrawn the needle from the vial.

Using IV Solutions

Normal saline used during the treatment is given through an intravenous (IV; into a vein) bag. Spike

Figure 6:
Drawing up a solution



(open) the bag and let the saline flow through the tubing to prime it (get it ready). Spiking the bag and priming the tubing before use expels all the air, so it can't enter the extracorporeal circuit or reach the patient's bloodstream.

Follow your center's procedure for connecting the IV tubing to the insertion port of the bag.

The port usually has a protective cap or tear tab that you must remove from the port. Place the bag on a flat surface or hang it up on an IV pole to make it easier to get a firm grasp of the port, so you can insert the spike of the IV tubing. Spiking IV solution is an aseptic procedure. After you spike the bag and attach it to the IV tubing, prime the tubing by letting the saline fill it until no air is left.

DOCUMENTATION

Information about each dialysis treatment becomes part of the patient's permanent medical record. Documentation (charting the patient's care in the medical record) also makes long-term follow-up of each patient's response to treatment possible. The chart is a written record of the care given by staff to a patient. A patient's record is kept to provide:

- A way for staff taking care of the same patient to share information
- A basis to prescribe medical treatment
- A diagnostic aid for the team
- Data for research and quality assurance
- A legal document, admissible in court as evidence of care the patient did or did not receive. ***Legally, if something was not charted, it was not done.***

Each center has policies and procedures for how to document patient care. Know your role in the patient's medical record.

Writing an Entry in the Medical Record

Proper charting techniques are vital for legal reasons. In most cases, entries can be printed or in script as long as they are legible and in ink. Each entry must be followed by the writer's name and title, in the format used by your center, for example, "J. Smith. D.T." Ditto marks, erasures, and correction fluid are not acceptable, because they could lead to legal questions if the chart is used in a court case. Instead, most centers require you to correct errors by drawing a single line through the wrong material, writing "error" or "mistaken entry" (ME) above it, and initialing the mistake:

ME or error (A.K.)

Example: Patient dialyzed for ~~4 hrs.~~ 3.5 hrs.

Never leave lines in a chart partly or completely blank. If the end of a line is not filled in, draw a single line through it to keep someone else from charting there. Record the time on all entries. Refer to your center's policy manual for specific how-to information. Always be accurate and factual when charting:

- Write the patient's full name on each page of the chart, or stamp it with the correct addressograph plate, to be sure that a page of one patient's chart is not accidentally placed in the wrong chart.
- Use only abbreviations and initials that are approved by your center.
- Include the effects and results of all treatments and procedures.
- Include detailed descriptions when you chart about pain, patient complaints, etc.

Dialysis Treatment Orders

Dialysis treatment orders include:

- Length and frequency of the treatments
- Dialyzer brand, model, and size
- Dialysate composition
- Heparin dose
- Blood and dialysate flow rates
- Ultrafiltration (UF) parameters

Electronic Charting

Your center may use electronic rather than paper charting. In this case, all of the patient's medical record is kept on the computer. To ensure that the electronic chart is not tampered with, and to keep patient confidentiality:

- Never share your password or computer signature with anyone—even another technician or nurse in the center, someone working temporarily in the center, or a doctor.
- Log off if you are not using your terminal, even if you just plan to step away for a moment.
- Follow your center's protocol for correcting errors. Computer entries are part of the patient's permanent record and, as such, cannot be deleted. In most cases, you can correct an entry error before you store the entry.
- Make sure that stored records have backup files—a vital safety feature. If you accidentally delete part of the permanent record, type an explanation into the file with the date, time, and your initials.
- Never display patient information. Don't leave information about a patient on a monitor where others can see it. Also, don't leave printed versions or excerpts of the patient's medical record unattended.

Predialysis Treatment Procedures

Several tasks must be done before a patient's treatment can start. This section will cover the treatment plan, preparing the dialysis equipment, and predialysis patient assessment.

TREATMENT PLAN

Dialysis is done according to a doctor's prescription. Each patient has a specific treatment plan. It is vital to know where to find these plans and how to carry them out as ordered. While dialysis treatments for all patients are similar, the nephrologist tailors each patient's treatment plan to meet the patient's needs. One patient may have a longer treatment time, while a second patient may use a different dialyzer. The physician continually evaluates each patient and varies the treatment plan, when needed, by writing new orders.[13]

EQUIPMENT PREPARATION

You will set up the equipment before each treatment and check the dialysate, extracorporeal circuit, dialyzer, and alarms. Module 4, *Hemodialysis Devices*, covers all of the equipment in detail. This section will give you an overview of what you need to do before each treatment.

Dialysate

Dialysate fluid helps remove wastes from the patient's blood. It can also replace needed substances, such as bicarbonate, to maintain the patient's acid-base balance. Since only a semipermeable membrane keeps the patient's blood apart from the dialysate, the exact make-up of the dialysate is key to your patient's well-being.

Dialyzer and Bloodlines

The extracorporeal circuit includes the:

- Dialyzer
- Bloodlines
- Monitoring lines
- Heparin line
- Transducer protectors

Key Points to Learn about Dialysate Set-up

Your task is to learn:

- How and when to verify that there are no chemical disinfectants in the dialysate lines
- How to choose the right dialysate concentrate for each patient and connect it to the machine
- How to check that the prepared dialysate temperature, conductivity, and pH are within acceptable limits

Key Points to Learn about Setting Up the Dialyzer and Bloodlines

- Learn how to check a dialyzer to verify that:
  - ➤ It is the one the doctor ordered
  - ➤ It is not defective (caps are on, no cracks or leaks etc.)
- Learn how to check a reprocessed dialyzer to verify that:
  - ➤ The patient's name is correct
  - ➤ Germicide is present
  - ➤ The time interval since the dialyzer was reprocessed is safe (not too long or too short)
- Learn how to correctly place the bloodlines, saline, and dialyzer on the machine.
- Learn how to keep the inside of the bloodlines sterile.

Key Points to Learn about Priming and Recirculation

Learn the correct way to:

- Do priming and recirculation
- Remove air from the bloodlines and dialyzer (air bubbles can cause blood clotting during the treatment)
- Test to be sure the germicide has been rinsed out of a reprocessed dialyzer

Key Points to Learn about Predialysis Alarm Checks

Learn how to:

- Complete these extracorporeal alarm checks:
  - **Air detector** (detects air in the bloodline after the dialyzer)
  - **Blood leak detector** (detects blood in the dialysate after the dialyzer)
  - **Arterial pressure high/low alarm** (detects pressure in the arterial bloodline that is outside set limits)
  - **Venous pressure high/low alarm** (detects postdialyzer pressure that is outside set limits)

If each of the above alarms is working, (1) the blood pump will stop, (2) the venous line should clamp, (3) the audio alarm will sound, and (4) the visual alarm message will appear.

- Complete the following dialysate alarm checks:
  - **Conductivity alarm** (detects if dialysate concentration is outside set limits)
  - **Temperature alarm** (detects if dialysate temperature is outside set limits)
  - **pH alarm** (if present, detects if dialysate pH is outside set limits)

If each of the above alarms is working, the machine will go into bypass mode (dialysate flow to the dialyzer should stop).

- Complete the UF check to verify that the volumetric/fluid removal components of the machine are working.
- Complete the negative germicide test to verify that the germicide has been removed from a reprocessed dialyzer.

You must use aseptic technique when you take any cap off of a bloodline, so you don't contaminate the inside of the bloodlines and cause an infection.

Priming and recirculation

You will learn to prepare the bloodlines and dialyzer for the treatment by priming (rinsing and filling the extracorporeal circuit with saline) them with normal saline. Then you will learn to attach the venous and arterial bloodlines together to form a loop, and recirculate the prime (send it around the loop). Priming removes air and germicide from the bloodlines and dialyzer; recirculation keeps the process going. During recirculation, UF and diffusion help "dialyze off" any germicide that is left. The germicide moves from the blood side of the dialyzer to the dialysate side, then down the drain. Priming also warms the saline so the patient does not get too cool when the treatment begins.

Predialysis safety check

Completing this check is vital for patient safety. If an alarm is not working correctly and the treatment is started, the patient could be harmed. All alarm checks must be successfully completed before the machine is used for a treatment. If any of the alarm checks fail, remove the machine from the patient area for inspection.

Predialysis patient evaluation

Part of your job will be to help evaluate the patient's health before a treatment. You will learn to compare this information with data from past treatment. You will also learn what abnormal findings should be reported to the nurse.[14] This is an important task since, in rare cases, the nurse may then decide that the patient's health is not stable and that treatment in an outpatient setting may not be safe.

Weight

Most dialysis patients make little or no urine. Between treatments, much of the fluid they drink stays in their bodies, so they gain weight. Signs and symptoms of too much fluid include edema from extra fluid in the tissues, shortness of breath from extra fluid in the lungs, and a rise in blood pressure from extra fluid in the blood. The patient's pretreatment weight is used to decide (1) how much fluid weight the patient gained since the last treatment, and (2) how much fluid weight to take off at this treatment. With respect to weight, your task is to learn:

- How the scale works and how to balance it to make sure it is accurate
- Your center's guidelines on recommended maximum weight gains between treatments
- When to tell the nurse about abnormal weight changes (too much or too little weight gained)

The dry weight or estimated dry weight (EDW) is what the patient's weight would be with no extra fluid and with a normal blood pressure. The doctor prescribes a "dry weight" for each patient. This number is then used to decide how much fluid weight is to be removed during the treatment. In an ideal case, by the end of a treatment the patient will be at or near dry weight. Not all weight gain is fluid—many factors can affect a patient's actual dry weight:

- A hospital stay or illness with loss of appetite, diarrhea, or vomiting can cause the dry weight to drop.
- The holidays often cause increases in dry weight because patients eat more than usual.
- Patients may lift weights to build muscle, and may gain real weight.
- Wearing different clothes or shoes to dialysis can raise or lower a patient's weight on the scale.

Taking off too much fluid can make the patient feel very ill; not taking off enough is also harmful. Because a patient's dry weight can change, its accuracy must be checked often.[15]

Components of the Predialysis Patient Evaluation

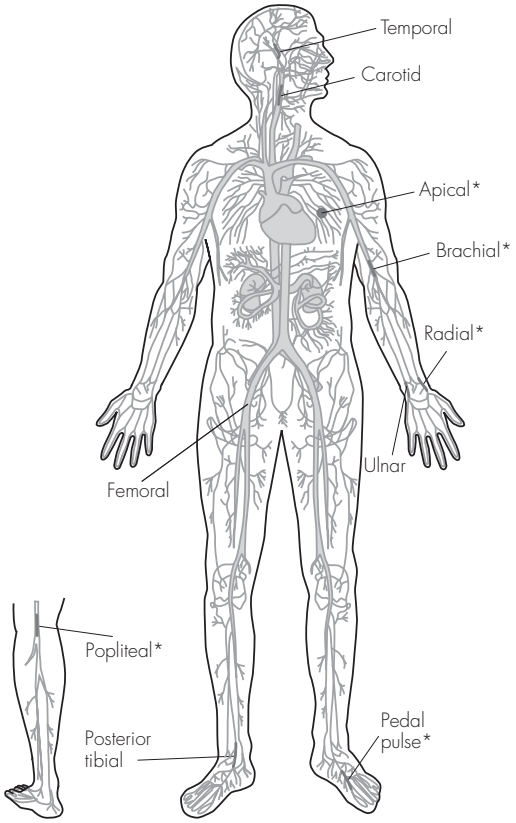
- Weight
- Edema (swelling)
- Pulse
- Blood pressure
- Respiration
- Temperature
- General physical and emotional state
- Problems since the last treatment
- Access status

Dry Weight Assessments

- After a treatment, a patient *at dry weight* should have:
  - Normal blood pressure
  - No edema (swelling)
  - No shortness of breath
- After a treatment, a patient *above dry weight* may have:
  - High blood pressure (hypertension)
  - Edema
  - Shortness of breath
- After a treatment, a patient *below dry weight* may have:
  - Low blood pressure (hypotension)
  - Light headedness or dizziness when standing
  - Muscle cramping

If you or the patient thinks the dry weight has changed, tell the nurse. A doctor's order is needed to change a patient's dry weight number.

Figure 7:
Sites used for assessing a pulse



The patient's pulse may be taken at several points.
*These pulse sites are commonly used for dialysis patients.

Key Points to Learn about Taking a Pulse

Your task is to learn:

- When to tell the nurse about an abnormal pulse rate or rhythm
- Where to check for the pulse. Sites include:
  - A **radial pulse** (at the wrist)
  - A **brachial pulse** (in the crease of the elbow)
  - An **apical pulse** (over the heart, using a stethoscope)
  - A **pedal pulse** (on the foot)

Edema

Edema occurs when extra fluid builds up in the patient's tissues. Due to gravity, it is often seen in the feet or ankles. Edema may also be seen in the hands, face, abdomen, or back. Asking simple questions like, "How do your shoes fit?" and, "Are your rings tighter than normal?" can help you to find problems with edema. You can also check for the amount of edema by gently pressing your thumb over the foot, ankle, or leg with slow, steady pressure. Be sure to learn:

- How your center wants you to check patients for edema
- When to tell the nurse about a patient's edema

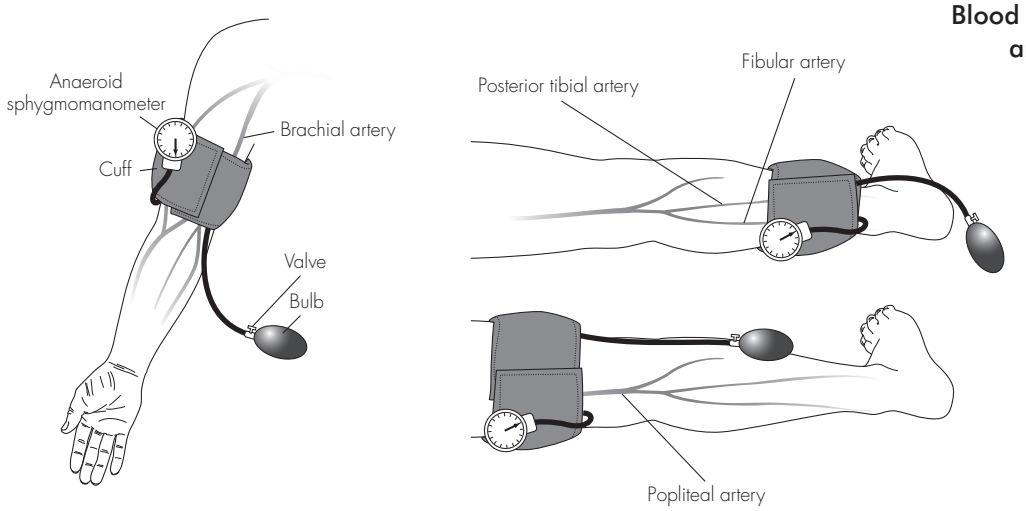
Pulse

With each heartbeat, the heart muscle pushes a wave of blood into the arteries. This "wave," or pulse, can be felt or heard at various points on the body. You will learn to measure a patient's pulse rate by feeling or listening at a pulse point (see Figure 7) and to record the number of heart beats per minute. The rhythm of the pulse can also be recorded. A normal pulse for an adult is between 60 and 100 beats per minute with a regular rhythm.

Blood Pressure (BP)

The pulse wave formed by each heartbeat causes pressure inside the arteries. The highest pressure in an artery occurs during a heartbeat, when the heart contracts. The lowest pressure is between contractions, when the heart is at rest. A BP reading records both the high number (systolic) and the low number (diastolic). So, if a BP reading is 120/70 (said as, "120 over 70"), the systolic pressure is 120 millimeters of mercury (mmHg) and the diastolic pressure is 70 mmHg.[16]

Figure 8:
Blood pressure on the arm and leg



A stethoscope and sphygmomanometer (blood pressure cuff) are used to check BP. You will take BP readings while the patient is seated and standing. In centers, BP readings are often taken by the dialysis machine, but you also should know how to take a manual BP. If a patient becomes light-headed in the waiting room, for example, a portable BP machine will be needed.

While you will usually check a patient's BP on his or her arm, you can also check BP on the leg (see Figure 8). You may need to do this in a patient who has accesses in both arms, or who has only one arm which has an access in it. Two sites for taking the leg BP are:

1. Placing the cuff above the knee, using the popliteal pulse
2. Placing the cuff above the ankle, using either the posterior tibial or dorsalis pedis pulse

According to the American Heart Association (AHA), the site of blood pressure measurement should be at the heart level. If the site (e.g., upper arm) is below the level of the right atrium, the readings will be too high; if the upper arm is above heart level, the readings will be too low.[17] The difference will be greatest if blood pressure in the leg is taken when the patient is standing. So, the leg blood pressure should be taken in the supine position with the leg at the level of the heart. Blood pressure reading on the leg is usually higher than pressures taken in the arm; even more so if a too-small cuff (same as for the arm) is used.

Key Points to Learn about Taking a BP

Your task is to learn:

- When to tell the nurse about an abnormally high or low predialysis BP reading
- How to correctly take a machine and a manual BP
- How to correctly take both an arm and a leg BP

Key Points to Learn about Taking Respirations

Your task is to learn:

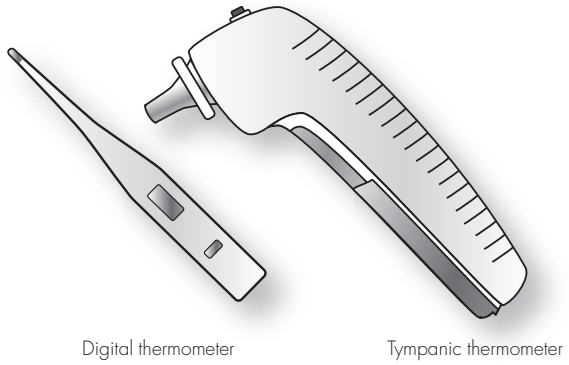
- How to correctly count the respiration rate and check respiratory status
- When to tell the nurse about an abnormal respiration pattern

On the other hand, patients with peripheral artery disease (PAD) will have lower popliteal and ankle blood pressures.

Both where you put the BP cuff and the cuff size can change the accuracy of a BP reading. Cuffs that are too wide compared to the patients body size will cause a falsely-low reading. Cuffs that are too narrow will cause a falsely-high reading. BP cuffs that are wrapped too loosely or unevenly will also cause a falsely-high reading.[18] The cuff bladder length recommended by the AHA is 80% of the patient's site circumference (arm or leg), and the ideal width is at least 40%.[17]

In patients with kidney failure, changes in fluid status are the key reason that BP readings rise or fall. As fluid weight increases, the BP also increases (extra fluid in the blood raises pressure inside the blood vessels). As fluid weight is removed, the BP goes down (total blood volume drops).

Figure 9:
Thermometer types



Key Points to Learn about Taking a Temperature

Your task is to learn:

- What type of thermometer your center uses and how to use it correctly
- When to tell the nurse about an abnormal temperature reading

Respiration

With each breath, oxygen from the air enters the lungs and carbon dioxide leaves the lungs. This exchange of gases affects the health of every cell in the body. An adult's respirations are normally regular at a rate of about 12–16 per minute. Patients may unconsciously (or "unknowingly") change their breathing patterns if they know their respirations are being counted.[18] So, you will usually count respirations while you are taking a patient's pulse.

In dialysis patients, fluid weight gains may cause fluid to enter the lungs. This leads to shortness of breath or labored, difficult breathing. Report these symptoms to the nurse. He or she may use a pulse oximeter ("pulse-ox" machine with a sensor probe) to check the oxygen level in the patient's blood. The probe, which looks like a clothespin, is placed on a finger, and the machine then displays the oxygen saturation ($Sa0_2$). A "pulse-ox" reading of less than 90% is considered abnormally low.[18]

Temperature

A variety of thermometers are used to measure temperature (see Figure 9). No one temperature reading is "normal" for all people. For young adults, the average oral (mouth) temperature is 98.6 degrees Fahrenheit (°F) or 37 degrees centigrade (°C). In older adults, temperature is often lower, around 96.8°F (36°C).[18] Hemodialysis patients also tend to have low baseline (predialysis) temperatures, for unknown reasons.[19] A high temperature before a treatment could be due to a cold or flu, or an infection (e.g., in an access, the urinary tract, or an infected foot—common with diabetes). Inflammation, such as pericarditis (an inflammation of the sac around

the heart), can also cause a fever. See Table 1 for a summary of vital sign information.

Vascular Access

The patient's vascular access is his or her lifeline. Before each treatment starts, check the access to be sure it is working. See Module 5: *Vascular Access* to learn how to check the access.

General and Emotional Health

Talking with patients, asking them questions, and listening to their answers is another way to gather predialysis information. Patients know themselves best. By talking to and watching them, you can find clues to their general health and emotional well-being. Here are some questions you might ask:

- How have you felt since your last treatment?
- Have you had any trips to the emergency room or outpatient procedures?
- Have you felt any chest pain? Any trouble breathing?
- Are you having any problems eating or digesting your food?
- Have you seen any doctors or started any new medications since your last treatment?

You can also learn about patients just by watching them. For example:

- When the patient walked into the center, did he or she walk as well as on other days?
- Is the patient's speech normal (not slurred)?
- Does the patient seem confused, agitated, or depressed?
- Is the patient's skin color normal or is it pale or ashen (gray)?

Table 1: Vital Signs Fact Sheet

Vital Sign/Definition	General Adult Norm	Terms
Blood pressure (BP) • Measurement of BP inside an artery • *Systolic*: pressure inside an artery during a *beat*; top number in a BP measurement • *Diastolic*: pressure inside an artery when the heart is *at rest*; lower number in a BP measurement	Optimal BP for adults:[20] ≥120/80 High BP for adults:[20] >140/90	Hypertension—high BP (often with no symptoms) Hypotension—low BP Orthostatic hypotension—a drop in BP of 15 mmHg or more upon rising from sitting to standing; causes dizziness and possible fainting
Pulse The wave of blood in an artery caused by each heart beat	60–100 beats per minute (with regular rhythm)[18]	Tachycardia—fast pulse, >100 Bradycardia—slow pulse, <60 Normal sinus rhythm—normal rate and rhythm Arrhythmia—irregular pulse and rhythm
Respiration Taking air into and pushing it out of the lungs	12–16 breaths per minute[18]	Dyspnea—shortness of breath Apnea—no breathing
Temperature Difference between body heat produced and heat lost	98.6°F (37°C) for young adults[18]	Afebrile—without fever Febrile—with fever

See Module 2: *The Person with Kidney Failure* for more information on patients' health.

Initiation of Dialysis

Once the predialysis tasks are done, the treatment can begin. A number of steps are needed to start the treatment: calculating how much fluid to remove, venipuncture (putting the needles into the patient's access), blood testing, and starting the machine.

REMOVING FLUID

Removing excess fluid from the blood is a main dialysis task. This process of fluid removal is called ultrafiltration (UF). Fluid moves out of the blood and across the dialyzer membrane due to a pressure difference between the blood and the dialysate (pressure is always higher on the blood side). How fast (and how much) fluid is removed (the UF rate) can be changed by increasing or decreasing the degree of pressure difference. In the past, such pressure differences and ultrafiltration rates (UFRs) were calculated by dialysis technicians. With modern, volumetric dialysis machines, all you need to do is tell the machine how much fluid you want removed from the blood during the treatment and how long the treatment will last.

The modern, volumetric dialysis machine will calculate the UFR and determine the correct pressure difference to remove the right amount of fluid during the treatment. To do this, the machine sets the desired pressure difference between the blood side and the dialysate side of the dialyzer by adjusting the dialysate pressure appropriately. This pressure difference is known as the TMP, which stands for transmembrane pressure.[21]

Table 2: Example of Total Fluid Removal Calculation[14]

Desired weight loss in mL (1 kg = 1,000 mL)	= 2,000 mL
Priming saline	= 240 mL
Saline rinseback	= 200 mL
Medications	= 250 mL
Dietary intake (ice chips, drinks)	= 120 mL
Total fluid amount to remove	**= 2,810 mL**
UFR per hour (mL/hr): 2,810 mL ÷ 4 hours (treatment time) = 702.5 mL/hr or 0.7 L/hr	

Appendix 1 on page 202 outlines the calculation for TMP. See Module 4: *Hemodialysis Devices* to learn more.

It is your job to calculate how much fluid to remove during dialysis. Starting with the desired weight loss (based on the patient's estimated dry weight and actual pretreatment weight), make adjustments for the patient's fluid intake during dialysis (see Table 2). Fluid intake includes saline prime (unless this has not been infused into the patient), rinseback (saline used to push the patient's blood back in the body after a treatment), ice chips, food and drink, and medications. Fluid output during dialysis (e.g., urinating, vomiting) is not usually included. When you enter the total fluid amount (in mL) into the dialysis machine, along with the treatment time, the machine will calculate and set the right TMP and hourly UFR.

Replacing Fluid

Rarely, you may need to give patients normal saline during the treatment to help them reach their goal weight. For example, a patient may come in for a treatment below the prescribed dry weight due to vomiting or diarrhea. Follow your center's policies and procedures to decide if saline is needed during a treatment and, if so, to figure out how much is needed.

VENIPUNCTURE

To do hemodialysis, an access is needed so blood can be pumped into the dialyzer and then back to the patient. Since in-center treatments are done three times a week at high blood flow rates, the patient's own veins can't be used for access as they are. Instead, a surgeon creates a dialysis access. For an arteriovenous fistula (AVF), the surgeon sews a patient's artery to a

vein. For a graft, the surgeon links the patient's vessels with a piece of artificial vein. A fistula is the best access, because it lasts longest and is less likely to become clotted or infected.

The access is the patient's lifeline. Each patient has only about 10 sites on his or her body where an access can be created—when they are used up, the patient must either get a transplant, or switch to peritoneal dialysis to continue living. So, venipuncture (putting needles into the patient's access) is one of the most vital tasks you will do.

With either a fistula or a graft, needles must be placed into the access. Skilled and gentle needle placement prolongs the life of the access. Good blood flow through the needles helps ensure that the patient will receive an adequate treatment, with proper clearances of waste and fluid from the blood. Some patients whose fistula or graft are not yet matured (ready to use) or who do not yet have a fistula or graft must use a catheter (a tube placed in a central vein in the neck, chest, or groin). Catheters must be used with great care to prevent infection. See Module 5: *Vascular Access* to learn more about venipuncture and the care and use of the different types of vascular access.

LABORATORY TESTS

Blood tests are done to assess how the patient is doing with dialysis and his or her diet limits. You will learn how to draw samples of the patient's blood from the blood tubing port or the needle tubing, using a needle and syringe or a vacuum adapter.

Drawing Blood Samples

Draw blood samples from the arterial port or arterial needle tubing before you give heparin or saline. In patients with catheters, a small amount of blood needs to be drawn and discarded prior to drawing blood samples for processing. The first blood drawn from a catheter will contain heparin, which may change the results of some blood tests. To draw activated clotting times (ACT, a test of blood clotting) from a catheter, follow your center's procedure.

Most blood tests are drawn before the treatment, except postdialysis BUN (a test of dialysis adequacy), recirculation studies (a test of how much blood is being cleaned during a treatment), and blood cultures (a test for bacteria). All blood tests need a doctor's order. You must wear gloves, a face shield or mask, and a gown to draw blood. After drawing the blood, use safe needle devices to prevent accidental needle sticks.

Key Points about Laboratory Testing

Learn how to:

- Use aseptic technique and dialysis precautions (see *Infection Control* on page 168).
- Draw samples from the arterial bloodline injection port or an arterial needle tubing.
- Draw blood samples before you give saline or heparin.
- Always draw blood into tubes with any anticoagulant in them last.
- Gently invert blood tubes back and forth to ensure proper mixing of blood with any additives in the tube. Never shake blood sample tubes vigorously.
- Keep blood tubes upright, label them correctly, and handle them properly.
- Know for which lab tests the test tube must sit idle for 10–20 minutes before spinning them.
- Avoid placing blood sample tubes on warm or hot surfaces (e.g., on top of the dialysis machine).

Most dialysis patients have anemia, a shortage of red blood cells. Blood tests remove even more red blood cells, which can worsen anemia. Draw the smallest amount of blood that the lab in your center will take for each blood test. Use pediatric methods and blood tubes when possible.

Follow your center's policies when drawing blood. Here are three ways that may be used to draw blood samples from a patient's needle tubing or bloodline:

1. Use a syringe and needle, needleless adapter, or vacutainer to withdraw blood from an injection port on the bloodline and then inject it into a sample tube.
2. Use a Luer-Lok®, adapter to draw blood directly into a vacuum sample tube.
3. Attach a syringe to the end of the patient's needle tubing and draw blood into the syringe. Then put a needle on the syringe and insert the needle into the rubber stopper of the sample tube. Note: remember to clamp the needle tubing before you remove the Luer-Lok adapters or syringes.

After you draw the sample, you will usually attach a syringe to the end of the needle tubing to flush the line with saline and keep the tubing sterile.

There are several types of blood sample tubes. Learn which tubes to use for each type of test. You can identify tubes by the color of their rubber caps (e.g., red speckled top, plain red top, lavender top). The color-coding is important, because some tubes have preservatives or solutions needed for a test. Also, it is important to know that vacuum tubes do not fill completely. Do not attempt to over-fill the tube by forcing blood into the vacuum tube from a syringe. When the vacuum stops pulling blood into the tube, the tube is full.

Using a Centrifuge

A centrifuge is a machine that uses centrifugal force to separate red blood cells from the serum. It may be your job to "spin down" or centrifuge blood samples. Follow your center's policies and procedures when using the centrifuge.

Testing Blood Sugar

Diabetes is the most common cause of kidney failure. It is treated with diet, pills, and/or insulin. To assess how well diabetes is controlled, the doctor may order a routine glucose (blood sugar) test. You measure the level of glucose in the blood.

Dialysate often contains glucose which helps keep the patient's glucose levels from becoming too low during the treatment.

MEASURING DIALYSIS ADEQUACY

How do we know if a patient is getting enough, or adequate, dialysis? There are two main lab tests that estimate the "adequacy" of dialysis given to a patient during a treatment: urea reduction ratio (URR) and urea kinetic modeling (UKM).[22]

Urea Reduction Ratio

The URR is an estimate of how much urea is removed from a patient's blood during dialysis. Urea, or blood urea nitrogen (BUN), is an easy-to-measure, small molecule waste product of protein breakdown. It indicates how well a treatment is working. If the change in BUN levels from predialysis to postdialysis is too small, the treatment may not be adequate.

How much urea is removed by dialysis is found using blood test results and a mathematical formula. The level of BUN before a treatment is compared to the level after a treatment. So, both predialysis and postdialysis BUN samples are needed (see Appendix 2 on page 203 for URR formula).

The URR is the simplest way to estimate the delivered dose of dialysis. But, it does not provide all of the information needed to prescribe a dialysis treatment. It doesn't tell you, for example, how much extra time a patient with a low URR might need to get adequate dialysis. URR does not account for a patient's production of urea during dialysis. Also, URR does not tell you how much urea is removed by UF during dialysis. This means URR is less accurate than UKM to estimate dialysis dose in patients who need a large amount of UF.[22]

Urea Kinetic Modeling

UKM is a more in-depth way to estimate the delivered dose of dialysis. It is more complex than the URR, but tells you more about a patient's treatment needs and is more accurate. UKM can help a doctor predict how much treatment time a patient should have, and determine a protein catabolic rate (PCR, the rate at which the body burns protein) to meet the patient's needs. UKM also figures in a patient's size and residual kidney function.

The formula used to find the dialysis dose is Kt/V, where:

K = dialyzer urea **clearance** in mL/min

t = **time** on dialysis in minutes

V = **volume** of urea in the patient's body, in mL

Values for K are based on dialyzer type, and blood and dialysate flow rates. Accurate values for V are hard to find, and require a computer program to estimate. Like URR, a pre- and postdialysis BUN are needed for UKM. Pre- and postdialysis weights are also needed. Kt/V can help you find the delivered dose of dialysis, or can help a doctor set a target value to decide a dialysis prescription.

The main advantage of UKM over URR is that it can be used both to measure and to prescribe a treatment. UKM gives the staff a number of options to help determine adequate dialysis and identify problems in delivering an adequate treatment.

Predialysis and Postdialysis BUN Measurements

Predialysis and postdialysis BUN samples are drawn each month so URR and Kt/V can be calculated. Draw the predialysis and postdialysis BUN samples during the same treatment.[22]

Predialysis

Draw predialysis BUN samples just before a treatment, and avoid diluting the sample with saline or heparin. Take the blood sample from the arterial needle before you connect the arterial blood tubing or flush the needle in patients with a fistula or graft. For patients with catheters, withdraw any heparin and saline from the arterial port, following your center's protocol. After removing the heparin and saline from inside the catheter lines, connect a new syringe to the arterial lumen to draw the sample for BUN measurement.

Postdialysis

Draw the postdialysis BUN at the end of the ordered treatment time, using your center's policy:

1. At the end of the treatment, turn off the dialysate flow. If the machine does not allow the dialysate flow to be turned off, or if this is against your center's policy, turn dialysate flow down to its lowest setting.
2. Reduce the UFR to 50 mL/hr, the lowest TMP/UFR setting, or off.
3. Turn blood flow down to 100 mL/min *for 15 seconds* and draw the blood sample, either shutting off the blood pump (stop pump) or leaving it running at 100 mL/min (slow pump). To keep the blood pump from turning off as the blood flow rate drops, you may need to manually adjust the arterial and venous pressure limits.[22]

The slow flow/stop pump and the stop pump sampling technique are as follows:

1. To use the **stop pump sampling technique**:
   - Slow the blood flow rate to 100 mL/min for 15 seconds.
   - Stop the blood pump.
   - Clamp the arterial and venous bloodlines and the arterial needle tubing.
   - Draw blood for the postdialysis BUN from the arterial sampling port closest to the patient with a syringe, *or* disconnect the arterial bloodline and attach a vacutainer and syringe to the arterial needle tubing to draw the sample.
   - Return the patient's blood and disconnect the patient per your center's protocol.
2. *Or*, to use the **slow flow sampling technique**:
   - With the blood pump still running at 100 mL/min, draw the blood sample for postdialysis BUN measurement from the arterial sampling port closest to the patient.
   - Stop the blood pump and disconnect the patient per your center's protocol.

Minimum Delivered and Prescribed Dose of Dialysis

The NKF-KDOQI™ guidelines use UKM or URR to decide the delivered dose of dialysis. UKM is best, since it is based on patient factors such as body size and residual renal function.[22]

KDOQI guidelines set standards for the minimum delivered and prescribed doses of dialysis to help ensure that patients get adequate treatment. The *minimum* delivered dose should be a Kt/V of at least 1.2. This would translate to a URR of about 65%, though the amount of UF a patient needs must be taken into account.[22]

Because patients do not always get this delivered dose (due to reduced urea clearance, time constraints, or other factors), the *minimum recommended prescribed dose* is a Kt/V of 1.4 (this translates to a URR of about 70%).[22]

FACTORS AFFECTING DIALYSIS TREATMENT

It is important to know what affects the delivered dose or adequacy of treatment. The clearance of wastes through a dialyzer depends on a good blood flow rate, the right dialysate flow rate, and proper anticoagulation to prevent the clotting of dialyzer fibers. How well you do your job can affect all of these factors.

Clearance Factors

Dialyzers vary in size, porosity, and surface area, all of which affect how much dialysis a patient receives during a treatment. Other

treatment factors can also reduce clearance (K) and the treatment's effectiveness. These include:

- Poor blood flow from the patient's access
- Poor dialyzer function due to insufficient heparin/anticoagulation
- Clotting of the dialyzer's fibers
- Wrong estimates of dialyzer performance
- Wrong blood flow rate settings
- Blood pump calibration errors
- Reduced blood pump speed, such as when the patient has hypotension or muscle cramps
- Wrong dialysate flow rate settings that do not match the physician's orders
- Access recirculation (mixing dialyzed venous blood with undialyzed arterial blood in the patient's access during a treatment)

Time Factors

Factors that affect the patient's time (t) per treatment will also affect adequacy. These may include:

- Stopping a treatment early
- Frequent alarms that stop the blood pump (extracorporeal arterial or venous pressure)
- Frequent alarms that divert dialysate to the drain (alarms that put the machine into "bypass")

Losing just 5 minutes from each treatment over a year adds up to 13 hours—or more than three treatments. Since even a good conventional dialysis treatment replaces only about 15% of normal kidney function, every minute is needed. When possible, add time at the end of the treatment to make up for a reduced blood flow rate or time lost due to blood pump shut-off or dialysate bypass. If the lost time is significant and the center is too busy to add time, a patient may need to come for an extra treatment.

Patient Well-being

Dialysis should control or reduce the complications of chronic kidney disease. Patient well-being is a way to tell if dialysis is adequate—but it is only a late measure. A patient who receives poor dialysis may have few symptoms in the short-term, but may run into severe problems in the long-term and is likely to die sooner.

Poor dialysis can cause uremia (high BUN) which can decrease the patient's appetite. A malnourished patient may lose weight (muscle), have no appetite, and have low BUN and serum albumin levels. Malnutrition raises the risk of patient hospital stays and death.

It is wise to measure adequacy with more than one test. Besides looking at the URR or UKM, consider the patient's nutritional status and sense of well-being. These measures serve as a check for the quality of the treatment. They also help alert you to problems and help the doctor tailor the prescription to meet the patient's needs.

STARTING THE DIALYSIS TREATMENT

The treatment can start after you:[14]

- Match the dialyzer and dialysate concentrate to the patient.
- Prime the dialyzer and tubing with normal saline.
- Check all tubing connections.

Key Points to Learn about Dialysis Treatment Monitoring

- How often to check the patient's vitals signs during treatment
- Signs and symptoms of dialysis-related problems
- Equipment safety checks and how often they are done
- Where to find all of the alarms, how they work, and what to do if an alarm goes off or an emergency occurs

- Test and arm all alarms.
- Take the patient's vital signs and complete predialysis assessments.
- Insert the dialysis needles and tape them in place, or be sure that the catheter is properly flushed and prepared.
- Make sure all monitors are set and are within limits (e.g., arterial and venous pressures, blood leak detector, UF, conductivity, temperature, dialysate flow, blood pump speed, and sodium variation).

After the vascular access has been cannulated and the bloodlines have been connected to the access, start the blood flow slowly. If the patient is to receive the priming solution in the bloodlines, connect both the arterial and venous bloodlines. If the priming solution is to be discarded, connect only the arterial end of the bloodline to the needle to allow priming solutions to drain into the waste receptacle. Follow your clinic's policies and procedures. Monitor the patient until the venous line is connected to the access, due to the risk of severe blood loss. If the priming solution is wasted, once the blood has reached the venous chamber, connect the venous line to the access. Once the arterial and venous bloodlines have been connected, slowly increase the blood flow rate to the prescribed rate.[23]

After the treatment has started, document information about the start of the treatment on the treatment flow sheet. Learn what your center requires you to record on the patient's treatment flow sheet. ***Before you leave the patient's chair, recheck to be sure that you have verified all alarms and settings.***[14]

Measures to Ensure Safe and Reliable Machine Operation[24]

Learn how to:

- Operate the machine and understand all the dials and displays as described in the manual.
- Test all alarms by hand or automatically before each treatment.
- Use only dialysate concentrate that is prescribed for the patient, and have enough ready for the whole treatment.
- Avoid changing the conductivity alarm limits during a treatment.

Monitoring During Dialysis

During the treatment, you will monitor the patient and the machine. Patient monitoring includes taking vital signs and assessing the patient's general condition. Machine monitoring includes doing equipment safety checks, monitoring the bloodlines and the machine readings, and checking the alarms when they occur.

PATIENT MONITORING

Vital Signs

You will check the patient's vital signs during dialysis to ensure a safe and effective treatment. Your center may have you check the patient's vital signs every half hour, or more often if the patient is having symptoms or is unstable. Report any unusual findings to the nurse.

General Patient Condition

You will also learn how patients are tolerating the treatment by watching and listening to them. Watch the patient's behavior, appearance, response, and symptoms. Teach your patients to recognize and report symptoms so the care team can take action early (see *Hemodialysis Complications* on page 198). Report any unusual events to the nurse.

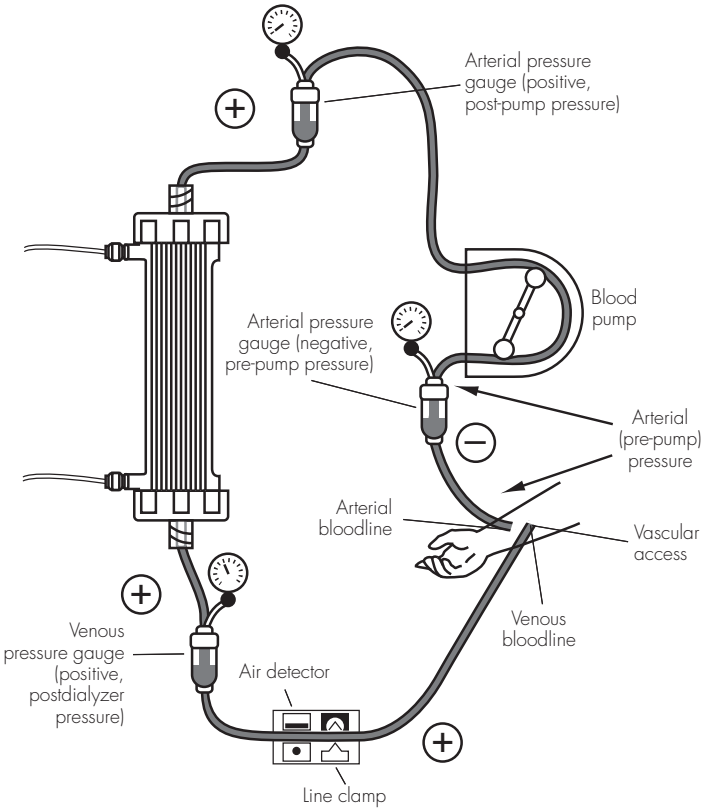
Giving Medications

Patients will need some medications before, during, or after a treatment. Drug timing depends on whether a drug will dialyze off, and on center policy and procedure. For example, patients can't take some blood pressure pills within a few hours before a treatment, because these medications may cause the blood pressure to drop during the treatment. Some drugs—such as volume expanders like hypertonic saline or mannitol—may be given by the nursing staff during a treatment if ordered to help remove fluid or maintain blood pressure. Others, like antibiotics, are given by the nursing staff near the end or after a treatment. This reduces the chance of the drug being removed during dialysis.

TECHNICAL MONITORING

You will learn how and why each monitor and alarm on the hemodialysis machine works, where to find it, and what to do if it should sound. If an alarm sounds or the equipment malfunctions during the treatment, you must act quickly to find the problem. Module 4: *Hemodialysis Devices* covers monitors and alarms in detail. It will be your job to monitor the extracorporeal circuit, dialysate circuit, and equipment for problems during each treatment (see Figures 10 and 11). These checks help

Figure 10: Pressure monitoring devices on arterial and venous bloodlines



The extracorporeal circuit has gauges to measure venous pressure and arterial pressure.

Figure 11: Air detector

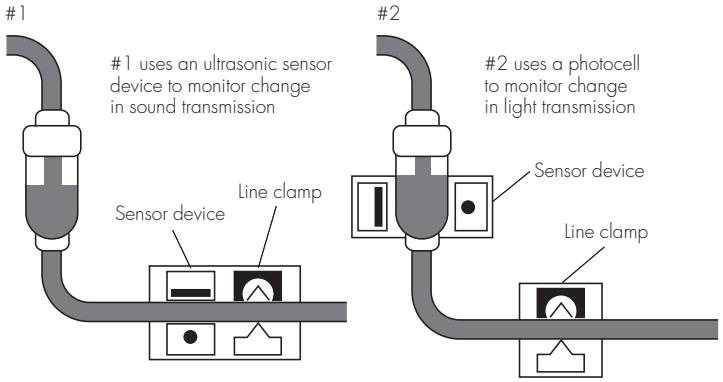
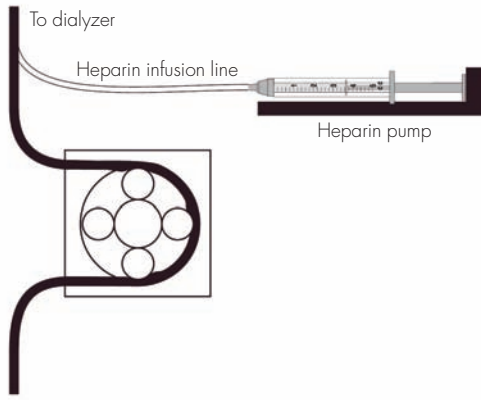


Table 4: Heparin Administration Methods[26]

Routine Continuous Infusion	• Inject a bolus (single amount) (e.g., 30–50 U/kg) 2–3 minutes before a treatment starts. • Use the heparin pump on the arterial bloodline to continuously pump heparin during the treatment (e.g., 750–1,250 U/hour). • Stop the heparin pump one hour before the end of the treatment, or per your center's policy.
Routine Repeated Bolus	• Inject a bolus dose of heparin 2–3 minutes before the start of the treatment. • Give bolus doses of heparin throughout the treatment, per center policy.
"Tight" Heparin	• Use for patients who have a slight to moderate risk of bleeding. The bolus dose and infusion rate is lower than with routine continuous infusion. • Inject a bolus (single amount) (10–20 U/kg) 2–3 minutes before a treatment starts. • Use the heparin pump (see Figure 12) on the arterial bloodline to continuously pump heparin during the treatment (500 U/hour). • Stop the heparin pump one hour before the end of the treatment, or per your center's policy.

Figure 12:
Heparin pump



ensure patient safety. Check all systems every half hour to hour, per your center's policy.

ANTICOAGULATION

During a treatment, the patient's blood comes in contact with the artificial (man-made) dialyzer and lines. This contact can cause blood clots, which could clog the dialyzer and make dialysis difficult or even impossible. Anticoagulants (blood thinners) help prevent clots and keep the patient's blood flowing freely. Anticoagulants used in dialysis include heparin, saline, or citrate.

Heparin

The anticoagulant of choice in hemodialysis is heparin. Heparin is easy to give, works fast, breaks down quickly in the body, and is removed quickly.[25] The patient's doctor prescribes the dose of heparin used in a treatment. There are three ways to give heparin before a treatment (see Table 4). Which technique is used will depend on the patient's needs and your center's procedure.

Activated clotting time (ACT) is a test of how long it takes for a patient's blood to clot. Heparin is given to keep the patient's clotting time at a prescribed limit, such as twice the baseline ACT, during a treatment. The Clinical Laboratory Improvement Amendments Act (CLIA) of 1988 requires human blood to be tested only in certified labs. This law has made it hard to do ACT testing in the dialysis center.[26] Follow your center's policies and procedures about how to check clotting times.

Learn the signs of heparin or bleeding problems and report any problems to the registered nurse. Check your patients for signs

and symptoms of too much or not enough heparin:

Signs of too much heparin:

- Nose bleeds
- Bleeding in the white part of the eyes
- Ecchymoses (bleeding into the skin)
- Prolonged bleeding from the access site after treatment

Signs of not enough heparin:

- Blood clots in the venous drip chamber or dialyzer
- Very dark-colored blood in the bloodlines
- Shadows or streaks in the dialyzer

Heparin-free Dialysis

Heparin-free dialysis can be done for patients who are at a high risk for bleeding or can't use heparin. Normal saline, 100 mL, is flushed through the arterial line, predialyzer, every 15–30 minutes. Heparin-free dialysis is very difficult to maintain. To succeed, a good arterial blood flow rate (>250 mL/min), a dialyzer with a high UF coefficient, and a dialysis machine with UF control are needed.[26]

Regional Citrate

Regional citrate anticoagulation is a rarely-used substitute for heparin-free dialysis. Regional citrate is for patients who have bleeding, are at high risk for bleeding, or who cannot receive heparin. Calcium allows blood to clot. So, another option to thin the blood without heparin is to reduce ionized calcium levels in the blood. This can be done by infusing trisodium citrate into the arterial bloodline, and using a calcium-free dialysate. However, it would be very dangerous to return the patient's blood with low calcium levels. So at the same time that trisodium citrate is infused into the arterial bloodline, calcium chloride is infused into the venous bloodline

Table 5: Clinical Complications of Hemodialysis

Complication	Causes	Signs/Symptoms	How to Prevent It
Air embolism (air bubbles block a blood vessel)	• Air detector is broken or not armed. • A leak or loose connection in the extracorporeal circuit before the blood pump. • Empty IV bags on the extracorporeal circuit before the blood pump.	Depends on the patient's body position when the air is infused. May include: • Chest pain • Trouble breathing • Coughing • Blue lips, fingers, toes (cyanosis) • Trouble seeing • Confusion	• Arm the air detector throughout a treatment. • Tighten all connections in the extracorporeal circuit. • Check the normal saline level in the IV bag. • Return the patient's blood with saline, with no air in the bloodlines.
Anaphylaxis (severe allergic reaction)	• Ethylene oxide (a new dialyzer germicide) allergy • Reaction to germicide left in the bloodlines • Drug allergy (e.g., to iron dextran, heparin)	• Trouble breathing (throat may close up) • Hypotension • Itching • Hives • Feeling anxious • Burning feeling • Unusual swelling • Cardiac arrest	• Rinse dialyzers and bloodlines well during equipment preparation. • Avoid drugs the patient has a known allergy to.

Table 5: Clinical Complications of Hemodialysis *(continued)*

Complication	Causes	Signs/Symptoms	How to Prevent It
Angina (chest pain due to low oxygen levels in the heart)	• Coronary artery disease (blocked heart arteries) • Anemia (shortage of red blood cells) • Hypotension • Anxiety	• Pain or tightness in chest • Patient may be pale, cold, sweating, and have trouble breathing	• Monitor blood pressure closely to avoid hypotension. • Calculate the fluid goal correctly.
Arrhythmias (irregular heartbeats)	• Changes in blood pH or electrolyte levels, especially potassium • Hypotension • Heart disease	• Irregular pulse (skipped or extra beats) • Slow or fast pulse • Patient has palpitations (strong heart beats)	• Use the right dialysate concentrate. • Manually check the patient's pulse during treatment. • Monitor blood pressure.
Cardiac arrest (the heart stops)	• Extreme hypotension • Electrolyte imbalance, especially high potassium • Arrhythmias • Heart attack • Air embolism • Severe blood loss	• No pulse • No breathing • Loss of consciousness	• Check vital signs during treatment. • Tell the nurse right away about major vital sign changes and/or the patient complains of chest pain and sweating.
Cramps	• Removing too much fluid • Changes in blood chemistry, especially sodium • Low potassium levels • Hypotension	• Painful muscle cramps, often in the hands and feet	• Get an accurate weight before a treatment. • Correctly calculate the fluid goal. • Use the prescribed dialysate concentrate. • Encourage patients to follow their salt and fluid limits.
Dialysis disequilibrium syndrome (brain swelling)	• If BUN is removed much faster from the blood than from the brain, disequilibrium is created and fluid moves into the brain cells. • This is seen more often in patients who have acute kidney disease or a BUN level >150 mg/dL.	• Headache • Nausea • Hypertension • Restlessness • Confusion • Blurred vision • Seizures	• Monitor the patient during treatment. • Tell the nurse right away about major vital sign changes. • In patients with high BUN (>150 mg/ml) a smaller dialyzer and/or slower blood and dialysate flows are preferred. Short, slow dialyses may be prescribed daily for a few treatments.

Table 5: Clinical Complications of Hemodialysis *(continued)*

Complication	Causes	Signs/Symptoms	How to Prevent It
Fever and/or chills	• Infection • Contaminated dialyzer or bloodlines (endotoxin exposure) • Too-cold dialysate	• Fever during dialysis • Feeling cold • Feeling cold without a fever (cold dialysate) • Redness, swelling, tenderness, warmth, or drainage from access or other sites (e.g., feet, skin wounds)	• Use aseptic technique to set up equipment. • Use aseptic technique to inserting needles. • Check vital signs. • Tell the nurse right away about major vital sign changes. • Check dialysate temperature before treatment. • Use the right process to disinfect the dialysis machine and the water components. • Test water and equipment for bacteria or pyrogens/endotoxins
First-use syndrome	• Reaction to ethylene oxide (used to sterilize new dialyzers) • Use of polyacrilonitrile (PAN) membranes in patients who take ACE inhibitors (a class of blood pressure pills)	Symptoms usually occur in the first 15–30 minutes of treatment: • Itching • Chest and/or back pain • Shortness of breath • Hypotension • Nausea • General discomfort	• Rinse the dialyzer well before treatment, per center procedure. • Use the right dialyzer.
Heparin overdose	• Error in heparin dosing • Broken heparin pump	• Unusual bleeding around needles • Longer than normal bleeding from needle sites after treatment	• Draw up heparin doses correctly. • Use the right type of heparin. • Monitor the heparin pump during treatment.
Hypertension (high blood pressure)	• Fluid overload • Patient missing their blood pressure pills • Anxiety • Dialysis disequilibrium syndrome	• May have no symptoms • Headache • Nervousness	• Calculate the fluid goal correctly. • Ask patients if they've taken their BP pills. • Encourage patients to follow their fluid limits.
Hypotension (low blood pressure)	• Removing too much fluid • Taking BP pills before dialysis • Heart disease	• Low BP reading • Dizziness • Tachycardia (rapid pulse) • Loss of consciousness	• Get an accurate weight before a treatment. • Calculate the fluid goal correctly. • Ask patients if they've taken their BP pills.

Table 5: Clinical Complications of Hemodialysis *(continued)*

Complication	Causes	Signs/Symptoms	How to Prevent It
Pruritus (itching)	• Uremia (high BUN) • High blood phosphorus levels • Calcium phosphate crystals under the skin • Secondary hyperparathyroidism	• Severe itching on and off dialysis • Red skin • Crusting on the skin	• Keep skin clean and dry. • Deliver dialysis treatment correctly. • Ask patients if they are taking their phosphate binders.
Seizures	• Severe hypotension • Electrolyte imbalance • Dialysis disequilibrium syndrome • Seizure disorder (epilepsy)	• Change in level of consciousness • Jerking movements of the arms and legs	• Monitor BP • Check that patients with epilepsy are taking their medications.

after the dialyzer. This method works very well, but is very complex to monitor, and therefore rarely done in the freestanding dialysis center.[26]

Hemodialysis Complications

Hemodialysis technology has improved, but there is always a risk of complications during a treatment. Complications can be either clinical (related to patient care) or technical (related to equipment). We will cover both types below.

CLINICAL COMPLICATIONS

Clinical complications that may occur during a treatment are described in Table 5.[23,27] Follow your center's policies and procedures to prevent or react to a complication. ***Tell the nurse right away if these problems occur.***

TECHNICAL COMPLICATIONS

Table 6 describes technical complications that may occur during hemodialysis.[23,24] Follow your center's policies and procedures to prevent or react to a complication. Tell the nurse right away if any of these problems occurs.

Postdialysis Procedures

At the end of a treatment, you will have another set of steps to do. These include discontinuing the dialysis treatment, taking the patient's vital signs and weight, documenting the treatment, and cleaning up the equipment.

DISCONTINUING DIALYSIS

At the end of the treatment, the blood pressure and pulse are taken. This will help you to determine the amount of saline you will need to use to return the patient's blood. You will draw any postdialysis blood samples that have been ordered by the physician. To end a treatment, you will reduce the blood flow rate and UFR. You will check the patient's vital signs again. Usually, when the fluid in the venous bloodline

Table 6: Technical Complications of Hemodialysis

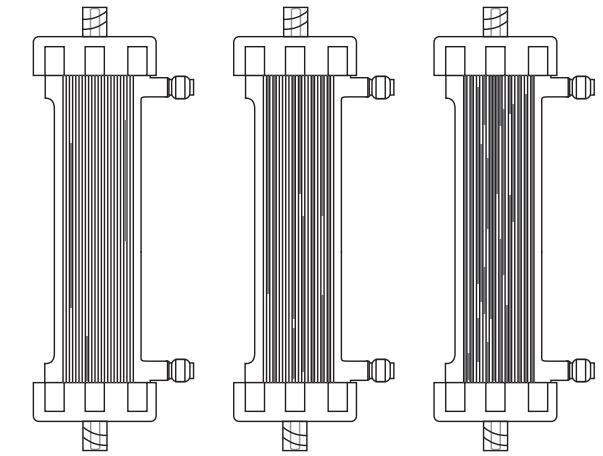
Complication	Causes	Signs/Symptoms	How to Prevent It
Air in bloodlines	• Underfilling of drip chambers • Empty saline bag • Loose connections in the extracorporeal circuit • Dialysis needle taken out while blood pump is on • Air left in extracorporeal circuit after priming	• Air bubbles or foaming in the bloodlines • Air in the blood alarm • May see collapse of arterial bloodlines	• Keep correct drip chamber levels. • Be sure the saline bag is not empty and line stays clamped. • Tighten all connections. • Tape needles securely. • Prime the extracorporeal circuit correctly before treatment starts. • Check for cracks or holes in needle line connections.
Clotting	• Wrong and/or inadequate anticoagulation • Low blood flow rate • Air in the extracorporeal circuit	• Blood turns very dark • Clots in the extracorporeal circuit (see during rinseback) • If clotting in dialyzer, may see a decrease in venous drip chamber pressure • If clotting in venous chamber, may see an increase in venous drip chamber pressure	• Give heparin as prescribed. • Maintain prescribed blood flow rates. • Prime the extracorporeal circuit correctly before treatment starts.
Exsanguination (severe loss of blood)	• Bloodlines come apart • Taking out dialysis needles with the blood pump on • Crack in dialyzer casing or improperly fitted header cap • Access rupture	• Blood on patient chair, clothes, and/or floor • Hypotension • Seizures • Cardiac arrest	• Tighten all extracorporeal connections. • Tape needles securely. • Keep all accesses in view at all times (no blankets over access limbs). • Monitor the extracorporeal circuit per procedure.
Hemolysis (bursting of red blood cells)	• Kinked bloodlines • Inadequate water treatment that allows chloramines, copper, zinc, or nitrates into the dialysate • Too-warm dialysate • Formaldehyde in a reused dialyzer	• Nausea • Headache • Stomach and back pain • Hypertension or hypotension • Cardiac arrest • Bright red colored blood	• Check dialysate conductivity and temperature before treatment. • Test dialysate for chloramines and disinfectants. • Monitor bloodlines for kinks. • Check that blood pump is calibrated for the bloodline header being used.
Power failure	• Machine failure • Machine unplugged • Power outage	• Machine stops during treatment • No lights on machine	• Check that the machine is completely plugged in before treatment. • Be sure the machine has been maintained per center procedure.

is pink, you will stop the saline. Check blood pressure and pulse rate again before the dialysis needles are removed. You will look at the dialyzer after the blood is returned to see how much blood was left clotted in the dialyzer after rinseback (see Figure 13). Learn and follow your center's policy on discontinuing dialysis.

POSTDIALYSIS PATIENT EVALUATION

After dialysis, you will recheck all the patient's vital signs (blood pressure, pulse, and temperature) and weight. Blood pressure should be the same as it was at the start of treatment, or lower. Take a sitting and a standing blood pressure to check for orthostatic hypotension (a drop in arm blood pressure when the patient stands up) before you take out the needles. If the patient has hypotension, you can give some normal saline, per your center's policy. The patient should weigh less after a treatment than before. If the patient has a fever, tell the nurse. Check the patient's vascular access (see Module 5: *Vascular Access*) and general condition. Tell the nurse about any changes or abnormal findings before the patient leaves the center.[14]

Figure 13:
Good, fair, and poor rinsebacks



Good rinseback – a few streaks of blood

Fair rinseback – several streaks, possibly in different places

Poor rinseback – many streaks

EQUIPMENT CLEAN-UP

If your center reuses dialyzers, you will prepare the dialyzer for reprocessing after the treatment. In many centers, you will instill heparin (from the infusion pump or a bolus dose) into the normal saline bag. Circulate this saline through the extracorporeal circuit to flush out some of the blood left in the dialyzer. ***Note: The dialyzer should be completely filled with saline; air will cause any blood that is left to clot.*** Cap all ports. After each treatment, remove the dialyzer and bloodlines from the hemodialysis machine. Throw away the bloodlines and disposable equipment. A dialyzer that is to be reused should be refrigerated or reprocessed within 10–15 minutes after a treatment to reduce the loss of volume. If your center does not reuse the dialyzer, discard it. Remove and disinfect clamps and other nondisposable items, per center policy, before using them for other patients.

To kill any bacteria, you must disinfect equipment that will be used for another patient. Otherwise, the bacteria could transfer to the next patient who uses it. Clean the outside of the machine with a disinfectant after each treatment. Pay special attention to control knobs and other surfaces that may have been touched and contaminated during the treatment.

You must disinfect the dialysate delivery system regularly with heat or chemicals:

- **Heat disinfection** is a 3-cycle process built in to some central dialysate systems and some individual patient machines. During a "warm-up" cycle, water is heated to 85°C–95°C. Depending on the system, hot water passes through the hydraulic circuit for 20–60 minutes in a "recirculation" cycle. This disinfects the machine. At the end of the cycle, the hot water is drained and replaced with cool water. The temperature-regulating mechanism resumes normal operation in the "normalization" cycle.
- **Chemical disinfection** is a 3-cycle (water fill, circulation, rinse) process. The machine runs with disinfectant instead of dialysate. The chemical disinfectant mixes with treated water and follows the dialysate path. The rinse cycle washes out the disinfectant.

Before you start the next treatment, the rinse water must be tested for residual disinfectant.

Conclusion

Dialysis is a complex process with many patient care and technical skills that you need to learn to provide safe patient care. You will work with your preceptor to practice the skills reviewed in this module. Before you work on your own, you will need to be able to show that you can complete all of the skills correctly.

Appendix 1

CALCULATING TRANSMEMBRANE PRESSURE (TMP)[14]

$$\text{TMP} = \frac{\text{Total fluid to be removed in mL} \div \text{hours on dialysis}}{K_{Uf} \text{ of dialyzer}}$$

K_{Uf} = ultrafiltration coefficient of dialyzer
mL of fluid ultrafiltered by the dialyzer per hour per mmHg of TMP.

Example

Physician's order:

- Dialyze for 4 hours
- Remove 2 kg
- Dialyzer K_{Uf} = 40 (i.e., 40 mL of fluid ultrafiltered by the dialyzer per hour per mmHg of TMP)

Weight to be removed in mL for the 4-hour session	= 2,000 mL
Oral intake	= 300 mL
Saline rinsed back	= 100 mL
Total fluid to be removed in mL for the 4-hour session	= 2,400 mL

Total fluid to be removed per hour: 2,400 mL/4 hours = 600 mL

TMP = (2,400 mL/4 hours) ÷ 40
= 600/40
= 15 mmHg

Estimation of dialysate pressure on the dialysate side:

TMP can also be roughly regarded as the difference in pressure between the blood compartment of the dialyzer and the dialysate compartment of the dialyzer (i.e., the blood side pressure minus the dialysate pressure).

Example

If the blood compartment pressure is 120 mmHg (as read on the venous pressure monitor), then the pressure in the dialysate compartment equals: 120 mmHg–105 mmHg=15 mmHg. So if you set your machine to remove 600 mL/hr, and the K_{Uf} is 40 mL/mmHg/hr, you would expect to have a TMP of 15 mmHg.

Appendix 2

UREA REDUCTION RATIO (URR) AND UREA KINETIC MODELING (UKM) FORMULAS[22]

URR formula:

$$URR\ (\%) = 100\ [1-(BUNpost/BUNpre)]$$

UKM formula example:

$$Kt/V = -\ln(R - 0.008t) + (4 - 3.5R)UF/W$$

Where:

ln is the natural logarithm

R is the postdialysis BUN ÷ predialysis BUN

t is the dialysis session length in hours

UF is the ultrafiltration volume in liters

W is the patient's postdialysis weight in kilograms

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