Hemodialysis, arteriovenous access

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Introduction

Hemodialysis is a lifesaving procedure that removes blood from the body, circulates it through an artificial kidney (known as a dialyzer or hemodialyzer), and then returns it to the body.[1] Various access sites are appropriate for this procedure. (See *Hemodialysis access*.) The access can be temporary or long-term depending on the patient's condition and needs. Catheters are for short-term access, whereas arteriovenous (AV) fistulas and AV grafts provide more permanent access for hemodialysis.[1,2]

AV fistulas are preferable for long-term access because research shows that they result in the longest survival, fewer access-related procedures, fewer hospitalizations due to infection, and lower overall costs of care. The Centers for Medicare and Medicaid Services, the National Kidney Foundation, and other kidney disease organizations developed Fistula First Catheter Last, a national campaign to increase the use of AV fistulas rather than catheters in patients who require hemodialysis;[3,4] however, using an AV fistula requires advance planning because the fistula must mature before a patient with stage 4 chronic kidney disease progresses to stage 5.[5]

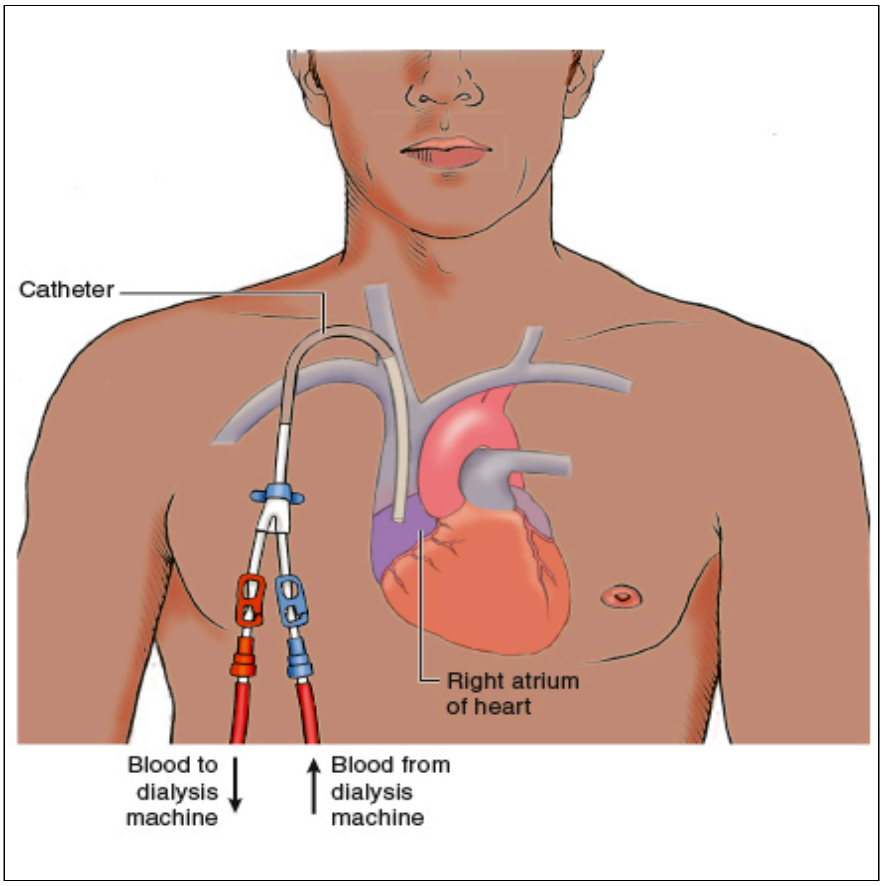
HEMODIALYSIS ACCESS

Hemodialysis requires vascular access.[1] The site and type of access vary depending on the expected duration of dialysis, the surgeon's preference, and the patient's condition.

Internal jugular vein catheterization

The internal jugular vein is the typical site for the placement of a double-lumen catheter.[6] If the internal jugular vein isn't appropriate, then the external jugular, femoral, subclavian, or lumbar vein is preferable (listed in order of preference).[2] Guidelines don't recommend using the subclavian vein for catheter placement in a patient who requires a permanent arteriovenous (AV) fistula *because the risk of thrombosis can compromise AV fistula creation.*[1,7]

A practitioner inserts an introducer needle into the internal jugular or subclavian vein using the Seldinger technique. The practitioner then inserts a guide wire through the introducer needle and removes the needle. Using the guide wire, the practitioner threads a 5″ to 12″ (13- to 30-cm) plastic or Teflon catheter (with a Y hub) into the patient's vein (as shown below).



Several types of double-lumen catheters are appropriate for dialysis access, depending on the patient's condition, practitioner's preference, and anticipated length of time the catheter will be needed. The internal diameter of each lumen is approximately 12G *to allow for high flow rates.* These catheters have two ports—one red and one blue. The red port withdraws the patient's blood and sends it to the dialyzer; the blue port returns dialyzed blood to the patient.

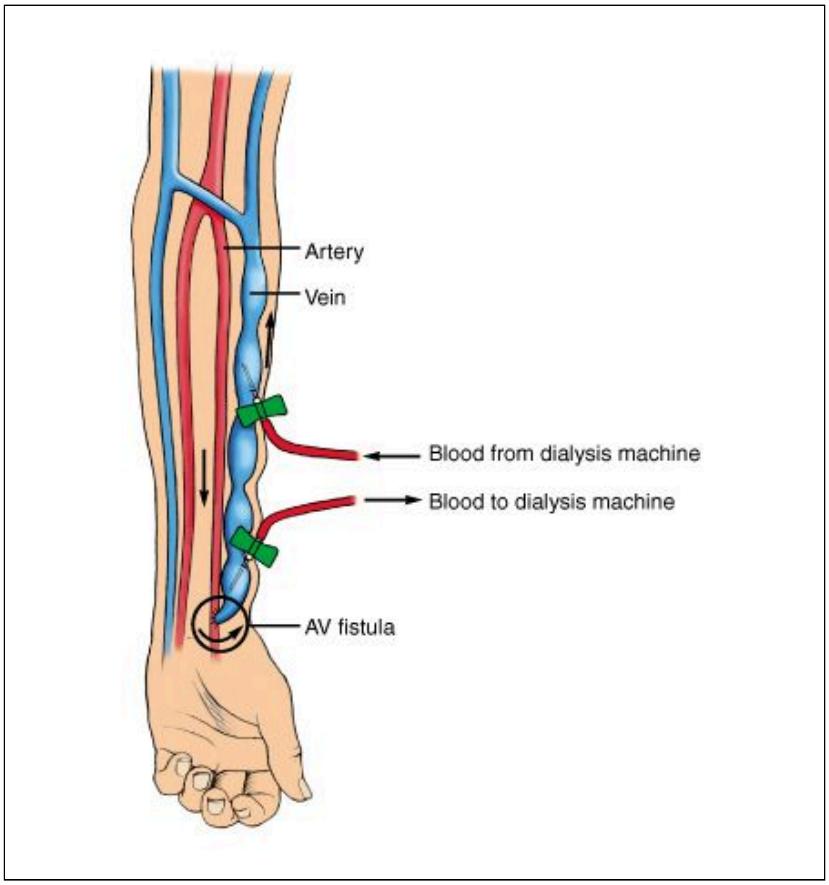
Most double-lumen catheters are appropriate for temporary dialysis access; however, a double-lumen tunneled catheter with a Dacron cuff is appropriate for longer-term use (months).[8] This type of catheter tunnels from the skin insertion site to the selected vein. The Dacron cuff on the catheter under the skin acts as a barrier to infection.

Femoral vein catheterization

For femoral vein catheterization, the practitioner uses the Seldinger technique to insert an introducer needle into the left or right femoral vein. The practitioner then inserts a guide wire through the introducer needle and removes the needle. Using the guide wire, the practitioner threads a 5" to 12" (13- to 30-cm) plastic or Teflon catheter with a Y hub or two catheters—one for inflow and another placed about ½" (1 cm) distal to the first for outflow—into the patient's vein. A femoral vein should be used only when no other access site is available *because doing so is associated with an increased risk of infection and deep vein thrombosis.*[9]

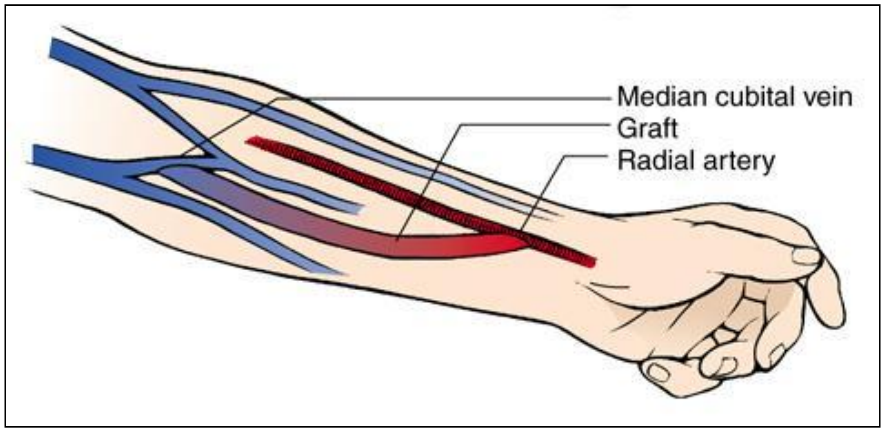
AV fistula

To create an AV fistula, a surgeon makes an incision in the patient's wrist or lower forearm and then makes two additional small incisions, one in the side of an artery and another in the side of a vein (as shown below). The surgeon sutures the edges of the incisions together to make a common opening that's about ⅛" to ¼" (3 to 7 mm) long. The minimum time for maturation of an AV fistula is 1 month, but guidelines usually recommend longer times (such as 6 to 12 months) as well as creating the fistula before hemodialysis *so that the fistula has matured and is ready for use.*



AV graft

To create an AV graft, a surgeon makes an incision in the patient's forearm, upper arm, or thigh. The surgeon then tunnels a natural or synthetic graft under the skin and sutures the distal end to an artery and the proximal end to a vein (as shown below).



The underlying mechanism in hemodialysis is differential diffusion across a semipermeable membrane, which extracts the by-products of protein metabolism (urea) as well as serum creatinine and excess fluid. The semipermeable membrane doesn't permit diffusion of large molecules, such as blood cells and plasma

proteins.[1] This process restores or maintains the balance of the body's buffer system and electrolytes. Hemodialysis promotes a rapid return to normal serum values and helps prevent complications associated with uremia. (See *How hemodialysis works*.)

Hemodialysis provides temporary support for patients with acute kidney injury. It also serves as regular long-term treatment for patients with stage 5 chronic kidney disease. Hemodialysis also may be needed to remove toxic substances from the blood in patients suffering from various acute poisonings or barbiturate or analgesia overdose.[1] The patient's condition, along with such variables as the rate of serum creatinine accumulation and weight gain, determines the number and duration of hemodialysis treatments. Determining the patient's ultrafiltration requirements calls for comparing current weight with the weight after the previous dialysis treatment and the target weight. Blood pressure and hemodynamic status are other important variables to consider.

Although specially trained personnel typically perform this procedure in a hemodialysis unit, it can be performed at the bedside on an intensive care unit if the patient is acutely ill and unstable.

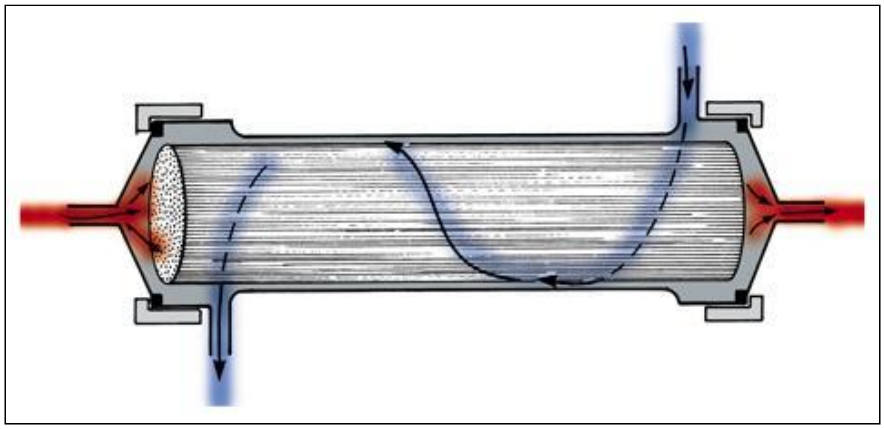
HOW HEMODIALYSIS WORKS

In hemodialysis, blood flows from the patient to an external dialyzer (or artificial kidney) through an access site. Inside the dialyzer, blood and dialysate flow concurrently, divided by a semipermeable membrane. The composition of the dialysate resembles normal extracellular fluid. The blood contains an excess of specific solutes (metabolic waste products and some electrolytes), and the dialysate contains electrolytes that may be at abnormal levels in the patient's bloodstream. The dialysate's electrolyte composition can be modified to raise or lower electrolyte levels, depending on need.

Excretory function and electrolyte homeostasis are achieved by diffusion—the movement of molecules across the dialyzer's semipermeable membrane from an area of higher solute concentration to an area of lower concentration.[1] Water (solvent) crosses the membrane from the blood into the dialysate by ultrafiltration. This process removes excess water, waste products, and other metabolites through osmotic pressure and hydrostatic pressure. Osmotic pressure is the movement of water across the semipermeable membrane from an area of lesser solute concentration to one of greater solute concentration.[1] Hydrostatic pressure forces water from the blood compartment into the dialysate compartment. Cleaned of impurities and excess water, the blood returns to the body through a venous site.

Dialyzer

The hollow-fiber dialyzer contains fine capillaries with a semipermeable membrane enclosed in a plastic cylinder. Blood flows through these capillaries as the system pumps dialysate in the opposite direction on the outside of the capillaries (as shown below).



Dialysate delivery systems

Three system types can deliver dialysate:

- The batch system uses a reservoir for recirculating dialysate.
- The regenerative system uses sorbents to purify and regenerate recirculating dialysate.
- The proportioning system (the most common) mixes concentrate with water to form dialysate, which then circulates through the dialyzer and goes down a drain after a single pass, followed by fresh dialysate.

Equipment

For initiating dialysis

- Adhesive tape
- Antibacterial soap or scrub and water
- Antiseptic agent (alcoholic chlorhexidine gluconate solution containing at least 2% chlorhexidine gluconate preferred; if contraindicated, an iodophor [such as povidone-iodine] or 70% alcohol) with sterile applicator[10]
- Appropriately sized fistula needles (typically 15G to 17G)
- Emergency equipment (code cart with emergency medications, defibrillator, handheld resuscitation bag with mask, intubation equipment)
- Facility-approved pain assessment tool
- Fluid-impermeable pads
- Gloves
- Gown
- Hemodialysis machine with appropriate dialyzer
- Intake and output monitoring equipment
- Mask with a face shield or a mask and goggles
- Normal saline solution
- Prescribed dialysate
- Prescribed medications
- Pulse oximeter and probe
- Scale
- Sterile 2" × 2" (5- × 5-cm) gauze pad
- Stethoscope
- Supplies for blood sampling (as indicated)
- Tourniquet
- Two 10-mL syringes
- Vital signs monitoring equipment
- Optional: bioimpedance spectroscopy, impedance cardiography, pulmonary artery pressure, or central venous pressure monitoring equipment; prescribed anticoagulant; prescribed topical anesthetic

For discontinuing dialysis

- Adhesive tape
- Disinfectant pad
- Dry sterile dressing
- Facility-approved disinfectant
- Gloves
- Gown
- Mask with a face shield or a mask and goggles
- Scale
- Sterile 4″ × 4″ (10- × 10-cm) gauze pads
- Stethoscope
- Vital signs monitoring equipment

Preparation of Equipment

Inspect all equipment and supplies. If a product is expired, is defective, or has compromised integrity, remove it from patient use, label it as expired or defective, and report the expiration or defect as directed by your facility.

Make sure emergency equipment is functioning properly and readily available.

Make sure that the dialysis machine was disinfected appropriately and that no disinfectant remains in the machine. (See the "Hemodialysis, machine disinfection" procedure.) Ensure that the water treatment system and alarms are functioning properly according to your facility's guidelines. (See the "Hemodialysis water preparation" procedure.) Set up and prepare the hemodialysis machine according to the manufacturer's instructions for use. (See the "Hemodialysis machine setup" procedure.)

Implementation

- Review the patient's medical record for advance directive and resuscitation status, isolation precautions (including the reason for isolation, date and source of culture, organisms cultured and their sensitivity, and type of isolation required), reason for admission, current problem list (including current medical diagnosis, recent surgical interventions, and recent diagnostic procedures), and medications.
- If required by your facility, confirm that informed consent has been obtained and that the signed consent form is in the patient's medical record.[11] [12] [13] [14]
- Avoid distractions and interruptions when preparing and administering the dialysate *to prevent administration errors.*[15] [16]
- Verify the practitioner's order. The hemodialysis order may include vascular access; treatment duration; dialyzer type; blood flow rate; dialysate flow rate, composition, and temperature; treatment frequency; target weight; anticoagulation (if needed); laboratory testing; maximum ultrafiltration rate; ultrafiltration and sodium profiles; fall risk score; allergies; and the language the patient speaks and understands.[17]
- Perform hand hygiene.[18] [19] [20] [21] [22] [23] [24]
- Confirm the patient's identity using at least two patient identifiers.[25]
- Provide privacy.[26] [27] [28] [29]
- Explain the procedure to the patient and family (if appropriate) according to their individual communication and learning needs *to increase their understanding, allay their fears, and enhance cooperation.*[30]
- Raise the bed to waist level (if applicable) before providing care *to prevent caregiver back strain.*[31]
- Perform hand hygiene.[18] [19] [20] [21] [22] [23] [24]
- Put on gloves and, as needed, other personal protective equipment *to comply with standard precautions.* Institute transmission-based precautions as needed.[32] [33] [34]

Performing prehemodialysis patient assessment

- Assess the patient's mobility, affect, hygiene, breathing (noting any shortness of breath), pain level, and overall well-being.[17]
- Obtain the patient's blood pressure. Obtain sitting and standing blood pressures (as the patient's condition permits) *to detect orthostatic changes.*[17] For an immobile patient, obtain blood pressure with the head of the bed down flat and then with the head of the bed elevated 80 to 90 degrees (unless contraindicated). Keep the head of the bed elevated at least 30 degrees for a patient with increased intracranial pressure (ICP). If the patient receives an antihypertensive medication, determine whether the practitioner withheld the pretreatment dose or changed administration times.
- Obtain the patient's temperature. Keep in mind that patients with uremia often have a body temperature of less than 98.6° F (37° C). Setting the dialysis solution temperature higher than the patient's temperature can cause vasodilation and subsequent hypotension.[17] An elevated temperature may indicate infection and increases insensible fluid loss.[17]

- Assess the patient's heart rate and rhythm. Auscultate heart sounds and report new findings to the practitioner.[17] Bradycardia may indicate digoxin toxicity or hyperkalemia, requiring an adjustment in dialysate *to prevent arrhythmias* and a review of medications *to check for other medications that can cause bradycardia.*
- Assess the patient's fluid balance, including intake (IV infusions, oral intake, and enteral feedings) and output (urine, removed ultrafiltrate, stool, drainage [for example, from chest tubes, a nasogastric tube, and wound drains], and insensible fluid losses caused by burns, wounds, ventilation, and temperature elevation).[17]
- Weigh the patient (in kilograms) at the same time daily. If you're using a bed scale, use standardized linens on the bed and bed positioning. Compare the daily weight with the prescribed "dry" weight obtained from outpatient records (if available) or the health care facility admission weight *for additional assessment of volume status.*[17]
- Assess for edema. If present, grade the severity using a scale (such as 0 = no pitting, 1+ = trace, 2+ = mild, 3+ = moderate, and 4+ = severe).[17] Inspect dependent areas for edema (sacral area for a patient in a supine position; legs, feet, and scrotum [as applicable] for a sitting or an ambulatory patient; and facial and periorbital area for a patient who's reclined or in a prone position) and assess for facial and upper extremity edema, *which may indicate occlusion of the subclavian and jugular veins.* Assess for brawny edema (dark-colored skin that appears distended and becomes so tight with fluid that applied pressure can't displace the fluid) and anasarca (generalized edema).
- Assess for ascites and jugular vein distention.[17]
- Assess the patient's mucous membranes and skin turgor and integrity. *Dry mucous membranes and skin tenting indicate volume depletion.*[17]
- If ordered, monitor hemodynamic status using bioimpedance spectroscopy, impedance cardiography, pulmonary artery pressure, or central venous pressure.[35]
- Assess pulmonary status by assessing respiratory rate, rhythm, and pattern; auscultating breath sounds; assessing for cyanosis; obtaining oxygen saturation level by pulse oximetry; assessing fraction of inspired oxygen (if applicable); and reviewing current arterial blood gas values and trends and chest X-ray results.[17]
- Assess the patient's GI status, including the presence of bowel sounds and stool output. Withhold anticoagulation and notify the practitioner if you suspect GI bleeding.
- Assess the patient's genitourinary status, including the primary cause of acute kidney injury or chronic kidney disease.[17]
- Assess the patient's endocrine status by reviewing blood glucose level stability and evaluating hemoglobin A_{1C} value if ordered. Monitor the use of systemic insulin for a patient who requires intensive care.
- Assess the patient's neurologic status, including level of consciousness, and assess for risk factors associated with hemodialysis (such as disequilibrium syndrome, use of anticoagulation, and intracranial bleed) and the presence of brain injury that requires ICP monitoring.
- Assess the patient's current laboratory test results (sodium, potassium, glucose, calcium, phosphorus, calcium phosphorus product, magnesium, carbon dioxide, blood urea nitrogen, creatinine, albumin, cholesterol, triglyceride, transaminase, ferritin, and iron levels; total iron-binding capacity; transferrin saturation; complete blood count; prothrombin time; D-dimer; heparin-induced thromboplastin antibody; and digoxin level) as needed and ordered.[17]
- Assess the AV access site for potential complications.[2]
    - Inspect the access extremity and compare it with the other extremity, noting any obvious differences. Assess the access extremity for swelling, collateral vein formation, change in color or temperature, tortuosity of the fistula, decreased sensation, movement limitation, and delayed capillary refill.
    - Assess the fistula for redness, warmth, drainage from previous needle sites, ecchymosis, hematoma, rash, skin breakdown, aneurysm, and stenosis.
    - Auscultate for the presence of a bruit, which indicates turbulent blood flow at the anastomosis.[1] When the fistula functions properly, no separation should exist between the systolic and diastolic components of the sound; it should sound like a continuous whooshing sound. A high-pitched

sound may indicate underlying stenosis. Notify the practitioner of changes in the sound or character of the blood flow through the fistula.
    - Palpate the fistula for a continuous vibration sensation known as a thrill. Stenosis may be present if the vibration becomes pulsatile or you can no longer feel a vibration.
- If applicable, determine whether the patient had any problems with the previous dialysis treatment and inquire about posttreatment recovery time.
- Compare your assessment findings with previous treatment records (if applicable) *to recognize changes in the patient's status that may require further evaluation and reporting.*[17]
- Remove and discard your gloves and, if worn, other personal protective equipment.[34]
- Perform hand hygiene.[18][19][20][21][22][23][24]

Initiating hemodialysis with AV access

- Collaborate with the practitioner to form the patient's treatment plan based on laboratory test results and predialysis assessment findings.[17]
- Perform hand hygiene.[18][19][20][21][22][23][24]
- Gather and prepare the necessary equipment and supplies.
- Assist the patient into a comfortable position (either a supine position or sitting in a recliner with the feet elevated).
- Apply a topical anesthetic to the AV puncture site approximately 45 to 60 minutes before cannulation as ordered following safe medication administration practices.[36][37][38][39] If you're using ethyl chloride, which has an anesthetic effect that lasts for 1 to 2 minutes, apply it immediately before cannulation.[40]
- Perform hand hygiene.[18][19][20][21][22][23][24]
- Wash the site with antibacterial soap or scrub and water.[2]
- Perform hand hygiene.[18][19][20][21][22][23][24]
- Put on gloves, a gown, and a mask with a face shield or a mask and goggles *to comply with standard precautions.*[19][32][33][34]
- Place the patient's AV access limb on a fluid-impermeable pad.[1]
- Clean the skin over the AV access using an antiseptic agent (alcoholic chlorhexidine gluconate solution containing at least 2% chlorhexidine preferred; if contraindicated, use an iodophor [such as povidone-iodine] or 70% alcohol).[10] Apply using a single-use sterile applicator containing antiseptic solution. Allow the solution to dry completely without fanning, wiping, or blowing.[41]
    - For alcoholic chlorhexidine gluconate solution, apply with an applicator using a gentle back-and-forth motion for 30 seconds. Allow the area to dry completely.[41][42]
    - For povidone-iodine solution, apply using a swab. Begin at the intended insertion site and move outward in concentric circles. Allow the solution to dry completely (typically at least 2 minutes).[41][43]
- Remove and discard your gloves.[34]
- Perform hand hygiene.[18][19][20][21][22][23][24]
- Put on new gloves.[19][32][33][34]
- Choose an appropriately sized needle to cannulate the fistula.
- Draw up normal saline solution into each 10-mL syringe.[1][7]
- Apply a tourniquet to the upper portion of the arm containing the fistula *to increase venous pressure, enlarge and stabilize the vein, and ease cannulation.*[1]
- Grasp the butterfly needle by the wings, prime the needle with normal saline solution until you've purged all the air, and then clamp the needle tubing.[1] If pretreatment blood samples are ordered, don't prime the arterial needle with normal saline solution. (See the "Hemodialysis blood sampling" procedure.)
- Using the hand that isn't holding the needle, place your thumb and forefinger lightly on either side of the vessel *to prevent the vessel from moving.*
- Pull the skin taut in the opposite direction of needle insertion. Stabilize the vessel but avoid using excess pressure.[7]

- Remove the protective cap and immediately cannulate the fistula. Insert the arterial needle in the direction of blood flow in the fistula (antegrade) or against the direction of blood flow (retrograde). Insert the needle at a 45-degree angle with the bevel up. Watch for blood flashback as you advance the needle.[1]
- Remove the tourniquet and then unclamp the tubing.[1]
- Aspirate 1 to 5 mL of blood with a 10-mL syringe, flush the needle with normal saline solution, and then clamp it. Observe for signs and symptoms of infiltration.[1]
- Secure the needle with three pieces of adhesive tape or according to your facility's guidelines. Place the first piece of tape over the wings *to stabilize the tip of the needle within the vessel*, and then cross a second piece of tape over the needle tubing using the chevron technique. Finally, apply a sterile 2" × 2" (5- × 5-cm) gauze pad over the needle insertion site and secure it with the third piece of tape *to prevent bacteria from migrating down the needle.*[1] [17]
- Cannulate the fistula with the venous needle 1½" to 2" (4 to 5 cm) beyond the arterial needle (farther from the AV anastomosis), inserting the needle in the same direction as the blood flow. Follow the steps you used for the arterial needle.[1]
- Remove the syringe from the end of the arterial needle tubing, uncap the arterial dialyzer tubing, and connect the two lines. Tape the connection securely *to prevent accidental separation of the tubing.*
- Remove the syringe from the end of the venous needle tubing, uncap the venous dialyzer tubing, and connect the two lines. Tape the connection securely *to prevent accidental separation of the tubing.*

♦ ***Clinical alert:*** Dialysate is considered a high-alert medication *because it can cause significant patient harm when used in error.*[44] [45] ♦

- If required by your facility, have another nurse perform an independent double-check before beginning hemodialysis with the dialysate *to verify the patient's identity and to make sure that you have the correct dialysate in the prescribed concentration, the dialysate's indication corresponds with the patient's diagnosis, the dosage calculations and formula used to derive the final dose are correct, the dialysis machine settings are correct, and the infusion line is attached to the correct port.*[46]
- After comparing the results of the independent double-check with the other nurse, unclamp the tubing and begin the hemodialysis treatment with the dialysate if there are no discrepancies. Keep the access and connections visible at all times. If discrepancies exist, rectify them before beginning hemodialysis.[46]
- Continuously monitor the hemodialysis equipment parameters.[1]
  - Verify that all lines are open and connections are intact and secure.[1]
  - Observe the color of blood in the dialyzer. *A dark color can precede filter clotting; cherry red may indicate hemolysis.*
  - Check pressure readings, including venous pressure, which shouldn't exceed 250 mm Hg *because high venous pressure may indicate clotting in the venous chamber, bloodline, or venous needle, and low venous pressure may indicate disconnection.* Low arterial pressure, which shouldn't exceed –250 mm Hg, may indicate hypotension, excess suction on the access wall, or a clotted arterial needle or access port; a sudden drop in arterial pressure may indicate needle migration or infiltration. High arterial pressure may indicate dialyzer or system clotting. Transmembrane pressure (venous pressure minus the dialysate pressure in millimeters of mercury) should rise slowly throughout hemodialysis in response to ultrafiltration with subsequent increased blood viscosity.
  - If prescribed, observe the anticoagulant pump *to make sure that you're administering the anticoagulant as prescribed.* Monitor the system and the patient's response to the anticoagulant through direct observation and blood specimen testing as indicated.[1] [17]
  - Check the blood and dialysate flow rates to ensure delivery of prescribed rates *to achieve the desired patient solute clearance.*[1]
  - Monitor and adjust the ultrafiltration rate according to the patient's response to treatment.[1]
  - Monitor dialysate conductivity *to ensure delivery of dialysis solution with an electrolyte concentration that won't cause hemolysis or crenation of red blood cells.*

- Closely monitor the patient's vital signs, oxygen saturation level, pain level, intake and output, anticoagulant administration, and laboratory test results as well as any complaints or changes in the patient's behavior throughout the treatment session *to promptly recognize changes in the patient's condition or vascular access.* Intervene quickly to resolve any treatment complications.
- Watch for signs and symptoms of complications, including muscle cramps, air embolism, dialyzer reaction (hypotension, pruritus, back pain, angioedema, and anaphylaxis), hypoxemia, and dialysis disequilibrium syndrome (headache, nausea, vomiting, hypertension, decreased sensorium, seizures, and coma).[1] If any of these signs or symptoms develop, notify the practitioner and intervene as ordered. You may need to discontinue the hemodialysis treatment or reduce the efficiency of the diffusion.
- Administer prescribed medications as ordered following safe medication administration practices.[36] [37] [38] [39]
- Obtain blood samples for coagulation studies, electrolyte levels, and glucose level as ordered.[1]
- Return the bed to the lowest position (if applicable) *to prevent falls and maintain the patient's safety.*[47]
- Discard used supplies in appropriate receptacles.[34]
- Remove and discard your gloves and other personal protective equipment.[34]
- Perform hand hygiene.[18] [20] [21] [22] [23] [24]
- Document the procedure.[48] [49] [50] [51]

Discontinuing hemodialysis using AV access

- Perform hand hygiene.[18] [20] [21] [22] [23] [24]
- Put on gloves, a gown, and a mask with a face shield or a mask and goggles *to comply with standard precautions.*[19] [32] [33] [34]
- Decrease the blood pump on the hemodialysis machine according to the manufacturer's instructions or as ordered.[1]
- Raise the bed to waist level (if applicable) before providing care *to prevent caregiver back strain.*[31]
- Remove the tape from the connection site of the arterial lines.
- Clamp the needle tubing and then disconnect the lines. Note that the blood in the arterial line will continue to flow toward the dialyzer, followed by normal saline solution. Clamp the bloodline just before the blood reaches the point where the saline solution enters the line.
- Unclamp the saline solution and allow a small amount of saline solution to flow through the line.
- Unclamp the dialyzer line and allow all the blood to flow into the dialyzer where it passes through the filter and back to the patient through the venous line.
- After the dialyzer retransfuses the blood, clamp the venous needle tubing and the dialyzer's venous line and turn off the blood pump.
- Remove the tape from the connection site of the venous lines and disconnect the lines.
- Apply a folded 4″ × 4″ (10- × 10-cm) sterile gauze pad over the needle site, but don't apply pressure.
- Remove the needles carefully, one at a time, *to prevent unnecessary loss of blood due to the force of pressure in the access.* Remove the needles at approximately the same angle as needle insertion *to prevent dragging the needle across the patient's skin and to avoid puncturing the vein wall.*[1]
- Using two fingers, apply moderate pressure to the site with the folded 4″ × 4″ (10- × 10-cm) sterile gauze pad until the bleeding stops.[1] Note that applying inadequate pressure can result in hematoma formation; excessive pressure can result in thrombosis. You should be able to continue to feel a thrill both above and below the compression site while holding pressure. Bleeding usually stops within 10 minutes.
- Cover the site with a dry sterile dressing.[8] Avoid circumferential taping of the dressing.
- Assess the patient's postdialysis weight (in kilograms), vital signs (including blood pressure sitting and standing if possible), and neurologic, respiratory, and cardiac status. Compare these findings with the predialysis assessment data.[17]
- Return the bed to the lowest position *to prevent falls and maintain the patient's safety.*[47]
- Remove and discard your gloves.[34]

- Perform hand hygiene.[18][20][21][22][23][24]
- Put on gloves.[32][33][34]
- Rinse and disinfect the delivery system according to the manufacturer's instructions.[52][53]
- Discard used supplies in appropriate receptacles.[34]
- Remove and discard your gloves and other personal protective equipment.[34]
- Perform hand hygiene.[18][20][21][22][23][24]
- Clean and disinfect your stethoscope with a disinfectant pad.[52][53]
- Perform hand hygiene.[18][20][21][22][23][24]
- Document the procedure.[48][49][50][51]

Special Considerations

- The Joint Commission issued a sentinel event alert concerning medical device alarm safety *because alarm-related events have been associated with permanent loss of function or death.* Among the major contributing factors were improper alarm settings, alarm settings turned off inappropriately, and alarm signals that were inaudible to staff. Make sure alarm limits are set appropriately and that alarms are turned on, functioning properly, and audible to staff. Follow facility guidelines for preventing alarm fatigue.[54]
- The Joint Commission issued a sentinel event alert related to managing risk during transition to new International Organization for Standardization tubing standards that were designed to prevent dangerous tubing misconnections, *which can lead to serious patient injury and death.* During the transition, make sure to trace the tubing and catheter from the patient to the point of origin before connecting or reconnecting any device or infusion, at any care transition (such as a new setting or service), and as part of the handoff process; route tubes and catheters having different purposes in different standardized directions; when there are different access sites or several bags hanging, label the tubing at both the distal and proximal ends; use tubing and equipment only as intended; and store medications for different delivery routes in separate locations.[55]

♦ ***Clinical alert:*** Complete each step in the hemodialysis procedure correctly. *Overlooking a single step or performing it incorrectly can cause unnecessary blood loss or inefficient treatment from poor clearances or inadequate fluid removal.* For example, when preparing the equipment, never allow a saline solution bag to run dry while priming the dialyzer *because air can enter the patient portion of the dialysate system.* Failure to perform accurate hemodialysis therapy can lead to patient injury or death.♦

Patient Teaching

Teach the patient and family (if applicable) how to care for the AV access site, including washing the site with soap and water daily and always before treatments and avoiding scratching the site or attempting to remove scabs. Teach the patient how to use a stethoscope to auscultate for the access bruit and how to palpate a thrill. Tell the patient to check the access site daily and to notify the practitioner of pain, swelling, redness, drainage, and any decrease in the access thrill or bruit.[56]

Teach the patient to avoid putting excessive pressure on the arm. The patient shouldn't sleep on it, wear constrictive clothing, or lift heavy objects with it. Teach the patient not to allow anyone to use the access arm to measure blood pressure or draw blood. Explain to the patient that needle sites should be rotated and gentle pressure used when removing the needle to prevent bleeding. Explain that, if bleeding occurs later, the patient should apply pressure and notify the practitioner if it doesn't stop within 30 minutes or if it's excessive.[56]

Complications

Complications associated with hemodialysis may include:

- hypotension[57]
- hypertension[57]

- cramps[57]
- nausea[57]
- vomiting[57]
- headache[57]
- angina[57]
- itching[58]
- fever[57]
- chills
- hemolysis (related to problems with the dialysate solution)[57]
  - chest or back pain
- arrhythmias (resulting from rapid electrolyte and fluid changes)[57]
- air embolism[57]
- dialysis disequilibrium syndrome (rare; typically occurring when patient first starts dialysis)
  - neurologic symptoms (possibly stemming from cerebral edema)[59]
- access site infection.[56]

Documentation

Documentation associated with hemodialysis includes:

- time treatment began
- predialysis assessment data and vital signs
- ongoing assessment data
  - vital signs obtained during treatment
- complications
  - name of the practitioner notified
  - date and time the practitioner was notified
  - prescribed interventions
  - response to those interventions
- blood samples obtained
- laboratory results obtained
- time treatment was completed
- response to treatment
- condition of the AV access site
- date and time of dressing change
- time to obtain hemostasis
- culture specimens obtained
- teaching provided to the patient and family (if applicable)
  - understanding of that teaching
  - follow-up teaching needed.

Related Procedures

- Hemodialysis, arteriovenous access, declotting, assisting
- Hemodialysis, double-lumen catheter
- Hemodialysis, pediatric

Related UpToDate Patient Teaching Handouts

- Dialysis and diet
- Enhanced recovery after surgery
- Hemodialysis catheter placement
- Lowering the risk of a surgical site infection
- Managing pain after surgery
- Pre-surgery shower
- Questions to ask if you are having surgery or a procedure
- What to expect the day of your surgery or procedure

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(Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions)

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Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions

The following leveling system is adapted from *Evidence-Based practice in nursing & healthcare: A guide to best practice,* Fifth edition, by Bernadette Mazurek Melnyk and Ellen Fineout-Overholt (2023).

Level I	Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs)

Level II	Evidence from well-designed single RCTs (experimental)
Level III	Evidence from well-designed nonrandomized controlled trials (quasi-experimental), systematic reviews of a complete body of evidence, and intervention studies using mixed methods
Level IV	Evidence from well-designed case-control and cohort studies (observational)
Level V	Evidence from systematic reviews of qualitative and descriptive studies
Level VI	Evidence from single descriptive and qualitative studies, evidence-based practice implementation, and quality improvement projects
Level VII	Evidence from expert opinion, expert committee reports, and literature reviews

Data from Gyatt, G., & Rennie D. (2002). Users' guides to the medical literature. American Medical Association; Harris, R. P., et al. (2001). Current methods of the U.S. Preventative Services Task Force: A review of the process. American Journal of Preventative Medicine, 20, 21-35.