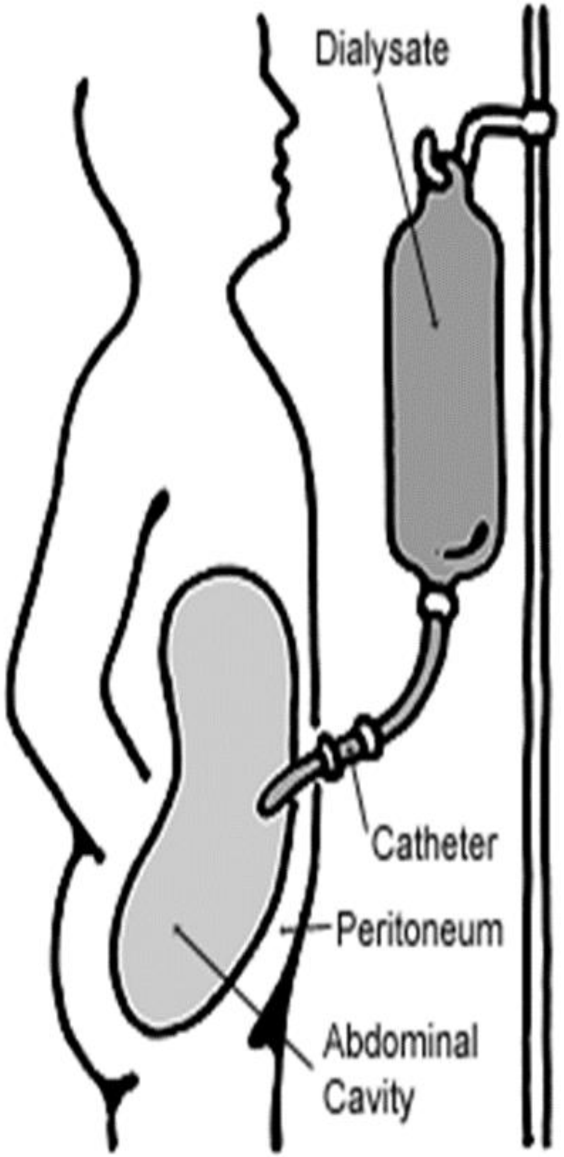
Dialysis



By
Dr. Muhammad Riaz

Dialysis

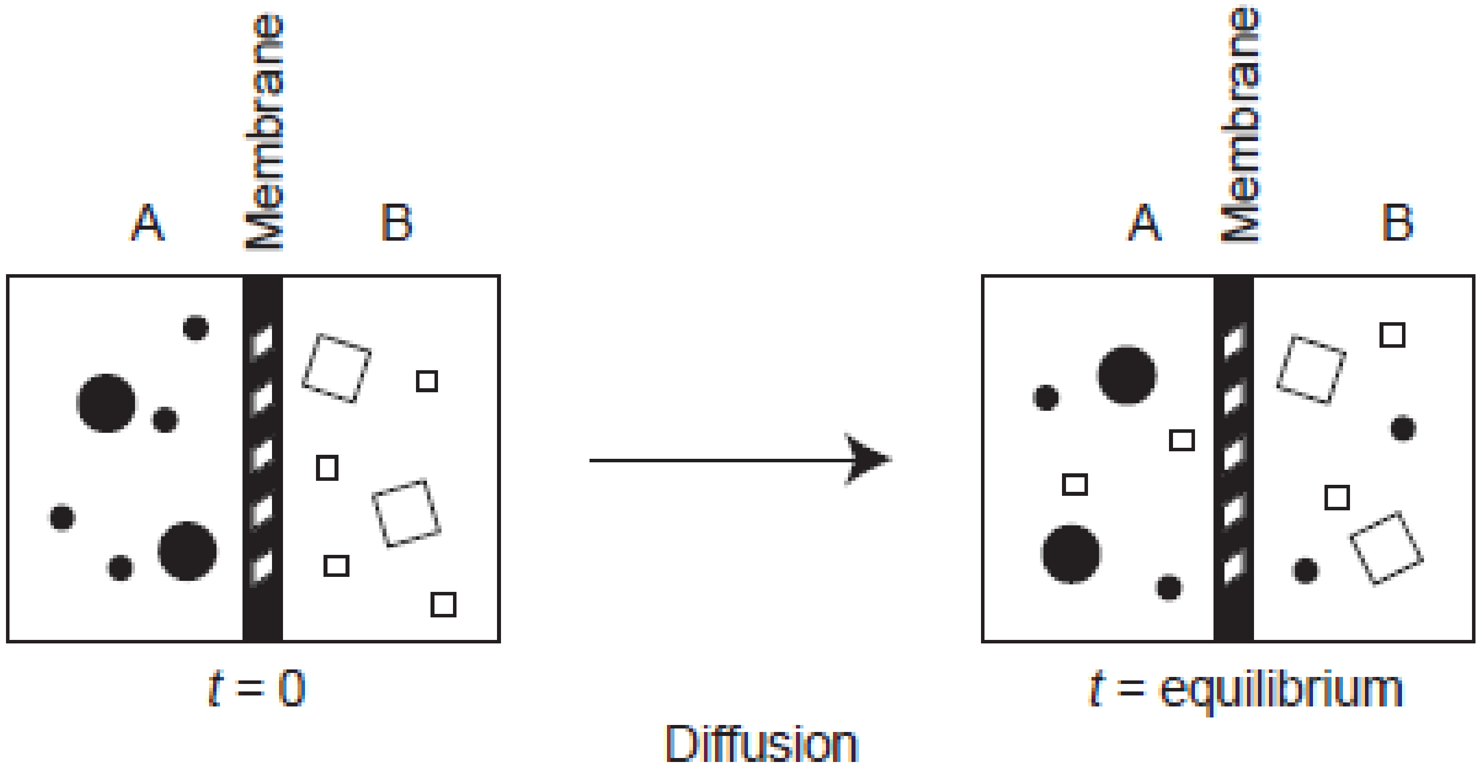
- (from Greek dialusis,"", meaning dissolution, dia, meaning through, and lysis, meaning loosening or splitting)
- A process for **removing waste, excess water, solute and toxins** from the blood in those whose native kidneys have lost the ability to perform these functions in a natural way
- Dialysis is a process whereby the solute composition of a solution, A, is altered by exposing solution A to a second solution, B, through a semipermeable membrane.
- Conceptually, one can view the semipermeable membrane as a sheet perforated by holes or pores
- Used primarily as an **artificial replacement for lost kidney function** in people with kidney failure.

MECHANISMS OF SOLUTE TRANSPORT

- Solutes that can pass through the membrane pores are transported by two different mechanisms: diffusion and ultrafiltration.

Diffusion.

- The movement of solutes by diffusion is the result of random molecular motion.
- The larger the molecular weight of a solute, the slower will be its rate of transport across a semipermeable membrane.
- Small molecules, moving about at high velocity, will collide with the membrane often, and their rate of diffusive transport through the membrane will be high.
- Large molecules, even those that can fit easily through the membrane pores, will diffuse through the membrane slowly because they will be moving about at low velocity and colliding with the membrane infrequently

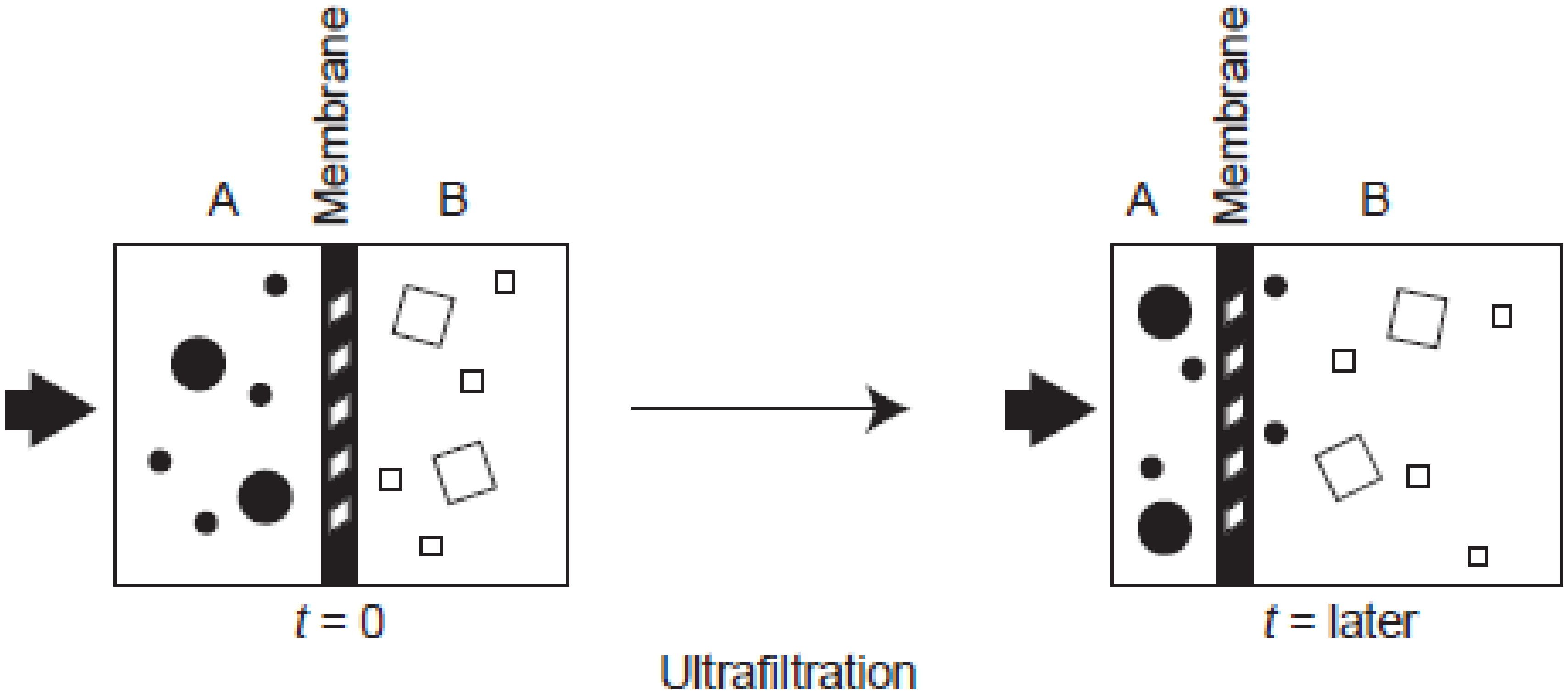


The processes of diffusion: low-molecular-weight solutes can cross the semipermeable membrane, whereas larger solutes are held back.

MECHANISMS OF SOLUTE TRANSPORT

Ultrafiltration.

- The second mechanism of solute transport across semipermeable membranes is ultrafiltration.
- Water molecules are extremely small and can pass through all semipermeable membranes.
- Ultrafiltration occurs when water driven by either a hydrostatic or an osmotic force is pushed through the membrane.
- Those solutes that can pass easily through the membrane pores are swept along with the water (a process called “solvent drag”).
- The water being pushed through the membrane is accompanied by such solutes at close to their original concentrations
- Larger solutes, especially those that are larger than the membrane pores, are held back. For such large solutes, the membrane acts as a sieve.



Ultrafiltration: low-molecular-weight solutes can cross the semipermeable membrane, whereas larger solutes are held back

Purpose of Dialysis

- used to **remove fluid and uremic waste products** from the body when the kidneys cannot do so.
- used to **treat patients with edema** that does not respond to treatment, **hepatic coma, hyperkalemia, hypercalcemia, hypertension, and uremia**.

Indications for Dialysis

- As recommended by the National Kidney Foundation's Kidney Disease Outcome Quality Initiative (K/DOQI), planning for dialysis should begin once the patient's glomerular filtration rate (GFR) or creatinine clearance (CL cr) drops below 30 mL/min per 1.73 m^2

- The primary criterion for initiation of dialysis is the patient's clinical status: the presence of persistent anorexia, nausea, and vomiting, especially if accompanied by weight loss, fatigue, declining serum albumin levels, uncontrolled hypertension or congestive heart failure, and neurologic deficits
- The need for dialysis may be acute or chronic.

1. Acute dialysis is indicated

A. when there is a high and rising level of serum potassium, fluid overload, or pulmonary edema, increasing acidosis, pericarditis, and severe confusion.

B. to remove certain medications or other toxins (poisoning or medication overdose) from the blood.

2. **Chronic or maintenance dialysis** is indicated in **chronic renal failure**, known as end-stage renal disease (ESRD)

Two main types of dialysis

- **Hemodialysis**
- **Peritoneal dialysis**

1. HEMODIALYSIS

- Although hemodialysis was first successfully used in 1940, the procedure was not used widely until the Korean War in 1952.
- Permanent dialysis access was developed in the 1960s, which allowed routine use of dialysis in patients with ESRD.
- Subsequent decades brought advances in dialysis technology, including the use of more efficient and biocompatible dialyzer membranes and safer techniques.
- Hemodialysis is now the most commonly used method of dialysis for patients who are acutely ill and require short-term dialysis (days to weeks)
- Indicated for patients with **ESRD who require long-term or permanent therapy**.
- Patients receiving hemodialysis must undergo treatment for the **rest of their lives** or **until they undergo a successful kidney transplant.**
- Treatments usually occur **three times a week** for at least **3 to 4 hours per treatment** (some patients undergo short-daily hemodialysis;)

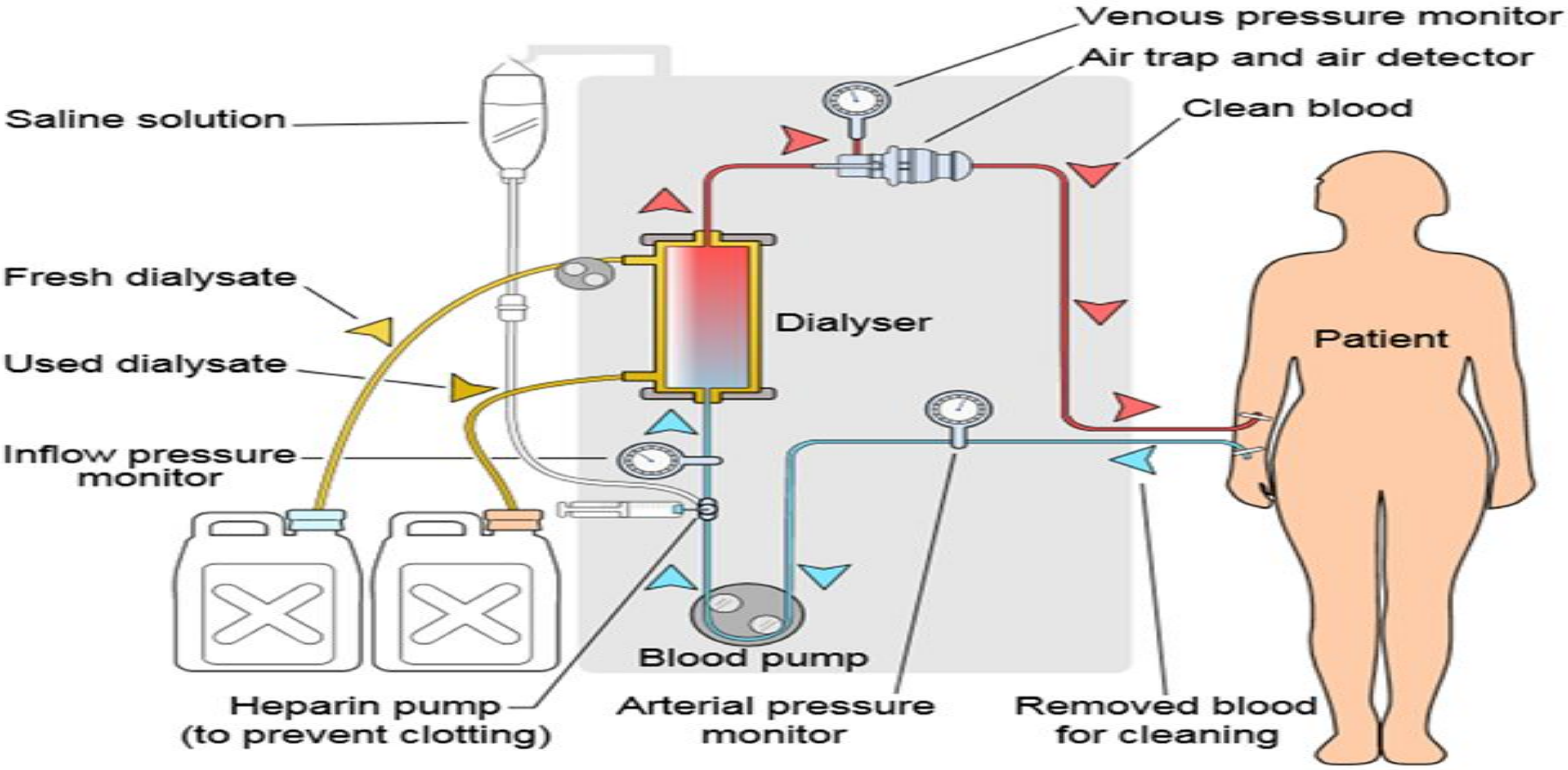
Principles of Hemodialysis

- The objectives of hemodialysis are **to extract toxic nitrogenous substances from the blood and to remove excess water**.
- In hemodialysis, the blood, loaded with toxins and nitrogenous wastes, is diverted from the patient to a **dialyzer**, in which it is cleansed and then returned to the patient.
- Multiple substances, such as water, urea, creatinine, uremic toxins, and drugs, move from the blood into the dialysate, by either passive diffusion or convection as the result of ultrafiltration
- **Diffusion** – movement from higher concentration (blood) to lower concentration (dialysate). The toxins and wastes in the blood are removed.
- Diffusion is the movement of substances along a concentration gradient;
- the rate of diffusion depends on the difference between the concentration of solute in blood and dialysate, solute characteristics, the dialyzer membrane composition, and blood and dialysate flow rates

1. **Osmosis -** Excess water is removed from the blood by osmosis, in which water moves from an area of higher solute concentration (the blood) to an area of lower solute concentration (the dialysate bath).
2. **Ultrafiltration** - water moving under high pressure to an area of lower pressure by **negative pressure** or a suctioning force to the dialysis membrane.

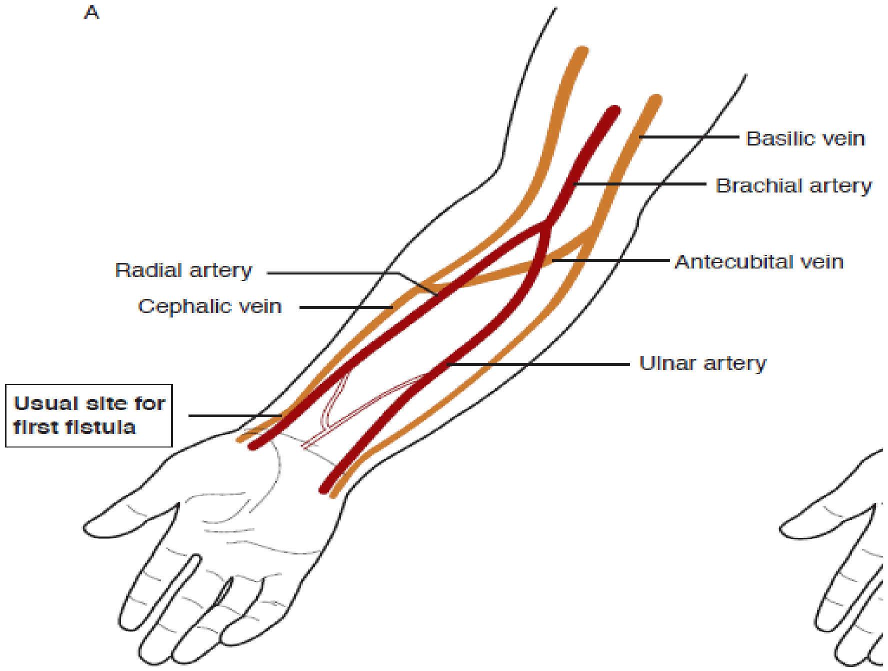
- Ultrafiltration is the movement of water across the dialyzer membrane as a consequence of hydrostatic or osmotic pressure and is the primary means for removal of excess body water.

HEMODIALYSIS



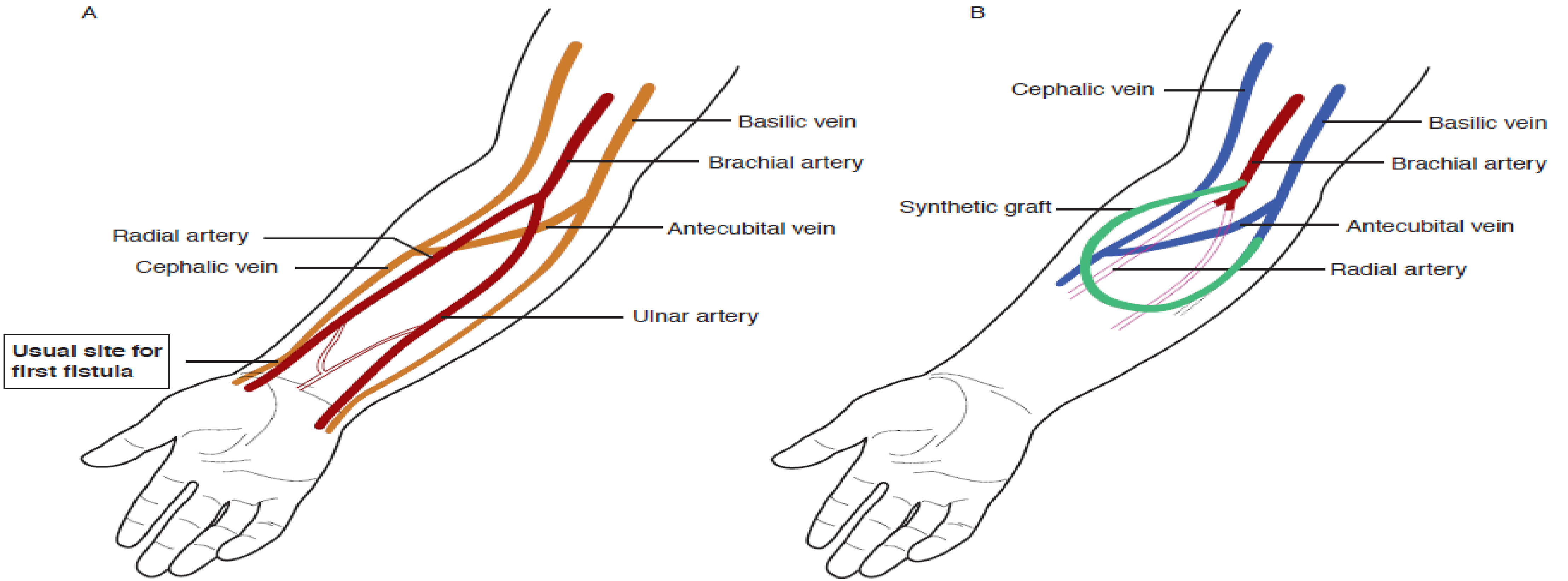
Vascular Access

- Access to the patient's vascular system must be established to allow blood to be removed, cleansed, and returned to the patient's vascular system at rates between 200 and 800 mL/minute.
- access to the bloodstream for hemodialysis may be through creation of an AV fistula, an AV graft, or by the use of venous catheters



- **SUBCLAVIAN, INTERNAL, JUGULAR, AND FEMORAL CATHETERS**
- **FISTULA** - The native AV fistula is created by the anastomosis of a vein and artery (ideally the radial artery and cephalic vein in the forearm)
- A more permanent access is created surgically (usually in the forearm) by joining (anastomosing) an artery to a vein, either side to side or end to side.
- Fistulas have the longest survival of all blood-access devices and are associated with the lowest rate of complications such as infection and thrombosis.
- Patients with fistulas have increased survival and lower hospitalization rates compared to other hemodialysis patients.
- Finally, the use of AV fistulas is the most cost-effective in terms of placement and long-term maintenance.
- Ideally, the most distal site (the wrist) is used to construct the fistula.
- This fistula is the easiest to create, and in the case of access failure, more proximal sites on the arm are preserved.
- Unfortunately, The fistula takes 4 to 6 weeks to mature before it is ready for use

- **GRAFT** - An arteriovenous graft can be created subcutaneously when the patient's vessels are not suitable for a fistula; usually placed in the forearm, upper arm, or upper thigh.
- Synthetic AV grafts, usually made of polytetrafluoroethylene, are another option for permanent AV access.
- In general, grafts require only 2 to 3 weeks to endothelialize before they can be routinely used.
- The **primary disadvantages** of this type of access are the shorter survival, and the fact that they have higher rates of infection and thrombosis than do AV fistulas
- **Venous catheters** can be placed in the femoral, subclavian, or internal jugular vein.
- The main advantage of catheters is that they can be used immediately.
- Catheters are often used in small children, diabetic patients with severe vascular disease, the morbidly obese, and other patients who have no viable sites for permanent AV access

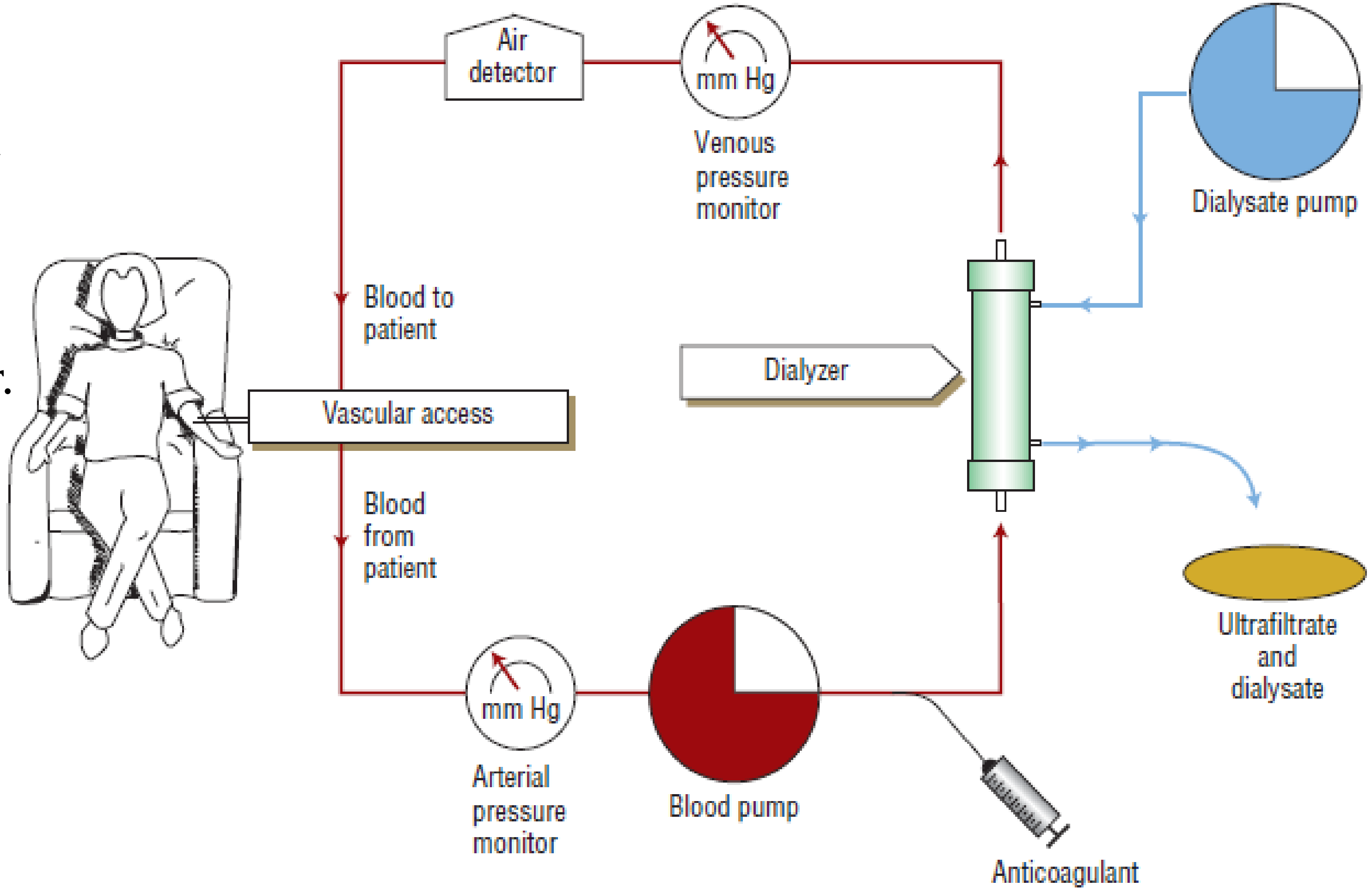


The predominant types of vascular access for chronic dialysis patients are *(A)* the arteriovenous fistula and *(B)* the synthetic arteriovenous forearm graft. The first primary arteriovenous fistula is usually created by the surgical anastomosis of the cephalic vein with the radial artery. The flow of blood from the higher-pressure arterial system results in hypertrophy of the vein. The most common AV graft (depicted in green) is between the brachial artery and the basilic or cephalic vein. The flow of blood may be diminished in the radial and ulnar arteries since it preferentially flows into the low pressure graft.

HEMODIALYSIS PROCEDURES

- The HD system consists of an external vascular circuit through which the patient’s blood is transferred in sterile polyethylene tubing to the dialysis filter or membrane (dialyzer) via a mechanical pump

FIGURE 48-2.
In hemodialysis, the patient’s blood is pumped to the dialyzer at a rate of 300 to 600 mL/min.
An anticoagulant (usually heparin) is administered to prevent clotting in the dialyzer.
The dialysate is pumped at a rate of 500 to 1,000 mL/min through the dialyzer countercurrent to the flow of blood.
The rate of fluid removal from the patient is controlled by adjusting the pressure in the dialysate compartment

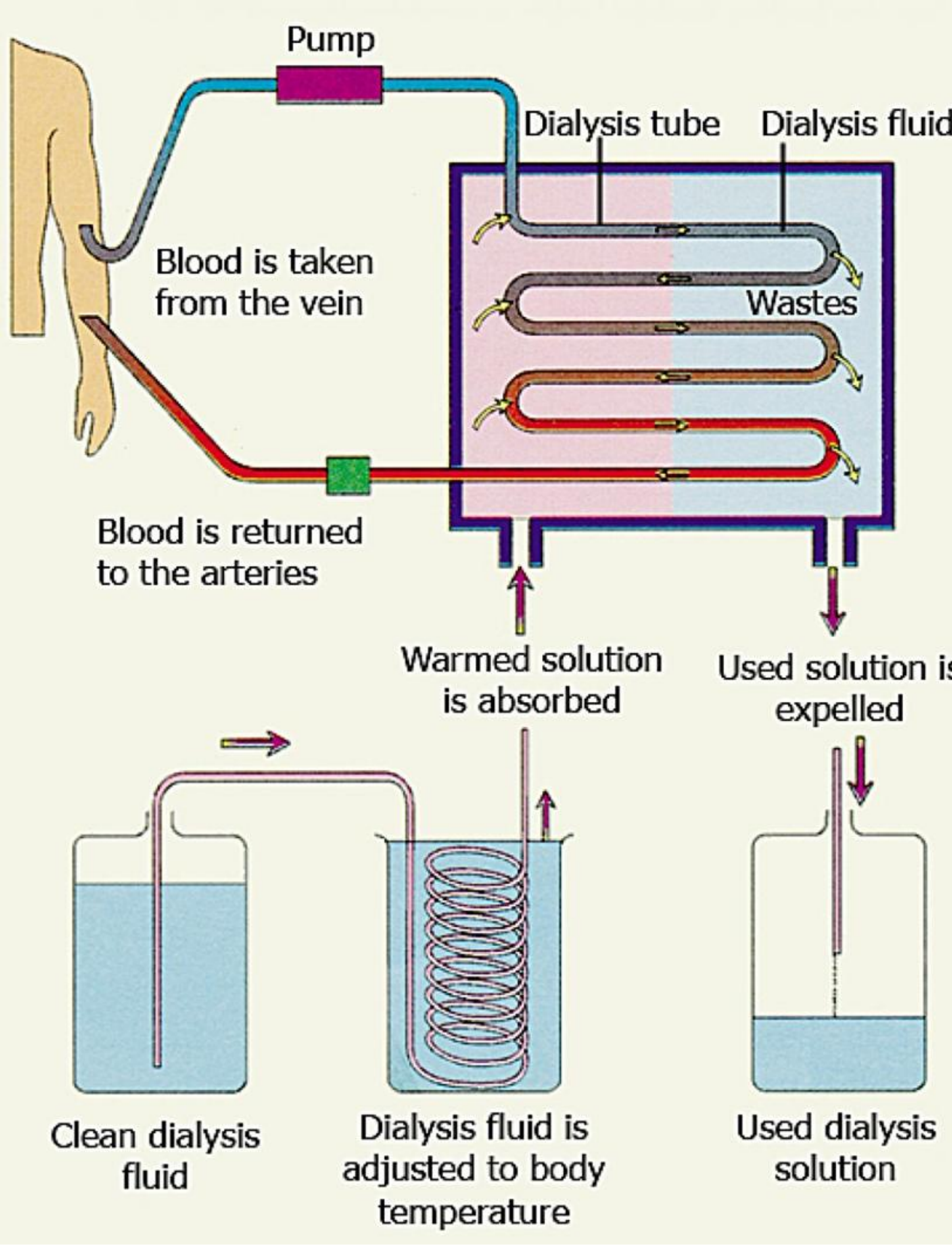


- The patient’s blood then passes through the dialyzer on one side of the semipermeable membrane and is returned to the patient.
- The dialysate solution, which consists of purified water and electrolytes, is pumped through the dialyzer countercurrent to the flow of blood on the other side of the semipermeable membrane.
- In most cases, systemic anticoagulation (with heparin) is used to prevent clotting of the hemodialysis circuit
- Dialysis membranes (conventional or standard, high efficiency, and high flux).
- Conventional dialyzers, mostly made of cuprophane or cellulose acetate, have small pores that limit clearance to relatively small molecules (size $\leq$ 500 daltons) such as urea and creatinine.
- High-efficiency membranes have large surface areas and thus have a greater ability to remove water, urea, and other small molecules from the blood

- High-flux membranes have large pores that are capable of removing high-molecular-weight substances, such as β2-microglobulin, and certain drugs, such as vancomycin.
- Hemodialysis is traditionally prescribed three times weekly for 3 to 5 hours.
- The mean dialysis treatment session duration is 3.6 ± 0.5 hours.
- Generally, larger patients require longer treatment times for adequate solute removal

Hemodialysis

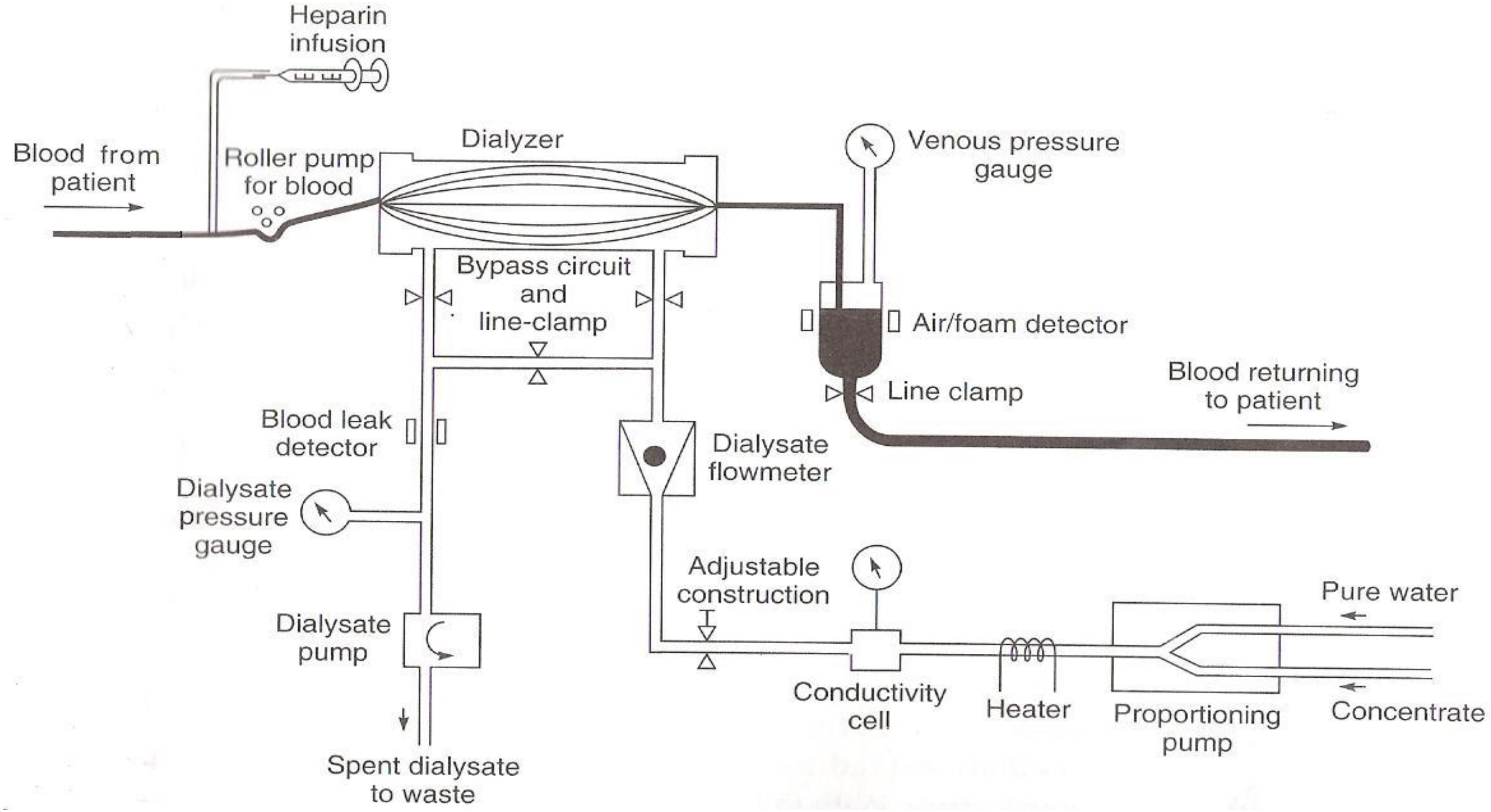
- removes wastes and water by circulating blood outside the body
- The anticoagulant **heparin** is administered to keep blood from clotting in the dialysis circuit
- The cleansed blood is then returned via the circuit back to the body
- By the end of the dialysis treatment, many waste products have been removed, the electrolyte balance has been restored to normal, and the buffer system has been replenished.



Equipment for HEMODIALYSIS

- **Dialyzers** (artificial kidneys) are either flat-plate dialyzers or hollow-fiber artificial kidneys that contain thousands of tiny cellophane tubules that act as semipermeable membranes.
- **Dialysate -** a solution with minerals (potassium and calcium) flows in the opposite direction with the blood circulating around the tubules

Hemodialysis Machine



Hemodialysis Machine

- Basic Functions of Hemodialysis Machine
- - Mixes the dialysate.
- - Monitors the dialysate.
- - Pump the blood and controls administration of anti-coagulants.
- - Monitors blood for presence of air.
- - Monitors ultra-filtration rate.

Dialysate Temperature Control and Measurement

- Dialysis normally done at body temperature.
- Lower than body temperature, dialysis is less efficient and blood has to be warmed before return to patient
- High temperature (>40C) will damage components of blood.
- Thus, temperature of dialysate is monitored and controlled before supplied to dialyzer.
- Temperature control system used to raise temperature of dialysate to a required value.
- If temperature exceeds, safety cut-out will ensure heater switched off.
- Required temperature varied from 36 to 42C.
- Two types of circuit for control of temperature :

  - Bi-metallic thermostat.

  - Electronic proportional controller.
- The latter use thermistor for sensing temperature and triac for control of power to heater.

- In micrprocessor-based hemodialysis machine, fluid temperature is displayed on monitor and control circuitry will control the heaters.
- Dual element heater assembly with 150 W and 300 W element are used to heat up fluid and maintain it in operating temperature.
- When temperature rises within 2.5C of preset temperature, 300 W heater off and only 150 W heater is used to maintain the set temperature.
- Enabling of heaters also dependent upon the fluid flow rate.
- Microprocessor reads the flow pulses and determines if there is adequate flow within the system.
- If flow inadequate heater elements disconnected.
- Flow is measured using flow-thru transducer.

Dialysate Pressure Control and Measurement

- Negative pressure upon dialysate created by effluent pump.
- Effluent pump is a fixed-flow, motor-driven gear pump.
- Pressure between zero and maximum by adjustment on machine panel.
- A relief valve limits maximum negative pressure and minimizing risk of burst in dialyzer membrane.
- Pressure adjustment should not produce any significant change in flow rate.
- Dialysate pressure is measured on one side of membrane and venous pressure on the other side.
- Effective pressure across membrane is algebraic sum of dialysate pressure and venous pressure
- This effective pressure important in consideration of filtration and weight control.
- If pressure goes beyond limit, effluent pump switched off.
- Dialysate by-passed to drain by way of header tank overflow and waste funnel.

Heparin Pump

- Usually of the plastic syringe type.
- Pump driven by stepper motor and drive screw mechanism.
- This drives the plunger of the syringe into its barrel which produces the pumping action.
- Stepper motor speed determined by computer based on heparin flow rate.
- Speed of stepper motor monitored using optical encoder.

Blood Leak Detector

- Blood leakage across dialyzer membrane can be detected by using photo-electric transducer.
- Leak detector examines light absorption of dialysate at 560 nm i.e. absorption wavelength of haemoglobin.
- Absolute value circuit provides signal whose peak value is proportional to the received 560 nm light.
- The peak value is compared to a reference voltage which is pre-set.
- Maximum setting detects blood leaks at rate of 65 mg/l of dialysate.
- If blood leak is detected, the effluent pump switched off automatically .

Ultrafiltrate Monitor

- Used to monitor amount of fluid removed from the patient.
- Also control the rate at which fluid is removed.

$$Ultrafiltration\ Rate = \frac{Total\ \ fluid\ \ removal\ required\,(litres)}{Treatment\ time\,(hours)}$$

- Ultrafiltration rate calculated by CPU in hemodialysis machine.

Clearance

- Complete removal of a solute from blood during a single pass defines the dialyzer clearance for that solute as equal to dialyzer blood flow.
- Under condition of steady-state dialysis, mass conservation requirement is expressed as

$$N = Q_B(C_{Bi} - C_{Bo}) = Q_D(C_{Do} - C_{Di})$$

- N is overall solute transfer rate between blood and dialysate.
- QB and QD are blood flow and dialysate respectively.
- CBi, CBo, CDi and CDo are solution concentrations C in blood,B, or dialysate, D, at the inlet, i, or the outlet, o of the machine.

- Dialyzer clearance is defined as mass transfer rate N divided by concentration gradient prevailing at the inlet of dialyzer

$$K = \frac{N}{C_{Bi} - C_{Di}}$$

Filtration

- Ultrafiltration is defined as difference between blood flow entering the dialyzer and blood flow leaving the dialyzer.

$$F = Q_{Bi} - Q_{Bo}$$

- Ultrafiltration can be enhanced by increasing resistance to blood flow at dialyzer outlet.
- Blood compartment pressure will be raised by subjecting dialysate to a negative pressure.

Complications of Hemodialysis

- **During dialysis (** hypotension, arrhythmias (irregular heartbeat), seizures, fever)
- **Between treatments** (Hypertension/Hypotension, Edema, Pulmonary edema, Hyperkalemia, Bleeding, Clotting of access
- **Long term :** Hyperparathyroidism, CHF, AV access failure, pulmonary edema, neuropathy, anemia, GI bleeding,

Common Complications during Hemodialysis

	Incidence (%)	Etiology/Predisposing Factors
Hypotension	20–30	Hypovolemia and excessive ultrafiltration Antihypertensive medications prior to dialysis Target dry weight too low Diastolic dysfunction Autonomic dysfunction Low calcium and sodium in dialysate High dialysate temperature Meal ingestion prior to dialysis
Cramps	5–20	Muscle hypoperfusion due to ultrafiltration and hypovolemia Hypotension Electrolyte imbalance Acid–base imbalance
Nausea and vomiting	5–15	Hypotension Dialyzer reaction

Common Complications during Hemodialysis

	Incidence (%)	Etiology/Predisposing Factors
Headache	**5**	**Disequilibrium syndrome** **Caffeine withdrawal due to dialysis removal**
Chest and back pain	2–5	Unknown
Pruritus	5	Inadequate dialysis Skin dryness Secondary hyperparathyroidism Abnormal skin levels of electrolytes Histamine release Mast cell proliferation
Fever and chills	<1	Endotoxin release Infection of dialysis catheter

TABLE 48-4 Management of Hypotension

Acute treatment	Place patient in Trendelenburg position
	Decrease ultrafiltration rate
	Give 100–200 mL bolus of normal saline intravenous
	Give 10–20 mL of hypertonic saline (23.4%) intravenous over 3–5 min
	12.5 g mannitol
Prevention	
Nonpharmacologic	Accurately set "dry weight"
	Use steady constant ultrafiltration rate
	Keep dialysate sodium greater than serum sodium
	Use cool dialysate
	Use bicarbonate dialysate
	Avoid food before or during hemodialysis
Pharmacologic	Midodrine 2.5–10 mg orally 30 min before hemodialysis (start at 2.5 mg and titrate)
	Other options (not well studied):
	Levocarnitine 20 mg/kg IV after hemodialysis
	Sertraline 50–100 mg daily
	Fludrocortisone 0.1 mg before hemodialysis

TABLE 48-5 Management of Cramps

Acute treatment	Give 100–200 mL bolus of intravenous normal saline
	Give 10–20 mL of intravenous hypertonic saline (23.4%) over 3–5 min
	Give 50 mL of 50% intravenous glucose (nondiabetic patients)
Prevention	
Nonpharmacologic	Accurately set "dry weight"
	Keep dialysate sodium greater than serum sodium
	Stretching exercises
Pharmacologic	Vitamin E 400 international units at bedtime.
	Quinine 325 mg daily (second-line therapy)

TABLE 48-6 Management of Hemodialysis Catheter Thrombosis

- Nonpharmacologic therapy
  - Forced saline flush
  - Referral to vascular surgeon
- Pharmacologic therapy
  - Alteplase: instill 2 mg/2 mL per catheter port; attempt to aspirate after 30 min; may repeat dose if catheter function not restored in 120 min; longer durations of instillation have been used

- **Advantages of Hemodialysis**

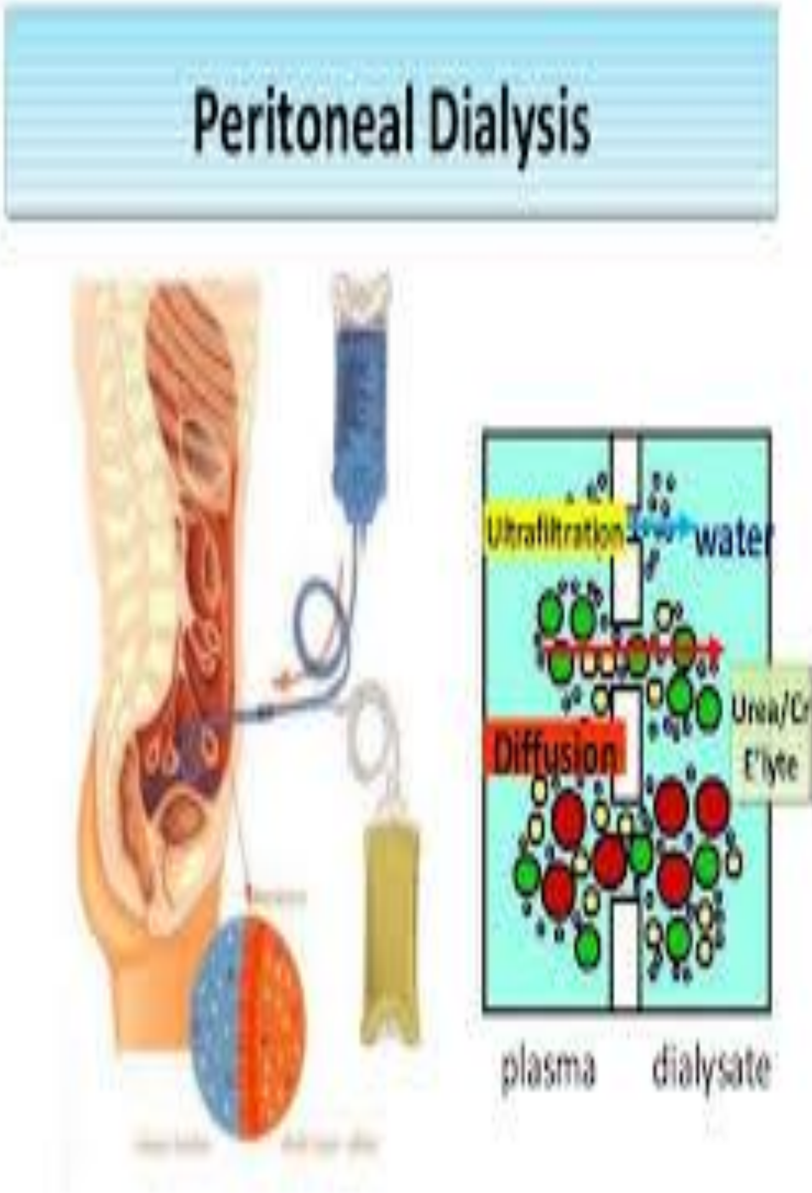
1. Higher solute clearance allows intermittent treatment.
2. Parameters of adequacy of dialysis are better defined and therefore underdialysis can be detected early.
3. Technique failure rate is low.
4. Even though intermittent heparinization is required, hemostasis parameters are better corrected with hemodialysis than peritoneal dialysis.
5. In-center hemodialysis enables closer monitoring of the patient.

- **Disadvantages of Hemodialysis**

1. Requires multiple visits each week to the hemodialysis center, which translates into loss of control by the patient.
2. Disequilibrium, dialysis hypotension, and muscle cramps are common. May require months before the patient adjusts to hemodialysis.
3. Infections in hemodialysis patients may be related to the choice of membranes, the complement-activating membranes being more deleterious.
4. Vascular access is frequently associated with infection and thrombosis.
5. Decline of residual renal function is more rapid compared to peritoneal dialysis

2. Peritoneal Dialysis

- In 1923 Peritoneal Dialysis was first employed as an acute treatment for uremia
- In 1975 PD was proposed as a chronic therapy for ESRD
- wastes and water are removed from the blood inside the body using the peritoneum as a natural semipermeable membrane.
- Wastes and excess water move from the blood, across the peritoneal membrane, and into a special dialysis solution, called dialysate, in the abdominal cavity



PRINCIPLES OF PERITONEAL DIALYSIS

- The three basic components of HD—namely, a blood-filled compartment separated from a dialysate-filled compartment by a semipermeable membrane—are also used for PD.
- In PD, the dialysate- filled compartment is the peritoneal cavity, into which dialysate is instilled via a permanent peritoneal catheter that traverses the abdominal wall.
- The contiguous peritoneal membrane surrounds the peritoneal cavity.
- The cavity, which normally contains about 100 mL of lipid-rich lubricating fluid, can expand to a capacity of several liters.
- The peritoneal membrane that lines the cavity functions as the semipermeable membrane, across which diffusion and ultrafiltration occur. The membrane is classically described as a monocellular layer of peritoneal mesothelial cells.
- The peritoneal membrane has a total area that approximates body surface area (approximately 1 to 2 m^2).

PERITONEAL DIALYSIS ACCESS

- Access to the peritoneal cavity is via the placement of an indwelling catheter.
- Most catheters are manufactured from silastic, which is soft, flexible, and biocompatible.
- A typical adult catheter is approximately 40 to 45 cm long, 20 to 22 cm of which are inside the peritoneal cavity.
- Placement of the catheter is such that the distal end lies low in a pelvic gutter.
- The center section of the catheter has one or two cuffs made of a porous material.
- This section is tunneled inside the anterior abdominal wall so that the cuffs provide mechanical support and stability to the catheter, a mechanical barrier to skin organisms, and prevent their migration along the catheter into the peritoneal cavity.
- The cuffs are placed at different sites surrounding the abdominal rectus muscle.
- The remainder of the central section of the catheter is tunneled subcutaneously before exiting the abdominal surface, usually a few centimeters below and to one side of the umbilicus.

These catheters can be used immediately if necessary, provided small initial volumes are instilled; however, a maturation period of 2 to 6 weeks is preferred

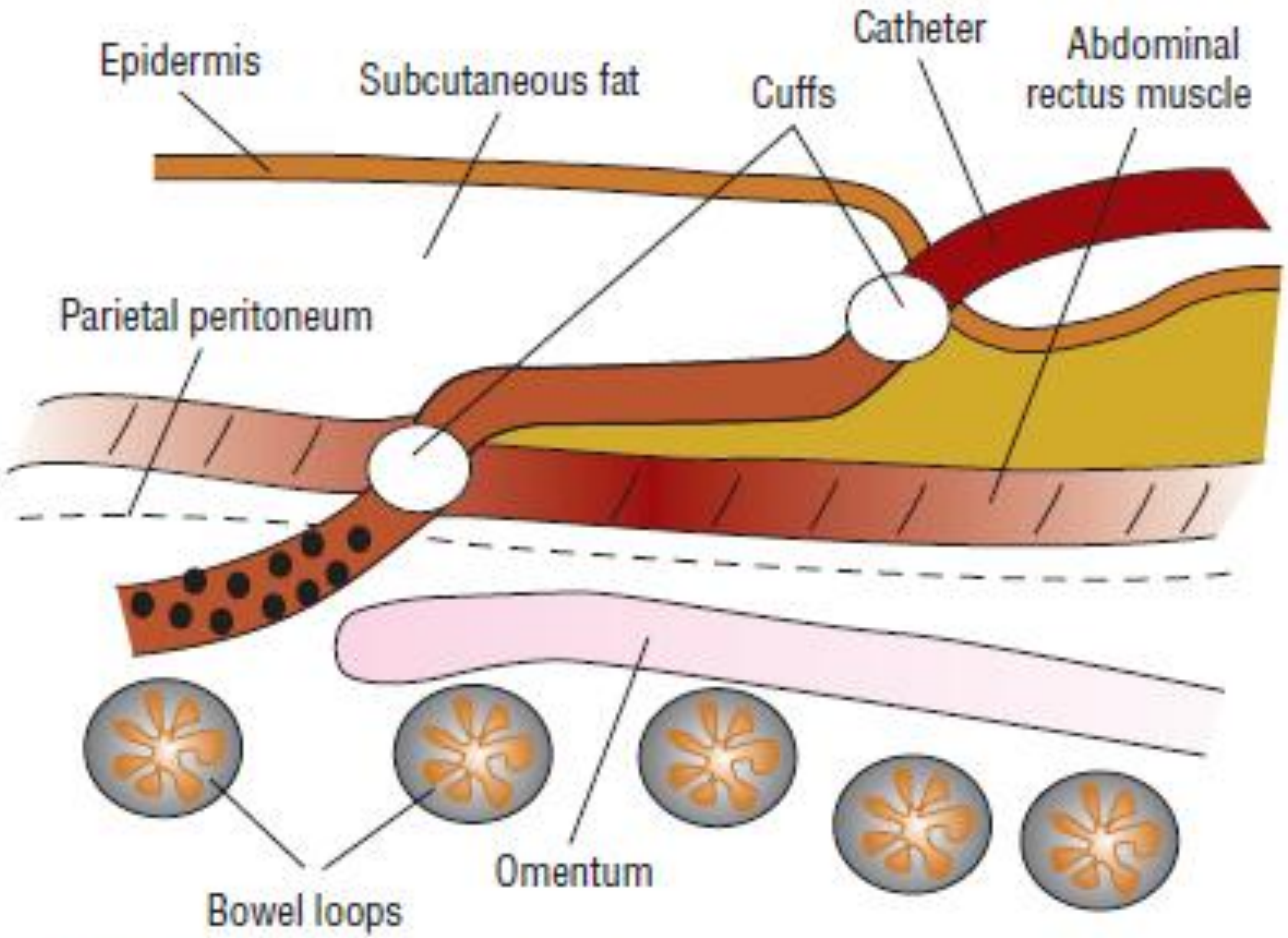
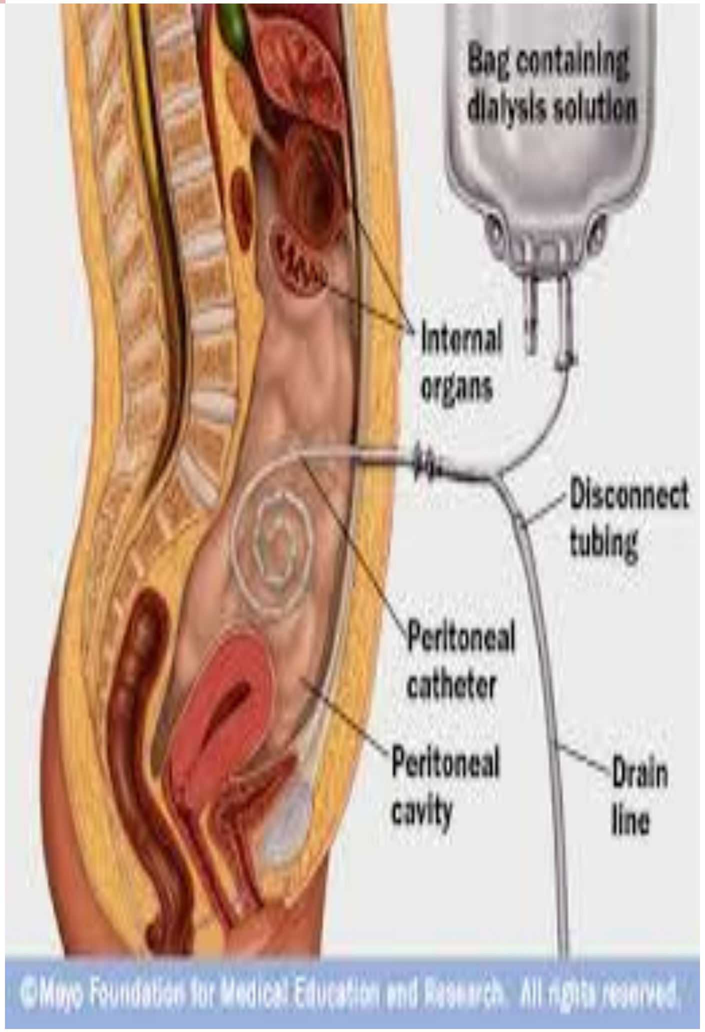


FIGURE 48-3. Diagram of the placement of a peritoneal dialysis catheter through the abdominal wall into the peritoneal cavity.

Indications for Peritoneal Dialysis

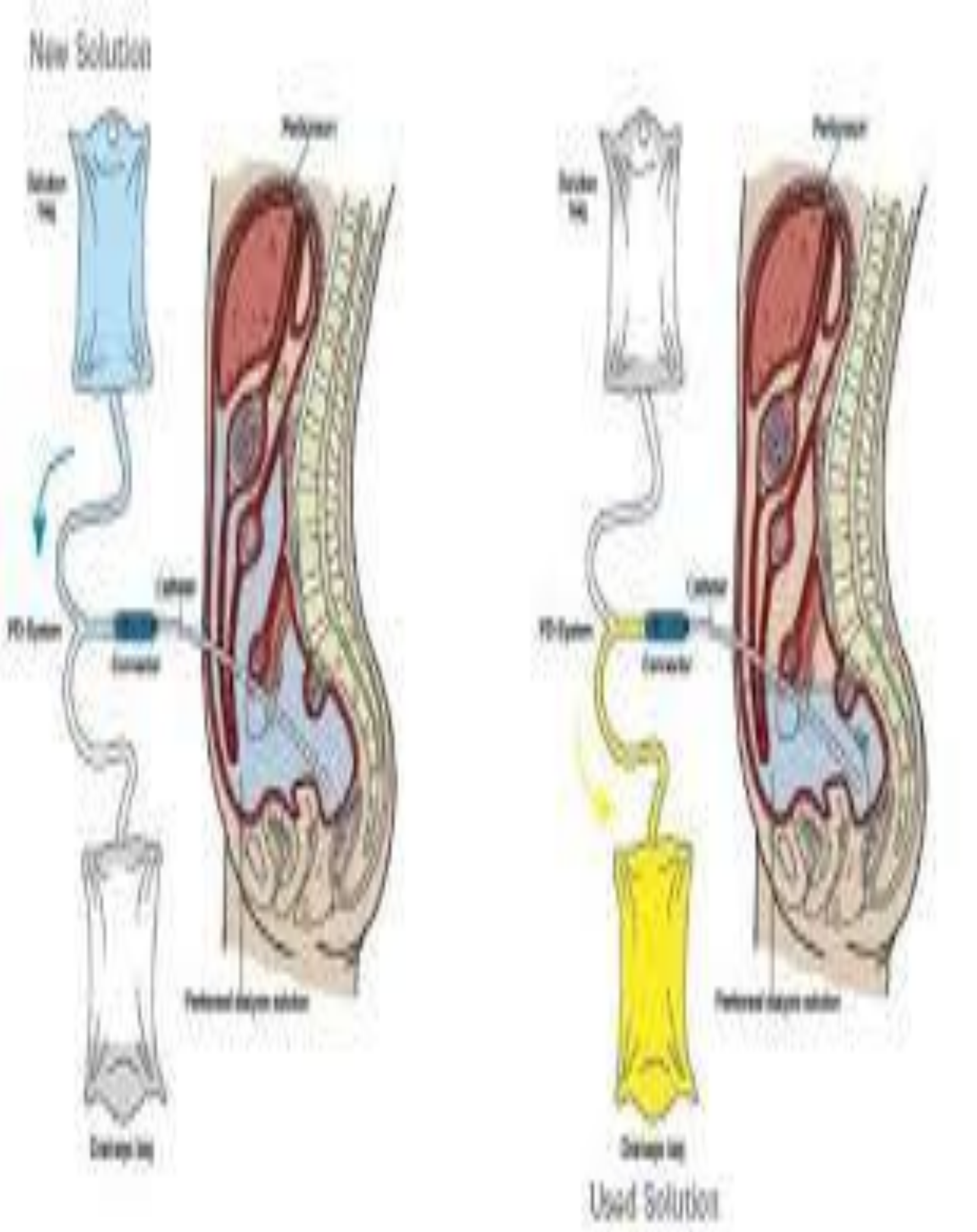
- Peritoneal dialysis may be the t**reatment of choice** for patients with renal failure who are unable or unwilling to undergo hemodialysis or renal transplantation.
- patients with diabetes or cardiovascular disease,
- many older patients, and those who may be at risk for adverse effects of systemic heparin



Procedure for Peritoneal dialysis

PREPARING THE PATIENT .

1. The nurse explains the procedure to the patient and obtains **signed consent** for it.
2. Baseline vital signs, weight, and serum electrolyte levels are recorded.
3. The patient is encouraged to **empty the bladder and bowel** to reduce the risk of puncturing internal organs.
4. Broad-spectrum antibiotic agents may be administered to prevent infection.



Procedure for Peritoneal dialysis

PREPARING THE EQUIPMENT (apply Strict Aseptic technique)

1. Consults the physician to determine the concentration of dialysate to be used and the medications to be added to it. (Heparin , Potassium chloride , Antibiotics’ Insulin) .
2. Before medications are added, the dialysate is **warmed to body** temperature to prevent patient discomfort and abdominal pain and to dilate the vessels of the peritoneum to increase urea clearance. **Solutions that are too cold cause pain and vasoconstriction** and reduce clearance. Solutions that are **too hot burn the peritoneum.**

Standard Tenckhoff catheter | Swan-neck catheter | Coil catheter

Procedure for Peritoneal dialysis

PREPARING THE EQUIPMENT (apply Strict Aseptic technique)

3. Assemble the administration set and tubing. Fill the tubing with the prepared dialysate to reduce the amount of air entering the catheter and peritoneal cavity, which could **increase abdominal discomfort and interfere with instillation** and drainage of the fluid.

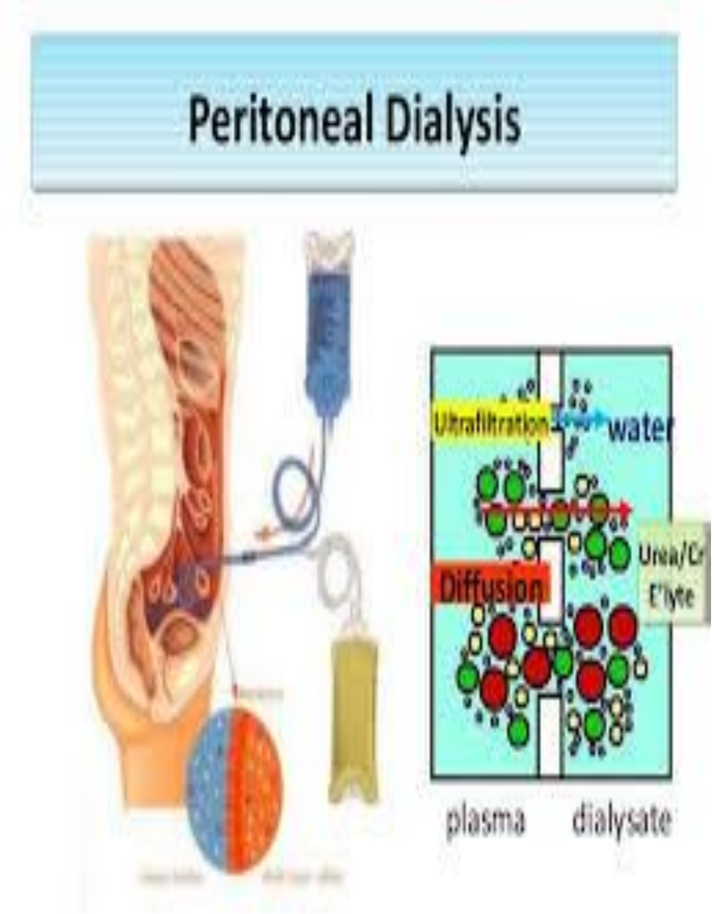
INSERTING THE CATHETER

- Ideally, the peritoneal catheter is inserted in the **operating room** to maintain surgical asepsis and minimize the risk of contamination. In some circumstances, however, the physician inserts the catheter at the **bedside under strict asepsis.**

PERFORMING THE EXCHANGE

(**1 to 4 hours,** depending on the prescribed dwell time.)

- Peritoneal dialysis involves a series of exchanges or cycles which is repeated throughout the course of the dialysis which is based on the patient's **physical status and acuity of illness.**
- An exchange is defined as the **infusion, dwell, and drainage of the dialysate**.

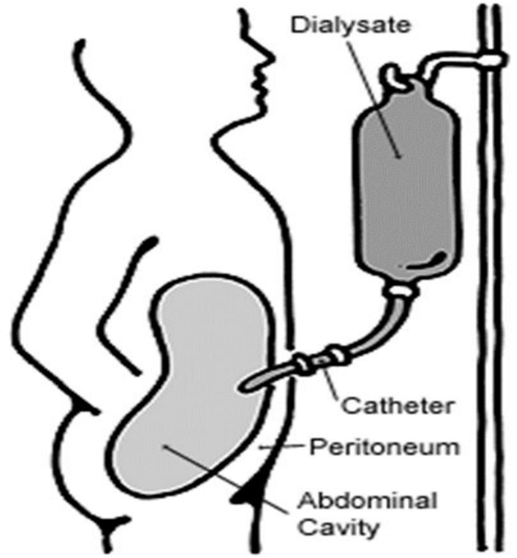


INFUSION : The dialysate is infused by gravity into the peritoneal cavity for a period of about 5 to 10 minutes to infuse 2 L of fluid.

DWELL: (equilibration time) allows diffusion and osmosis to occur. (peaks in the first 5 to 10 minutes)

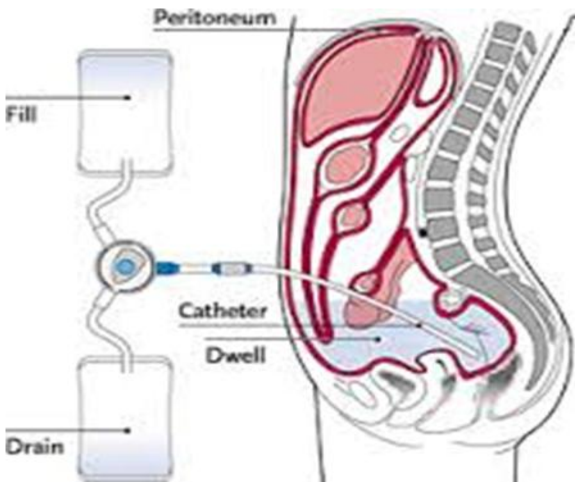
PERFORMING THE EXCHANGE

(**1 to 4 hours,** depending on the prescribed dwell time.)



DRAINAGE

- The tube is unclamped and the solution drains from the peritoneal cavity by gravity through a closed system (10 to 30 minutes).
- The drainage fluid **is normally colorless** or **straw-colored** and should **not be cloudy.** Bloody drainage may be seen in the first few exchanges after insertion of a new catheter but should not occur after that time.
- The removal of excess water during peritoneal dialysis is achieved by using a **hypertonic dialysate** with a high dextrose concentration that creates an osmotic gradient (Dextrose solutions of 1.5%, 2.5%, and 4.25%).



NURSING RESPONSIBILITY

- Maintain the cycle in a **Strict aseptic technique**
- Vital signs, weight, intake and output, laboratory values, and patient status are frequently monitored.
- Assesses skin turgor and mucous membranes to evaluate fluid status and monitor the patient for edema.
- Facilitate drainage by **turning the patient from side to side** or raising the head of the bed, checking the patency of the catheter by inspecting for kinks, closed clamps, or an air lock.
- **Monitor for complications,** including peritonitis, bleeding, respiratory difficulty, and leakage of peritoneal fluid.

NURSING RESPONSIBILITY

- Measure **abdominal girth** to determine if the patient is retaining large amounts of dialysis solution.
- Ensure that the peritoneal dialysis catheter remains **secure** and that the **dressing remains dry. The catheter should never be pushed in.**
- Use a **flow sheet to document** each exchange and record vital signs, dialysate concentration, medications added, exchange volume, dwell time, dialysate fluid balance for the exchange (fluid lost or gained), and cumulative fluid balance

Peritoneal Dialysis Solutions

- All forms of PD use the same dialysate solutions, commercially available in volumes of 1 to 3 L in flexible polyvinyl chloride plastic bags.
- PD solutions include varying concentrations of electrolytes, such as sodium (132 mEq/L), chloride (96 to 102 mEq/L), calcium (0 to 3.5 mEq/L), magnesium (0.5 mEq/L), and lactate (35 to 40 mEq/L).
- Dialysate pH is maintained at 5.2-6.3
- The PD dialysate solution may contain 1.5%, 2.5%, 3.86%, or 4.25% dextrose or icodextrin (a glucose polymer) at a concentration of 7.5%.
- The dextrose solutions are hyperosmolar (osmolarity ranges from 346 to 485 mOsm/L) and induce ultrafiltration (removal of free water) by crystalline osmosis.
- Dextrose is not the ideal osmotic agent for peritoneal dialysate due to bioincompatibility and cytotoxicity due to osmolar load & low pH of the solutions

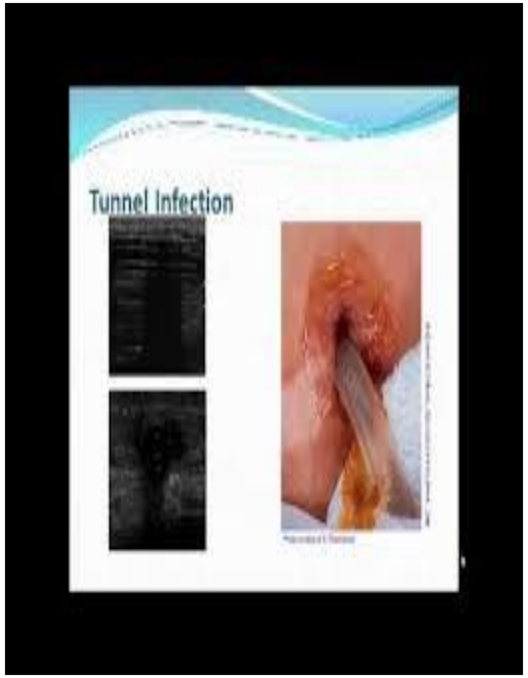
Additives to Peritoneal Dialysis Solutions: Insulin and Heparin

- Possible advantages of intraperitoneal versus subcutaneous insulin include the avoidance of erratic absorption (both rate and extent of absorption), convenience, avoidance of subcutaneous injection site related complications, and prevention of peripheral hyperinsulinemia.
- bioavailability of intraperitoneal insulin is reported to be approximately 25% to 30%

- Many PD patients secrete large quantities of fibrinogen into the peritoneal cavity, which results in fibrin formation.
- This can lead to intraperitoneal adhesions and outflow obstruction.
- Intraperitoneal heparin 500 to 1,000 units/L may prevent this complication as a result of its local antifibrin effect

Complications of Peritoneal Dialysis

- **PERITONITIS** (inflammation of the peritoneum) is the most common and most serious complication; characterized by cloudy dialysate drainage, diffuse abdominal pain, and rebound tenderness.
- **LEAKAGE** of dialysate through the catheter site may occur immediately after the catheter is inserted
- **BLEEDING** - common during the first few exchanges after a new catheter insertion because some blood exists in the abdominal cavity from the procedure.



LONG-TERM COMPLICATIONS

- Hypertriglyceridemia ; abdominal hernias (incisional, inguinal, diaphragmatic, and umbilical), hemorrhoids.

CLINICAL PRESENTATION OF PERITONEAL DIALYSIS–RELATED PERITONITIS

General

- Patients generally present with abdominal pain and cloudy effluent

Symptoms

- The patient may complain of abdominal tenderness, abdominal pain, fever, nausea and vomiting, and chills

Signs

- Cloudy dialysate effluent may be observed
- Temperature may or may not be elevated

Laboratory Tests

- Dialysate white blood cell count >100/mm^3, of which at least 50% are polymorphonuclear neutrophils
- Gram stain of a centrifuged dialysate specimen

Other Diagnostic Tests

- Culture and sensitivity of dialysate should be obtained

Comparison between hemodialysis and peritoneal dialysis

- **How is the procedure done?**
- **Hemodialysis**
  Procedure uses a dialyzer (manmade membrane). 2 needles are inserted through an access point and blood is drawn from the body via fistula, graft or catheter and then filtered. Fluid, waste and chemicals are removed, and the filtered blood is returned to the body.

- **Peritoneal dialysis**
  Procedure uses the peritoneal membrane (the lining of the abdominal cavity) and dialysate (solution). Dialysate is transferred via small tube into abdomen. Fluid, waste and chemicals move from blood to dialysate. Dialysate is then drained from the abdomen and the process starts once more

Dialysis access

- **Hemodialysis**
  Via an arteriovenous fistula, arteriovenous graft or dialysis catheter, placed in advance in arm, leg or groin. Fistula is placed 3-12 months prior to treatment start, graft 2-3 weeks in advance. Catheter can be used immediately (usually for short term).
- **Peritoneal dialysis**
  Via catheter placed in abdomen at least 2 weeks prior to start of treatment.

Independence

- **Hemodialysis**
  Carried out by health professionals or at home by a caregiver who has undergone instruction.
- **Peritoneal dialysis**
  Can be done by patient.

Travel

- **Hemodialysis**
  Requires planning and making arrangements with dialysis centers. Home equipment is bulky and hard to move.
- **Peritoneal dialysis**
  Equipment is portable and can be taken with you, can be done everywhere and anywhere.
- **Hemodialysis**
  Dietary and fluid restrictions:
  – Requires high protein
  – Limited potassium
  – Limited fluid intake
  – Avoidance of salt
  – Limit phosphorous
- **Peritoneal dialysis**
  Fewer restrictions, may need to restrict calories.

- **Where is the procedure done**
- **Hemodialysis**
  Usually at a hospital or dialysis center. Can be done at home after properly adapting the house and having a caretaker trained in HD use.
- **Peritoneal dialysis**
  At home, work or where ever you want.

- **Possible Side effects**
- **Hemodialysis**
  - Muscle cramps
  - Hypotension
  - Dizziness
  - Nausea
  - High blood potassium levels
  - Depression
  - Itchiness
  - Fatigue
  - Loss of libido
  - Anxiety
  - Dry mouth
- **Peritoneal dialysis**
  - Weight gain
  - Reduction in protein levels leading to malnutrition
  - Fatigue