

# Practice Exam Questions

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Nephrology Nursing Certification Commission

**CCHT**

**Certified Clinical Hemodialysis Technician**



**EXAMAIDES**

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## Total Question: 150 QAs

Question No: 1

Peritoneal dialysis (PD) differs from hemodialysis in which of the following ways?

- A. PD requires both vascular access and abdominal access
- B. PD cannot be done at home
- C. PD access is by an intra-abdominal catheter
- D. Sterile dialysate is not required for PD

Answer: C

Explanation: Hemodialysis requires vascular access since the blood flows out of the patient, through the dialysis machine's semipermeable membrane, and then back into the patient. The membrane keeps certain waste products or excess water from returning to the patient, while electrolytes and blood cells are returned. Peritoneal dialysis is performed with an intra-abdominal catheter without blood ever leaving the body. Vascular access is not required. The blood vessels of the abdominal cavity act as a filter similar to the semipermeable membrane used in hemodialysis. Peritoneal dialysis may be performed at home with a cycler machine to exchange fresh sterile dialysate, often overnight 7 days a week. Manual exchange of dialysate may also be done.

Question No: 2

The main difference between an arteriovenous shunt (AVS) and an arteriovenous fistula (AVF) is an:

- A. AVS is entirely within the arm.
- B. AVF is entirely within the arm.
- C. AVF is more likely to become clotted or infected.
- D. AVF requires an external tube.

Answer: B

Explanation: Since hemodialysis must be carried out repetitively, usually three times a week for 4 hours, repeated vascular access is required. Arterial blood is sent to the dialyzer and returned to the patient by an arm vein. Arteriovenous shunts connect the artery and vein by an external tube, which has a connecting port so that blood may be sent to the dialysis machine from the artery and returned to the vein. These shunts are subject to infection and clotting so that surgically implanted arteriovenous fistulas were developed, which connect artery and vein entirely within the arm. These are still standard for most dialysis patients.

Question No: 3

Which of the following dialyzers is used currently?

- A. Kiil
- B. Flat plate
- C. Coil
- D. Hollow tube

Answer: D

Explanation: Dialysis machines have evolved since their initial frequent use in the 1960s. The initial type, the so-called Kiil, consisted of 70 lb. flat plates covered by sheets of cellophane. They required cleaning and storage after each use, and membranes had to be replaced. The coil dialyzer was supported by a mesh screen coiled around a central core. It required complete sterilization with a large amount of blood in a canister that was

bathed in the dialysate. The Gambro flat plate dialyzer used a new membrane type named cuprophane. These early machines were replaced by the so-called hollow fiber dialyzer, which is the type in use today. In this model, the blood flows through tiny hollow tubes (fibers) while the dialysate flows around the outside of these fibers. Biocompatible membranes, sophisticated alarms, and automatic functions characterize the modern dialyzer.

Question No: 4

Which of the following kidney structures connects with and delivers urine directly to the ureter?

- A. Pelvis
- B. Calyx
- C. Glomerulus
- D. Cortex

Answer: A

Explanation: The kidney is a fist-sized bilateral organ with a tough outer capsule. The most external portion of the organ is called the cortex. The renal medulla or interior portion of the kidney contains sections called pyramids with points referred to as papillae. Each papilla delivers urine into a receptacle-like calyx, which then transmits urine into the renal pelvis. The pelvis connects to the ureter and delivers urine for excretion. The functional unit of the kidney is the nephron, present in the cortex and extending into the medulla. The nephron is composed of a glomerulus, a tangled bunch of capillaries, which produces the glomerular filtrate, and a renal tubule, which acts on the filtrate to reabsorb water and exchange electrolytes. Blood is conducted to the glomerulus via an afferent arteriole and is filtered by the glomerular capillaries, which retain blood cells and large molecules, such as proteins. The blood is then returned by way of an efferent arteriole.

Question No: 5

The glomerular filtration rate is an important index of renal function and in the normal adult is approximately:

- A. 50 ml/min/1.73 m<sup>2</sup>.
- B. 75 ml/min/1.73 m<sup>2</sup>.
- C. 125 ml/min/1.73 m<sup>2</sup>.
- D. 200 ml/min/1.73 m<sup>2</sup>.

Answer: C

Explanation: The normal adult has a glomerular filtration rate (GFR) of about 125 ml/min, although there is some variability due to age and sex. Clinically, this value is often expressed as GFR/m<sup>2</sup> body surface area. It is usually measured by the so-called creatinine clearance in which blood and urine creatinine concentrations and the urine volume are measured, and the GFR calculated. Little creatinine is reabsorbed by the renal tubules, thus making it a valuable standard for estimating glomerular function. In end stage renal disease, the GFR is often below 15 ml/min/1.73 m<sup>2</sup>, and dialysis is required. Many drugs are excreted by the kidneys, and dosage adjustments based on GFR are often necessary.

Question No: 6

All of the following substances are produced by the kidney EXCEPT:

- A. renin.
- B. aldosterone.
- C. erythropoietin.
- D. calcitriol.

Answer: B

Explanation: In addition to its role in water and electrolyte balance and acid- base control, the kidney also produces substances that are of importance in erythropoiesis, vitamin D metabolism, and blood pressure control. Production of the hormone erythropoietin by juxtaglomerular renal cells is important in controlling red blood cell production in the bone marrow. In the presence of anemia, the resulting hypoxia stimulates the hypoxia-inducible transcription factor in these cells, and increased amounts of erythropoietin are produced. A decrease in renal perfusion leads to increased production of renin by the kidney; this enzyme catalyzes the conversion of angiotensinogen to angiotensin 1, which is subsequently converted to angiotensin 2 by an angiotensin-converting enzyme. The latter stimulates aldosterone secretion by the adrenal gland. The renin-angiotensin- aldosterone system is of great importance in the regulation of blood pressure. The active form of vitamin D, calcitriol, is also produced in the kidney.

Question No: 7

The most likely cause of post-renal failure is:

- A. severe dehydration.
- B. nephrotoxic drug.
- C. glomerulonephritis.
- D. benign prostatic hypertrophy.

Answer: D

Explanation: Acute renal failure (ARF) is usually classified by the anatomic location of the damage. Pre-renal failure typically is caused by hypotension, resulting from trauma, dehydration, or blood loss in which the renal blood flow is markedly diminished. Intra renal failure is caused by intrinsic kidney diseases, such as glomerulonephritis or renal toxic drugs, such as certain antibiotics, chemotherapy agents, or radiologic contrast materials. Post-renal failure may be caused by problems distal to the kidney that cause obstruction to urine flow, such as ureteral calculi, kinked ureter, neoplastic invasion, or prostatic hypertrophy in men. ARF may proceed to chronic renal failure but may resolve with careful medical treatment and sometimes hemodialysis.

Question No: 8

The most common cause of chronic kidney disease in the United States is:

- A. diabetes.
- B. hypertension.
- C. glomerulonephritis.
- D. polycystic kidney disease.

Answer: A

Explanation: Diabetes mellitus is the commonest cause of chronic renal failure (CRF) in the United States. Because of the obesity epidemic, type 2 diabetes (90% of diabetic patients) is on the rise, and thus, there may be even more cases of CRF in the future. Diabetic nephropathy is most likely caused by endovascular damage to the renal vessels. Hypertension is the second leading cause of CRF. It is most often of the so-called essential type in which the exact cause is unknown. In the first few years of this decade, about 27% of patients on dialysis had kidney failure as a result of hypertension. Renal disease or renal artery stenosis may also cause hypertension with its deleterious effects. Additional causes of CRF include glomerular diseases and polycystic disease. Less common causes of CRF are cancer, kidney infections, AIDS, systemic lupus erythematosus, and sickle cell disease.

Question No: 9

Which of the following conditions is LEAST likely to be caused uremia?

- A. Itching
- B. Edema (swelling) of the extremities
- C. Anemia
- D. Urinary tract infection

Answer: D

Explanation: Uremia is the term given to a constellation of symptoms resulting from kidney failure, with a resultant buildup of waste products in the circulation (e.g., urea). Some of the typical symptoms include fatigue (often resulting from anemia, which is common in chronic renal disease), itching, myalgias, dyspnea or edema from fluid retention, skin pallor or yellowish cast, foamy urine (due to protein), and nocturia.

Loss of protein in the urine greater than 3.5 g/d is referred to as the nephrotic syndrome and may be a cause of excessive fluid retention. Often these symptoms develop gradually so frequent inquiry of the patient is indicated. Hemodialysis may improve uremic symptoms, but it only reproduces about 15% of normal kidney function; thus, an increased frequency and duration of hemodialysis may be indicated if the symptoms persist. Urinary tract infections are caused by the introduction of bacteria, not by uremia.

Question No: 10

All of following conditions are associated with chronic kidney failure EXCEPT:

- A. low hemoglobin.
- B. hypoparathyroidism.
- C. hyperkalemia.
- D. hyperphosphatemia.

Answer: B

Explanation: Numerous abnormalities of the blood, protein, and electrolytes occur in chronic renal failure. Anemia is very common due to frequent blood loss with resulting iron deficiency and diminished secretion of erythropoietin by the diseased kidney. Calcium absorption is impaired due to inadequate calcitriol, and phosphate is not adequately excreted by the tubules, resulting in elevated phosphate levels. A low calcium level stimulates the parathyroid gland to produce more parathyroid hormone, producing so-called secondary hyperparathyroidism. This may result in calcium deposition in the heart and blood vessels. Elevated potassium levels are also quite common in these patients and may be life threatening.

Question No: 11

What percentage of transplanted kidneys are functional 1 year after transplantation?

- A. 90%
- B. 70%
- C. 50%
- D. 30%

Answer: A

Explanation: Kidney transplant has become a major form of treatment for chronic renal disease. About 15,000 are done each year in the United States. The donor kidney may be from a living related individual (e.g., brother or sister), a living non-related donor (e.g., spouse or friend), or a cadaver kidney, usually from a non-related individual who has died recently. In the latter case, the patient is usually matched from the national donor list.

Living donors should be in good physical and mental health, and in all cases, blood and tissue type (human leukocyte antigen) matching is very important for the survival of the organ in the recipient. The transplanted kidney may last up to 20 years or more, nearly always with the use of immunosuppressant drugs that lower the chance of rejection. About 89%- 95% of transplanted kidneys are functional at 1-year post-surgery.

Question No: 12

Which hemodialysis schedule is likely to be most efficient?

- A. In-center hemodialysis, 3-4 hours a session, 3 days a week
- B. Conventional home hemodialysis
- C. Short daily home hemodialysis, 2- 3 hours a session, 5- 7 days a week
- D. Nocturnal home hemodialysis, 8 hours during sleep, 3 days a week

Answer: C

Explanation: Most hemodialysis in the United States is done in centers, usually 3- 4 hours a session, 3 days a week. The presence of nurses, technicians, and other patients is often reassuring to the individual undergoing treatment. However, the time commitment may interfere with work schedules or parenting of young children. Some centers offer night treatment with the patient sleeping over while having hemodialysis. Home hemodialysis, using dialyzers appropriately designed for home use, is another option, but the patient and spouse or partner must undergo training regarding techniques and standard procedures and a plan of action in emergencies. Nocturnal home hemodialysis during sleep allows prolonged treatment and has been shown to reduce many of the symptoms of chronic renal disease. Probably the most efficient schedule is that of the newer short daily home hemodialysis, usually 2- 3 hours a session, 5- 7 days a week. The initial 2 hours of dialysis are the most efficient, and the shortened time schedule allows more time for work and recreational activities.

Question No: 13

The fluid restriction for most patients undergoing in-center hemodialysis is equal to urine volume/day plus:

- A. 0 L.
- B. 0.5 L.
- C. 1 L.
- D. 2 L.

Answer: C

Explanation: Since there is little or no urine production in patients with end-stage renal disease, excess fluid must be removed by dialysis. The volume of urine that the patient does produce plus so-called insensible losses (e.g., breathing, stool, perspiration), around 600 ml/d, is the usual fluid replacement formula.

Thus, a typical prescription would be urine volume plus 1 L (4 cups) a day. Close attention to dry weight (post-dialysis weight) and symptoms of dehydration (e.g., thirst, weight loss, poor skin turgor, hypotension) or fluid overload (e.g., edema, pulmonary congestion, hypertension) must be a part of the evaluation of every patient. Since loss of appetite and malnutrition are common in these patients, dietary considerations are very important, and consultation with a dietitian trained in renal failure is often necessary.

Question No: 14

Failure to excrete beta2-microglobulin in patients with kidney failure predisposes the patient to:

- A. pericarditis.
- B. amyloidosis.

C. neuropathy.

D. seizures.

Answer: B

Explanation: Betamicroglobulin is a protein widely distributed on cell surfaces and in body fluids. It is a precursor of the protein amyloid, which is formed when the betamicroglobulin enters tissues and is converted to amyloid. Healthy kidneys remove excess betamicroglobulin, but in renal failure, levels rise, and so-called amyloidosis occurs. This may lead to carpal tunnel syndrome, joint pain, bone cysts, compression fractures, and cutaneous bleeding. Nearly 20% of hemodialysis patients develop amyloidosis after 10 years and 80%-100% after 29 years. Pericarditis, inflammation, and fluid accumulation within the pericardium, is common in chronic renal disease as is peripheral neuropathy, most likely due to inadequate excretion of neurotoxic substances. Seizures may occur but are usually related to electrolyte abnormalities, especially hyponatremia.

Question No: 15

Blood tests for ferritin are performed in hemodialysis patients:

A. to check for iron stores.

B. to check for magnesium levels.

C. as an alternative to hemoglobin concentration.

D. to maintain electrolyte balance.

Answer: A

Explanation: Ferritin is the main storage protein for iron, required for hemoglobin synthesis, and is usually low in iron deficiency anemia. Most patients with chronic renal failure are anemic, usually from inadequate erythropoietin production by the kidney or bleeding, often gastrointestinal, or both. Erythropoietin levels may be checked, but drugs, such as Epogen or Procrit, that stimulate red cell production will not work effectively unless iron stores are adequate. The use of these erythropoiesis-stimulatory agents is quite common in hemodialysis patients, aiming for a hemoglobin level in the 10-12 g/dL range. Blood transfusions may thus be avoided. Iron supplementation may be required to keep the ferritin level above 200 ng/mL. It should be checked monthly. A potential source of blood loss should be investigated.

Question No: 16

Which of the following phosphate binders would best control hyperphosphatemia with the fewest side effects in patients with end stage kidney disease?

A. Aluminum hydroxide

B. Calcium carbonate

C. High dairy product diet

D. Lanthanum carbonate

Answer: D

Explanation: Hyperphosphatemia (elevated serum phosphate) is common in chronic renal failure patients since the kidneys are unable to excrete this substance. Low calcium and elevated phosphate levels are typical of these patients and lead to secondary hyperparathyroidism and bone loss (renal osteodystrophy). A low phosphate diet, calcium supplements with vitamin D, and phosphate binders are all useful in limiting high phosphate levels. High phosphate foods include chocolate, dairy products, dried beans, nuts, pizza, and cola drinks. Calcium supplements with vitamin D may also be useful in controlling the elevated phosphate. The most effective agents are phosphate binders, which bind to phosphate in the gastrointestinal tract and prevent absorption. Of these, the nonaluminum and calcium-containing compounds (e.g., lanthanum carbonate) are

preferred because there is less toxicity.

Question No: 17

Hemodialysis patients should be taught to:

- A. put in their own needles.
- B. weigh themselves and record it.
- C. check their dialyzer settings and dialysate.
- D. do all of the above.

Answer: D

Explanation: Engaging the patient in his or her own care usually has positive benefits. This is especially true for patients who wish to do home dialysis. The technical staff should assess the patient's capacity for these techniques and their implications. The more skillful the patient is with needle placement to the access site, choosing the right foods, calculating weight and fluid status, and checking the dialyzer and dialysate, the more likely he or she will have a positive attitude toward the treatment and prognosis. The same is true for a spouse or other caregiver. Learning for what each medication is needed and watching out for specific symptoms are also important for patient education and safety.

Question No: 18

All of the following statements about vitamins in dialysis patients are true EXCEPT:

- A. dialysis does not remove water-soluble vitamins.
- B. supplemental B-complex vitamins should be given.
- C. vitamin D should be given to most dialysis patients.
- D. megadose fat- or water-soluble vitamins should not be given.

Answer: A

Explanation: Dialysis does remove some water-soluble vitamins, such as biotin, folate, niacin, pantothenic acid (vitamin B5), thiamine, and riboflavin so supplements of these are recommended. Patients should take 60-100 mg of vitamin C and 800-1000 mcg folic acid daily. Exact doses in multivitamin tablets should be checked. Megadose vitamin therapy is not recommended. The healthy kidney may excrete high vitamin doses, but toxic levels may accumulate as dialysis is unlikely to handle large doses. This is especially true of fat-soluble vitamins A and D and possibly E and K. Over-the-counter herbs and food supplements should be discussed with a medical professional before using them.

Question No: 19

Osmosis is best defined as:

- A. diffusion of solute through a semipermeable membrane from a high- to low-solute concentration.
- B. diffusion of solvent through a semipermeable membrane from low- to high-solute concentration.
- C. a version of hydraulic pressure used in dialysis.
- D. diffusion of solvent through a semipermeable membrane from high- to low-solute concentration.

Answer: B

Explanation: Diffusion refers to the movement of solute through a semipermeable membrane from a high concentration to a low concentration, a so-called concentration gradient. Unlike hydrostatic pressure, no external force is required; the molecules supply their own energy. In time the solute concentration on both sides of the membrane equalizes. Factors that influence the speed of diffusion include the size and number of the membrane pores, the size of the solute molecules (molecular weight), and the temperature of the

solution. Osmosis refers to the movement of solvent through the semipermeable membrane from a low-solute concentration to a high-solute concentration, sometimes referred to as movement of solvent from low-osmotic pressure or osmolality to high-osmotic pressure or osmolality. Both processes occur across living cell membranes and in dialysis.

Question No: 20

In hemodialysis, blood and dialysate have which of the following properties?

- A. They flow in the same direction
- B. They flow in opposite directions
- C. They mix with in the dialyzer
- D. They do not require a semipermeable membrane

Answer: B

Explanation: In hemodialysis, both diffusion and osmosis occur. The dialysate is prepared with solutes (e.g., ions, glucose) to achieve desired levels in the blood. More efficient exchange of fluid and solute is obtained if the two fluids flow in opposite directions, a so-called countercurrent exchange. This is because the gradients can be maintained for the entire length of the tubing, speeding up the elimination of waste products (e.g., urea). Flow of both fluids in the same direction would decrease the diffusion and osmotic gradients over the length of the fiber and would be less efficient. Excess water may be removed, using hydraulic pressure and ultrafiltration through a filter that traps large molecules (e.g., proteins) and blood cells. So-called convective transport may occur, leading to solvent drag in which solvent crossing the semipermeable membrane drags along smaller solutes.

Question No: 21

In the dialyzer, water may be removed from:

- A. the intracellular compartment.
- B. the intravascular compartment.
- C. the interstitial compartment.
- D. all of the above compartments.

Answer: B

Explanation: Body fluids are present in three different sites, known as compartments. The fluid inside cells is referred to as the intracellular compartment. The fluid between cells is called the interstitial compartment. Blood in vessels makes up the intravascular compartment. Differences in osmotically active solute concentration (gradients) in different compartments cause water to flow toward a state of equilibrium. Hemodialysis acts only on blood that is removed from the access site (intravascular blood), pumped through the hollow fibers of the dialyzer, which has a semipermeable membrane that separates the blood from the dialysate, and is then returned to the body. Water flows through the membrane to the higher osmotically active fluid, largely determined by the sodium concentration and with some contribution from other osmotically active molecules.

Question No: 22

Which site in the hemodialysis pathway has the highest positive pressure?

- A. Arterial blood in the afferent tubing
- B. Blood entering the dialyzer fibers
- C. Blood leaving the dialyzer fibers

D. Blood in the venous return

Answer: B

Explanation: In hemodialysis, arterial blood is conducted through tubing to a pump, which forces the blood through the hollow fibers in the dialyzer. The pre-pump blood usually has a negative pressure, while the postpump blood (arterial header) about to enter the hollow fibers has the highest positive pressure, the value depending on the resistance of the fibers. Pressure then diminishes over the length of the fiber, and the pressure in the venous return is the lowest positive pressure in the system. The dialysis machine can control the pressure differential between the dialysate and the blood, the so-called transmembrane pressure. This may be adjusted to control the amount of fluid removal. The average pressure difference between blood entering and leaving the dialyzer fibers determines the net hydraulic pressure, forcing fluid out of the blood, through the membrane, and into the dialysate.

Question No: 23

The term "sieving coefficient of a membrane" refers to the:

- A. fraction of solute that passes through the membrane by convection.
- B. amount of water required for solute drag through the membrane.
- C. concentration of pores in the membrane.
- D. size of the pores in the membrane.

Answer: A

Explanation: As water moves through the membrane from the blood to the dialysate (convection), it drags molecules along with it (solvent drag). The size of the molecule and the size and number of the pores in the membrane determine the fraction of solute that undergoes convective transport. Small molecules pass easily and quickly, but large molecules pass more slowly. The term "sieving coefficient of a membrane" refers to the amount of a given solute that passes through the membrane from the blood into the dialysate. A sieving coefficient of 1.0 indicates that 100% of a given solute passed through the membrane, while a sieving coefficient of 0.4 indicates that only 40% of a given solute passed through the membrane by a convective mechanism.

Question No: 24

Water moves from one body compartment to another by:

- A. ultrafiltration.
- B. active transport.
- C. osmotic forces.
- D. all of the above.

Answer: C

Explanation: Osmotic forces determine which way water will move from one body fluid compartment to another. In hemodialysis, water is forced through the membrane by ultrafiltration so that the solute concentration of the blood is lowered. Water is then returned to the cells and tissues from the blood by osmotic forces since the cellular osmotically active solute concentration is now higher than in the blood. This may result in a fall in blood volume and result in hypotension. Sodium may be added to the dialysate, which will then increase the osmolality of the blood, pulling water out of the cells and tissues. The sodium in the dialysate is then lowered later in the dialysis process so that the excess water can be removed from the blood. Ultrafiltration occurs within the dialyzer but not within the body compartments. Active transport may drive ion exchange across cellular membranes, but water movement is passive and determined by osmotic forces.

Question No: 25

Biocompatibility is best illustrated by:

- A. synthetic membranes that do not adsorb blood proteins as well as cellulose membranes.
- B. independence from protein adsorption of the membrane.
- C. reprocessed dialyzers that have a lower biocompatibility than new ones.
- D. reprocessed dialyzers that have a better biocompatibility than new ones.

Answer: D

Explanation: Biocompatibility refers to the interaction of the membrane with the blood contents. Touching of blood to the membrane may activate certain cellular or protein elements in the blood, causing immunologic reactions, such as allergic reactions or anaphylaxis. Release of deleterious cytokines or enhanced clotting may occur. Adsorption of blood proteins onto the fiber wall tends to improve biocompatibility since the material is no longer seen as "foreign" by immunocompetent cells. In general, synthetic membranes are more biocompatible than those of cellulose due to their ability to absorb proteins better than the latter. Reprocessed (cleaned and reused) dialyzers may be more biocompatible than new ones since they retain some adsorbed protein (unless bleach is used to strip off the protein).

Question No: 26

The amount of fluid to be taken from the patient during hemodialysis:

- A. is independent of the filtration pressure.
- B. requires the dialysate to have a higher pressure than the blood.
- C. may be calculated by subtracting the patient's estimated dry weight from the pre-dialysis weight and adding any fluid the patient receives during treatment.
- D. may be calculated by adding the patient's pre-dialysis weight and the amount of fluid the patient receives during treatment.

Answer: C

Explanation: For ultrafiltration to force fluid through the semipermeable membrane, the hydraulic pressure in the blood compartment must be higher than in the dialysate compartment. This pressure difference is referred to as a hydraulic pressure gradient or a transmembrane pressure. The pressures in each compartment may be set by the dialysis machine. A simple method of calculating the amount of fluid to be removed is by subtracting the estimated dry weight (EDW) of the patient from his or her predialysis weight (PRW). Any fluid given during the procedure may then be added to the difference.

Assuming 1 L of water weighs 1 kg, the EDW is 75 kg, the PRW is 80 kg, and the patient receives 0.5 L during the treatment. Thus, the amount of fluid to be removed would be:  $80 - 75 + 0.5 = 5.5$  L.

Question No: 27

The ultrafiltration coefficient of a dialyzer refers to the:

- A. fluid that passes through the membrane in 1 hour.
- B. pressure in the blood compartment needed to force fluid through the membrane.
- C. pressure difference across the membrane.
- D. fluid that passes through the membrane in 1 minute.

Answer: A

Explanation: The dialysis machine can alter the hydraulic pressures in the blood and dialysate compartments and thus control the ultrafiltration rate of the fluid transfer. Each dialyzer has an ultrafiltration coefficient (Kuf)

determined by the manufacturer. This refers to the volume of fluid (in ml ) that passes through the membrane at a given pressure difference in 1 hour. Thus, a dialyzer with a Kuf of 5 and a transmembrane pressure of 50 mm Hg transfers 250 ml (5 x 50) of fluid in 1 hour of dialysis. Patients with kidney failure are often edematous with excess water in the interstitial compartment so that removal by dialysis represents an efficient way of controlling fluid volume and weight. Since the patient's kidneys are not functioning, diuretic drugs are of little benefit.

Question No: 28

The molecular weight cutoff of a dialyzer is 12,000 daltons. Which of the following molecules would not pass through the membrane into the dialysate?

- A. Phosphate
- B. Urea
- C. Albumin
- D. Sodium

Answer: C

Explanation: Molecular weights of a chemical compound represent the sum of the atomic weights of the atoms that make up the molecule. Each dialyzer membrane has a molecular weight cutoff (in daltons) that determines the size of the molecules that can pass through it. These may range from 3000 to 15,000 daltons. Small molecules (e.g., sodium, potassium, phosphate, urea, water) pass through the filter easily, while large molecules, such as proteins (e.g., albumin with a molecular weight of 66,000 daltons) cannot. Choosing the appropriate molecular cutoff for a membrane helps to determine what size molecule may be removed from the blood. This is particularly important for drug overdoses and toxins.

Question No: 29

Clearance of low-molecular-weight molecules by dialysis is accomplished mostly by:

- A. convection.
- B. diffusion.
- C. adsorption.
- D. solvent drag.

Answer: B

Explanation: The volume of blood that can be cleared of a given solute per unit time is referred to as clearance (K). The clearance for a given solute is given by the manufacturer based on blood and dialysis flow rates; membrane characteristics; and the molecular weight, size, and charge of the solute. Most low-molecular weight solutes are removed during dialysis by diffusion from the high-concentration to the low-concentration side of the membrane with the rate also dependent on temperature. Large molecules tend to cross the membrane by convection (solvent drag). The sieving coefficient (SC) indicates the amount of solute passing through the membrane with the rest rejected or adsorbed.

Thus, an SC of 0.4 predicts that 40% of a given solute will pass through the membrane. Mostly small proteins are removed from the blood by adsorption to the membrane, although cellulose membranes tend to absorb more than synthetic hydrophobic ones. Membranes with adsorbed material are more biocompatible but may diminish diffusion and convection.

Question No: 30

A hollow fiber dialyzer has which of the following properties?

- A. Very fine fiber tubes held in place by polyurethane material
- B. Fibers about 1 cm in width
- C. A high-membrane compliance
- D. A high resistance in the fibers, enhancing ultrafiltration pressure

Answer: A

Explanation: A hollow fiber dialyzer holds thousands of fiber tubes through which the blood flows. They are surrounded by dialysate, separated by the membrane. The blood and dialysate flow in opposite directions, a so-called countercurrent mechanism, which enhances molecular exchange. This is because the concentration gradients are little changed from one end of the fiber to the other. The hollow fibers are very thin but rigid so that the membrane compliance (deformability or volume change) is low. Ultrafiltration rates are predictable so that precise amounts of fluid removal may be accomplished. The hollow filters have a low resistance to blood flow so that there is not much volume difference at low and high pressure.

Question No: 31

Synthetic membranes have which of the following properties?

- A. They are cellulose membranes in which hydroxyl groups are replaced with acetate
- B. They have thick fiber walls
- C. They have poor adsorption
- D. They remove solute by diffusion only

Answer: B

Explanation: Dialysis membranes may be of three types: cellulose, modified cellulose, and synthetic. Cellulose membranes have thin fiber walls, and solutes pass through them mostly by diffusion. The molecular cutoff is low, about 3000 daltons, so that intermediate-size molecular passage (e.g., beta<sub>2</sub> microglobulin at 11,800 daltons) is limited. They are also the least biocompatible of the three types since adsorption is limited. Modified-cellulose membranes have the hydroxyl groups of the molecule replaced by acetate, amino acids, or other synthetic molecules. Their adsorption is improved, and diffusion, convection, and adsorption of solute are better than cellulose. The most effective membranes are purely synthetic made of polymers (e.g., polysulfone, polymethacrylate) formed into hollow fibers with thick walls. These membranes can remove solute up to 15,000 daltons in size, and their adsorption is quite good, leading to an improved biocompatibility.

Question No: 32

If a dialyzer has a urea clearance rate (K) of 200 mL/min and a blood flow rate (Q<sub>b</sub>) of 300 mL/min, what volume of the blood will be cleared of urea in 1 minute?

- A. 100 ml
- B. 200 ml
- C. 300 ml
- D. 500 ml

Answer: B

Explanation: A dialyzer's clearance rate for a particular solute indicates the volume of blood from which the solute will be removed per unit time. It is usually expressed as a K value in mL/min. Thus, with a K of 200 mL/min for urea, 200 mL of the 300 mL blood flowing through in 1 minute will be cleared of urea in 1 minute. Of course, blood is continually recirculated through the dialyzer so a considerable amount of urea may be removed. Blood flow rate (Q<sub>b</sub>) may be increased to lessen the time of dialysis, but there is a rate limit due to the amount of blood that can flow through the needle in the patient's vascular access. Dialysis flow rate (Q<sub>d</sub>)

may also increase clearance but to a lesser degree.

Question No: 33

To determine the most accurate clearance rate of a particular solute, one should:

- A. use water instead of blood.
- B. use a large-molecular-weight molecule.
- C. reduce the manufacturer's stated rate by 10%.
- D. measure the solute concentrations of blood going into and out of the dialyzer.

Answer: D

Explanation: The manufacturer's stated clearance for a particular solute is based on laboratory analysis of watery fluids that only approximate the rheological properties of blood. The actual value may differ by  $\pm 10\%$ -30%. Urea is the solute most frequently employed. The true clearance may be calculated by measuring the concentration of the solute going in and coming out of the dialyzer. The formula for dialyzer solute clearance is:  $K = (C_{bi} - C_{bo}) / C_{bi} \times Q_b$ , where K is the clearance,  $C_{bi}$  is the inlet solute concentration (arterial),  $C_{bo}$  is the outlet solute concentration (venous), and  $Q_b$  is the blood flow in ml/min. Increasing the dialysate flow rate ( $Q_d$ ) may slightly improve the solute clearance, but this is not a part of the formula.

Question No: 34

All of the following substances are added to the dialysate EXCEPT:

- A. bicarbonate.
- B. chloride.
- C. sodium.
- D. phosphate.

Answer: D

Explanation: The dialysate composition contains ions and glucose in concentrations similar to those of the blood. Usually two concentrates are prepared: acid (contains sodium, potassium, magnesium, calcium, chloride, and glucose) and bicarbonate buffer. Acetic acid is added to the acid solution to adjust the pH. The two concentrates are then mixed and diluted with treated water. The concentrates come in three different formulations so it is important to mix the compatible ones. The final concentrations of the ions are adjusted, depending on whether one wishes to raise or lower their blood concentration.

Thus, for a hyperkalemic (high potassium) patient, one might not add any potassium or keep it lower than the blood concentration. Phosphate is not routinely added to the dialysate.

Question No: 35

Sodium modeling refers to:

- A. changing the concentration of the dialysate sodium during the course of dialysis.
- B. injecting sodium chloride directly into the patient's vein.
- C. adjusting the sodium concentrate of the dialysate with normal saline.
- D. none of the above.

Answer: A

Explanation: Usually sodium concentration in the dialysate is kept the same or similar to that of the blood: 135- 145 mEq/L. However, higher concentrates are sometimes used at the outset to drive sodium into the blood and raise its concentration. This then enhances an osmotic fluid shift from the interstitial space into the blood and accelerates fluid withdrawal. Then the sodium concentration is slowly reduced during the course

of the dialysis, a process called sodium modeling. Caution must be used when performing this procedure since increased thirst and hypertension may result. The physician usually prescribes the concentration of sodium and the speed with which it is reduced.

Question No: 36

Conductivity is best defined as:

- A. a method of checking electrolyte levels in the dialysate.
- B. the voltage required to maintain the dialysis pump to achieve a given flow rate.
- C. a monitor and alarm system to measure dialysate flow rate.
- D. something that is measured once to check the final ionic concentrations of the dialysate.

Answer: A

Explanation: Conductivity refers to an electrical method of measuring the electrolytes in the dialysate. Most dialysis units have two conductivity meters, one for the initial concentrate mixture and one for the final dialysate. Electrodes or sensor cells may be employed to measure the current generated by the ionic strength of the solution. The conductivity is monitored in a so-called redundant fashion so that two monitors are used to protect patient safety. Alarms and automatic bypass systems warn of errors in the dialysate composition, and the fluid is diverted to a drain before reaching the patient. Low conductivity is the most common cause of alarm, usually due to low-concentrate levels. A high conductivity alarm may indicate poor water flow to the proportioning system, untreated incoming water, or use of the wrong dialysate concentrate.

Question No: 37

Which of the following statements about the proportioning system is correct?

- A. The concentrates are mixed manually
- B. It relies on a continuous supply of fresh concentrate and treated water
- C. The concentrates are heated after mixing
- D. Fixed-ratio mixing is the only method used

Answer: B

Explanation: Dialysate is made by mixing treated fresh water with concentrates containing the appropriate salts and glucose. The exact amounts of water and concentrate to be mixed depend on the dialysis center and the needs of a particular patient. There must be adequate volumes of water and concentrate for the entire procedure. Mixing of concentrate and water may be accomplished by two different methods: (1) by fixed-ratio pumps in which a diaphragm or piston pump delivers water and concentrate, according to a preset formula; or (2) by a servo-controlled mechanism in which the proportions of water and concentrate are automatically adjusted based on the conductance of the mixture, which is set to a prescribed level.

Question No: 38

An advantage of high-flux dialysis is:

- A. small pore size.
- B. fast removal of fluid.
- C. retention of beta2-microglobulin in the blood.
- D. slow blood flow, leading to more efficient removal of toxic substances.

Answer: B

Explanation: High-flux dialysis is a new, more efficient method of hemodialysis than the conventional method. The dialyzer has larger pores for more rapid removal of uremic toxins. Because of the large pores in the