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ASSIGNMENT TITLE: RENAL PHYSIOLOGY

COURSE TITLE: RENAL PHYSIOLOGY, BODY FLUID AND TEMPERATURE REGULATION

COURSE CODE: PHS 303

QUESTION 1: Discuss the pathophysiological process involved in renal failure.

ANSWER: Renal failure is due to dysfunctioning of kidneys. We have acute renal failure and chronic failure. Pathophysiological process just means the functioning of the diseased organs.

ACUTE RENAL FAILURE OR ACUTE KIDNEY INJURY: This is a rapid decrease in renal function over days to weeks, causing an accumulation of nitrogenous product in blood (azotemia) with or without reduction in amount of urine output. It often results from inadequate renal perfusion due severe trauma, illness or surgery but it is sometimes caused by a rapidly progressive intrinsic renal disease. Symptoms may include anorexia, nausea, vomiting. Seizures and coma may occur if condition is untreated. Fluid, electrolyte and acid-base disorders develop quickly. Creatinine and urea build up in blood over several daysand fluid and electrolyte disorders develop. The most serious of these disorders are hyperkalemia and fluid overload (possibly causing pulmonary edema). Phosphate retention leads to hyperphosphatemia. Hypocalcemia is thought to occur because the impaired kidney no longer produces calcitriol. Acidosis develops because hydrogen ions cannot be excreted. With significant uremia, coagulation may be impaired and pericarditis may develop. Urine output varies with the type and cause of AKI.

CHRONIC RENAL FAILURE OR CHRONIC KIDNEY DISEASE: This is a long-standing, progressive deterioration of renal function. Renal function is clinically monitored by measurement of serum creatinine, blood urea nitrogen (BUN) and urinalysis.

- Once serum creatinine in an adult reaches 3mg/dL, renal disease is irreversible and a progression to ESRD is inevitable.
- Azotemia means an elevation of BUN
- Uremia means presence of symptoms secondary to renal nitrogen retention. This

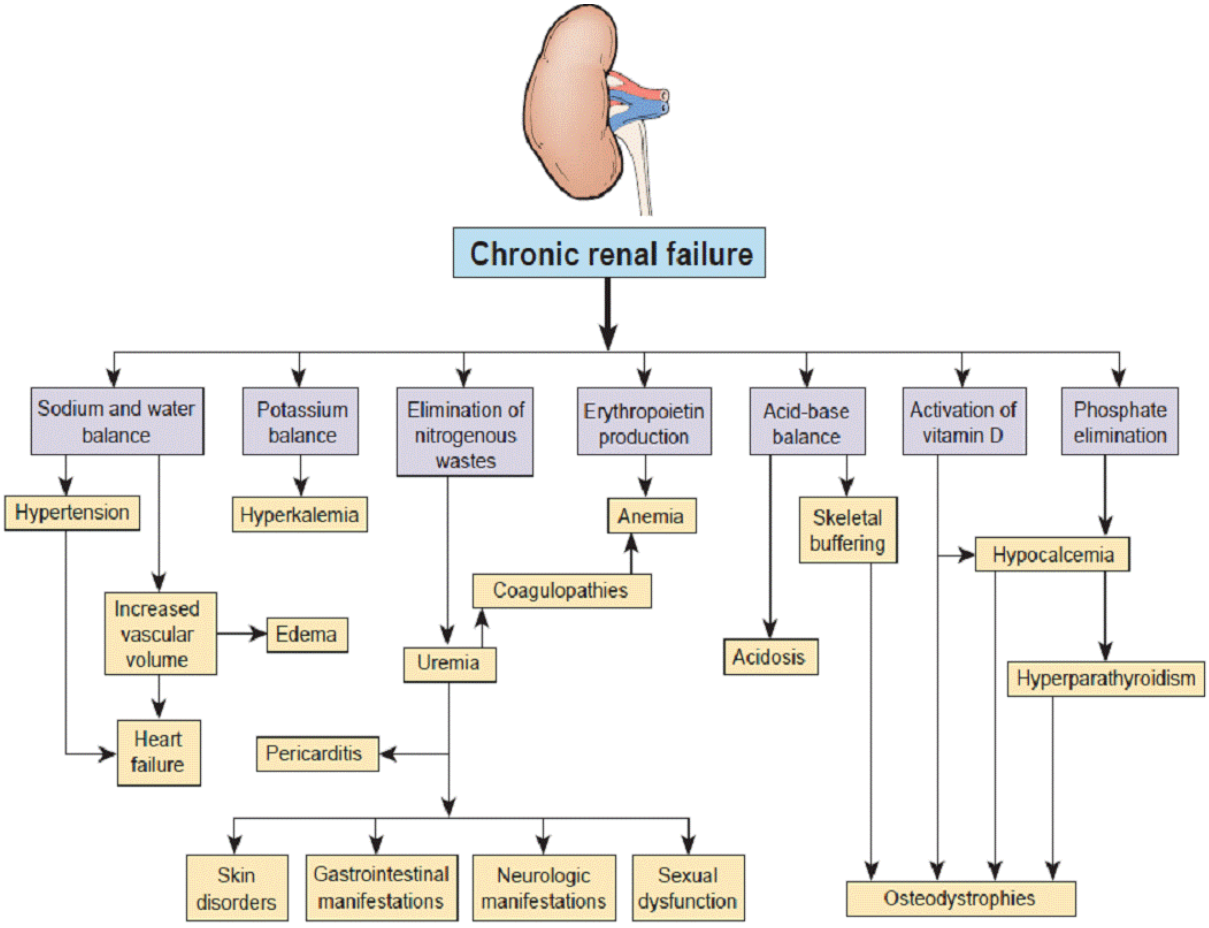
is when BUN exceeds 100mg/dL. At this stage, 75% of renal function has been lost.

Symptoms slowly develop and in advanced stages include anorexia, nausea, vomiting, stomatitis, dysgeusia, nocturia, lassitude, fatigue, pruritus, decreased mental acuity, muscle twitches and cramps, water retention, undernutrition, peripheral neuropathies and seizures. Chronic renal failure or CKD is a progress or regression from acute renal failure. It was initially described as diminished renal reserve or renal insufficiency, which may progress to renal failure (end-stage renal disease). Initially, as renal tissue loses function, there are a few abnormalities because the remaining tissue increases it performance (renal functional adaptation). Decreased renal function interferes with the kidneys' ability to maintain fluid and electrolyte homeostasis. It also interferes with the maintenance of normal levels of normal blood pressure, hematocrit, sodium, water, potassium and acid-base balance. The ability to concentrate urine declines early and is followed by decreases in ability to excrete excess phosphate, acid, and potassium. When renal failure is advanced (i.e. when glomerular filtration rate [GFR] ≤ 15mL/min/1.73m^2), the ability to effectively dilute or concentrate urine is lost; thus, urine osmolality.

PATHOPHYSIOLOGY OF CHRONIC RENAL FAILURE

- Regardless of primary cause of nephron loss, some usually survive or are less damaged.
- These nephrons adapt and enlarge, and clearance per nephron markedly increases.
- If the initiating process is diffuse, sudden and severe, such as in some patients with rapidly progressive glomerulonephritis (crescentic glomerulonephritis), acute or subacute renal failure may ensue with the rapid development of ESRD.
- In most patients, disease progression is more gradual and nephron adaptation is possible.
- Focal glomerulosclerosis develops in the glomeruli, and they eventually become non-functional.
- At the same time as development of focal glomerulosclerosis, proteinuria increases and systemic hypertension worsens.
- This process of nephron adaptation has been termed the "final common path".

- Adapted nephrons enhance the ability of the kidney to postpone uremia, but this leads to the demise of the nephrons.
- Adapted nephrons have not only an enhanced GFR but also enhanced tubular functions in terms of, for example, potassium and proton secretion.
- All CRF patients with the exception of those with medullary cystic kidney disease have fixed proteinuria (>200mg/24hours).
- Hypertension develops in 95% of patients with CRF before ESRD does and this is due to retention of NaCl.
- Heart failure is common and due to sodium and water retention, acid-base changes, hypocalcemia. Uremia may also impair myocyte function.



QUESTION 2: With the aid of suitable diagrams, discuss the types of dialysis you know.

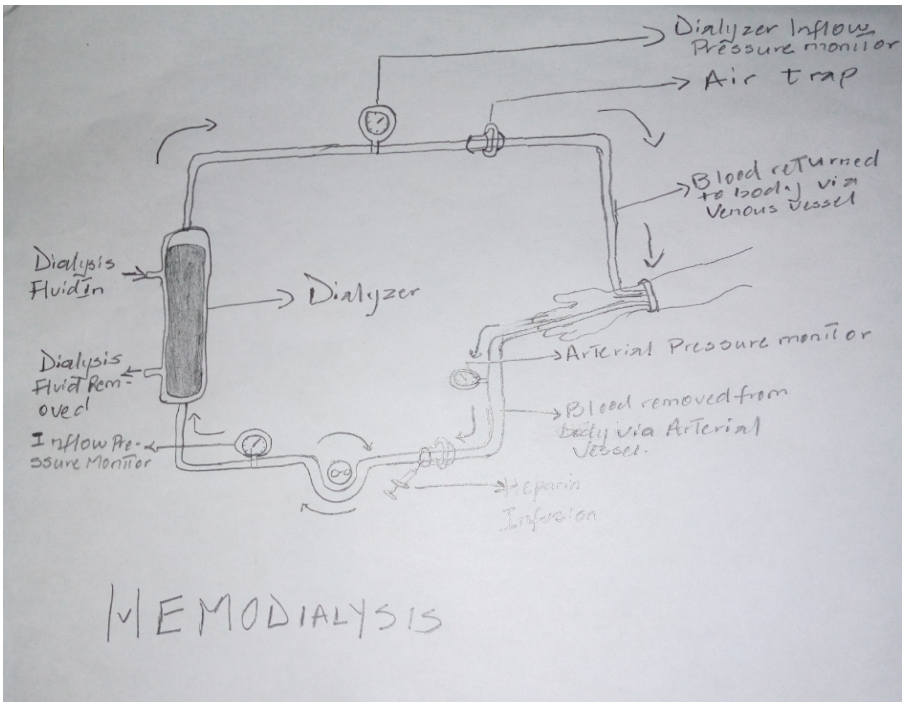
ANSWER: Dialysis is a treatment that filters and purifies the blood using a machine. It helps to keep your fluids and electrolytes in balance when the kidneys can't do their job.

End-stage kidney failure occurs when the kidneys are performing only about 10-15% of their normal function. Functions of kidneys are to filter your blood by removing waste and excess fluid from your body. They also help to control blood pressure and regulate the level of chemical elements in the blood. These elements may include sodium and potassium. The kidneys even activate a form of vitamin D that improves the absorption of calcium. When the kidneys cannot perform these functions, dialysis can help to keep the body running as normal as possible.

TYPES OF DIALYSIS

- **HEMODIALYSIS:** Hemodialysis is the most common type. This process involves using an artificial kidney (hemodialyzer) to remove waste and extra fluid from the blood. The blood is removed from the body and filtered by an artificial kidney which has a hemofilter. The filtered blood is then returned to the body via dialysis machine. To get blood to flow to the artificial kidney, the doctor-in-charge will perform a surgery to create an entrance point (vascular access) into the patient's blood vessels. Total amount of blood in the dialysis machine at a time is about 500 mL. The rate of blood flow through the dialysis machine is about 200 to 300 mL/minute. The rate of dialysate flow is about 500 mL/minute. The three types of entrance points are:
    - Arteriovenous (AV) fistula: This type connects an artery and a vein. It is the common and preferred option.
    - AV graft: this type is a looped tube
    - Vascular access catheter: this may be inserted into the large vein in the neck.

AV fistula and AV graft are designed for long term dialysis treatments. People who receive AV fistulas are healed and ready for dialysis two to three months after their surgery. People who receive AV grafts are ready in two to three weeks. Catheters are for short-term or temporary use. Hemodialysis treatments usually last three to five hours and are performed three times a week. However, the treatments can be completed in shorter, more frequent sessions. The length of treatment depends on body size, the amount of waste in the body and current state of body health.

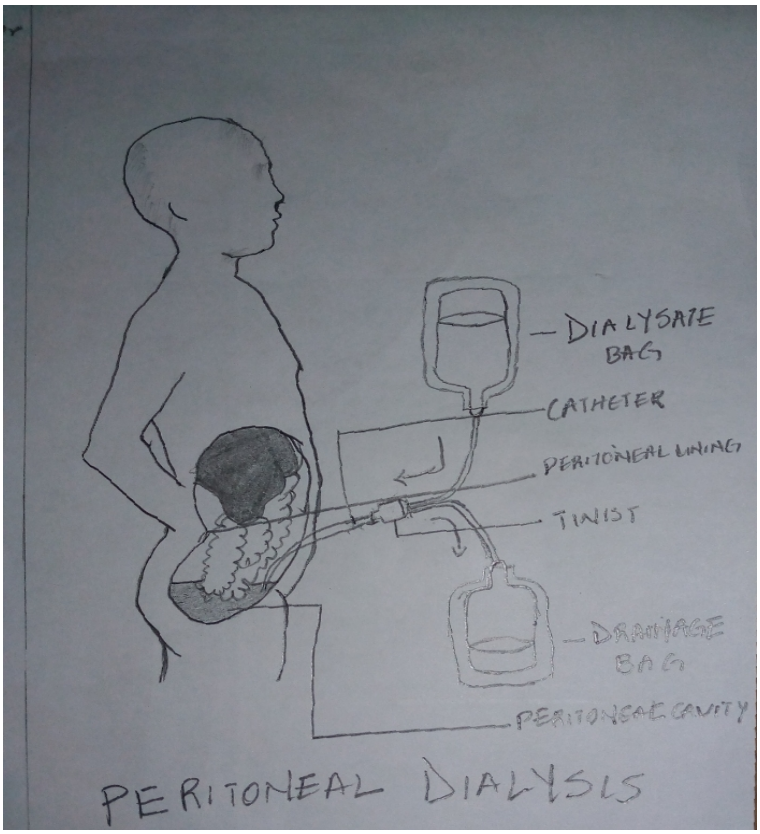


RISKS INVOLVED IN HEMODIALYSIS

- ✓ Low blood pressure
- ✓ Anemia
- ✓ Muscle cramping
- ✓ Difficulty sleeping
- ✓ Itching
- ✓ High blood potassium levels
- ✓ Pericarditis, an inflammation of membrane around the heart
- ✓ Sepsis
- ✓ Irregular heartbeat
- ✓ Sudden cardiac death (this is the leading cause of death in people undergoing dialysis)

- **PERITONEAL DIALYSIS:** Peritoneal dialysis involves a surgery to implant a peritoneal dialysis (PD) catheter into your abdomen. The catheter helps to filter your blood through the peritoneum, a membrane in the abdomen. During dialysis, a special fluid called DIALYSATE flows into the peritoneum. The dialysate absorbs waste. Once the dialysate draws the waste out of the bloodstream, it is drained from the abdomen. It takes a few hours and needs to be repeated four to six times per day. However, the exchange of fluid can be done whether awake or asleep. There are different types of peritoneal dialysis. The main ones include:

    - Continuous ambulatory peritoneal dialysis (CAPD): The abdomen is filled and drained multiple times each day. This method doesn't require a machine and must be performed awake.
    - Continuous cycling peritoneal dialysis (CCPD): It uses a machine to cycle the fluid in and out of the abdomen. Usually done at night when asleep.
    - Intermittent peritoneal dialysis (IPD): This treatment is usually done in the hospital, though it may be performed at home. It uses the same machine as CCPD but takes longer.



RISKS INVOLED IN PERITONEAL DIALYSIS

- ✓ Increased risk for infections in or around the catheter site in the abdominal cavity. E.g. peritonitis
- ✓ Abdominal muscle weakening
- ✓ High blood sugar due to dextrose in dialysate
- ✓ Weight gain
- ✓ Hernia
- ✓ Fever
- ✓ Stomach pain

- **CONTINOUS RENAL REPLACEMENT THERAPY (CRRT):** This therapy is used primarily in the intensive care unit for people with acute kidney failure. It is also known as hemofiltration. A machine passes the blood through tubing. A filter removes waste products and water. The blood is returned to the body along with replacement fluid. This procedure is usually performed 12 to 24 hours a day, generally every day.

RISKS ASSOCIATED WITH CRRT

- ✓ Infection
- ✓ Hypothermia
- ✓ Low blood pressure
- ✓ Electrolyte disturbances
- ✓ Bleeding
- ✓ Delayed renal recovery
- ✓ Weakening of bones
- ✓ anaphylaxis