NAME: OKOLO AWELE CHRISTABEL

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DEPARTMENT: MEDICINE AND SURGERY

COURSE CODE: PHS 303(RENAL PHYSIOLOGY)

1. Discuss the pathophysiological process involved in renal failure.
2. With the aid of suitable diagrams discuss the types of dialysis you know.

Answers

1. Chronic renal failure (CRF) and end-stage renal disease (ESRD) are functional diagnoses characterized by a progressive decrease in glomerular filtration rate (GFR). CRF occurs where GFR has been reduced to 10% of normal function (20 ml min–1) and ESRD when GFR falls below 5% (10 ml min–1).

   Each patient is classified into one of the following 5 stages of CKD because management and prognosis varies according to the progression of damage.

   - Stage 1: Kidney damage with normal or increased GFR (>90 mL/min/1.73 m2)
   - Stage 2: Mild reduction in GFR (60-89 mL/min/1.73 m2)
   - Stage 3: Moderate reduction in GFR (30-59 mL/min/1.73 m2)
   - Stage 4: Severe reduction in GFR (15-29 mL/min/1.73 m2)
   - Stage 5: Kidney failure (GFR <15 mL/min/1.73 m2 or dialysis)

   Pathophysiology

- Patients with stages 1-3 ([GFR] >30 mL/min) of CKD are generally asymptomatic; water/electrolyte imbalances or endocrine/metabolic derangements are not clinically evident.
- These disturbances manifest clinically in CKD stages 4-5 (GFR < 30 mL/min).

Sign/lab finding	Symptoms	Mechanism
Generalized edema	Swelling	Water retention due to a loss of GFR leading to sodium and fluid retention. Fluid moves into the extravascular space, due to increased hydrostatic pressure, causing pitting edema in the lower extremity (fluid movement could also be due to hypoalbuminemia, in some diseases, leading to a low oncotic pressure).
Pulmonary crackles	Shortness of breath	Fluid accumulation causes pulmonary edema and loss of air space causing

		ventilation-perfusion mismatch. This leaves less area for oxygen diffusion form the blood vessels.
Anemia	Fatigue, reduced exercise capacity, and pallor	Erythropoietin (EPO), the major erythropoiesis stimulator, is released from the kidneys; with renal failure, there is loss of EPO release.
Weight loss	Loss of lean body mass	Protein-energy malnutrition due to metabolic acidosis. Loss of kidney function results in impaired H+ secretion from the body.
Hyperkalemia	Malaise, palpitations	Inability of the kidneys to secrete potassium in the urine leads to life threatening arrhythmias.
Mechanisms of renal osteodystrophy		
Hyperphosphatemia		Damaged kidneys fail to excrete phosphate. Also secondary to high parathyroid hormone levels.
Hypocalcemia		Thought to be secondary to low Vitamin D3 levels. In early stages of CKD, low levels of calcitriol are due to hyperphosphatemia (negative feedback). In the later stages of CKD, low levels are hypothesized to be due to decreased synthesis of 1α-hydroxylase (enzyme that converts calcifediol to calcitriol in the kidneys).
Secondary and tertiary hyperparathyroidism		To compensate for the low calcium due to low Vitamin D levels, the parathyroid glands increase the parathyroid hormone secretion. This leads to a high bone turnover, always attempting to normalize the low calcium levels in the blood. Over time, this becomes maladaptive leading to extraosseous calcification, and parathyroid hyperplasia develops (tertiary hyperparathyroidism).
Complications of uremia Urea and other toxins accumulate in the blood and cause life threatening		

issues.		
Ecchymosis, GI bleeding	Increased tendency to bleed and ecchymosis	Uremia-induced platelet dysfunction
Pericardial friction rub	Chest pain, malaise	Uremic pericarditis
	Headaches, confusion, coma	Uremic encephalopathy; adverse effects of urea on the CNS. Mechanisms unclear.

2. Dialysis is a treatment that filters and purifies the blood using a machine. This helps keep your fluids and electrolytes in balance when the kidneys can't do their job. There are three different types of dialysis:

A. Hemodialysis

Hemodialysis is the most common type of dialysis. This process uses an artificial kidney (hemodialyzer) to remove waste and extra fluid from the blood. The blood is removed from the body and filtered through the artificial kidney. The filtered blood is then returned to the body with the help of a dialysis machine.

To get the blood to flow to the artificial kidney, your doctor will perform surgery to create an entrance point (vascular access) into your blood vessels. The three types of entrance points are:

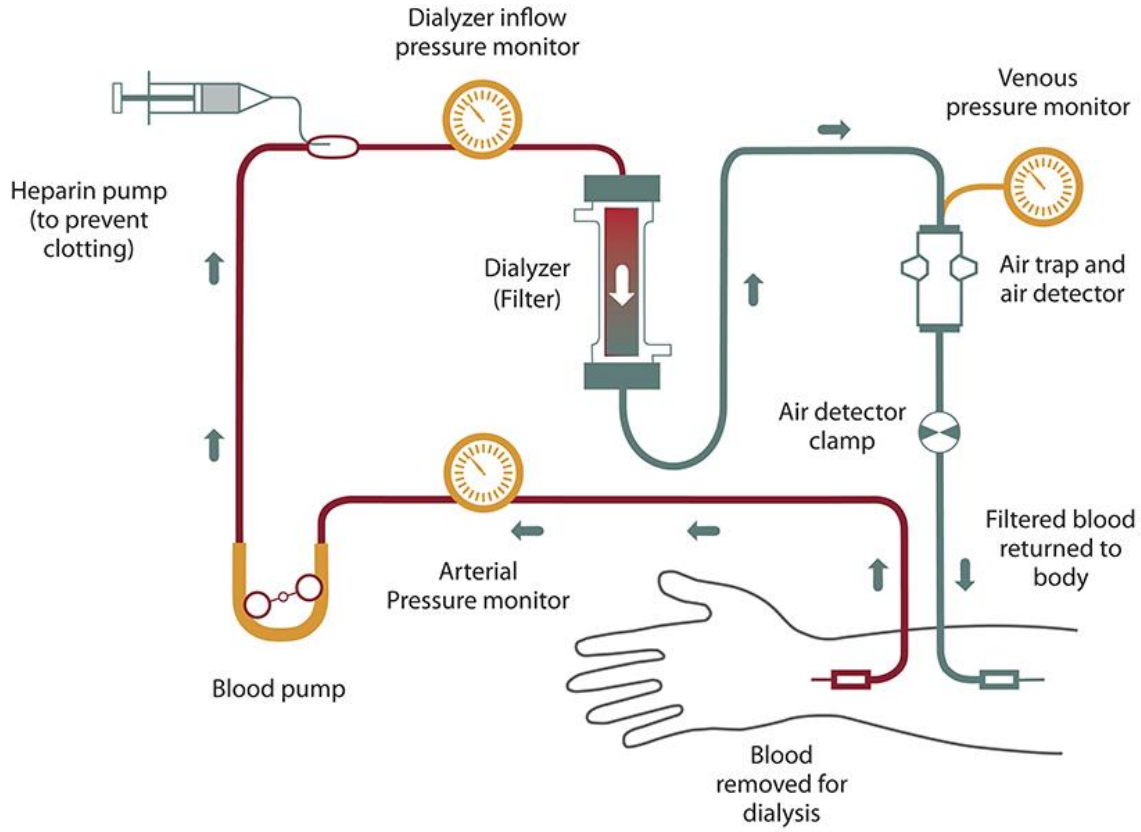
- Arteriovenous (AV) fistula: This type connects an artery and a vein. It's the preferred option.
- AV graft: This type is a looped tube.
- Vascular access catheter: This may be inserted into the large vein in your neck.

Both the AV fistula and AV graft are designed for long-term dialysis treatments. People who receive AV fistulas are healed and ready to begin hemodialysis two to three months after their surgery. People who receive AV grafts are ready in two to three weeks. Catheters are designed for short-term or temporary use.

Hemodialysis treatments usually last three to five hours and are performed three times per week. However, hemodialysis treatment can also be completed in shorter, more frequent sessions. Most hemodialysis treatments are performed at a hospital, doctor's office, or dialysis center. The length of treatment depends on your body size, the amount of waste in your body, and the current state of your health.

After you've been on hemodialysis for an extended period of time, your doctor may feel that you're ready to give yourself dialysis treatments at home. This option is more common for people who need long-term treatment.

DIAGRAM SHOWING HEMODIALYSIS



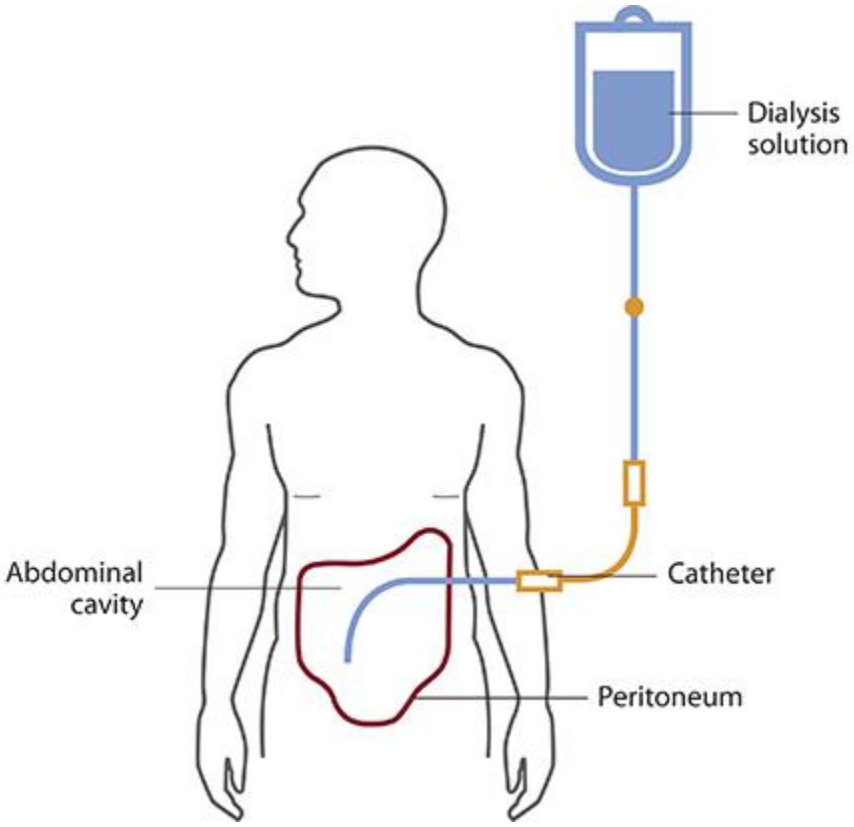
B. ***Peritoneal dialysis***

Peritoneal dialysis involves surgery to implant a peritoneal dialysis (PD) catheter into your abdomen. The catheter helps filter your blood through the peritoneum, a membrane in your abdomen. During treatment, a special fluid called dialysate flows into the peritoneum. The dialysate absorbs waste. Once the dialysate draws waste out of the bloodstream, it's drained from your abdomen. This process takes a few hours and needs to be repeated four to six times per day. However, the exchange of fluids can be performed while you're sleeping or awake. There are numerous different types of peritoneal dialysis. The main ones are:

- Continuous ambulatory peritoneal dialysis (CAPD): In CAPD, your abdomen is filled and drained multiple times each day. This method doesn't require a machine and must be performed while awake.
- Continuous cycling peritoneal dialysis (CCPD): CCPD uses a machine to cycle the fluid in and out of your abdomen. It's usually done at night while you sleep.

- Intermittent peritoneal dialysis (IPD): This treatment is usually performed in the hospital, though it may be performed at home. It uses the same machine as CCPD, but the process takes longer.

DIAGRAM OF PERITONEAL DIALYSIS



C. Continuous renal replacement therapy (CRRT)

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