Chronic kidney disease and acute renal failure cause the kidneys to lose their ability to filter and remove waste and extra fluid from the body. As a result, patients must be treated with either hemodialysis or peritoneal dialysis.

**Dialysis**

Definition: Separation of solutes by differential diffusion through a semipermeable membrane that is placed between the two solutions.

**Purposes:**
- Eliminate excess body fluids
- Maintain or restore electrolyte balance
- Maintain or restore acid-base balance
- Eliminate nitrogenous wastes and toxins from the blood.

**Indications**
- Acute or chronic renal failure
- Drug intoxication – (done acutely only in the inpatient setting)

**Components**
- Dialysate: solution of water, electrolytes (sodium chloride, magnesium, bicarbonate, and possibly potassium), non-electrolytes (glucose), and buffer (acetate). The electrolyte concentration is adjusted to the individual patient’s needs.
- Semipermeable membrane: extracorporeal membrane (hemodialysis) or peritoneum (peritoneal dialysis)
- Patient’s blood in contact with the membrane.

**Principles**
- Osmosis: A hypertonic solution is used as the dialysate to move water across the semipermeable membrane.
b) Diffusion: The dialysate solution contains a concentration of selected solutes lower than the blood so that these solutes will move across the semipermeable membrane and into the dialysate.

![Diffusion Diagram](image)

**Diffusion**
(Solvent moves by concentration gradient)

c) Filtration: There is a pressure difference between the sides of the semipermeable membrane, with the highest pressure on the forward side of the membrane to act as a hydrostatic force pushing against the membrane to provide filtration.

![Filtration Diagram](image)

Types of Dialysis

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| • Need for rapid treatment  
• Fluid overload  
• Electrolyte imbalance  
• Acute or chronic renal failure  
• Drug overdose or poison intoxication with dialyzable agent | • Rapid treatment required  
• Hemodynamic instability  
• Hypovolemia  
• Inadequate vascular access  
• Coagulopathy | • Rapid and efficient: only 4-6 hours per session (usually 3x/wk)  
• Very efficient; corrects biochemical disturbances quickly | • Complex procedure requiring extensive staff training  
• Expensive  
• Requires anticoagulation  
• Vascular access necessary |
| | | • Equipment is easily and readily assembled  
• Fairly simple: requires less staff and education  
• Less expensive  
• Minimal danger of acute electrolyte imbalance or hemorrhage  
• Anticoagulation not required | • Relatively slow to alter biochemical imbalances  
• May cause protein loss  
• May be difficult to gain and maintain peritoneal access |

### Complications That May Occur During Hemodialysis

**Hypotension**  
A decrease in blood pressure is the most frequent complications reported during hemodialysis. When fluid is removed during hemodialysis, the osmotic pressure is increased and this prompts refilling from the interstitial space. The interstitial space is then refilled by fluid from the intracellular space. Excessive ultrafiltration with inadequate vascular refilling plays a major role in dialysis induced hypotension. The immediate treatment to hypotension is to discontinue dialysis and place the patient in trendelenberg position. This will increase cardiac filling and may increase the blood pressure promptly.

**Cramps**  
In the majority of hemodialysis patients, cramps occur toward the end of the dialysis procedure after a significant volume of fluid has been removed by ultrafiltration. The immediate treatment for cramps is directed at restoring intravascular volume through the use of small boluses of isotonic saline. Prevention of cramps has been attempted with the prophylactic use of quinine sulfate at least 2 hours ours prior to dialysis.

**Cardiac Dysfunction**  
Chest pain occurs frequently during dialysis. A cardiac origin should usually be considered due to the high prevalence of coronary disease in renal failure patients. Patients on maintenance hemodialysis are at risk of cardiac arrhythmias. Both acute and chronic alterations in fluid, electrolyte and acid-base homeostasis may be the cause.
Dialysis Complications of Chronic Renal Failure

Electrolyte Abnormalities

Electrolyte abnormalities may result from renal disease itself or as an iatrogenic (induced inadvertently by medical treatment) complication

Hyperkalemia
Hyperkalemia is the most common clinically significant electrolyte abnormality in chronic renal failure. This condition is uncommon when patients with end-stage renal disease are compliant with treatment and diet, unless an intercurrent illness such as acidosis or sepsis develops. Electrocardiography (ECG) may be useful in diagnosis of suspected hyperkalemia. Severely peaked T waves are a relatively specific finding. Widening of the QRS complex indicates severe hyperkalemia.

This tracing of a patient with hyperkalemia shows a wide QRS and very large T wave. Hyperkalemia may be completely asymptomatic until a lethal arrhythmia occurs.

Hyponatremia, Hypocalcemia, and Hypermagnesemia
Fluid overload may cause hyponatremia that may result in mental status changes or seizures. Hypocalcemia or hypermagnesemia may cause weakness and life-threatening dysrhythmias. Neuromuscular irritability is seen with hypocalcemia and may present as tetany or paresthesia. Hypermagnesemia causes neuromuscular depression with weakness and loss of reflexes. Acidosis may present as shortness of breath due to the work of breathing from compensatory hyperpnea.

Dialysis Dysequilibrium Syndrome
This syndrome is a common neurologic complication seen in dialysis patients that is characterized by weakness, dizziness, headache and in severe cases mental status changes.

Infection

Vascular Access Site (AV fistula, graft, double lumen vascular access site)
Patients with a vascular access site for hemodialysis are at risk for infection which manifest with typical signs and symptoms such as local pain, redness, warmth, or fluctuance. Fever may be present without local signs.

Peritoneal dialysis
Peritonitis is common in patients who are being treated with peritoneal dialysis, occurring approximately once per patient year. Patients present with generalized abdominal pain, which may be mild, or they may complain that the draining dialysate is cloudy. There may or may not be a fever.

Anemia
Anemia is inevitable in chronic renal failure because of loss of erythropoietin production. Abnormalities in white cell and platelet functions lead to increased susceptibility to infection and easy bleeding and bruising. This condition results in fatigue, reduced exercise capacity, decreased cognition, and impaired immunity.
**Hemorrhage**

Patients may present after dialysis with bleeding from their vascular access site. Active bleeding can also occur from the incisional wound of a newly placed fistula or graft. The bleeding can usually be controlled with elevation and firm but nonocclusive pressure for 10 – 15 minutes. You should have a high suspicion of bleeding from even minor trauma. The bleeding may be due to uremic coagulopathy or from anticoagulation during hemodialysis.

**Outcome of Patients on Dialysis**

The mortality rate of dialysis patients is approximately 20% despite careful attention to fluid and electrolyte balance or other treatment. The most common cause of sudden death in renal failure patients is hyperkalemia, which is often encountered in patients after missed dialysis or those who are noncompliant with their medications and diet.

The morbidity and mortality of dialysis patients is much higher in the United States compared with most other countries, which is probably a consequence of selection bias. Due to liberal criteria for receiving government-funded dialysis in the US and rationing (both medical and economic) in most other countries, US patients receiving dialysis are on the average older and sicker than those in other countries.
1. List the 4 purposes of dialysis
   A. ________________________________________________________________
   B. ________________________________________________________________
   C. ________________________________________________________________
   D. ________________________________________________________________

2. What are the three principles of dialysis?
   A. __________________
   B. __________________
   C. __________________

3. Explain the difference between hemodialysis and peritoneal dialysis.

4. List the advantages for each hemodialysis and peritoneal dialysis
   Hemodialysis –
   Peritoneal dialysis –

5. Explain the cause of hypotension that occurs during hemodialysis
6. Explain the cause of cramps that occurs during hemodialysis

7. Explain the changes you may see on your monitor as a result of hyperkalemia.

8. What is Dialysis Dysequilibrium Syndrome?

9. What are the signs and symptoms of anemia in the chronic renal failure patient?

10. The most common cause of sudden death in renal failure patients is ________________________.