SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT : PHYSICIAN ASSISTANT

COURSE NAME : NEPHROLOGY

UNIT : CLINICAL EXAMINATION OF KIDNEY

TOPIC : RENAL REPLACEMENT THERAPY

RENAL REPLACEMENT THERAPY

- Renal Replacement Therapy (RRT) is a medical intervention for individuals experiencing acute kidney injury (AKI) or chronic kidney disease (CKD), particularly in the later stages where the kidneys can no longer perform their essential functions.

- The primary aim of RRT is to replicate the kidneys' role in maintaining fluid, electrolyte, and acid-base balance while also removing metabolic waste products from the blood.

TYPES

- Hemodialysis (HD)
- Peritoneal Dialysis (PD)
- Continuous Renal Replacement Therapy (CRRT)
- Hemofiltration
- Kidney Transplantation

HEMODIALYSIS (HD)

Principles:

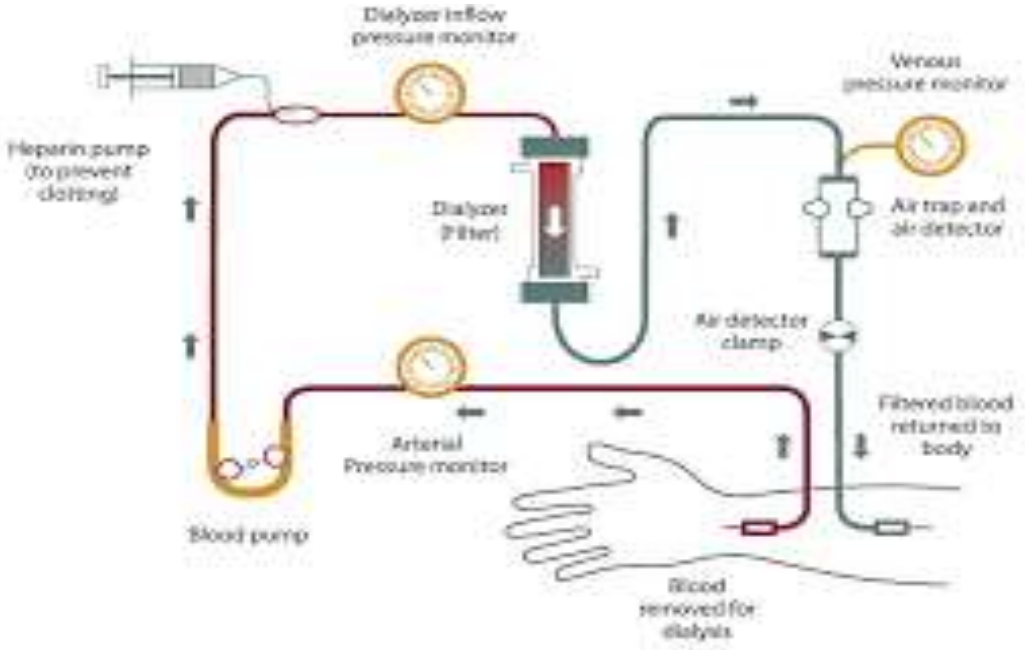
- Hemodialysis involves circulating the patient's blood outside the body through a dialyzer, or artificial kidney.
- The dialyzer contains a semipermeable membrane that separates the blood from a dialysis solution (dialysate).
- Waste products and excess electrolytes in the blood diffuse into the dialysate, while essential substances can be added.

Process:

- Vascular Access: Essential for HD, typically achieved through an arteriovenous fistula (AVF), arteriovenous graft (AVG), or central venous catheter (CVC).
- Dialyzer and Dialysate: The dialyzer filters waste, while the dialysate's composition is tailored to correct electrolyte imbalances and remove waste.

- Blood Flow: Blood is pumped from the patient's body, through the dialyzer, and back to the body.

- Frequency: Typically performed three times a week, each session lasting about 4 hours.


Dialyzer inflow pressure monitor
Venous pressure monitor
Heparin pump (to prevent clotting)
Dialyzer (Filter)
Air trap and air detector
Air detector clamp
Filtered blood returned to body
Arterial Pressure monitor
Blood pump
Blood removed for dialysis

Indications:

- Chronic kidney disease (CKD) stage 5.
- Acute kidney injury (AKI) with severe metabolic derangements.
- Severe electrolyte imbalances (e.g., hyperkalemia).
- Fluid overload unresponsive to diuretics.

Advantages:

- Effective and rapid removal of toxins and fluid.
- Easier management in an outpatient setting.

Complications:

- Hypotension during treatment.
- Vascular access issues (e.g., thrombosis, infection).
- Disequilibrium syndrome (rare).
- Electrolyte imbalances post-dialysis.

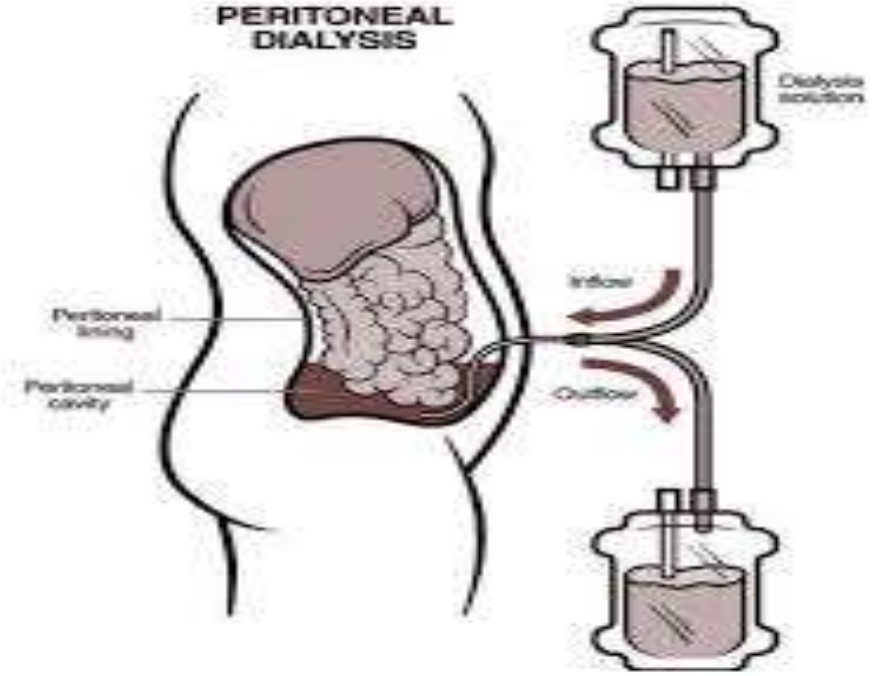
PERITONEAL DIALYSIS (PD)

Principles:

- Utilizes the patient's peritoneum as a semipermeable membrane.
- Dialysate is infused into the peritoneal cavity, where waste products and excess electrolytes diffuse from the blood into the dialysate.

Process:

- Catheter Placement: A Tenckhoff catheter is surgically placed in the peritoneal cavity.
- Dialysate Exchange: Dialysate is instilled into the peritoneal cavity, dwells for a specified period, and then drained. This can be done manually or using a machine (cycler).


PERITONEAL DIALYSIS
Dialysis solution
Inflow
Peritoneal lining
Peritoneal cavity
Outflow

Types of PD:

- Continuous Ambulatory Peritoneal Dialysis (CAPD): Manual exchanges typically 4-5 times a day.
- Automated Peritoneal Dialysis (APD): Machine-assisted exchanges usually done overnight.

Indications:

- Patients with CKD who prefer home-based therapy.
- Contraindications to HD (e.g., severe cardiovascular disease).

Advantages:

- Greater patient autonomy and flexibility.
- Gentle and continuous removal of waste and fluid.
- Less dietary and fluid restrictions compared to HD.

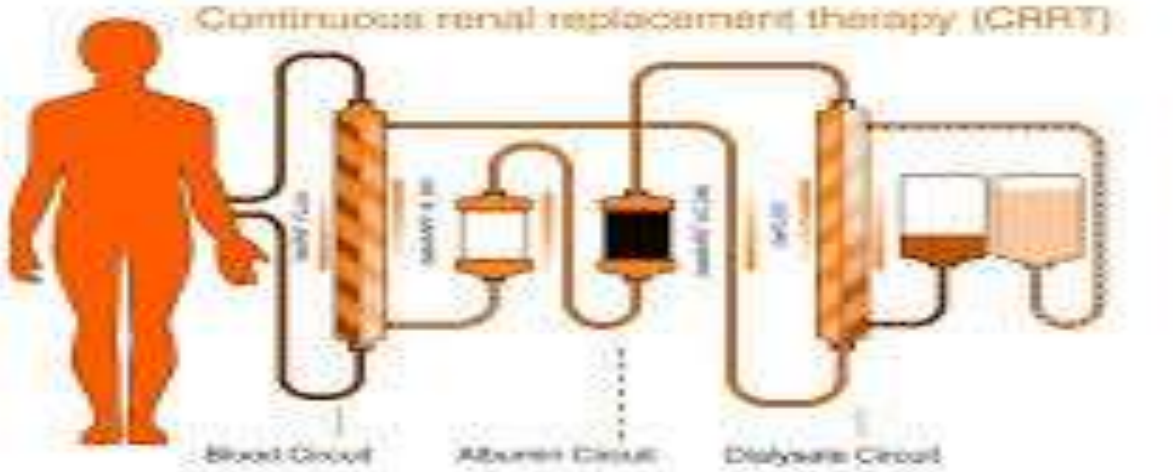
Complications:

- Peritonitis (infection of the peritoneal cavity).
- Catheter-related issues (e.g., blockage, infection).
- Hernias due to increased intra-abdominal pressure.
- Membrane dysfunction over time.

CRRT

Principles :

- Convection: Solute removal driven by solvent drag through a semi-permeable membrane (hemofiltration).
- Diffusion: Solute removal by concentration gradient across a semi-permeable membrane (hemodialysis).
- Adsorption: Binding of solutes to the membrane surface.
- Ultrafiltration: Removal of plasma water and solutes by pressure gradient across a membrane.



Continuous renal replacement therapy (CRRT) is any extracorporeal blood purification therapy designed to substitute for impaired renal function over an extended period, and intended to be applied for up to 24 hours a day.

Process :

- Vascular Access: Central venous catheters are used, usually placed in large veins such as the internal jugular or femoral vein.
- Blood Flow: Blood is continuously pumped from the patient to the CRRT machine.
- Filtration: The blood passes through a filter where solutes and fluid are removed.

- Replacement Fluids: Replacement fluids or dialysate are added back to the blood as needed to maintain electrolyte balance and fluid status.
- Return of Blood: The filtered blood is returned to the patient.

Indications:

- Acute Kidney Injury (AKI)
- Fluid Overload
- Electrolyte Imbalances
- Severe Sepsis and Septic Shock
- Drug Overdose

Advantages:

- Hemodynamic Stability
- Continuous Therapy
- Flexible Management
- Improved Outcomes in Critical Illness

Complications:

- Infection
- Bleeding
- Electrolyte Imbalances
- Hypotension
- Filter Clotting
- Technical Issues

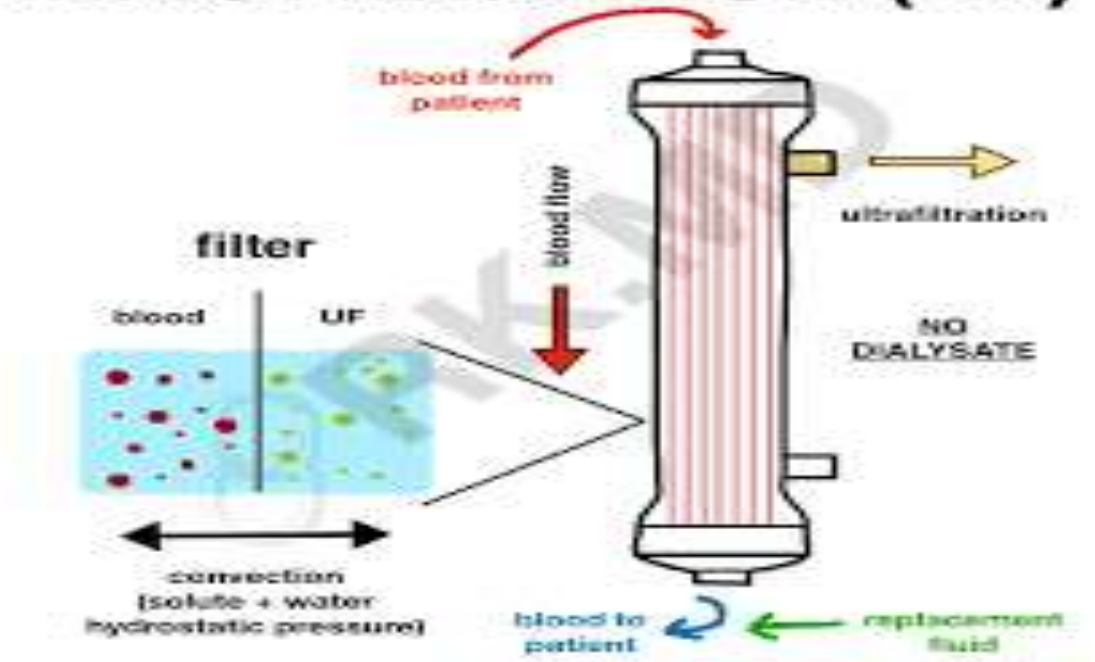
HEMOFILTRATION

Principles :

- Convection: This is the main mechanism in hemofiltration, where solutes are dragged across the membrane along with the fluid, driven by a pressure gradient.

- Ultrafiltration: The process of removing water from the blood by pushing it through a semi-permeable membrane using a pressure gradient.

HEMOFILTRATION (HF)



Process :

- Blood Access: Blood is typically accessed through a central venous catheter.
- Blood Pump: Blood is pumped from the patient into the CRRT machine.
- Hemofilter: Blood passes through a hemofilter where convection removes solutes and fluid.

- Ultrafiltrate Removal: The ultrafiltrate (filtered fluid and solutes) is collected and discarded.
- Replacement Fluid: Sterile replacement fluid is infused to compensate for the removed ultrafiltrate.
- Return to Patient: The filtered blood, now balanced with replacement fluid, is returned to the patient.

Indications :

- Acute Kidney Injury (AKI)
- Chronic Kidney Disease (CKD)
- Fluid Overload
- Severe Electrolyte Imbalances
- Sepsis and Multi-Organ Failure

Advantages :

- Hemodynamic Stability
- Better Fluid Management
- Improved Toxin Clearance
- Nutritional Support

Complications :

- Hypotension
- Bleeding
- Infection
- Electrolyte Imbalances
- Clotting of the Circuit
- Technical Issues

KIDNEY TRANSPLANTATION

Principles:

- Surgical procedure where a healthy kidney from a donor is implanted into a patient with end-stage renal disease (ESRD).
- The new kidney takes over the function of the failed kidneys.

Process:

- Donor Selection: Can be from a deceased donor or a living donor.
- Surgery: Involves placing the donor kidney in the lower abdomen and connecting the blood vessels and ureter.
- Immunosuppression: Lifelong immunosuppressive therapy to prevent rejection.

Indications:

- ESRD patients without contraindications to surgery or immunosuppression.
- Patients who have the potential for improved quality of life and longevity with a transplant.

Advantages:

- Best long-term outcomes and quality of life.
- No need for dialysis.
- Restoration of more normal kidney function.

Complications:

- Risk of surgical complications (e.g., bleeding, infection).
- Acute or chronic rejection.
- Side effects of immunosuppressive drugs (e.g., infections, malignancies, cardiovascular disease).
- Graft dysfunction or failure.

ASSESSMENT

- What is Hemodialysis ?
- What is CRRT ?