

Hemodialysis Essentials

Hemodialysis (HD) is a renal replacement therapy (RRT) that removes waste products, excess fluids, and toxins from the blood in patients with **kidney failure** (usually end-stage renal disease - ESRD). It mimics the **filtration function** of healthy kidneys.

Key Objectives:

- Correct fluid and electrolyte imbalances.
- Remove nitrogenous waste products (e.g., urea, creatinine).
- Manage acid-base disorders.
- Control blood pressure in volume-overloaded states.

Clinical Pearl: Hemodialysis is not a cure but a **lifesaving supportive therapy** for patients with ESRD or acute kidney injury (AKI) when conservative treatment fails.

Indications for Hemodialysis

Hemodialysis is indicated in both **acute** and **chronic** kidney failure. The following acronym "**AEIOU**" is useful for remembering emergency dialysis indications:

"AEIOU" Indications for Emergent Dialysis:

Acronym	Meaning	Examples
A	Acidosis (severe, refractory)	pH < 7.1 despite treatment
E	Electrolyte imbalance (esp. hyperkalemia)	K ⁺ > 6.5 mmol/L with ECG changes
I	Intoxications	Lithium, methanol, ethylene glycol
O	Overload (volume overload unresponsive to diuretics)	Pulmonary edema
U	Uremia	Encephalopathy, pericarditis, bleeding

Chronic Indications:

- Glomerular filtration rate (GFR) < 10 mL/min/1.73 m²
- Symptoms of uremia
- Severe fluid overload
- Intractable hypertension

The Hemodialysis Machine

The **hemodialysis machine** functions as an **artificial kidney**. It pumps the patient's blood through a dialyzer where **diffusion**, **ultrafiltration**, and **osmosis** occur to purify the blood.

Major Components:

Component	Function
Dialyzer	The "artificial kidney" with semi-permeable membrane
Blood pump	Moves blood from the patient to the dialyzer
Dialysate pump	Delivers dialysate to the dialyzer
Heparin pump	Administers anticoagulant to prevent clotting
Monitors	Track blood flow, pressure, temperature, air bubbles, and safety
Air detector/clamp	Detects air embolism risk and stops flow

Parts of the Dialysis Machine & Circuit

1. Dialyzer (Artificial Kidney)

- Contains thousands of **hollow fibers** with **semi-permeable membranes**.
- Blood flows inside fibers; dialysate flows outside ? **waste and excess solutes move across the membrane**.

2. Dialysate

- A solution containing **electrolytes** and **bicarbonate**.
- Does **not contain urea or creatinine**, promoting diffusion from blood into dialysate.
- Adjusted to meet patient-specific needs (e.g., potassium concentration).

3. Tubing System

- **Arterial line**: Carries blood from the patient to the dialyzer.
- **Venous line**: Returns clean blood to the patient.

4. Blood Pump

- Ensures continuous flow (usually **300–500 mL/min**) through the dialyzer.

5. Ultrafiltration System

- Controls **fluid removal** via transmembrane pressure (TMP).

Vascular Access for Hemodialysis

Effective dialysis requires **high blood flow** (?300 mL/min). Access is typically through:

Arteriovenous (AV) Fistula

- **Preferred access:** connects a vein to an artery (e.g., radial-cephalic).
- **Matures over 6–12 weeks.**
- Long-term use with **low complication rate.**

Clinical Tip: Always assess the "**thrill and bruit**"—absence may suggest thrombosis.

Arteriovenous (AV) Graft

- Synthetic tube connects artery and vein.
- Used if veins are unsuitable.
- Higher risk of infection and thrombosis than AV fistula.

Central Venous Catheter (CVC)

- **Temporary access** (e.g., internal jugular, femoral vein).
- Used in **emergency or acute dialysis.**
- High risk of **infection, stenosis, and thrombosis.**

Hemodialysis Procedure Overview

1. **Pre-Dialysis**
 - Assess **vitals, fluid status, access site.**
 - Check labs (especially **K⁺, BUN, creatinine, Hb**).
 - Weigh the patient.
2. **During Dialysis**
 - Monitor vitals, machine alarms, blood flow rate.
 - Watch for **complications:** hypotension, cramping, nausea, clotting.
3. **Post-Dialysis**
 - Reassess weight and vitals.
 - Check access site.
 - Monitor for signs of bleeding or complications.

Complications of Hemodialysis

Complication	Description / Features
Hypotension	Most common; due to fluid removal
Cramps	Electrolyte or fluid shifts
Dialysis Disequilibrium Syndrome	Cerebral edema due to rapid urea removal
Infection (Access-related)	Especially in CVCs
Anemia	Due to reduced EPO and blood loss
Amyloidosis	?2-microglobulin accumulation in long-term dialysis

Nursing and Clinical Considerations

- **Daily Assessments:** Monitor weight, fluid status, and access patency.
- **Education:** Teach patients to avoid compression or venipuncture on fistula arm.
- **Asepsis:** Critical when handling catheters.
- **Nutrition:** Limit sodium, potassium, phosphorus; adequate protein intake.
- **Medication Timing:** Some meds (e.g., antihypertensives) may be held before dialysis.