

# Renal Replacement Therapy

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## Renal Replacement Therapy: RRT

- ▀ fluid overload
- ▀ electrolyte disturbances (e.g. hyperkalemia)
- ▀ acid-base imbalances
- ▀ uremic complications
- ▀ pulmonary edema

## RRT

Indication	Clinical Setting
A: acid-base abnormalities	Metabolic acidosis (pH < 7.2)
E: electrolyte imbalance	Sever hyperkalemia and/or hypermagnesemia
I: intoxications	Salicylates, lithium, methanol, ethylene glycol, theophylline, phenobarbital
O: fluid overload	Esp. pulmonary edema unresponsive to diuretics
U: uremia	Uremia or associated complications (neuropathy, encephalopathy, pericarditis)

## Intermittent Hemodialysis: IHD

- ▀ Most frequently used
- ▀ Usually last 3 to 4 hours with blood flow rates to the dialyzer from 200 to 400 mL/min

### Advantages:

- ▀ Rapid removal of volume and solutes
- ▀ Contribute to correction of most of electrolyte abnormalities

## IHD

### Challenges:

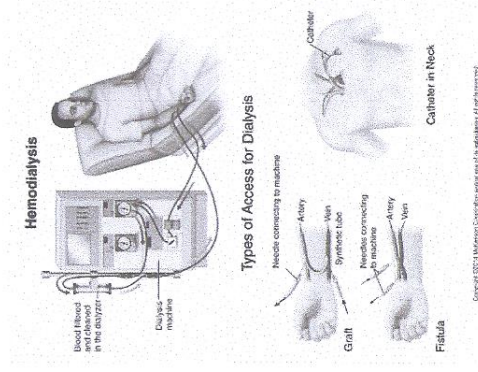
- Hypotension
- Difficulty for venous access for dialysis
- Ineffective solute clearance
- Lack of acidosis correction
- Continued volume overload
- Delayed recovery

## Continuous Renal Replacement Therapy: CRRT

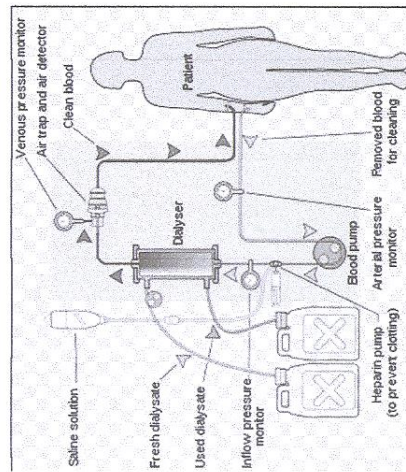
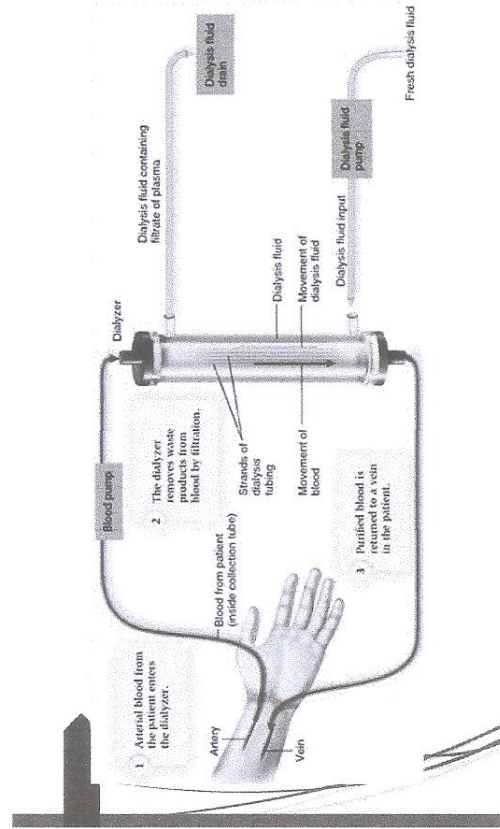
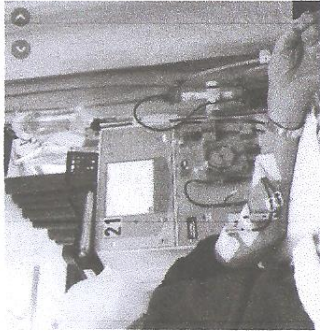
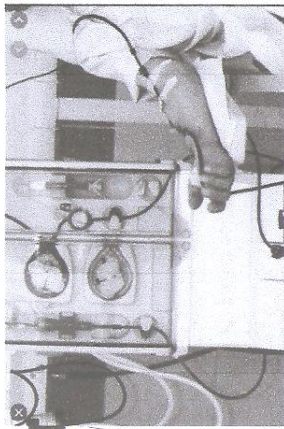
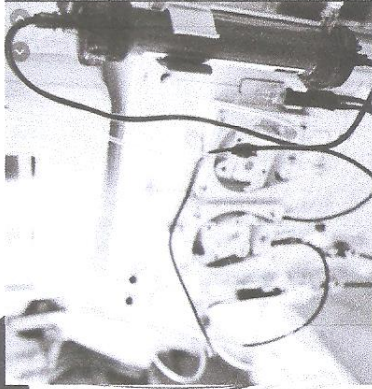
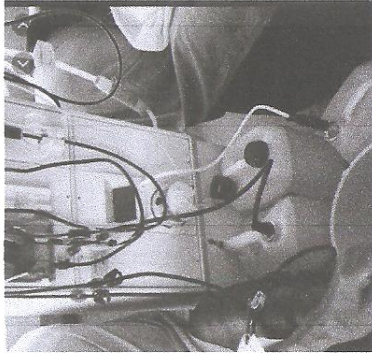
- Option to manage hemodynamically unstable patients with AKI esp. who cannot tolerate rapid volume removal
- Runs continuously 24 hours a day
- Providing a slower but more consistent removal of solutes and fluid
- Greater amount of solute removal and higher mean arterial pressures (MAP) compared with IHD

## Continuous Renal Replacement Therapy: CRRT

- 3 different mechanisms:
  - Diffusion
  - Convection
  - Membrane adsorption
- Including:
  - Continuous Venovenous Hemofiltration (CVVH)
  - Continuous Venovenous Hemodialysis (CVVHD)
  - Continuous Venovenous Hemodiafiltration (CVVHDF)



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### Dialysis

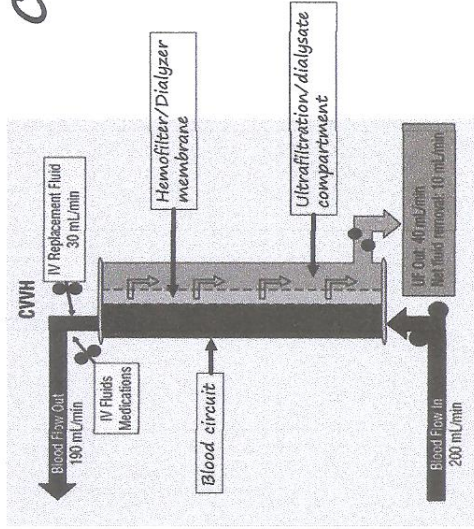
- <https://youtu.be/3UakOLABVq8>
- <https://youtu.be/2nEN-hLxqog>

### CWH

- Solute and fluid clearance is primarily a result of convection
- Passive diffusion of the fluid containing solutes is removed then fluid absent of solutes is replaced



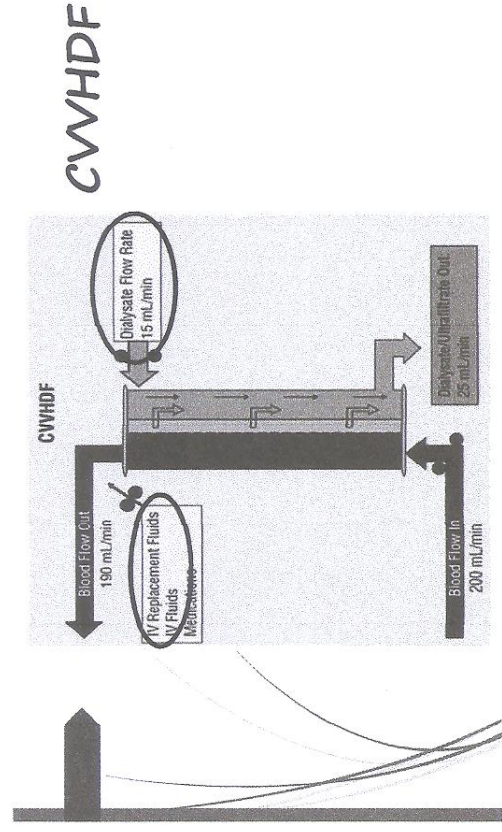
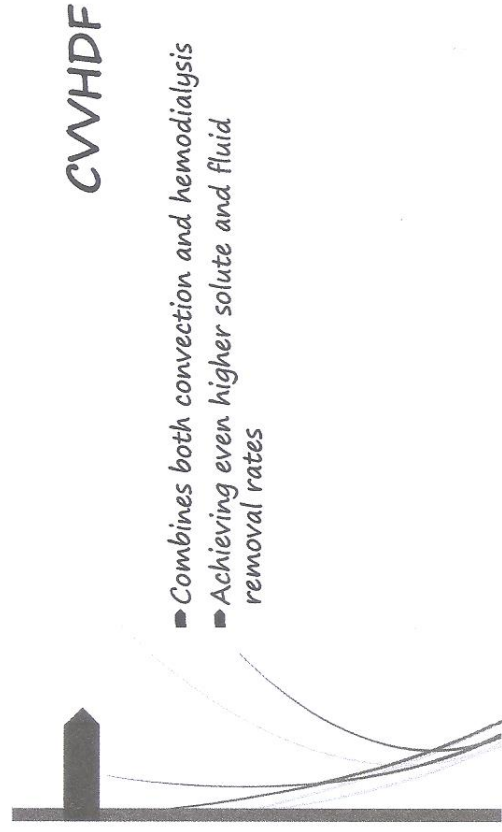
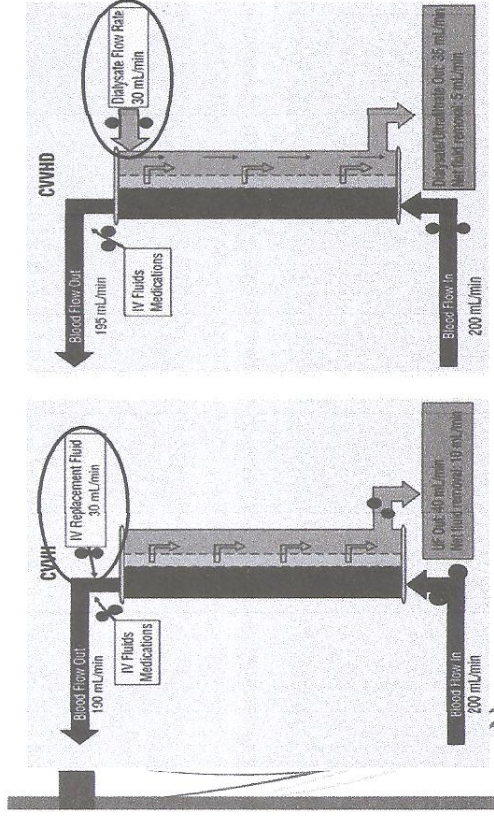
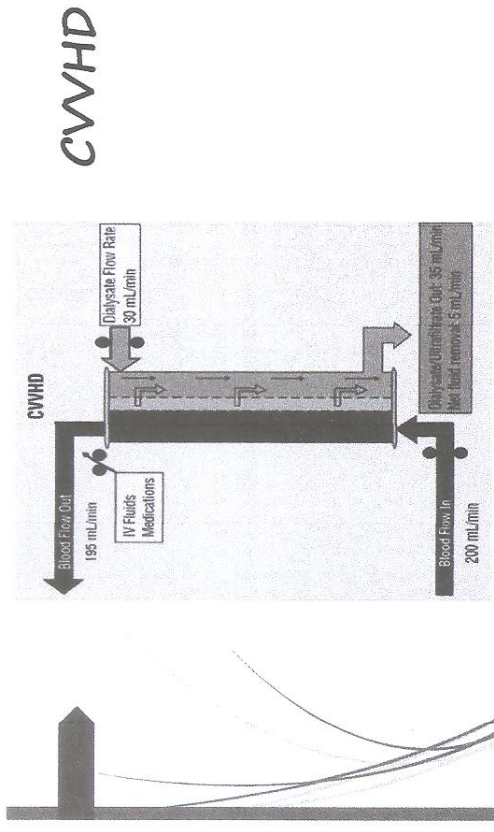
### CWH



### CWHD

- Provides a more extensive solute removal that works primarily by diffusion
- Solute molecules at a higher concentration (plasma) pass through the dialysis membrane to an area of lower concentration (dialysate)
- Some fluid is removed as a function of the ultrafiltration coefficient of the dialyzer and the patient's blood pressure

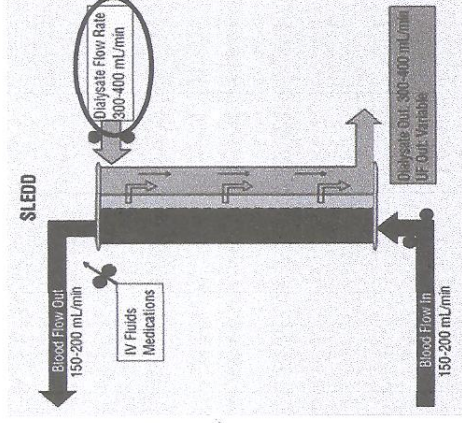




- Combines both convection and hemodialysis
- Achieving even higher solute and fluid removal rates

## SLEDD

- Sustained low-efficiency daily dialysis
- Employs lower blood and dialysate flow rates than intermittent hemodialysis
- It is a gentler means of achieving adequate waste product and fluid removal



## SLEDD

## CRRT

- The ultrafiltration rate is an important determinant of the effectiveness of CRRT
- Higher ultrafiltration rates ultimately lead to a greater removal of electrolytes, nutrients, and drugs
- Current KDIGO guidelines recommend an ultrafiltration rate of no more than 20 to 25 mL/kg/hr during CRRT
- CRRT is clearly indicated in severe and life-threatening complications of AKI e.g. refractory acidosis, diuretic-resistant pulmonary edema 2<sup>nd</sup> to fluid overload, uremic complications, overdose from a dialyzable drug



## Anticoagulant vs CRRT

- Is a major consideration as circuit clotting and filter patency can limit CRRT performance
- Typical anticoagulation is parenteral agents such as unfractionated heparin or regional citrate
- Unfractionated heparin is widely available and easy to monitor but it also systemically anticoagulates the patient leading to an increased risk of bleeding
- Citrate chelates ionized calcium in the extracorporeal circuit and impairs progression of the coagulation cascade, required infusion of parenteral calcium and frequent monitoring of ionized calcium levels



## Anticoagulant vs CRRT

- Citrate is associated with less circuit clotting, longer filter lifetimes and lower risk of bleeding
- Citrate increases the production of bicarbonate 2<sup>nd</sup> to dissociation of the calcium-citrate complexes in the liver, can increase the risk of metabolic alkalosis
- The KDIGO recommends regional citrate as the preferred anticoagulant of choice for patients receiving CRRT
- Low-molecular weight heparins (LMWH) may be used but less common or only recommended due to increased cost, limited supporting data, poor removal by CRRT and less data

## Anticoagulant vs CRRT

- Direct thrombin inhibitors such as argatroban or bivalirudin are typically reserved for patients with heparin-induced thrombocytopenia, but may be used in settings of heparin resistance or frequent thrombosis of the dialysis circuit
- Many patients on CRRT require systemic anticoagulation for an underlying comorbidity (e.g. atrial fibrillation artificial heart valve) and will not need additional anticoagulation for RRT

## PIRR

- Prolonged Intermittent Renal Replacement Therapies
- Had a variety of names: extended-duration IHD, hybrid IHD, sustained low-efficiency dialysis (SLED) or sustained low efficiency daily dialysis (SLEDD)
- Lower blood (150-200 mL/min) and dialysate (300-400 mL/min) flow rates with extended treatment periods of 6 to 12 hours