





TYPE OF HEMODIALYSIS

ارائه دهنده:
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بیماران دیالیز

دانشگاه علوم پزشکی اصفهان

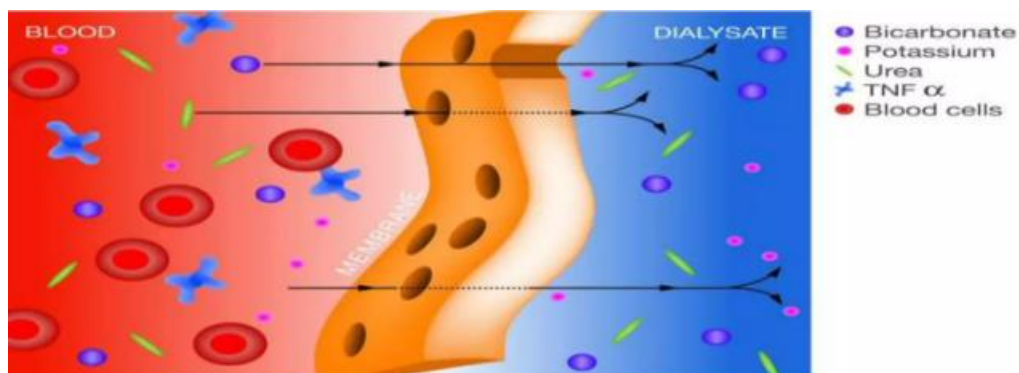
مرداد 1405



MECHANISMS OF SOLUTE TRANSPORT

Diffusion:

- The **movement of solutes** through a semi-permeable membrane **from an area of higher concentration to an area of lower concentration**
- The movement result of random molecular motion.
- Rate of **Small molecules** transport through the membrane will be high.
- Large molecules, will diffuse through the membrane slowly

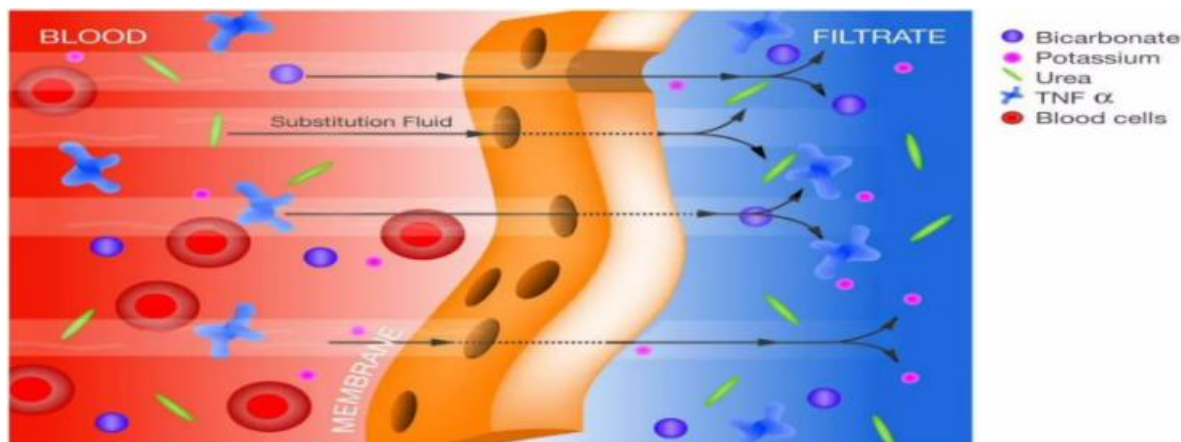




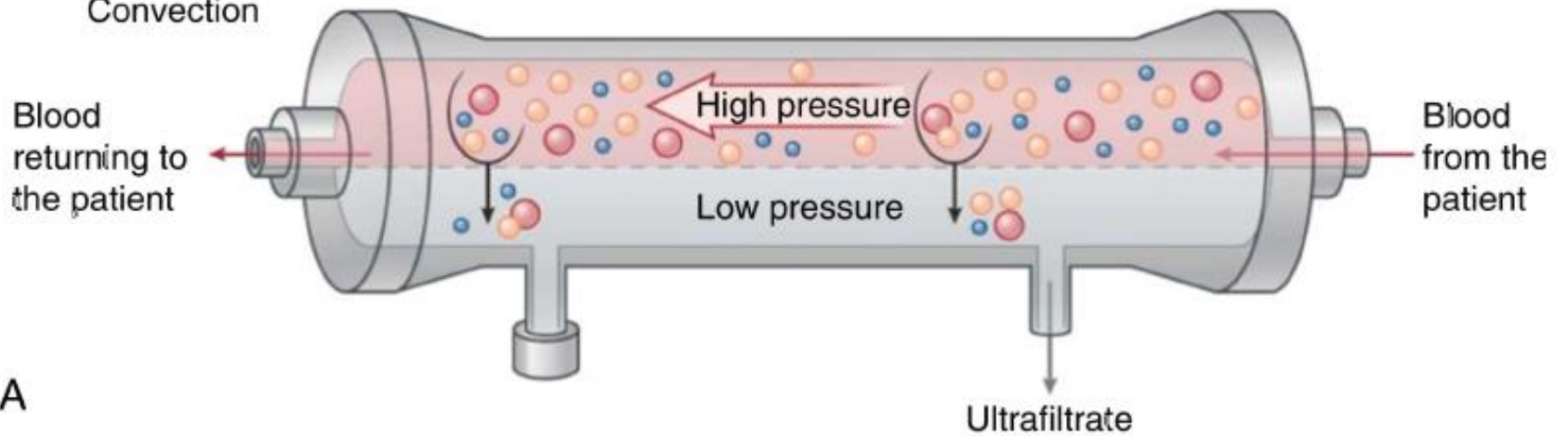
MECHANISMS OF SOLUTE TRANSPORT

Ultrafiltration (convective transport):

- Movement of **fluid** along pressure gradients across the semi-permeable membrane
- Larger and smaller Solutes can pass easily through the membrane with the water (**solvent drag**).

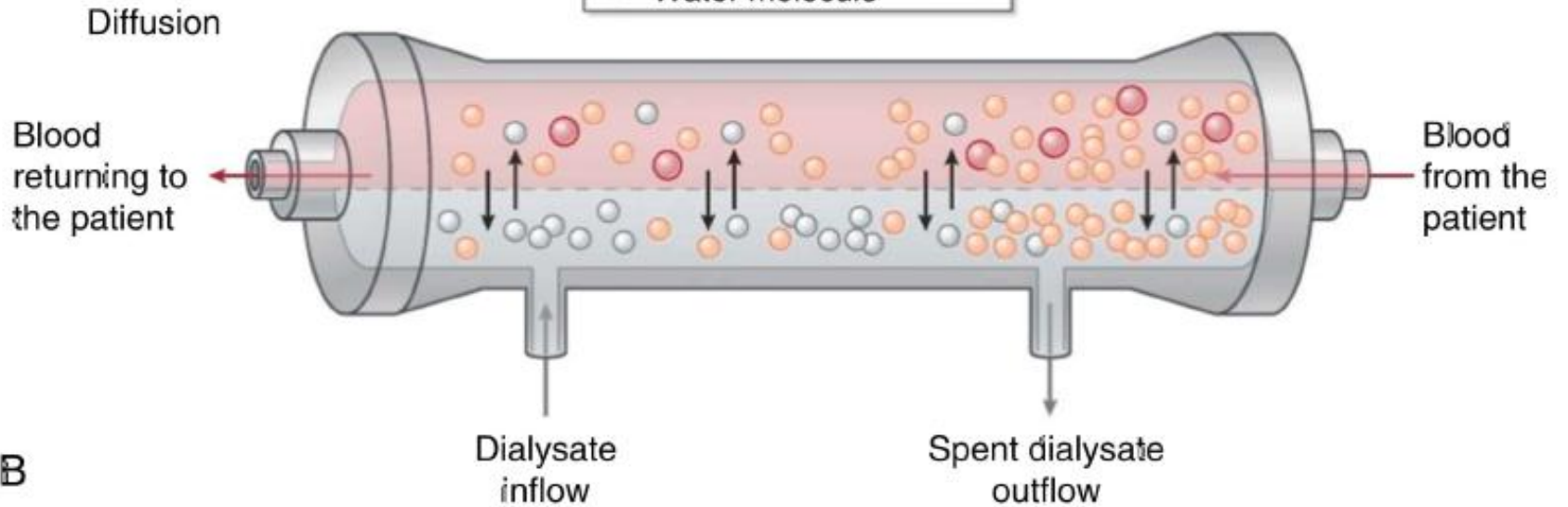


Convection



A

Diffusion



B



LIST OF TITLES

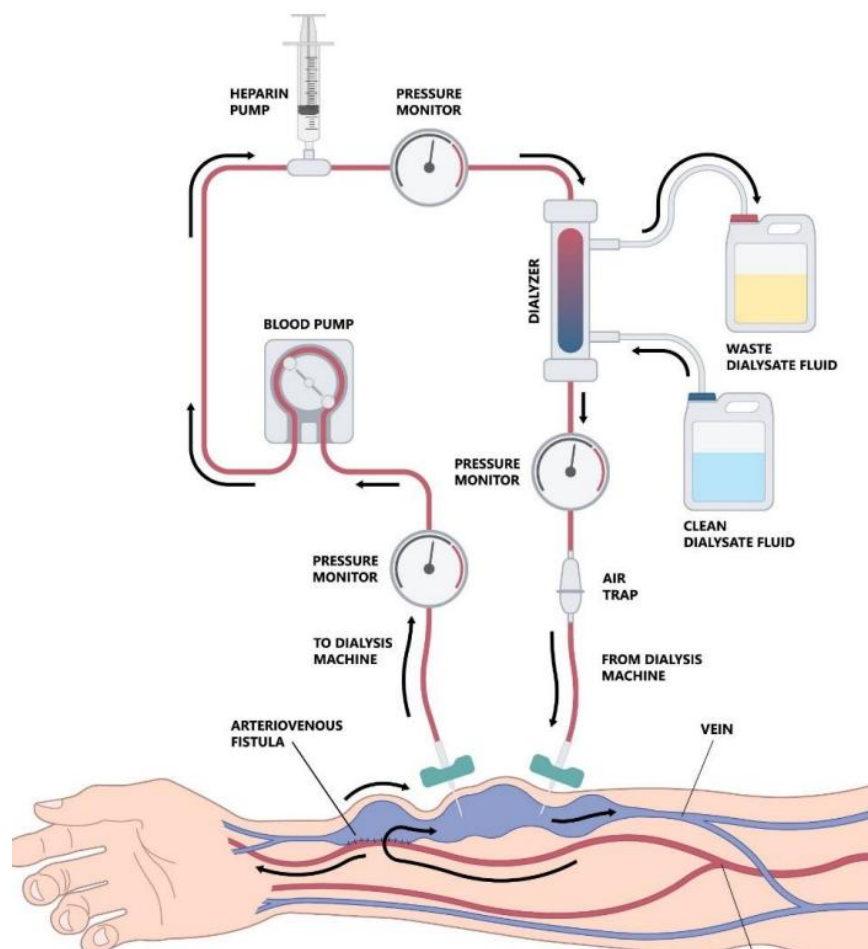
- ☐ Intermittent hemodialysis : IHD
- ☐ prolonged intermittent renal replacement therapy: PIRRT
 - Sustained low-efficiency hemodialysis : SLED
- ☐ Continuous Renal Replacement Therapies: CRRT
 - Continuous hemodialysis : CHD
 - Continuous hemofiltration : C-HF
 - Slow continuous hemodiafiltration : C-HDF
 - Slow continuous ultrafiltration : SCUF



INTERMITTENT HEMODIALYSIS

Hemodialysis:

- Most common form of dialysis.
- Removes blood from the body by a machine through a dialysis access.
- Diffusion and ultrafiltration happens in dialyzer.





IHD

IHD sessions are typically prescribed:

- Three times weekly
- Lasting 3 to 4 hours each
- Blood flow rates of 300 to 500 mL/min
- Dialysate flow rates of 500 to 800 mL/min
- Ultrafiltration removes excess fluid, and solute clearance mainly relies on diffusion



ADVANTAGES OF IHD

- ✓ Widespread availability
 - ✓ Low cost of disposables
 - ✓ Delivery with no anticoagulation usually feasible
 - ✓ Most rapid instantaneous clearance
 - ✓ May be performed with catheter or arteriovenous fistula or graft
 - ✓ Lowest rate of hypophosphatemia
 - ✓ Time off KRT allows more time for physical therapy relative to CRRT
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- ❖ IHD is preferred for rapid correction of electrolyte imbalances and drug intoxications due to its rapid solute removal



DISADVANTAGES OF IHD

- Likely highest risk of hypotension
- Likely highest risk of exacerbating intracranial hypertension
- Limited fluid removal
- Often requires limitation in dietary potassium or phosphate intake



SLED

- ❖ SLED is a form of IHD using:
 - Extended (6- to 10-hour) session length
 - Reduced blood and dialysate flow rates.
 - Blood flow rates are about 150 to 200 mL/min
 - Dialysate flow rate is 100 to 300 mL/min.
- ❖ The same machine used for IHD often can be used for SLED.
- ❖ SLED allows units where CKRT equipment or personnel are unavailable, achieve similar benefits as CKRT.



CRRT

- ❖ CRRT uses diffusion, convection, or a combination to remove solutes and fluids gradually.
- ❖ KDIGO Guidelines for **AKI** suggest that clinicians use **CKRT**
 - Hemodynamically unstable patients
 - septic patients
 - In patients with:
 - Acute brain injury or
 - Other causes of increase intracranial pressure or
 - Generalized brain edema





POTENTIAL ADVANTAGES OF SLOW CONTINUOUS THERAPIES

Continuous therapies:

1. **Hemodynamically well tolerated**; smaller change in plasma osmolality
2. **Better control of azotemia** and electrolyte and acid-base balance
3. Highly effective in **removing fluid** (postsurgery, pulmonary edema, ARDS)
4. Facilitates administration of parenteral nutrition and obligatory intravenous medications by creating unlimited “space”
5. Less effect on **intracranial pressure**
6. User-friendly machines available



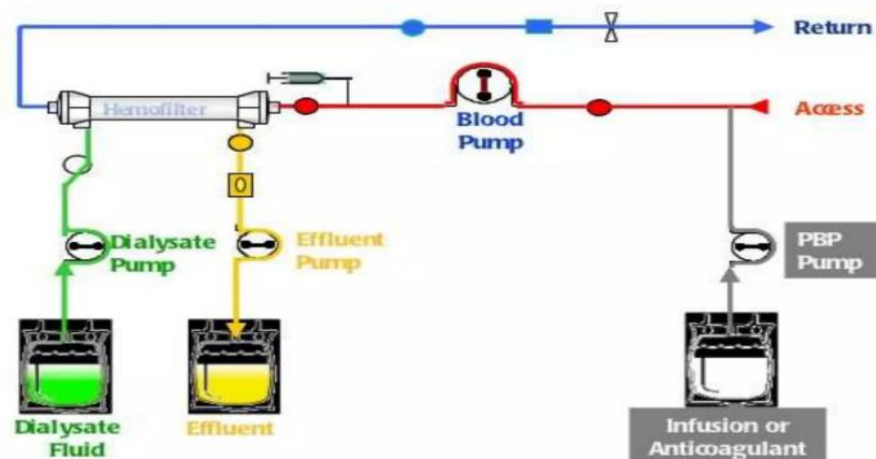
C-HD

The standard **dialysis solution** inflow rate is about **20 to 25 mL/kg/h**.

The **blood flow rate** should be **at least 3 times** the dialysate flow rate.

At this slow blood flow rate and high blood-to-dialysate flow ratio, the outflow dialysate is almost 100% saturated with urea and other small-MW solutes.

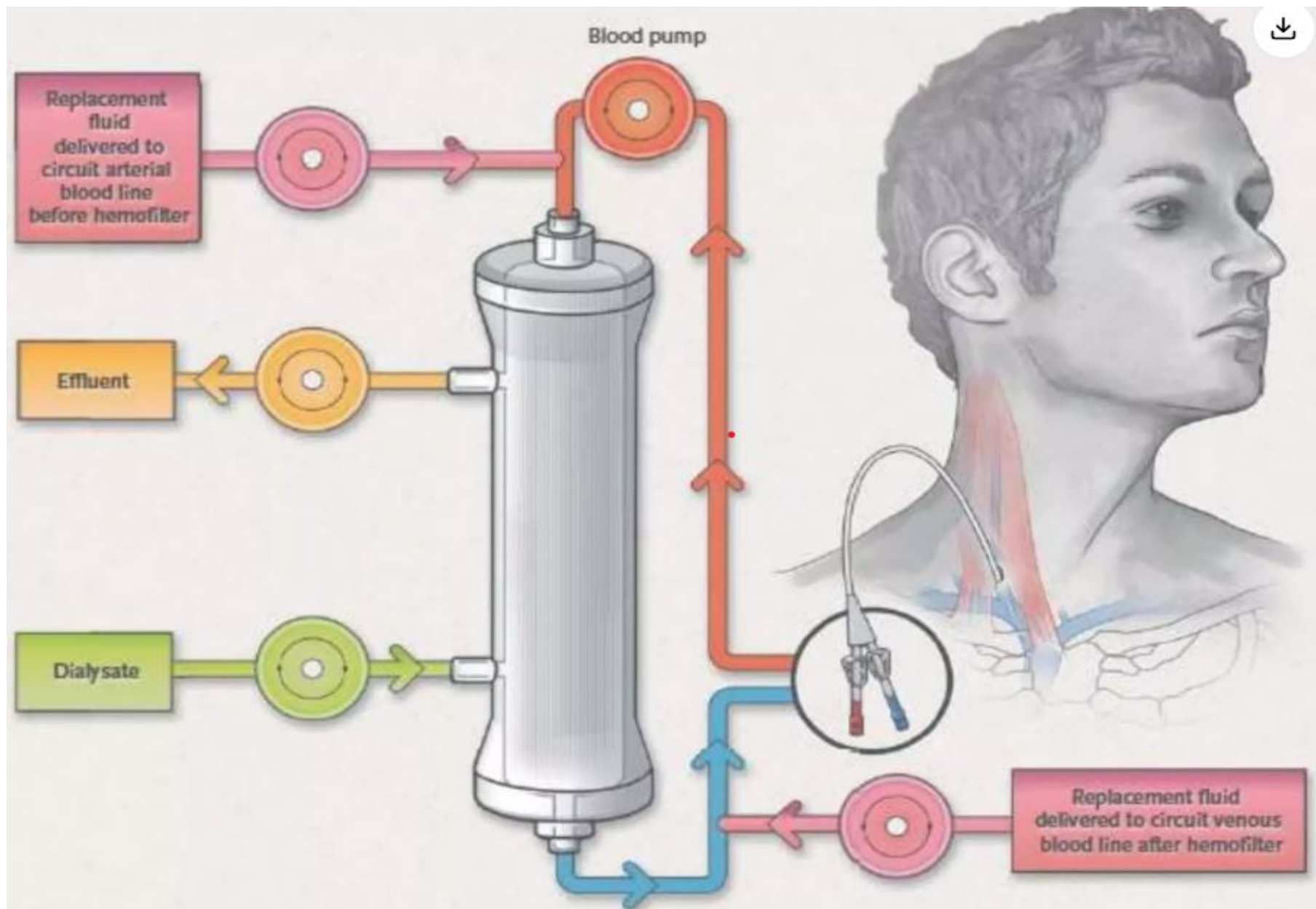
CVVHD Continuous VV HemoDialysis





C-HF

- ❖ C-HF is a **purely convection-based** blood cleansing technique.
- ❖ As blood flows through the hemofilter, a **transmembrane pressure gradient** between the blood compartment and the ultrafiltrate compartment causes **plasma water to be filtered** across the highly permeable membrane. As the water crosses the membrane, it sweeps along with it (nonprotein-bound) small and large molecules (pore size permitting) and remove them from the blood.
- ❖ The removed ultrafiltrate is **replaced by a balanced electrolyte solution** infused into either the inflow (**predilution**) or the outflow (**postdilution**) line of the hemofilter.





FILTRATION FRACTION

- This is the fraction of plasma flowing through the hemofilter that is removed and should be **kept at 25% or lower** to avoid overconcentration of red cells and plasma proteins in the hemofilter.
- Overconcentration results in fouling of the membrane pores, which can impair ultrafiltration efficiency and lower the sieving coefficient, and overconcentration can also increase the likelihood of clotting.
- When a high replacement fluid infusion rate in postdilution mode is desired, the blood flow rate needs to be increased above the usual 150 mL/min.



PREDILUTION MODE

We recommend using predilution whenever:

- It is desirable to **remove more than 25 L/d**.
- If the baseline blood viscosity is elevated (eg, if the **hematocrit is >35%**).
- ❖ A slight lowering of the **urea concentration** of ultrafiltrate (usually to 80%-90% of the corresponding plasma value), but this small amount of dilution is outweighed by the ability to deliver an increased replacement solution infusion rate, enhancing overall middle-molecule clearances.
- ❖ A combination of pre- and postdilution has been advocated by some practitioners.



SMALL- VERSUS MIDDLE-MW SOLUTE REMOVAL

- With CHD: larger-MW substances diffuse slowly in solution and thus have a lower rate of diffusive transfer across the dialyzer membrane.
- With C-HF: convective removal rates of small- and larger-MW solutes are similar.
- ❖ Hence, C-HF is more efficient than C-HD in terms of larger-MW toxin removal, including peptides, certain antibiotics, and vitamin B12.
- ❖ But using a high replacement fluid flow rate with a small hemofilter can not increase the removal of larger, middle molecules.



VENOVENOUS BLOOD ACCESS

- ❖ A dual-lumen cannula inserted into a large (**internal jugular or femoral**) vein.
- ❖ The 2012 KDIGO AKI guidelines recommend using **uncuffed venous catheters** for CRRT
- ❖ Use of **longer (20-24 cm)** soft, silicone temporary catheters for CKRT targeting placement of the **catheter tip near the right atrium** versus shorter (15-20 cm) catheters were associated with longer filter life and improved dose of therapy.



FILTER SURFACE AREA AND SIZE

- ❖ The size of the filter should take the blood flow rate into account.
- ❖ When large filters are used at low blood flow rates, the risk of clotting may be increased and Flow velocity through each fiber will be slow.
- ❖ Use of a larger-size filter might be considered when removal of larger-MW solutes is desired and a high replacement fluid rate is to be used.



CRRT FLUIDS

Premixed as commercially prepared sterile solutions.

They are typically packaged in 2.5-L or 5-L bags

- Lactate or bicarbonate based solutions : The 2012 KDIGO AKI guidelines suggest using bicarbonate based solutions for all patients with AKI , more strongly for patients with liver failure and/or lactic acidosis and for patients in circulatory shock.
- Citrate-based solutions. These fluids evolved from attempts to merge the buffering and anticoagulation properties of citrate.
- Sodium , potassium, phosphate, calcium and Mg and glucose.



ISOLATED ULTRAFILTRATION AND SCUF

- ❖ **Isolated ultrafiltration** is achieved using standard dialysis equipment by simply putting the dialysate in bypass and can be performed prior to dialysis, after dialysis, or independently of dialysis.
- ❖ **SCUF** is achieved using the same circuitry as for C-HD but omitting dialysis solution. It is used primarily in an ICU setting to remove excess fluid from patients in whom residual kidney function is substantial and in whom electrolyte and acid-base imbalances are not an issue (refractory heart failure and mildly impaired kidney function)

	IHD	SLED	SCUF	C-HF	C-HD	C-HDF
Membrane permeability	Variable	Variable	High	High	High	High
Anticoagulation	Short	Long	Continuous	Continuous	Continuous	Continuous
Blood flow rate (mL/min)	250-400	100-200	100-200	200-300	100-300	200-300
Dialysate flow rate (mL/min)	500-800	100	0	0	16-35	16-35
Filtrate (L per day)	0-4	0-4	0-5	24-96	0-4	24-48
Replacement fluid (L per day)	0	0	0	22-90	0	23-44
Effluent saturation (%)	15-40	60-70	100	100	85-100	85-100
Solute clearance mechanism	Diffusion	Diffusion	Convection (minimal)	Convection	Diffusion	Diffusion + convection
Urea clearance (mL/min)	180-240	75-90	1.7	17-67	22	30-60
Duration (hr)	3-5	8-12	Variable	>24	>24	>24



CEREBRAL EDEMA

- ❖ C-HF and C-HD systems with tight volumetric control should be used.
- ❖ If possible, anticoagulation should be avoided.
- ❖ Dialysis or replacement fluid should have a relatively **higher sodium (>140 mM)** and a **lower bicarbonate (30 mM)** concentration.
- ❖ In severe cases of uncontrolled intracranial pressure, **cooling** of the dialysis or replacement solutions may be helpful, in addition to other measures used to cool the patient to 32 °C to 33 °C. At these temperatures, cranial oxygen demands are reduced.



SEPSIS AND MULTIORGAN FAILURE

- Many centers will treat septic patients with C-HDF to increase removal of potential sepsis-mediating molecules (proinflammatory (TNF β , thromboxane B2, platelet activating factor) and anti-inflammatory mediators (IL-10) while retaining the efficiency associated with use of dialysis.
- Using a clearance dose of 35 mL/kg/h and dividing equally between dialysis and hemofiltration is a common strategy



OTHER INDICATIONS

- ❑ Acute lung injury and ARDS: Respiratory improvement appears to be due more to the volume removal effect rather than to the removal of inflammatory mediators.
- ❑ Intoxication with dialyzable or filter-permeable drugs or toxins: especially when there is a risk of rebound in serum concentrations of the drug or toxin after IHD.



Thanks for
your
attention