Continuous Renal Replacement Therapy (CRRT)

"Cheat Sheet"

Indications for renal replacement

Traditional		Other
A	acidosis	Rhabdomyolysis
E	electrolyte abnormalities	Sepsis
I	intoxication	
O	fluid overload	
U	uremia	

Types of CRRT

CVVH - Continuous veno-veno hemofiltration (greater than 1L/hr ultrafiltrate production). Requires replacement fluid.

CVVHD - Continuous veno-veno hemodialysis (24-30 g/day urea clearance). Requires dialysate.

CVVHDF - Continuous veno-veno hemodiafiltration (36-38 g/day urea clearance). Requires dialysate and replacement fluid.

SCUF - Slow continuous ultrafiltration (removal 1-4 mL/min or 3-6 g/day of urea). No replacement fluid.

Definitions

Ultrafiltrate (UF) - Fluid collected in the bag distal to the hemofilter.

Dialysate - Fluid instilled into filter counter-current to flow of the blood.

Effluent = UF + dialysate

Substitution/Replacement fluid - Fluid instilled pre or post-filter to replace ultrafiltrate volume.

Sieving coefficient (Sc) - Ability of substance to pass through filter (Sc=1 passes freely; Sc=0 unable to pass).

"Solute drag" - Free circulating, unbound solutes carried with water during ultrafiltration. Solutes bound to red blood cells or proteins are NOT cleared.

Qb - Blood flow rate (typically 150-300 mL/min).

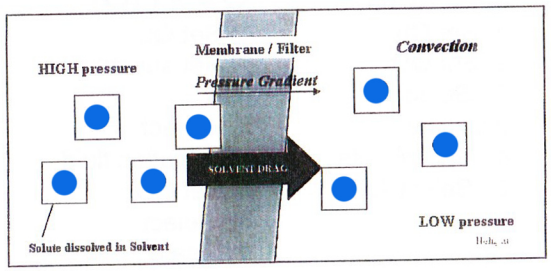
QD - Dialysate flow rate (typically 1-3 L/hr).

INITIAL: 25cc/kg/hr
↳ IHD ~ 3x/wk

Concepts

Filtration - *convective* clearance

occurs when water driven by hydrostatic or osmotic force is pushed through a membrane. Solutes that can pass easily through the membrane pores are swept along with the water ("solute drag").



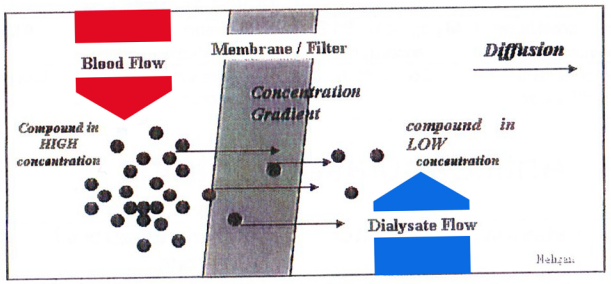
Convective clearance (urea) = $\frac{\text{UF (urea) X Quf}}{\text{Plasma (urea)}}$

Solute clearance is dependent on *ultrafiltration* production rate

UF (urea) = ultrafiltrate urea concentration (mg/dL), Quf = ultrafiltration production rate (mL/min), Plasma (urea) = plasma urea concentration (mg/dL).

Dialysis - *diffusive* clearance

occurs due to movement of solutes as the result of random molecular motion. If the solute molecule encounters a pore of sufficient size, the molecule will pass through the filter. Can occur in either direction.



Diffusive clearance (urea) = $\frac{\text{Dialysate (urea) X Qd}}{\text{Plasma (urea)}}$

Solute clearance is dependent on *dialysate infusion* rate

Dialysate (urea) = exiting dialysate urea concentration (mg/dL), Qd = dialysate flow rate (mL/min), Plasma (urea) = plasma urea concentration (mg/dL).

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D. Stein and M. McCunn - updated 6/06

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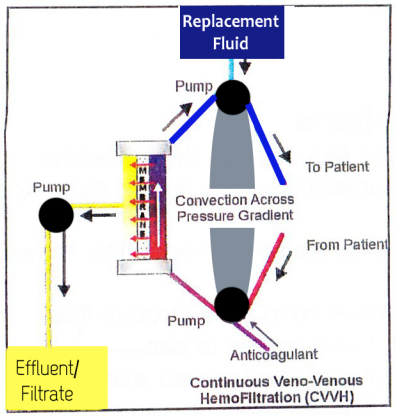

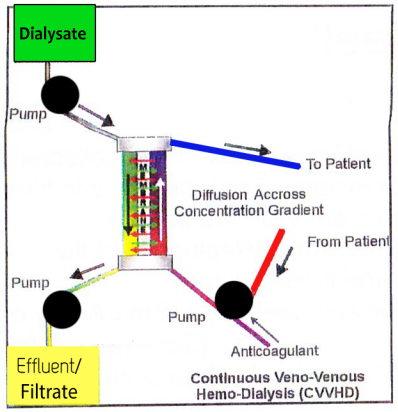

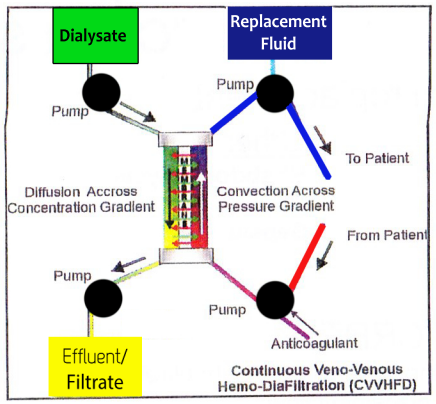

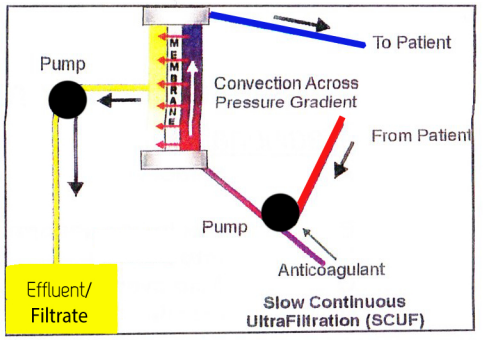

Images by Patrick Mulligan

Comparison of Different CRRT Modalities

Modality	Urea Clearance (g/ Day)	Replacement Fluid / Dialysate	Middle Molecular Clearance
SCUF	1 - 4	No / No	+
CVVH	22 – 24	Yes / No	+ +
CVVHD	24 - 30	No / Yes	-
CVVHDF	36 - 38	Yes / Yes	+ + +

Clearance Table

Molecular size	Small solutes (< 300D)	Middle molecules (500-50,000D)	Low molecular weight proteins (5,000-50,000D)	Large proteins (> 50,000D)
Substances	Urea, creatinine, amino acids	Myoglobin, B12, vancomycin	Inflammatory mediators	Albumin
Clearance mechanism	Convection / diffusion	Convection	Convection + / - absorption	Convection

Anticoagulation Options

Type	Initiation	Monitor	Contraindications / Cautions
Heparin	Bolus 40u/ kg then gtt @10u/ kg	Pre and post filter PTT	TBI, SCI, coagulopathy, HIT
Tri-Sodium Citrate	gtt @ 15mmol/ hr	Pre and post-filter Ca^{++}	Hypernatremia, alkalosis, hypocalcemia

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Initiation of CRRT

Select modality based on indication and goals of clearance/volume removal.

CVVH
ie. Fluid Management, Middle molecule clearance - oliguria and rhabdo

1. Set Qb
2. Set substitution flow
3. Select substitution fluid (pre or post filter)
4. Set UF rate
5. Select A/C

CVVHD
Ie. Solute clearance - uremia

1. Set Qb
2. Set QD
3. Select dialysate
4. Set UF rate
5. Select A/C

CVVHDF
ie. Fluid Management, Solute and LMW protein clearance - sepsis and ARF

1. Set Qb
2. Set substitution flow
3. Select substitution fluid
4. Set QD
5. Select dialysate
6. Set UF rate
7. Select A/C

SCUF
ie. Fluid Management - CHF

1. Set Qb
2. Set UF rate
3. Select A/C

References:

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Mann. Continuous renal replacement therapies: an update. Am J Kid Dis. 1998;32:185-207.

Ronco, Bellomo, and Ricci. Continuous renal replacement therapy in critically ill patients. Nephrol Dial Transplant. 2001;16:S67-72.

Ricci, Ronco, Bachetoni, et al. Solute removal during continuous renal replacement therapy in critically ill patients: convection versus diffusion. Critical Care. 2006;10:R67.

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