CKRT Modalities

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Major Renal Replacement Techniques

Intermittent

- **IHD** – Intermittent haemodialysis
- **IUF** – Isolated Ultrafiltration

Hybrid

- **SLEDD** – Sustained (or slow) low efficiency daily dialysis
- **SLEDD-F** – Sustained (or slow) low efficiency daily dialysis with filtration

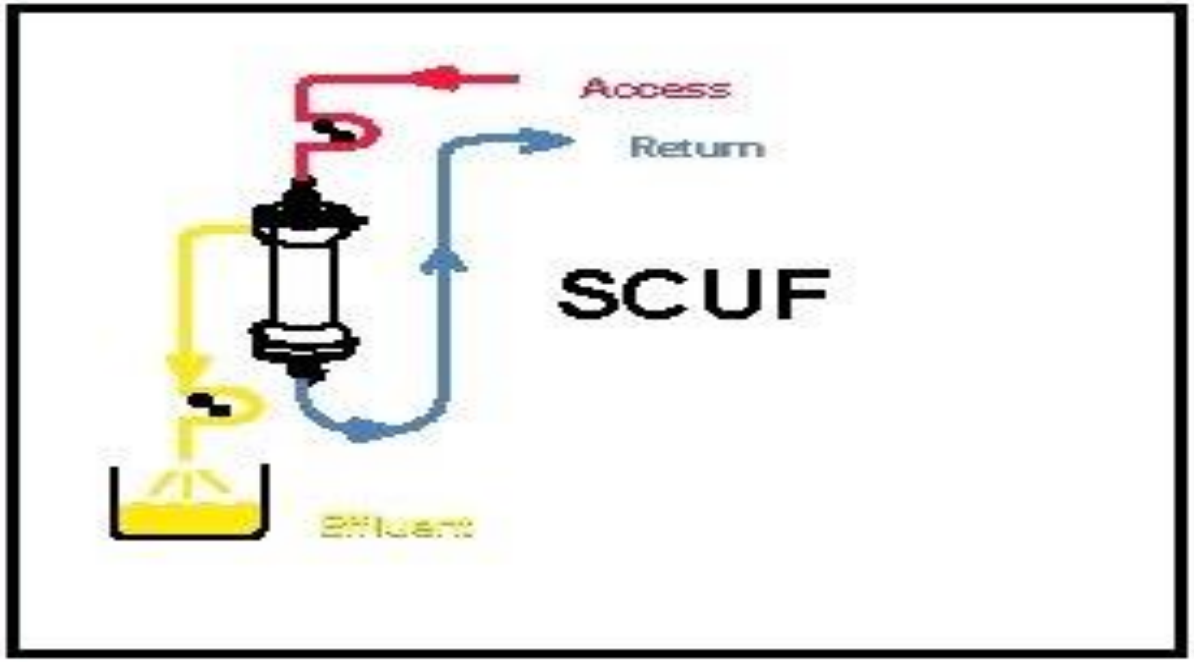
Continuous

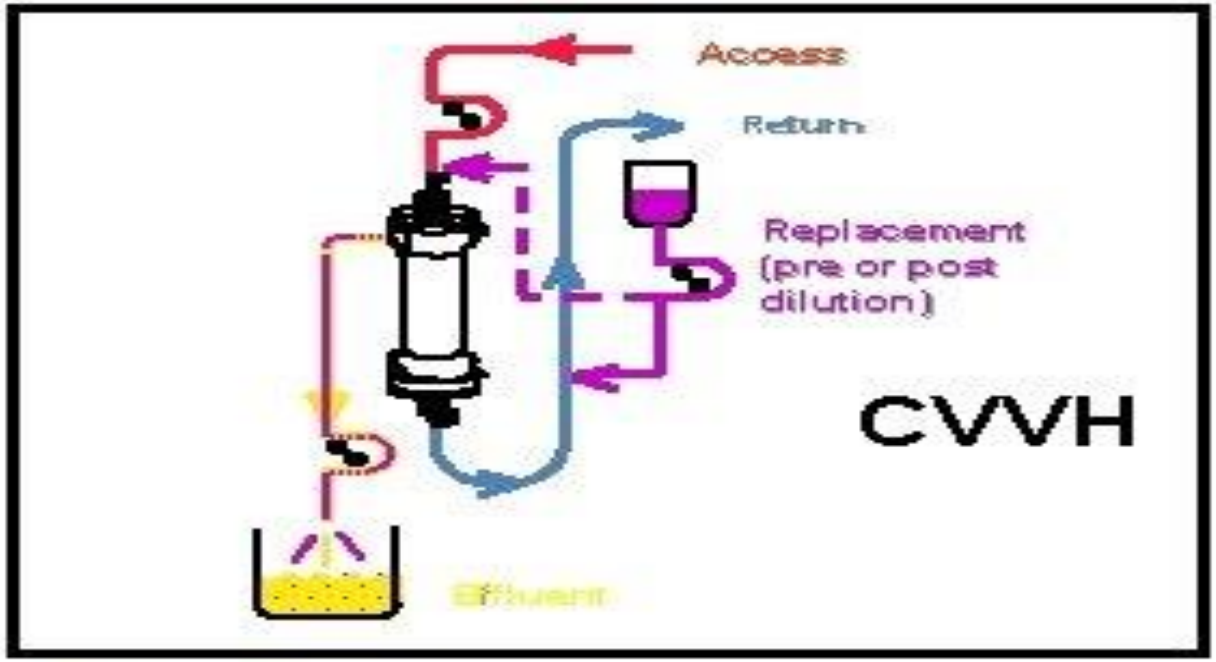
- **CVVH** – Continuous veno-venous haemofiltration
- **CVVHD** – Continuous veno-venous haemodialysis
- **CVVHDF** – Continuous veno-venous haemodiafiltration
- **SCUF** – Slow continuous ultrafiltration

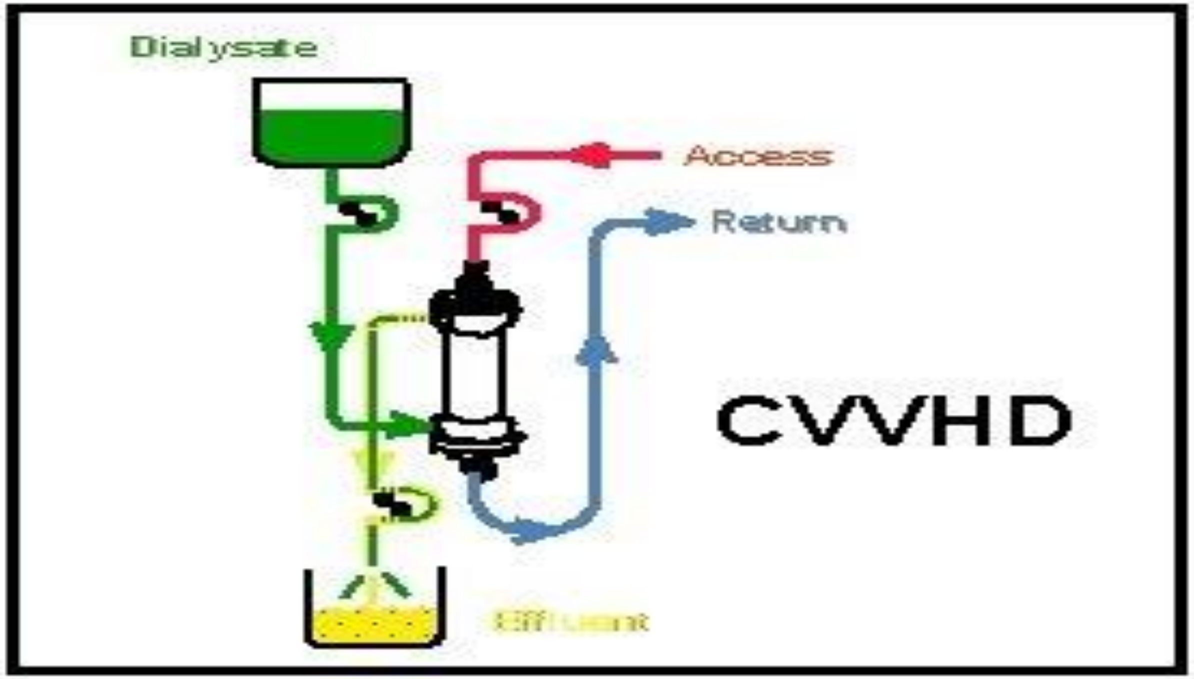
PIRRT

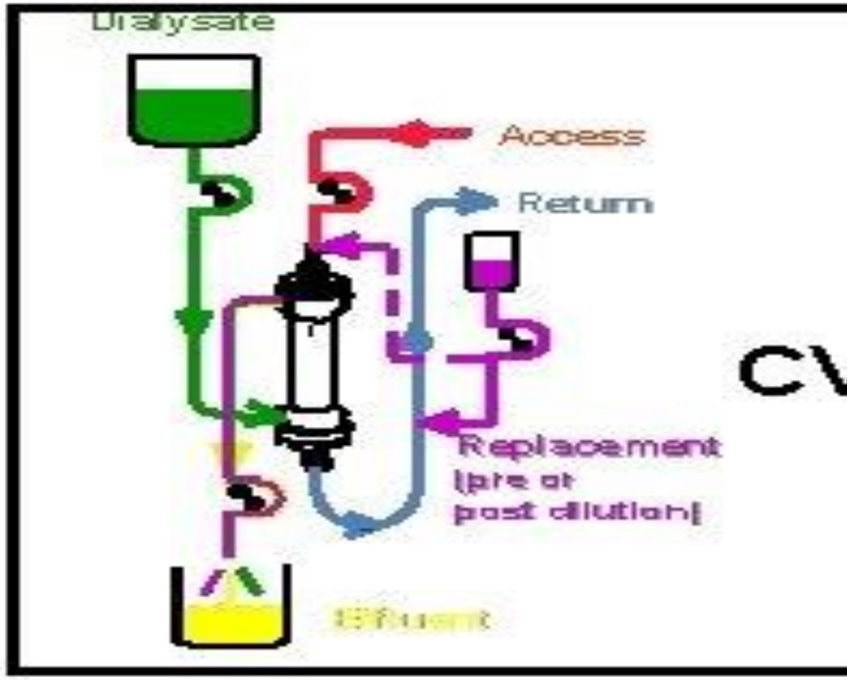
- Sustained low-efficiency dialysis (SLED),
- Extended daily dialysis with filtration (EDD-f),
- Accelerated venovenous hemofiltration

Compared to ‘CRRT’ SLEDD is ‘high efficiency’!


Access
Return
SCUF
Effluent

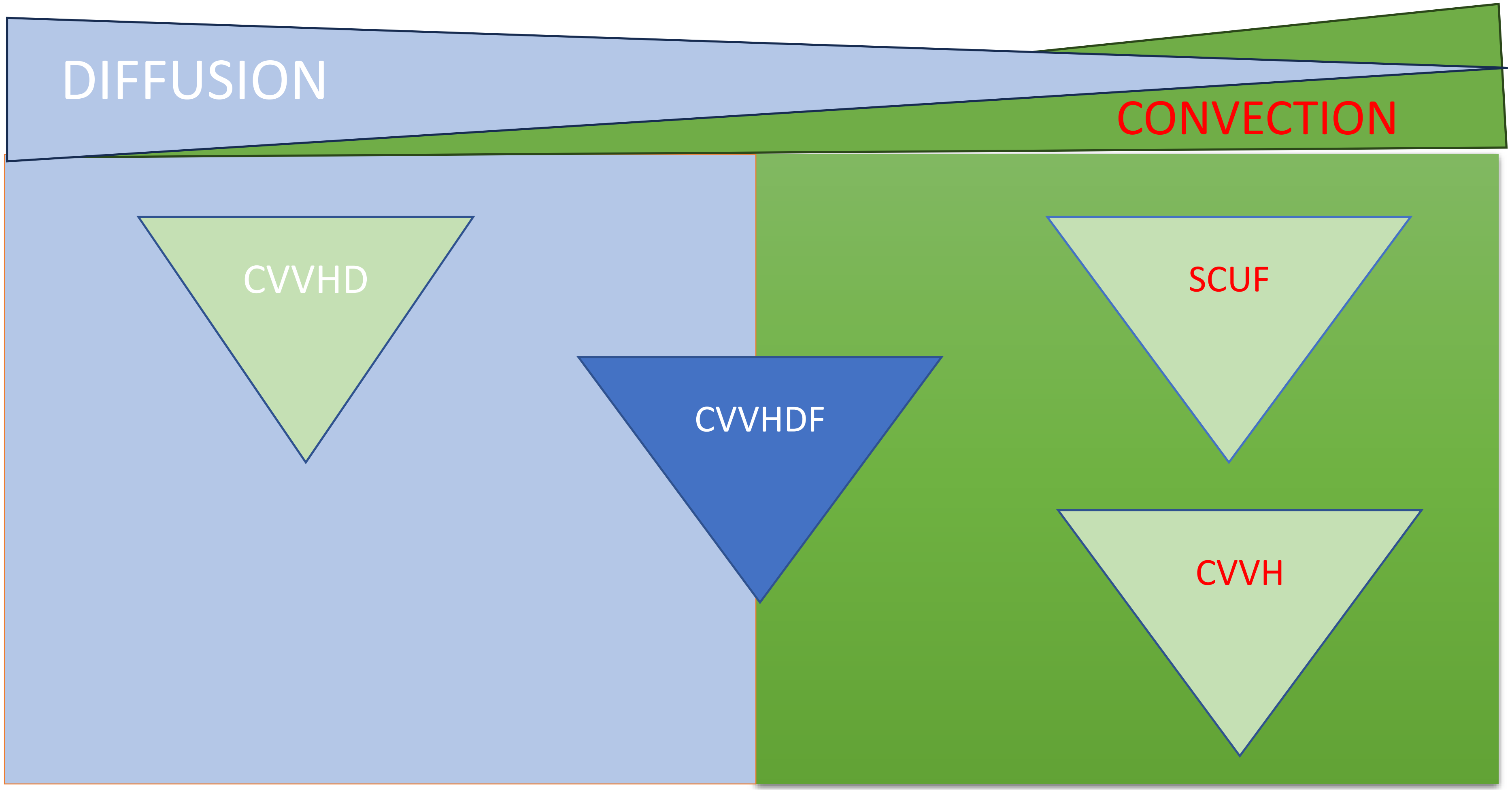

Access
Return
Replacement
(pre or post
dilution)
CVVH
Effluent


Dialysate
Access
Return
CVVHD
Effluent


Dialysate
Access
Return
CVVHDF
Replacement
(pre or
post dilution)
Effluent

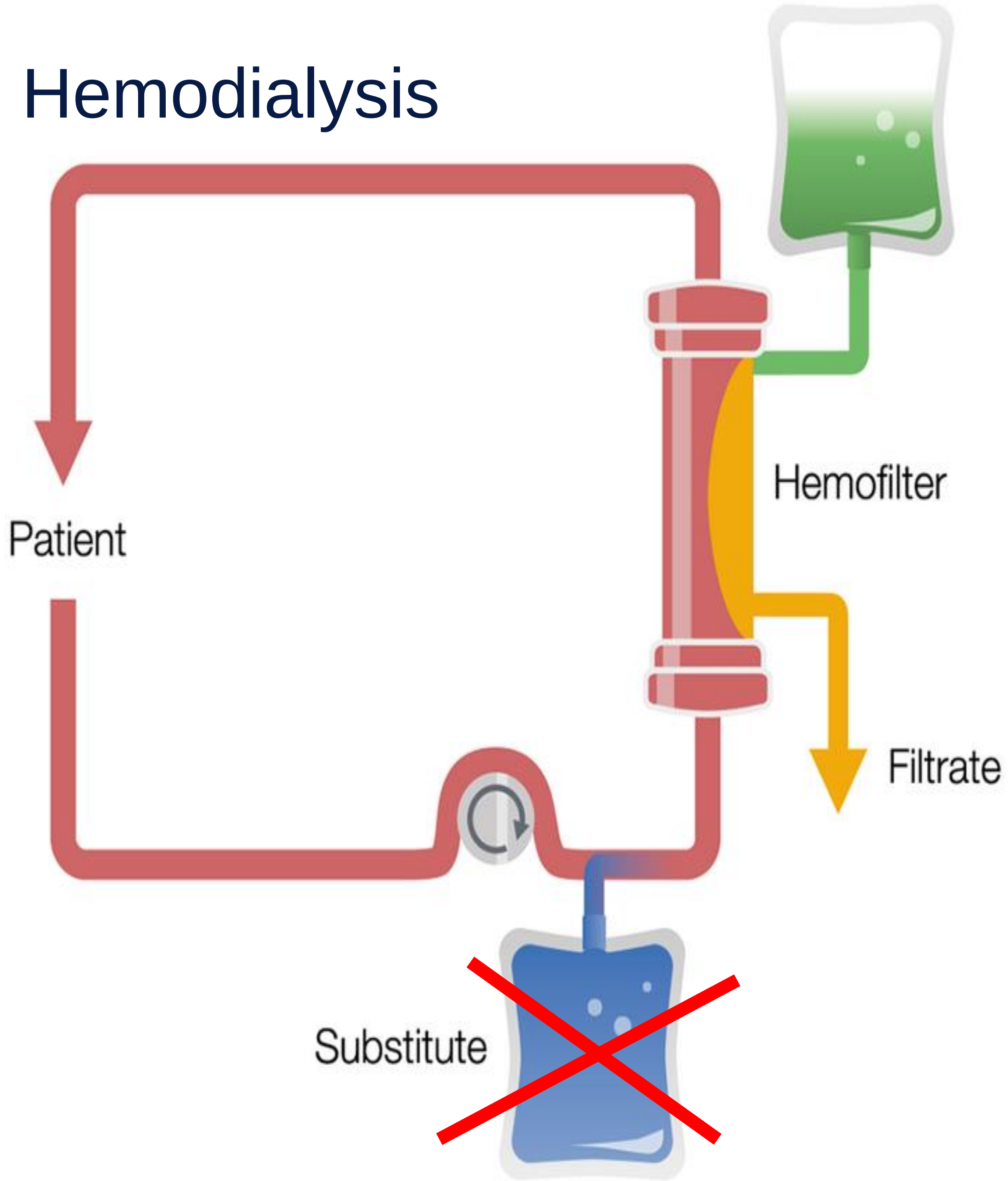
Manipal

CKRT: A spectrum of therapies

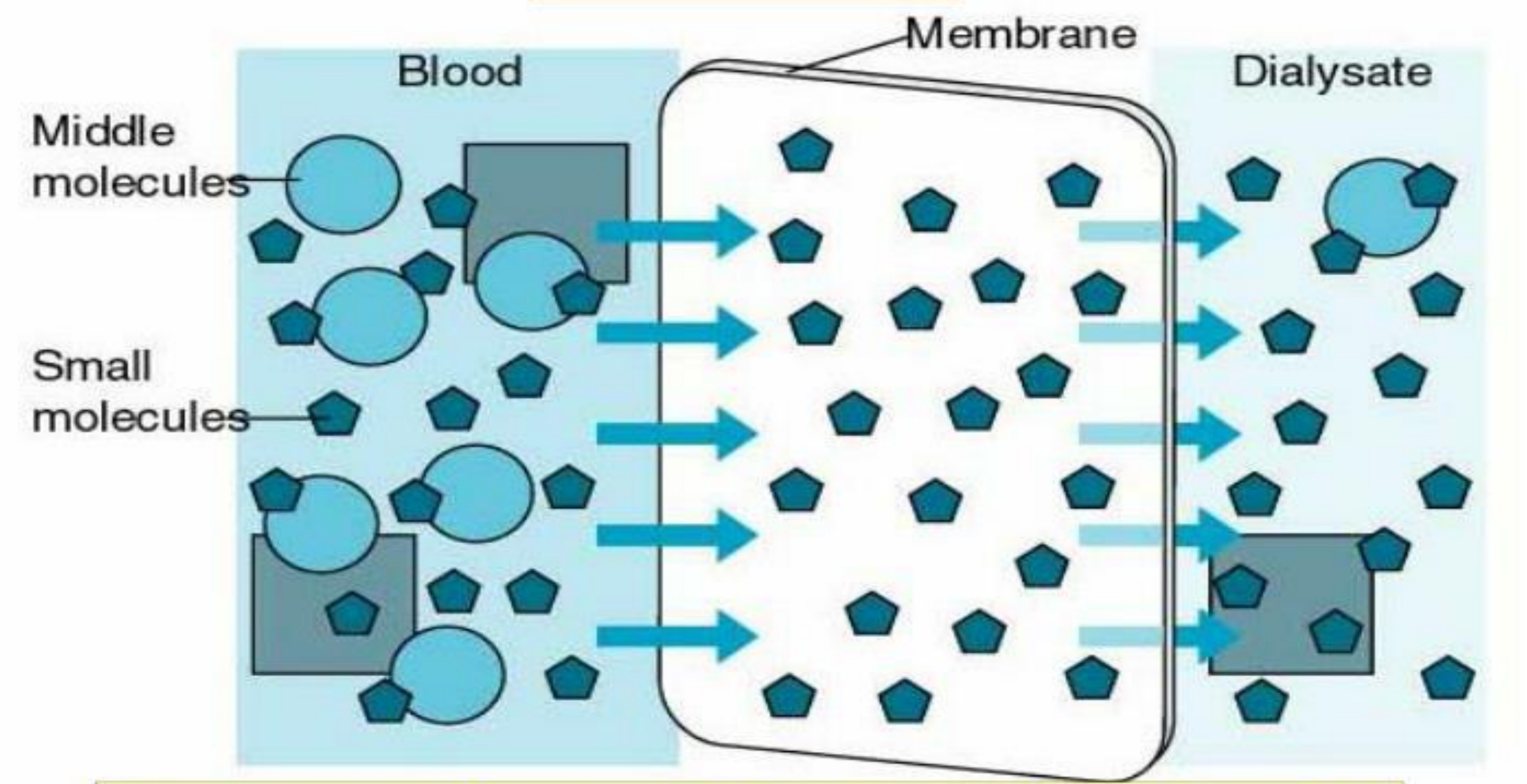


Continuous Veno-Venous Hemodialysis (CVVHD)

- **Requires the use of blood, effluent and dialysis pumps**
- **Replacement solution is not required**
- **Plasma water and solutes are removed by diffusion and ultrafiltration**



Diffusion



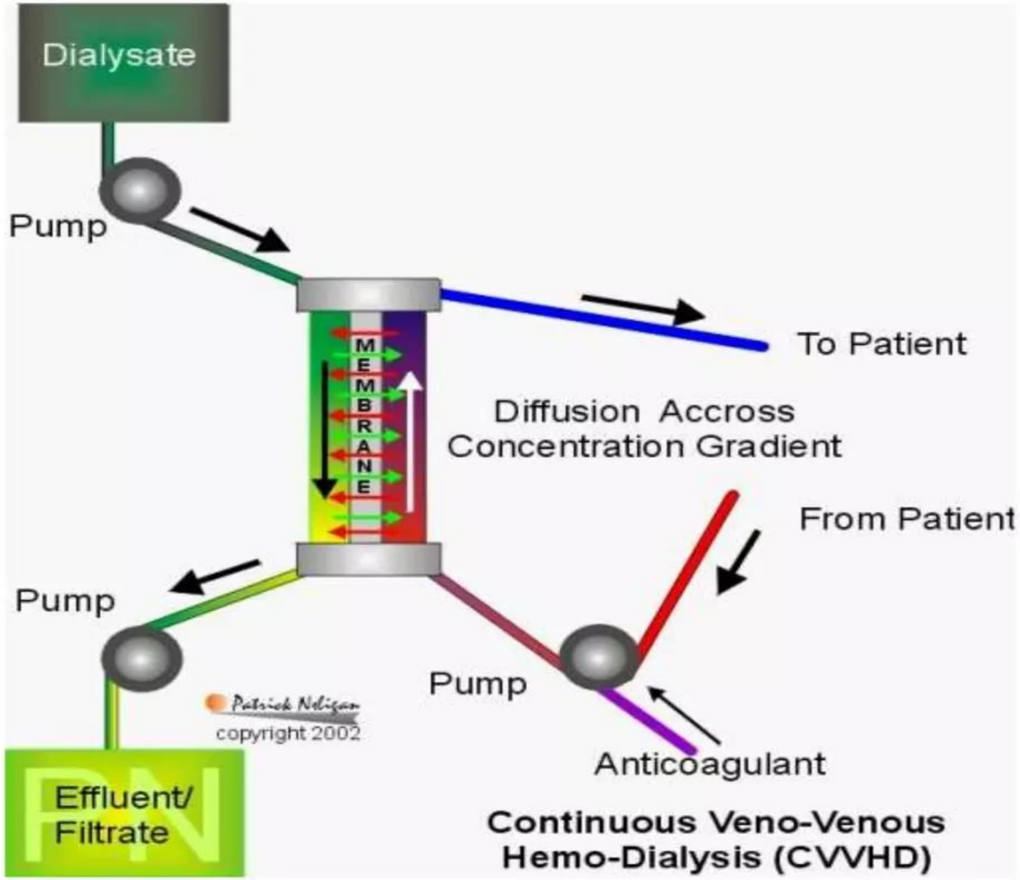
Concentration gradient, small molecule

Surface of membrane

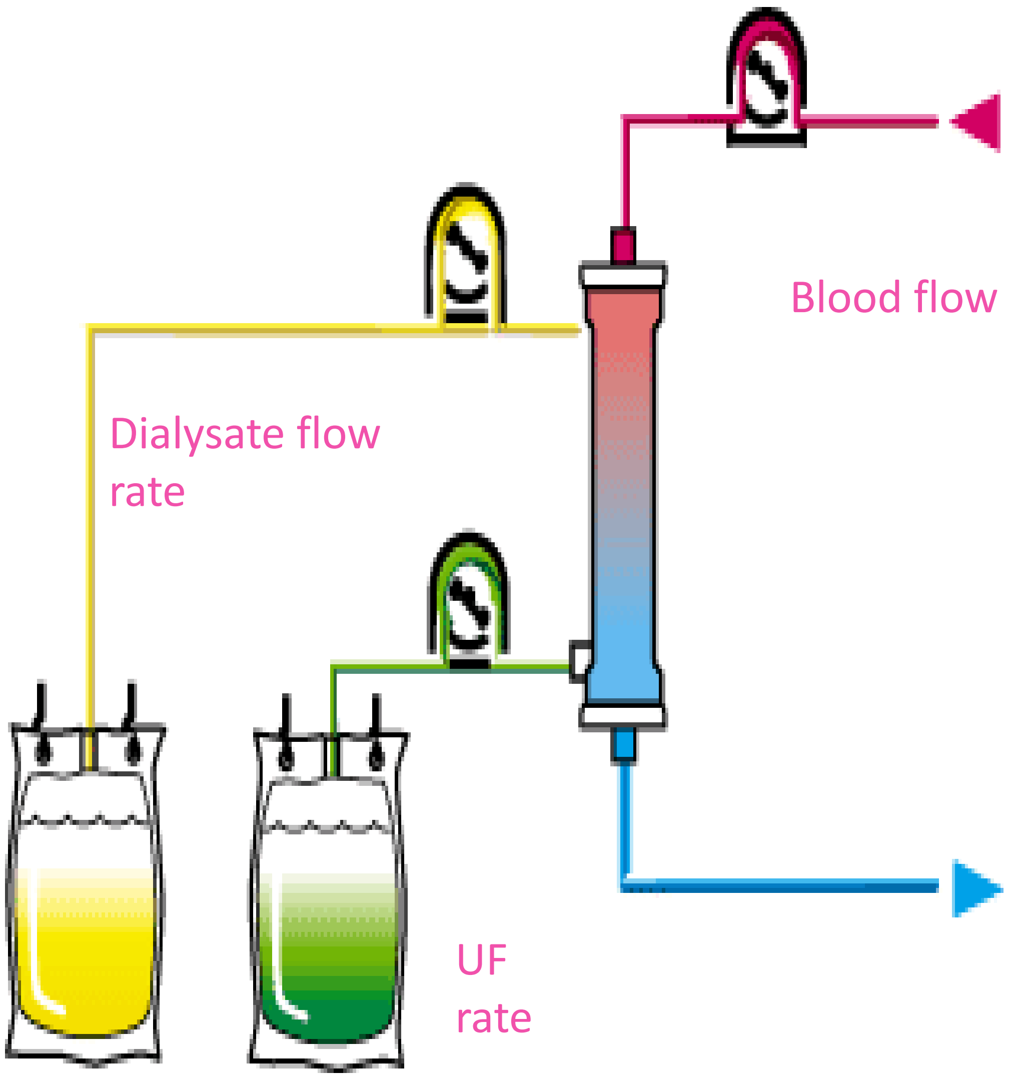
QB, DFR

Continuous Venovenous Hemodialysis (CVVHD)

- Dialysate solution runs countercurrent to the flow of blood at a rate of 1 to 2.5 L/h
- Solute removal occurs by **diffusion.**
- Unlike IHD, the **dialysate flow rate is slower than the blood flow rate**, allowing small molecules to equilibrate completely between the blood and dialysate.
- As a result, the dialysate flow rate approximates urea and creatinine clearance.



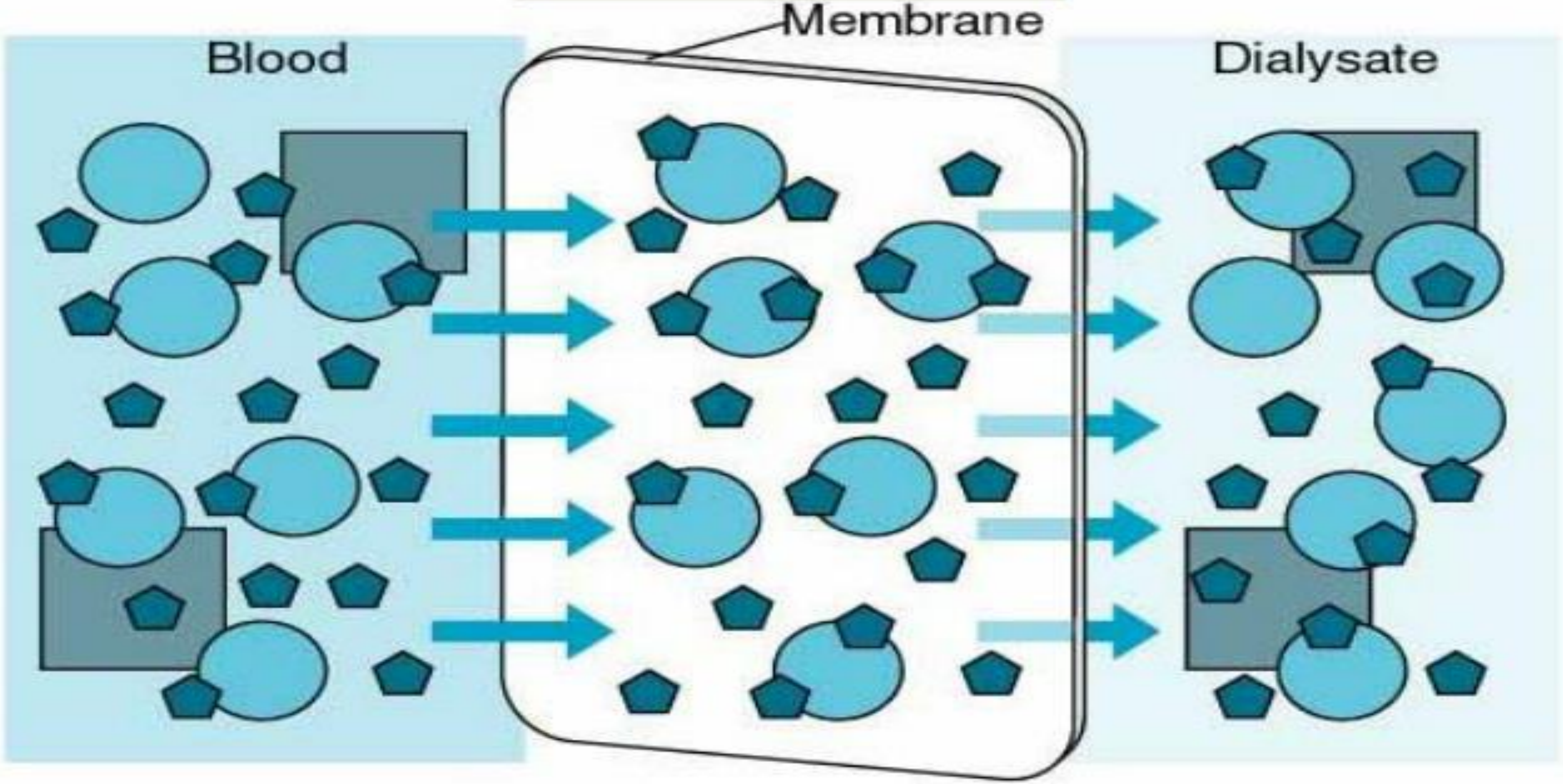
CVVHD



- High flux membranes
- Extended period up to weeks
- ***Diffusive*** solute clearance
- Countercurrent dialysate
- UF for volume control

- Blood flow 50-200 ml/min
- UF rate 1-8 ml/min
- Dialysate flow 15-60 ml/min

Convection

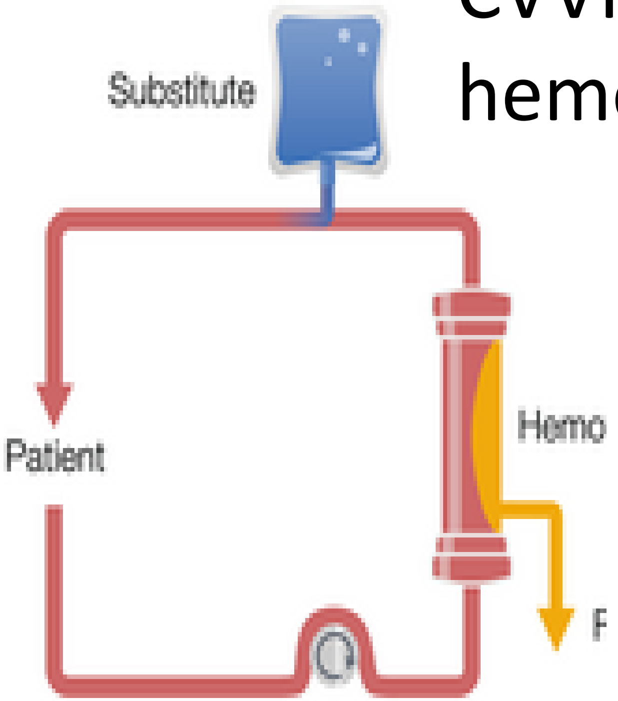


Movement of water (ultrafiltration), middle mol.

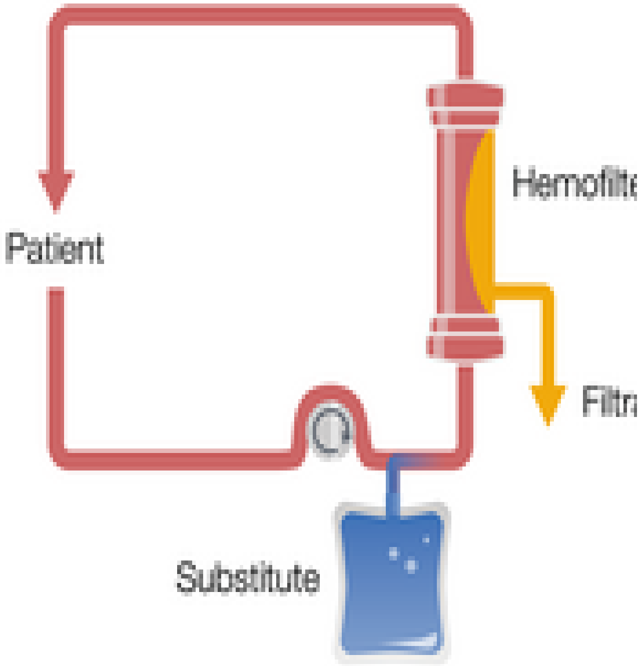
Replacement Fluids

- **Sterile replacement solutions may be:**
  - **Bicarbonate-based or Lactate-based solutions**
  - **Electrolyte solutions**
  - **Must be sterile and labeled for IV Use**
  - **Higher rates increase convective clearances**

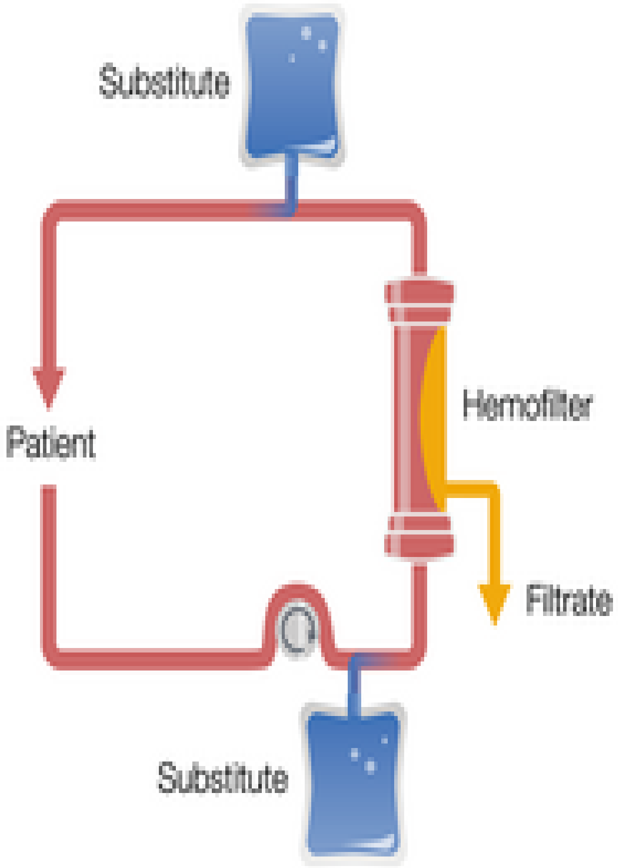
CVVH: Continuous veno-venous hemofiltration



Post-CVVH



Pre-CVVH



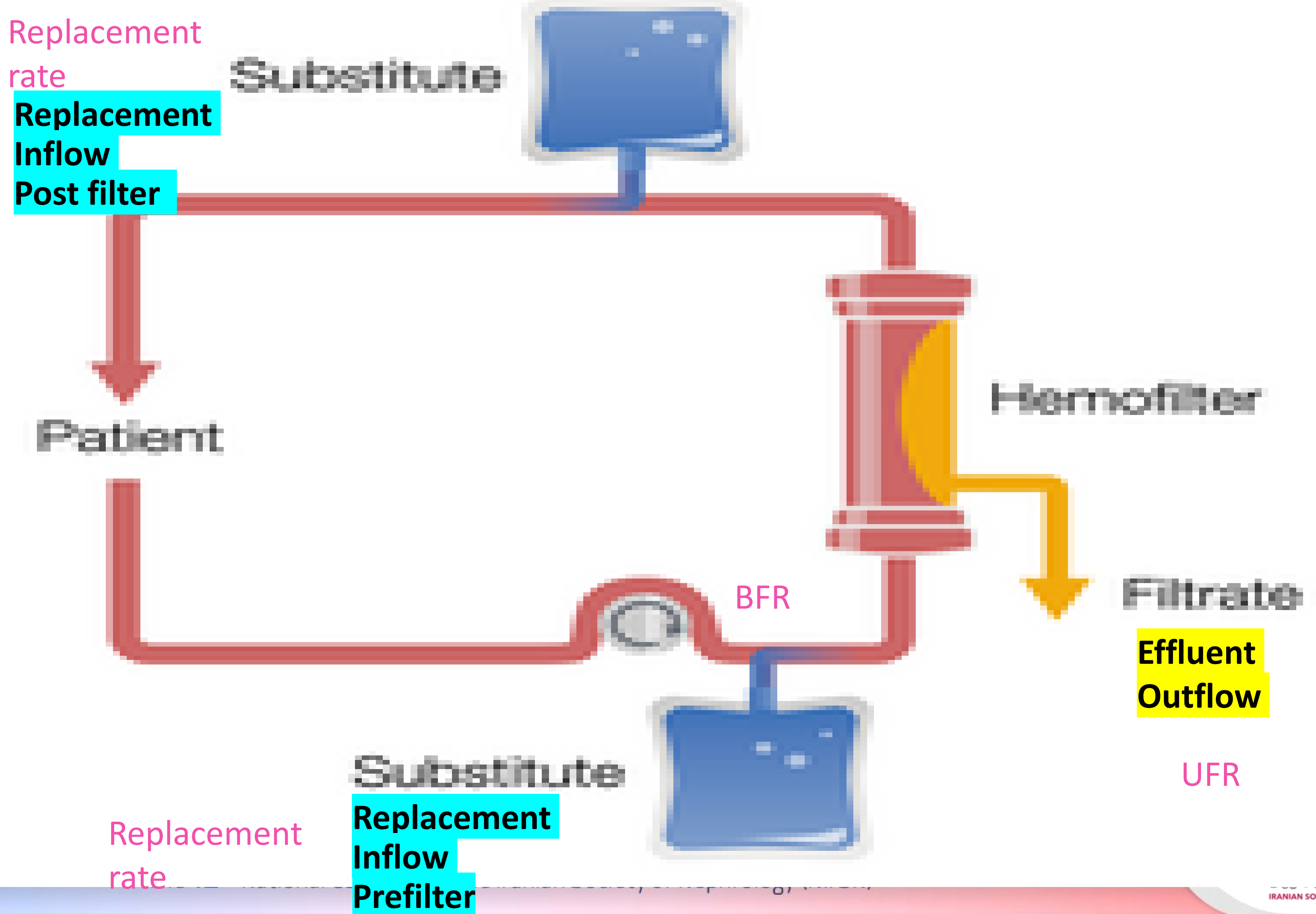
Pre-Post CVVH

Requires blood, and replacement

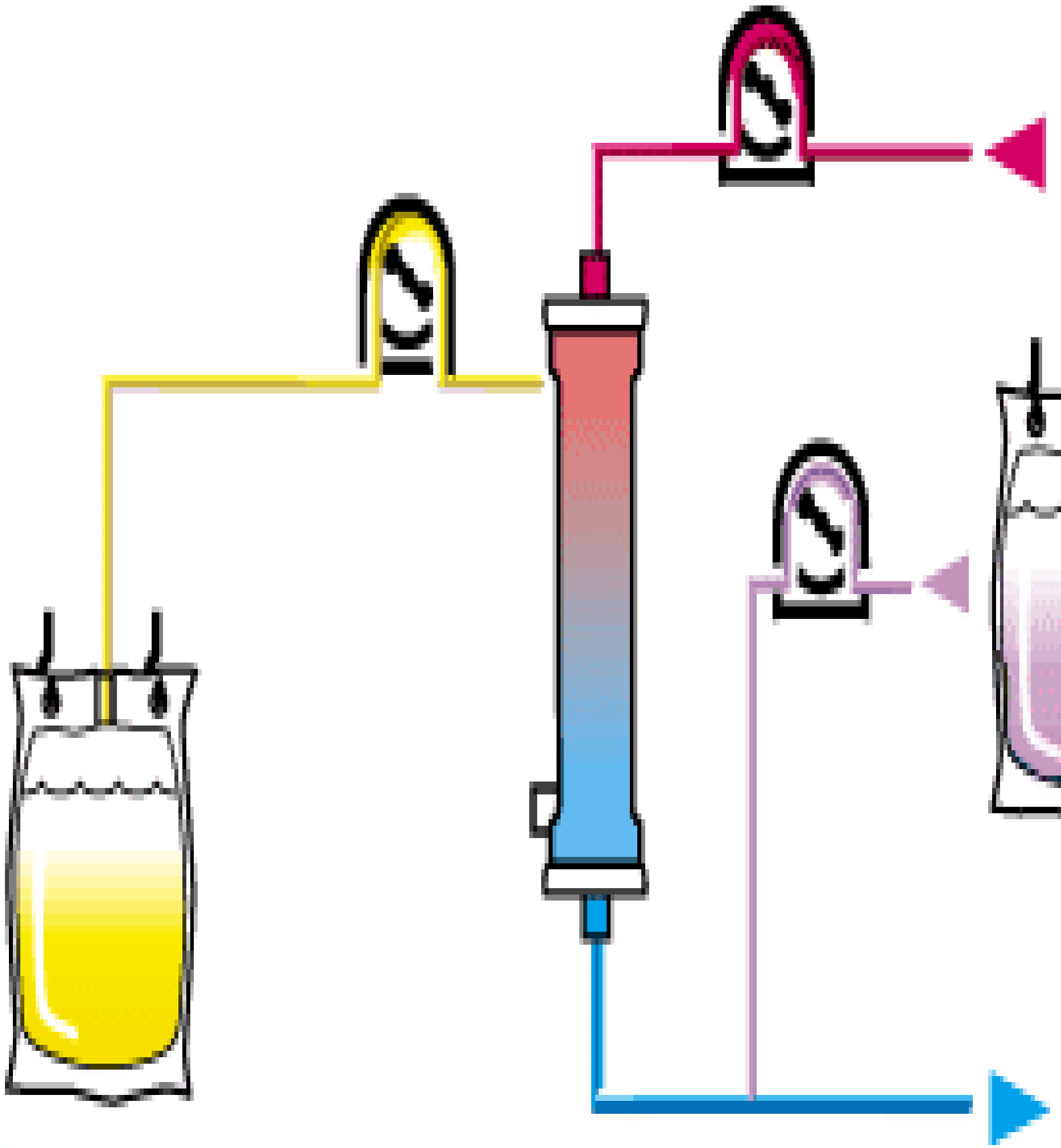
Dialysate is not required

Plasma water and solutes are removed by convection and ultrafiltration

Pre-Post CVVH :



CVVH : Continuous veno-venous hemofiltration



- Extended duration up to weeks
- High flux membranes
- Mainly ***convective*** clearance
- UF > volume control amount
- Excess UF ***replaced***
- Replacement pre-or postfilter
- Blood flow 50-200 ml/min

Replacement fluid pre -dilution

Advantage:

- Dilute blood before filter (Hemodilution)(↓HCT)
- Reduce filter clotting
- Prolong filter life
- No Uf rate limitation

Disadvantage:

- Reduce solute clearance
- More replacement solution

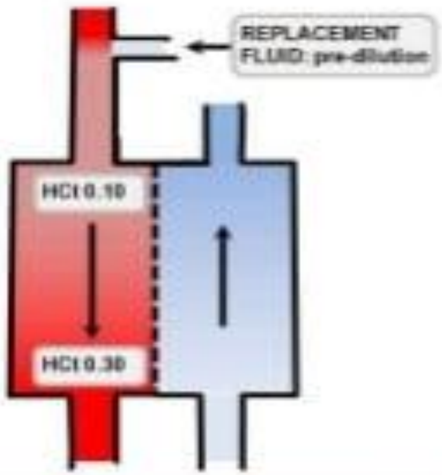
Replacement fluid post -dilution

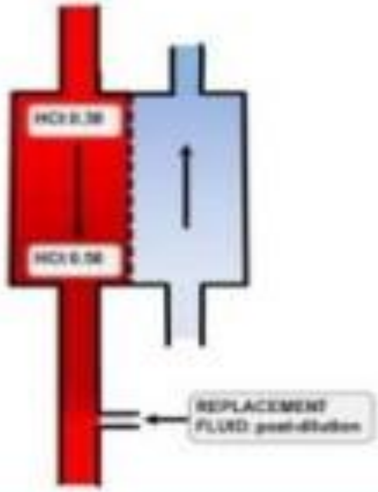
Advantage:

- No reduction solute clearance
- Clearance directly related to UF rate
- Lower replacement solution rates

Disadvantage:

- Hemoconcentration in filter increase risk of filter clotting
- May increase need for anticoagulant or BFR
- Limit on UF rate due to hemoconcentration of blood





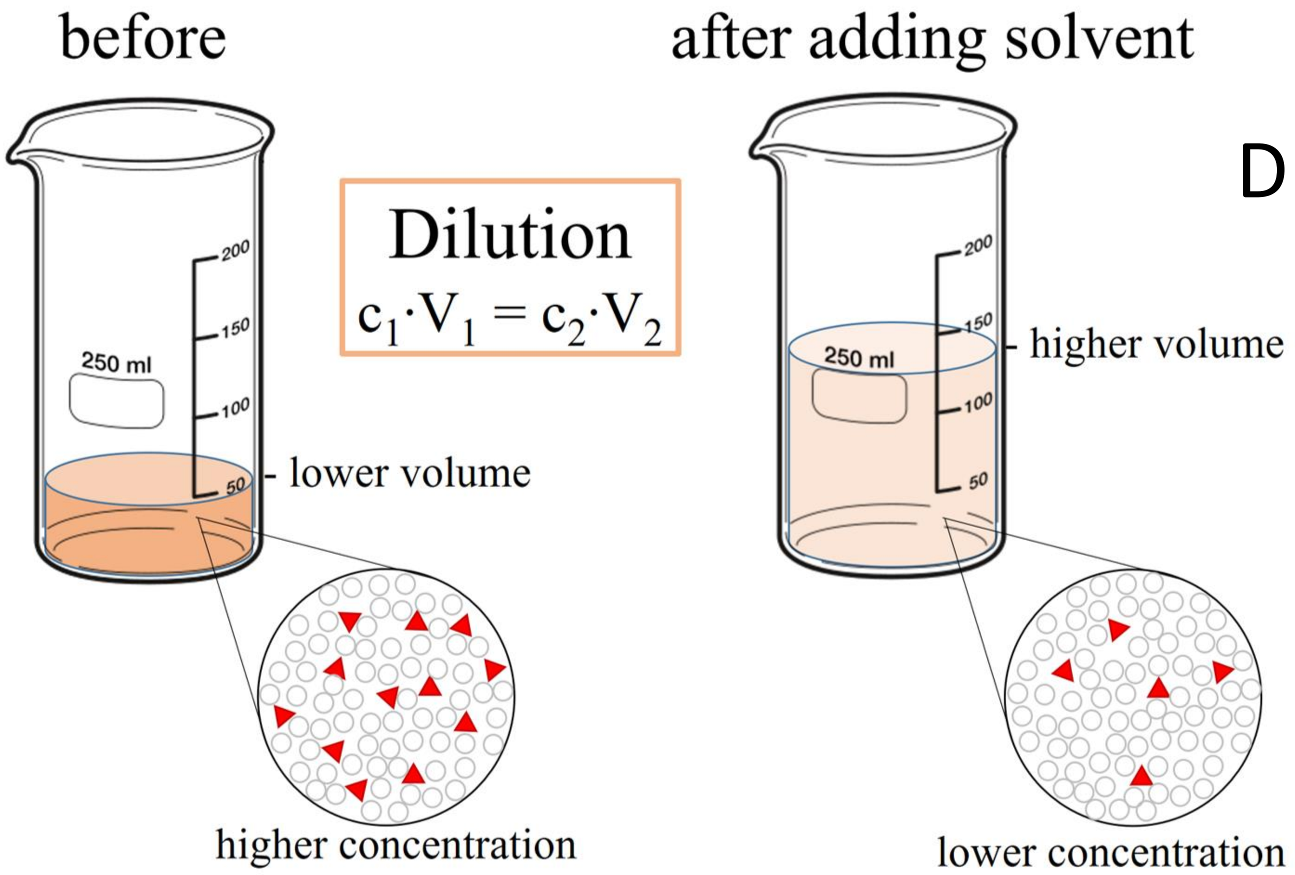
Pre-dilution	Post-dilution
Low risk of clotting	High risk of clotting

No clinical study has definitively addressed when pre- or post-dilution HF should be used, so this decision is largely a matter of local experience and preference.

Ronco et al. Critical Care (2015) 19:146

www.NephroTubeCNE.com

Dilution effect on clearance



DF=V1/V2

Dilution factor:

$$DF = \frac{\text{Plasma flow}}{\text{Plasma Flow + Pre replacement fluid}}$$

Plasma flow ={(1- Htc) x Q blood

Dialysis fluid not affect on dilution factor

Dilution factor example

- If blood flow is 120 , HCT is 40%
- Plasma flow=120(1-40)=72CC
- If replacement fluidrate=1800cc/h=30cc/min
- Solute concentration is diluted by 30%
- DF=72/72+30=70%

$$FF = \frac{\text{fluid removed from the filter}}{\text{fluid entering the filter}}$$

$$FF = \frac{\text{Ultrafiltration Flow}}{\text{Plasma Flow + Predilution}}$$

Filtration Fraction

$$FF = \frac{\text{Ultrafiltration Flow}}{\text{Plasma Flow + Predilution}}$$

$$= \frac{\text{Pre + Post + net UF}}{\{(1-\text{Htc}) \times \text{Q blood}\} + \text{Predilution}}$$

Must be kept <20% to minimize coagulation

- Implies the **highest possible blood flow**
- Adapt ultrafiltration to max blood flow
- Catheter might be a limiting factor

Filtration Fraction

FF = Ultrafiltration Flow / (Plasma Flow + Predilution)

Must be kept <20% to minimize coagulation

In CVVHD Mode: filtration fraction is never an issue (usually <5%)

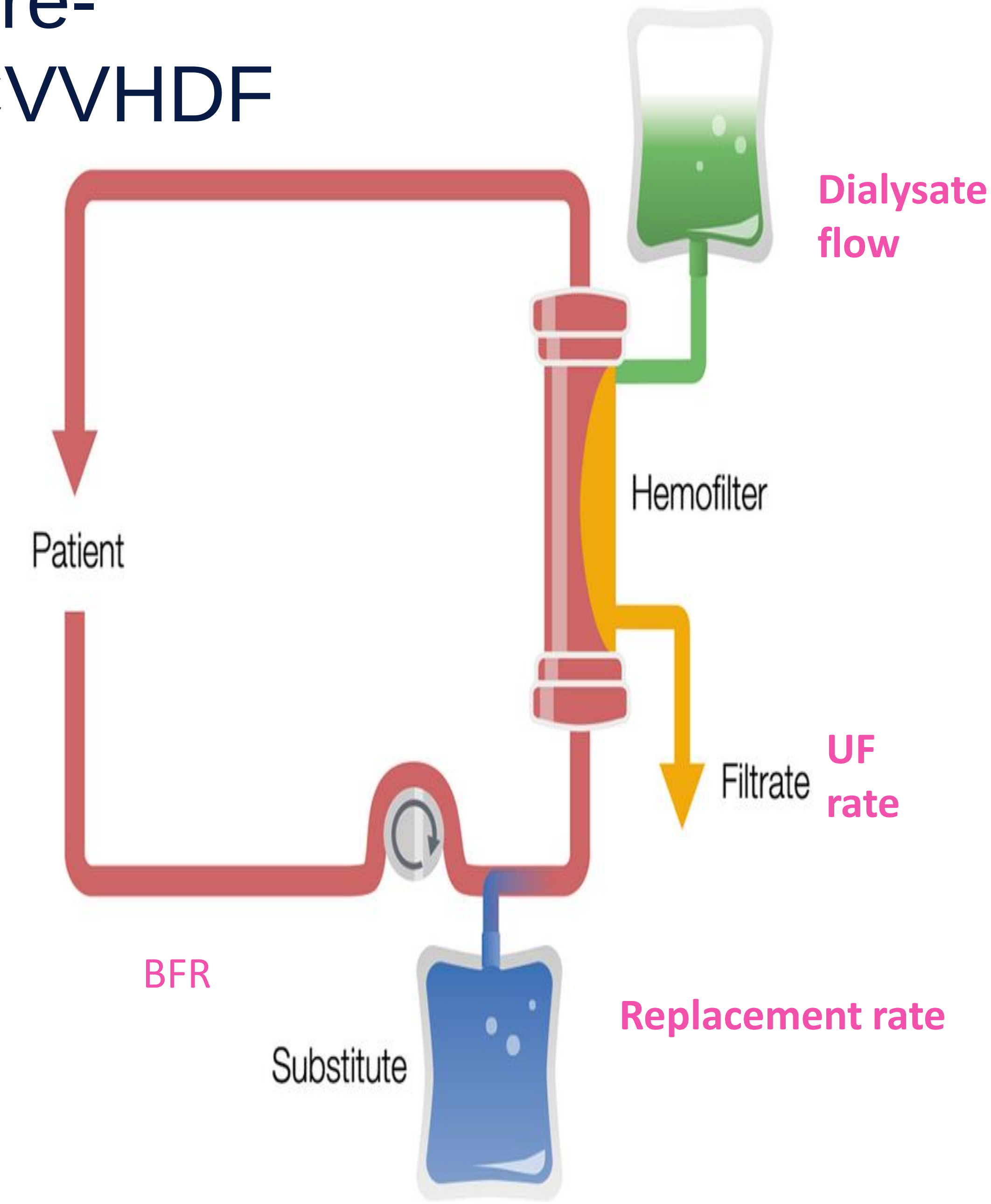
=

catheter might be a limiting factor

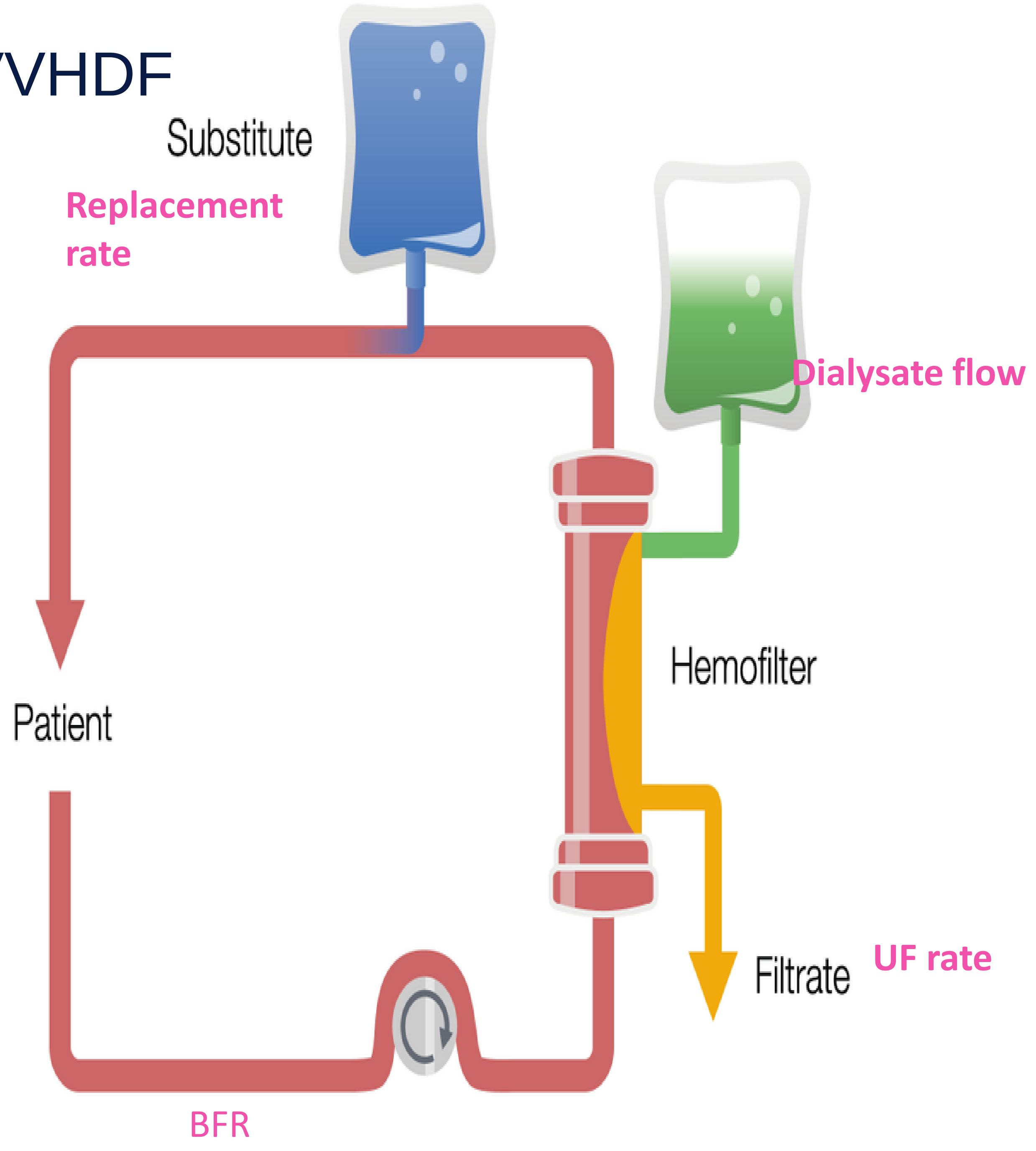
CVVHDF :diffusion, convection and ultrafiltration

- **Continuous veno-venous hemodiafiltration**
  - **Requires the use of a blood, effluent, dialysate and replacement pumps**
  - **Both dialysate and replacement solutions are used**
  - **High flux membranes**
  - **Extended period up to weeks**
  - **Countercurrent dialysate**
  - **Blood flow 50-200 ml/min, UF rate: base on patient volume status, Dialysate flow 15-30 ml/min**

Pre-CVVHDF

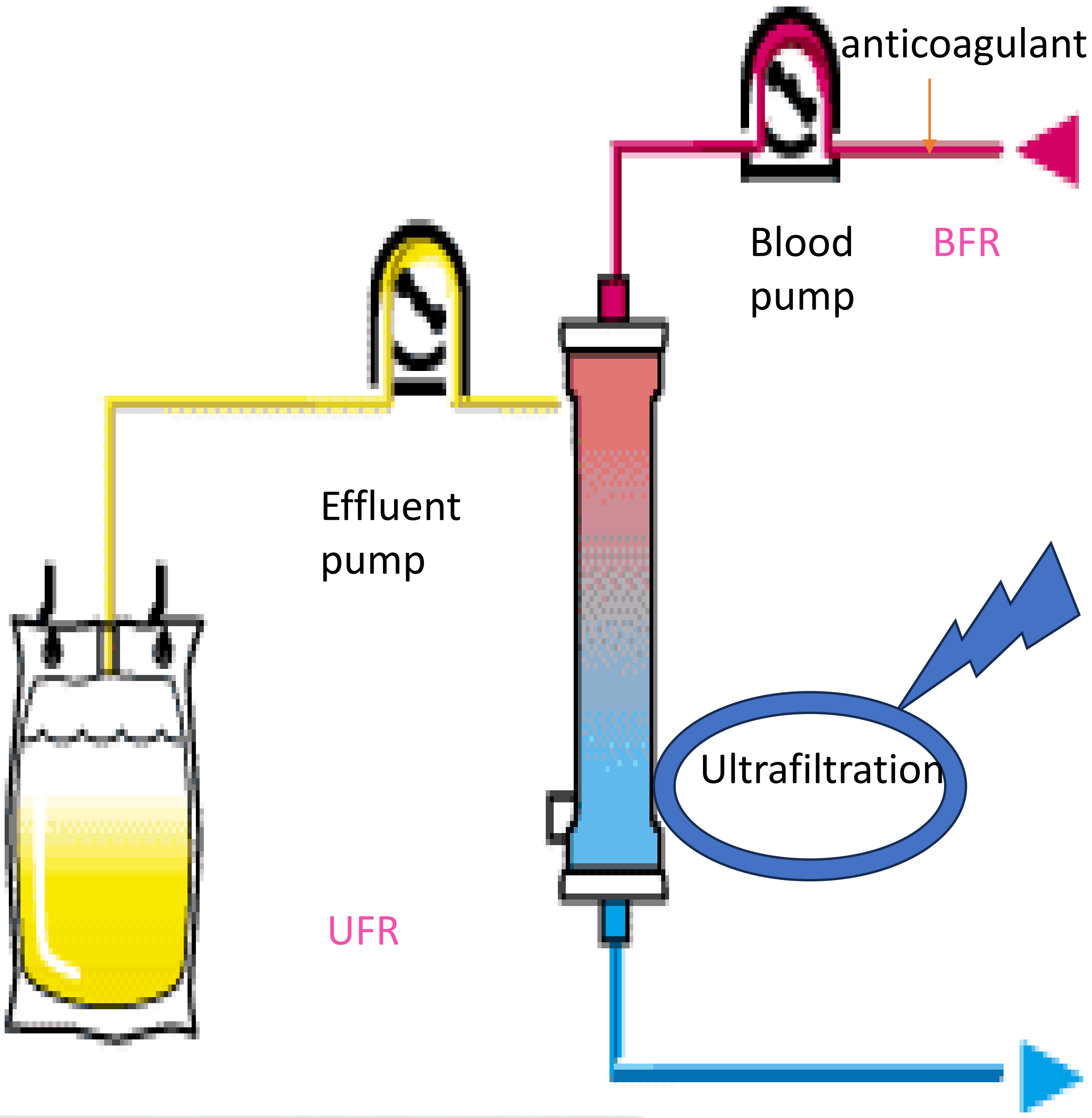


Post-CVVHDF

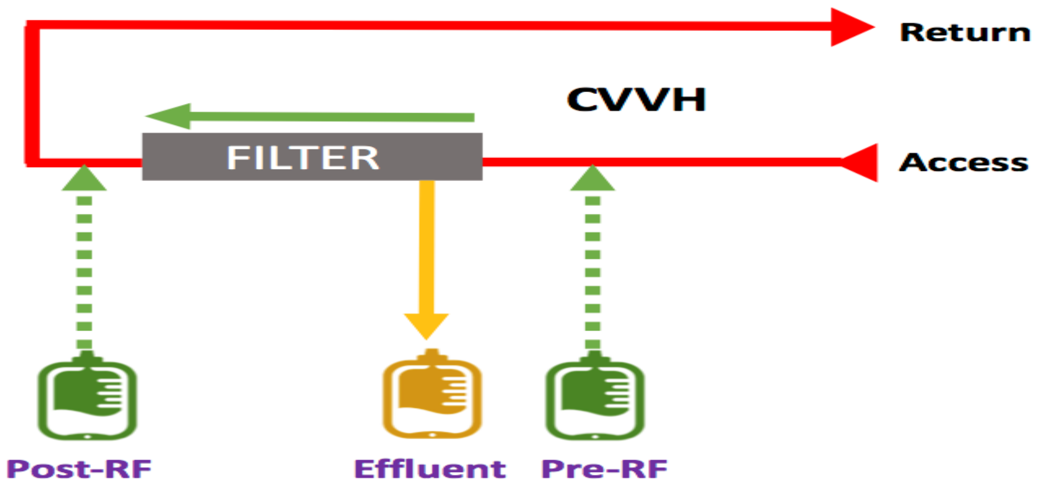


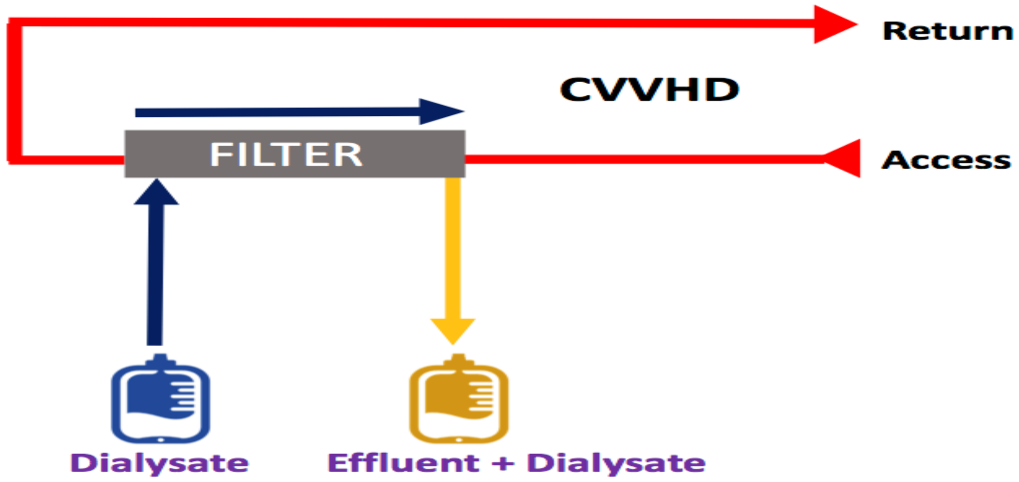
Slow continuous ultrafiltration:SCUF

- **No dialysate or replacement solution**
- **High flux membranes**
- **Blood flow 50-200 ml/min**
- **UF rate 2-8 ml/min(100-300cc/h)**
- **Indication:**
- **Volume overload Refractory to diuretics**
- **Not result in significant convective clearance of solute**

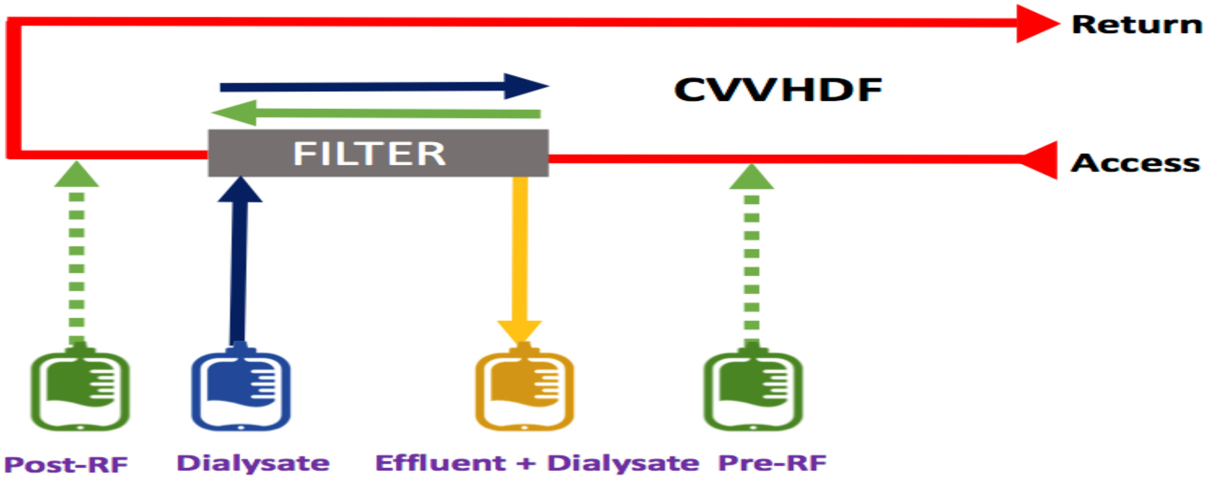


CRRT DOSE Prescribed;effluent rate normalized to body weight (25-30cc/kg/h)





Effluent = ultrafiltrate (UFNET) + replacement fluid and/or dialysate



Fluid balance in CRRT;UFNET rate

- Fluid removal directly from the patients intravascular compartment
- UFNET rate is not the same as machine set fluid removal rate
- continuous evaluation of the patient
- UFNET depends on fluid balance patients:(overload, dehydrated or normovolumia), Underlying pathophysiology ; hemodynamic tolerance(vasopressors and inotropes dose).,…

Net Uf rate:

- Start fluid removal at 1 mL/kg/h with close monitoring of hemodynamics
- gradually increased at 0.5 mL/kg/h up to 2 -3mL/kg/h **as tolerated**

- For example patient weight is 80 kg and overload:

start fluid removal at 1 mL/kg/h (i.e., 80 mL/h) with close monitoring of hemodynamics. then be gradually increased at 0.5 mL/kg/h (i.e., 40 mL every h) up to 2-3 mL/kg/h (i.e., 160-180 mL/h)

UFNET rate:

- patient receiving 70 mL/h of intravenous fluids ; need 80cc/h UF rate
- UF rate at first hours :
- 1 mL/kg/h (80 mL/h) +(70 mL/h) =150 mL/h

Patient NET UF:

- Fluid removal directly from the patients intravascular compartment
- Non-CRRT intake and output must be calculated
- Sample:

Intake non CRRT: IV fluid(100cc/h)+ NG(75cc/h)=175

Output non CRRT: urine(10cc/h)+ other out put (drain,…)=10

Balance non CRRT=165

Desired net Fluid removal with CRRT: 100CC/h

Net fluid removal rate to be set on CRRT : 165+100=265cc/h

Goal of UFNET rate:

- Recent observational studies indicate that UFNET rates >1.75 mL/kg/h are associated with an increased risk of death, decreased renal recovery, and hemodynamic instability compared with UFNET rates between 1.01 and 1.75 mL/kg/h during CRRT

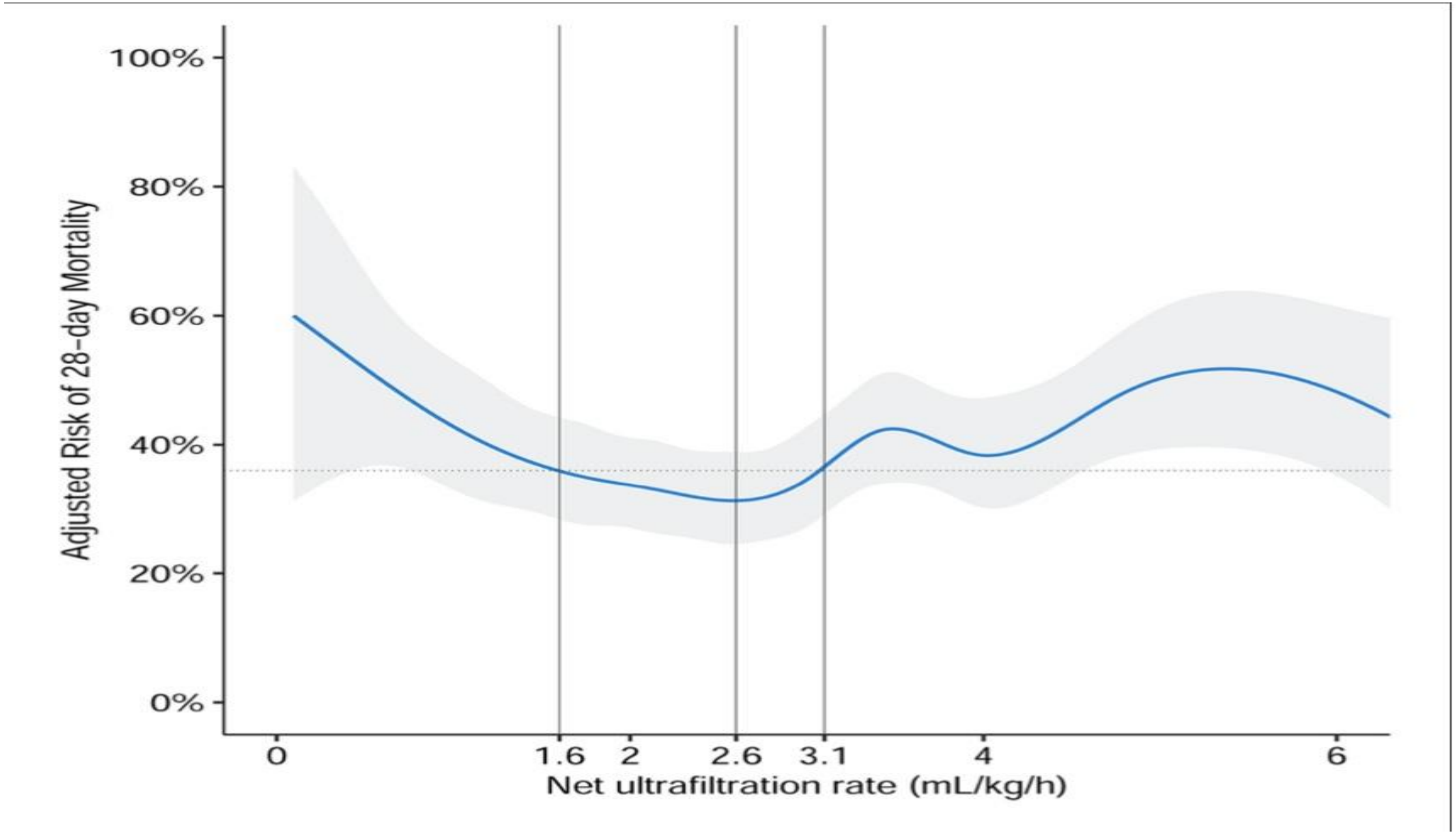
2021;203(9):1199–201.

The Association of an Early Net Ultrafiltration Rate and 28-Day Mortality in Patients Receiving Continuous Kidney Replacement Therapy

*Buyun Wu†, Yining Shen†, Yudie Peng, Changying Xing and Huijuan Mao**

Retrospective, observational study
All patients in Intensive Care Unit,Total of patients: 911

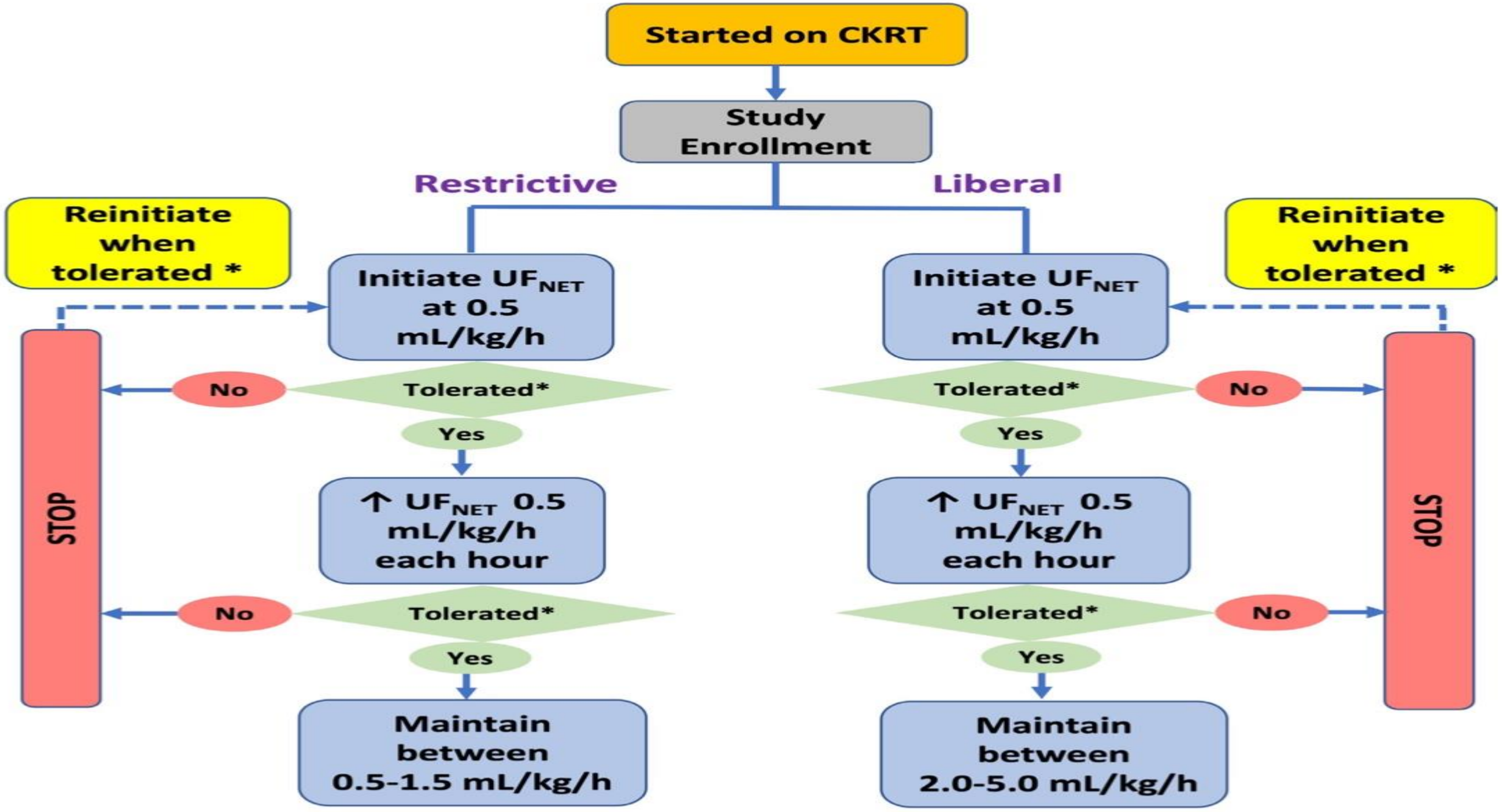
CRRT for more than 24 h within 14 days after intensive care unit admission
Early (initial 48 h) NUF rate as the amount of fluid removal per hour adjusted by the patients’ weight and took it as a classified variable (low rate: < 1.6, moderate rate: 1.6–3.1 and high rate: > 3.1 ml/kg/h)



Compared with NUF rates between 1.6–3.1 ml/kg/h in the first 48 h of CKRT, NUF rates > 3.1 and < 1.6 ml/kg/h were associated with higher mortality.

BMJ Open

Restrictive versus Liberal Rate of Extracorporeal Volume Removal Evaluation in Acute Kidney Injury (RELIEVE-AKI): a pilot clinical trial protocol



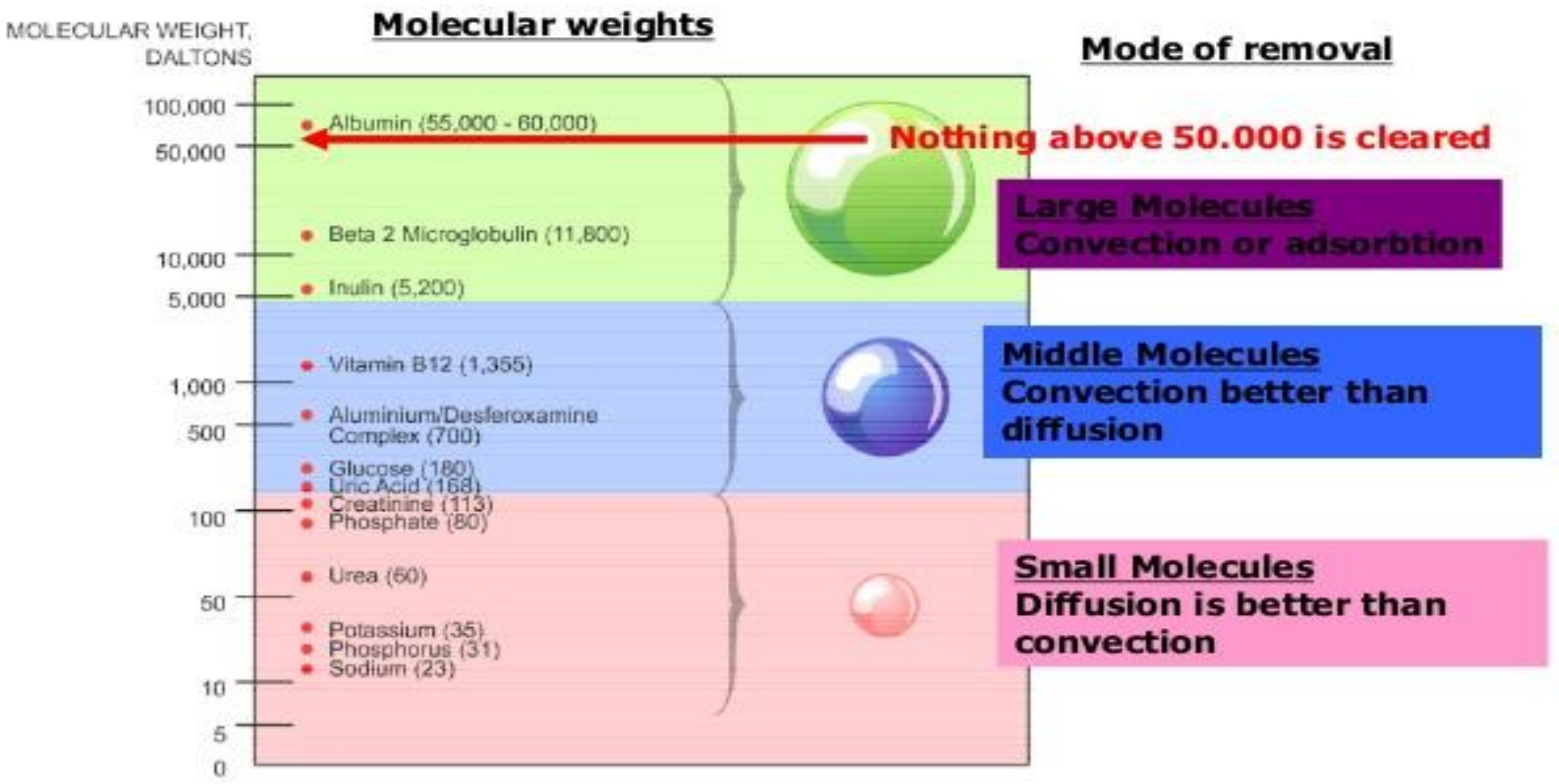
* Tolerance assessed by MAP ≥65 mmHg and systolic blood pressure ≥90mmHg

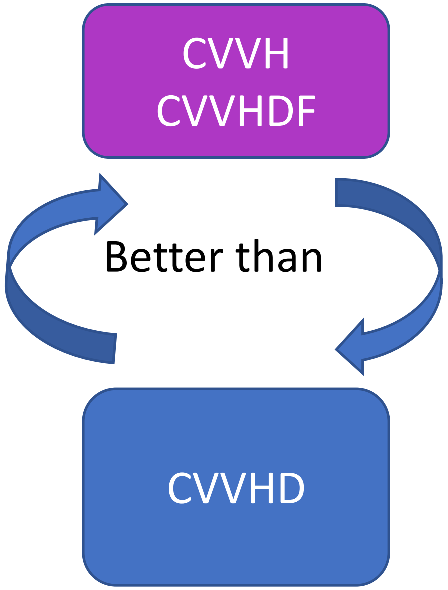
CRRT modality Choice

What about clearance?

CRRT Modality

Size of molecules cleared by CRRT Hemofilter





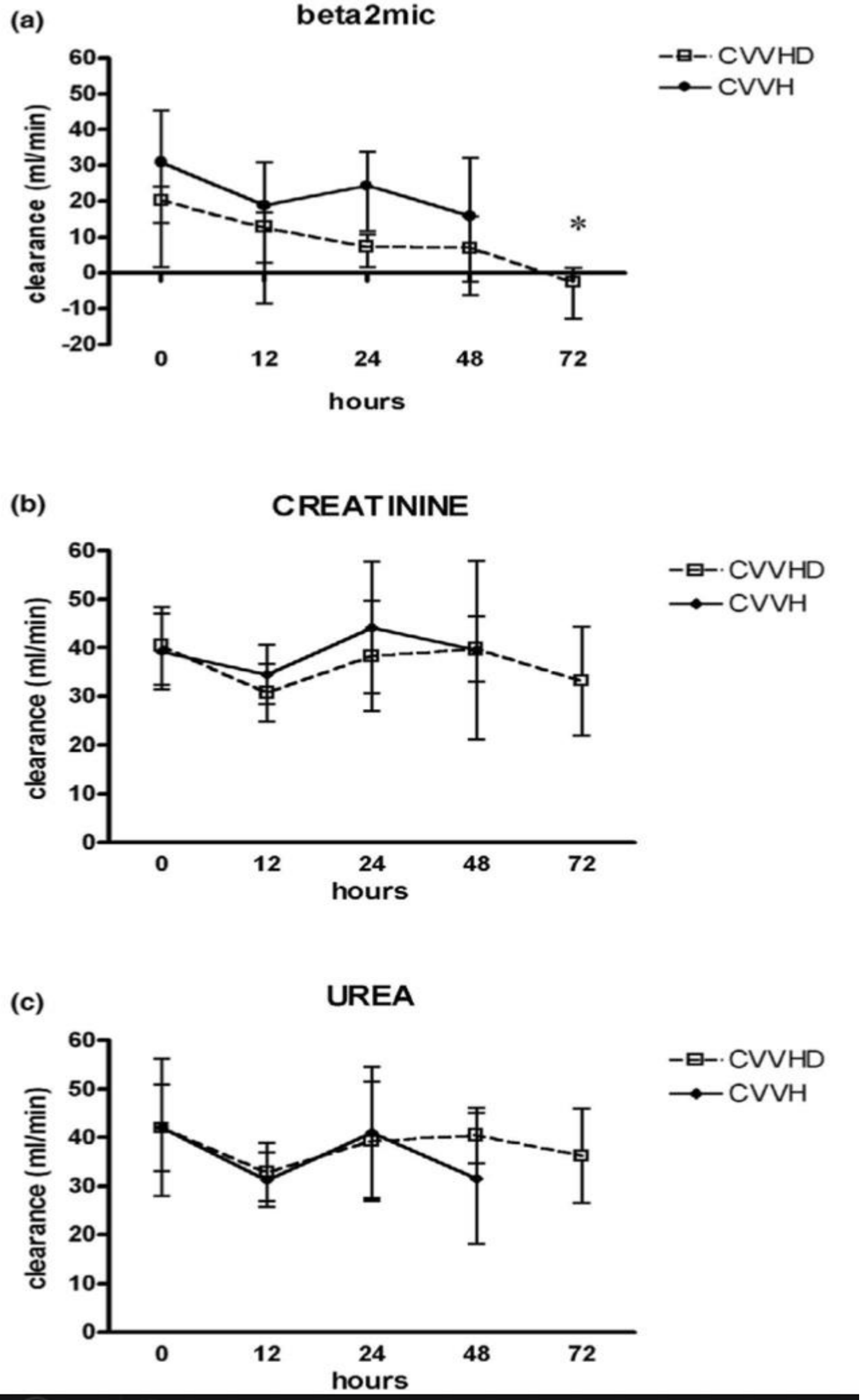
Research

Open Access

Solute removal during continuous renal replacement therapy in critically ill patients: convection versus diffusion

Zaccaria Ricci[1], Claudio Ronco[2], Alessandra Bachetoni[3], Giuseppe D'amico[4], Stefano Rossi[4], Elisa Alessandri[1], Monica Rocco[1] and Paolo Pietropaoli[5]

comparable for the removal of small and middle molecular weight solutes



THE CHANGES OF THE C REACTIVE PROTEIN LEVEL DURING THE CRRT PROCEDURE

- Observational, retrospectively prospective study
- 154 pts(343 CRRT)
- RRT modalities : CVVHD and CVVHDF
- CRRT modality impact on changes of CRP level
- In a higher percentage of CVVHD proc (48.32%) a decrease in CRP level was seen compared to CVVHDF proc (36.36%) (p = 035). A significant difference was found in the changes of CRP levels in relation to the filters used (p = 011)
- Conclusion: level of CRP in significantly influenced by the average hourly ultrafiltration, the CRRT modality, the filter used.

Blood Purification

Critical Care Nephrology – Research Article

Blood Purif 2022;51:840–846
DOI: 10.1159/000521312

Received: September 1, 2021
Accepted: December 2, 2021
Published online: January 18, 2022

Ammonia Clearance with Different Continuous Renal Replacement Therapy Techniques in Patients with Liver Failure

12 Adult patients with hyperammonaemia, liver failure, and AKI
CVVH ,CVVHD or CVVHDF
No significant difference in ammonia clearance according to CRRT technique and demonstrated that ammonia clearance is significantly less than urea or creatinine clearance

Available online at ScienceDirect
Resuscitation
journal homepage: www.elsevier.com/locate/resuscitation

Letter to the Editor

Is continuous renal replacement therapy an option for hyperkalemic cardiocirculatory arrest?

- CRRT is less efficient than cHD with the need for an additional 23 minutes in CVVHDF and 38 minutes in CVVHD to reach a potassium concentration of 6.5 mmol/L
- This simulation provides evidence to support the fact that cHD remains the standard RRT in HCA. CRRT should only be used when cHD is not available and **CVVHDF** (using the above optimized parameters) should be the preferred mode of therapy

What about life span of filter?

Comparison of filter life span and solute removal during continuous renal replacement therapy: convection versus diffusion - A randomized controlled trial

Sixty patients CVVHDF (n = 30) or CVVH (n = 30)

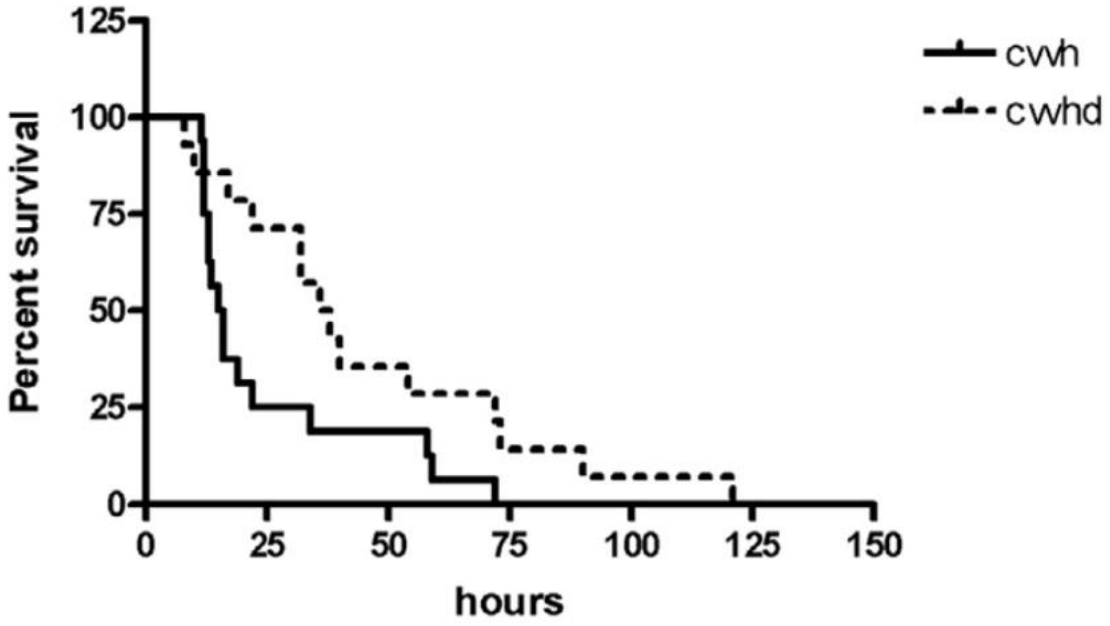
Patients in the CVVH group had a shorter median time of filter life span compared with those in the CVVHDF group (20 vs. 37.5 h, $p = 0.002$). **Urea and creatinine clearance were not significantly different between groups over time** ($p > 0.05$). **IL-6, β2-microglobulin, and myoglobulin clearance were higher in the CVVH group**

Research

Open Access

Solute removal during continuous renal replacement therapy in critically ill patients: convection versus diffusion

Zaccaria Ricci[1], Claudio Ronco[2], Alessandra Bachetoni[3], Giuseppe D'amico[4], Stefano Rossi[4], Elisa Alessandri[1], Monica Rocco[1] and Paolo Pietropaoli[5]



Kaplan-Meier analysis of circuit survival for continuous veno-venous hemofiltration (CVVH) and continuous veno-venous dialysis (CVVHD).

- Median filter lifespan was significantly longer during CVVHD (37 hours, IQR 19.5 to 72.5) than CVVH (19 hours, IQR 12.5 to 28) ($p = 0.03$)

RESEARCH ARTICLE

CVVHD results in longer filter life than pre-filter CVVH: Results of a quasi-randomized clinical trial

Lewis Mann[1], Patrick Ten Eyck[2], Chaorong Wu[2], Maria Story[1], Sree Jenigiri[1],

unblinded, quasi-randomized cluster trial conducted in critically ill adult patients with severe acute kidney injury (AKI)

sample size of 137 patients

filter life, number of filters used, number of filters reaching 72 hours, and in-hospital mortality

PLOS ONE | https://doi.org/10.1371/journal.pone.0278550 January 11, 2023

RESEARCH ARTICLE

CVVHD results in longer filter life than pre-filter CVVH: Results of a quasi-randomized clinical trial

Unadjusted Outcomes*	***CVVH (n = 94, 346)***	***CVVHD (n = 67, 245)***	***P value***
	N (%)	***N (%)***	
Filter Life, hours, median (IQR)	21.8 (11.4–45.3)	26.6 (13.0–63.5)	**.02**
Filter Life, hours, mean (SD)	32.1 (28.1)	40.0 (34.2)	**.002**
Number of filters, median (IQR)	2 (1–4)	2 (1–5)	.86
CKRT Days, median (IQR)	3 (2–7)	4 (2–9.25)	.31
Filter Life >72 hours	41 (11.8)	52 (21.2)	**.002**
In-hospital mortality	57 (60.6)	47 (70.1)	.21
Reason for Filter Loss‡			**.04**
Clotting/Clogging	92 (26.7)	43 (17.5)	
Maximu			
Imaging			
Access c			
Death/H			
Other/U			
Modeled C			*P value*
Intention-to			**.02**
Per Protocol	0.82 (0.68–1.00)		**.04**

Among critically patients with severe AKI requiring CKRT, use of pre-filter CVVH resulted in significantly shorter filter life compared to CVVHD

P-values < 0.05 are **Bolded**.

*Values are frequency and column percents unless otherwise specified

Received: 14 November 2022 | Accepted: 8 February 2023
DOI: 10.1111/sdi.13147

Seminars in Dialysis WILEY

ORIGINAL ARTICLE

An evaluation of different dilution modes on circuit lifespan during continuous veno-venous hemodiafiltration without anticoagulation

Characteristic	Pre-dilution (n = 40)	Post-dilution (n = 42)	Pre- to post-dilution (n = 50)	p
Demographics				
Sex, no. (%)				0.360
Men	26 (65.0)	33 (78.6)	34 (68.0)	
Women	14 (35.0)	9 (21.4)	16 (32.0)	
Age, mean (SD), y	48.58 (16.23)	49.86 (17.43)	50.69 (16.65)	0.839
Vascular access, *n* (%)				0.803
Femoral vein	36 (90.0)	37 (88.1)	44 (88.0)	
Jugular vein	3 (7.5)	4 (9.5)	6 (12.0)	
Vena subclavia	1 (2.5)	1 (2.4)	0 (0)	
Baseline characteristics				
Hb, mean (SD), g/L	94.1 (30.90)	102.00 (27.20)	96.90 (26.40)	0.146
WBC, median (IQR), 10^9/L	10.5 (11.30)	12.7 (1.60)	13.6 (6.80)	0.062
APTT, mean (SD), s	54.29 (27.56)	51.81 (29.21)	57.87 (27.22)	0.614
PT, mean (SD), s	19.94 (12.22)	16.55 (4.98)	22.19 (13.39)	0.057
PLT, median (IQR), 10^9/L	39.00 (100.00)	48.5 (98.51)	30 (84.00)	0.411
HCT, median (IQR), 10^9/L	0.25 (0.10)	0.26 (0.06)	0.25 (0.07)	0.729
TG, mean (SD), mmol/L	1.6 (1.3)	1.5 (1.3)	1.9 (1.5)	0.407
TC, mean (SD), mmol/L	2.2 (1.1)	2.2 (1.1)	1.8 (0.7)	0.460
BUN, mean (SD), mmol/L	12.36 (9.30)	13.99 (8.81)	12.74 (8.30)	0.666
Scr, mean (SD), μmol/L	119.15 (70.83)	131.36 (83.50)	112.65 (73.20)	0.496
Underling disease, no. (%)				
Sepsis	9 (22.5)	4 (9.5)	8 (16.0)	0.285
Myocarditis	2 (5.0)	0 (0.0)	1 (2.0)	0.393
AKI	16 (40.0)	21 (50.0)	18 (36.0)	0.398
SAP	4 (10.0)	8 (19.0)	11 (22.0)	0.313
MODS	1 (2.5)	4 (9.5)	5 (10.0)	0.355
Hepatic failure	3 (7.5)	2 (4.8)	3 (6.0)	0.905
Severe pneumonia	4 (10.0)	5 (9.5)	4 (8.0)	0.933
CKD	1 (2.5)	0 (0.0)	1 (2.0)	0.757
Traffic accident injuries	2 (5.0)	0 (0.0)	1 (2.0)	0.393
Others	1 (2.5)	0 (0.0)	1 (2.0)	0.757
Filter membrane, no. (%)				0.078
AN69-M150	18 (45.0)	22 (51.2)	34 (45.9)	
AN69-ST150	22 (55.0)	21 (48.9)	16 (68.0)	

Characteristic	Pre-dilution (*n* = 40)	Post-dilution (*n* = 42)	Pre- to post-dilution (*n* = 50)	p
Primary outcome				
Circuit life span, mean (SD), h	31.58 (16.39)[1]	35.20 (17.91)[2]	45.72 (21.00)	0.001
Circuit clotting site, no. (%)	[illegible]	[illegible]	[illegible]	0.001
Filter clotting	[illegible]	[illegible]	[illegible]	
Bubble trap cha	[illegible]	[illegible]	[illegible]	
Secondary outcomes				
ΔScr, median (IQR), μmol/L	[illegible]	[illegible]	14.00 (32.00)	0.747
ΔBUN, median (IQR), mmol/L	2.25 [illegible]	2.60 (5.30)	2.81 (4.09)	0.316
Length of stay, mean (SD), d	29.62 (19.58)	33.00 (27.92)	32.98 (27.25)	0.788
All-cause mortality, no. (%)				
28 d	27 (67.5)	29 (69.0)	34 (68.0%)	0.221

The pre- to post-dilution mode significantly extends the circuit lifespan during CVVHDF for critically ill patients undergoing CKRT without anticoagulant use

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ORIGINAL ARTICLE

Further improvement of circuit survival in citrate based continuous renal replacement therapy

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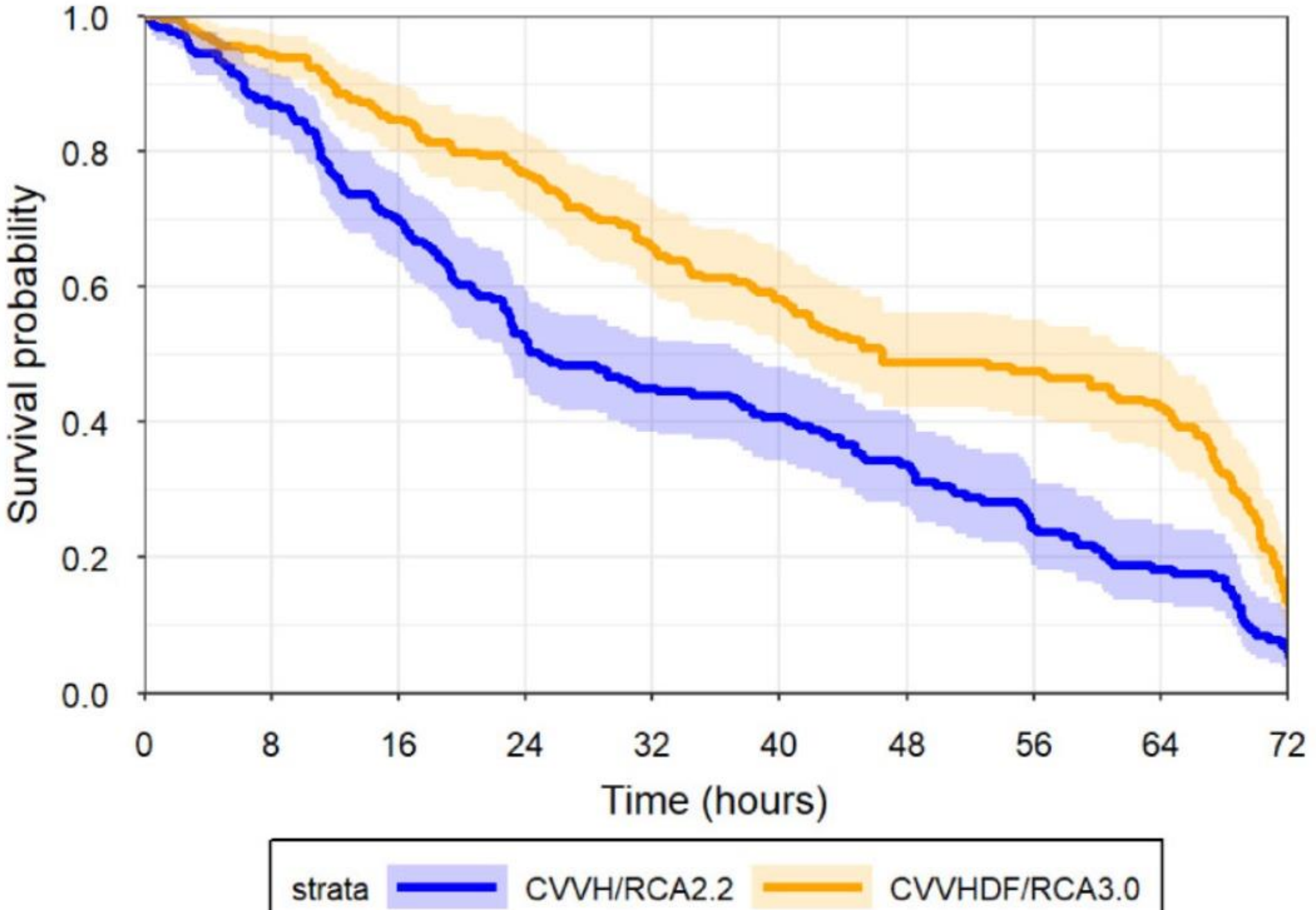
and Meir



ISN INTERNATIONAL SOCIETY OF NEPHROLOGY

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IRANIAN SOCIETY OF NEPHROLOGY

What about survival?

SURVIVAL COMPARISON BETWEEN CVVHDF AND CVVH FOR SEPTIC ACUTE KIDNEY INJURY

- Prospective randomized pilot study
- 100 patients were assigned to CVVH or CVVHDF
- Baseline characteristics did not vary (age, sex, body weight, serum creatinine, blood urea nitrogen (BUN), beta-2 microglobulin, APACHE II and SOFA)
- No significant differences in the reduction ratios of serum creatinine, BUN, beta-2 microglobulin, APACHE II and SOFA scores between the two groups
- Seven-, 28- and 60-day survival also did not vary

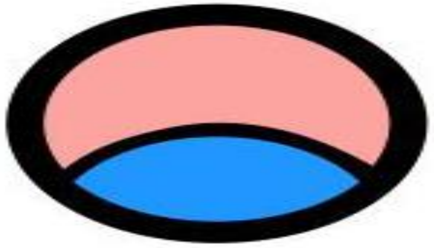
- **CONCLUSION:** CVVH and CVVHDF led to similar clearance of waste products and survival at the same net effluent in this study

Why Is CVVHD my preferred modality?

1. Low blood flows
   - Less risk of citrate accumulation
   - Less strain on the catheter
2. No need for predilution
3. Similar clearance for small molecules
4. Less protein cake formation

Vascular acssess:

- Ideally vascular access should be:
  - Made of silicone (biocompatibility and less “kinking”)
  - Designed to minimize turbulent flow: shotgun tip and « kidney » shape lumen
  - Inserted in a large vessel (prefer RIJ or femoral veins)



OPTIMAL CATHETER LOCATION

- The optimal site for catheter insertion is uncertain
- Avoid subclavian dialysis catheters (risks of subclavian vein stenosis, disability for direct hemostasis in the event of hemorrhage)
- KDIGO guidelines recommend:

1. Right internal jugular vein
2. Right femoral veins
3. left internal jugular vein –femoral
4. Subclavian vein
5. External jugular veins :when other veins are not usable

Reserve the contralateral side for future dialysis access

Hemodialysis catheter:

- Temporary HD catheter
- Length of catheter: important for sufficient BFR and less clotting

❖RIJ: 15-20 cm

❖Femoral: 24-30 cm

❖Left IJ: 20-24 CM

❖Subclavian: 20cm

cuffed catheter& AV access

➢**cuffed catheter**

might sometimes delay initiation of therapy

average duration of CRRT is only 12–13 days

➢**CRRT using AV access:**

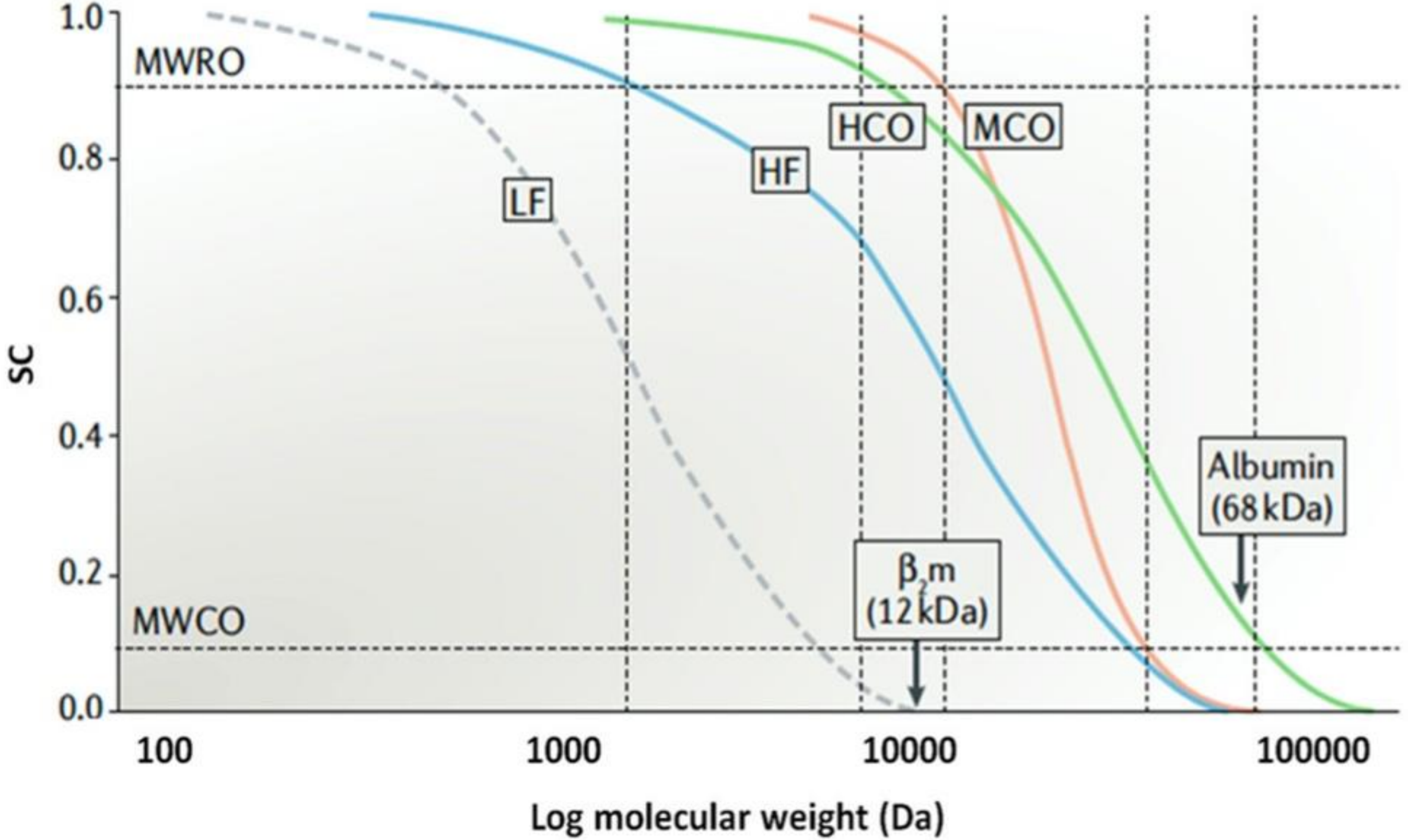
may be lifesaving in situations (e.g., earthquake ,rhabdomyolysis)

➢**Catheter changes:**

only when clinically indicated; catheters should not be changed according to some predetermined schedule in the hopes of minimizing the rate of catheter sepsis

Classification of commercial dialyzers accordance with the clearance of β2-microglobulin (β2-M) and the level of albumin loss (in gram) per 4 h

Class	[a] Ultrafiltration Coefficient, K_{UF} (mL/h/mmHg)	β_2-Microglobulin (β_2-M)		Albumin	
		[b] Clearance (mL/min)	[c] Sieving Coefficient	[d] Loss into Dialysate (g)	[c] Sieving Coefficient
Low flux	<10	<10	-	0	0
High flux	20–40	20–80	<0.7–0.8	<0.5	<0.01
Medium cut-off	40–60	>80	0.99	2–4	<0.01
Protein leaking	>40	>80	0.9–1.0	2–6	0.01–0.03
Super high flux	40–60	-	1.0	9–23	<0.2



1.0
0.8
0.6
0.4
0.2
0.0
SC
MWRO
MWCO
LF
HF
HCO
MCO
β2m
(12 kDa)
Albumin
(68 kDa)
100
1000
10000
100000
Log molecular weight (Da)

	MWRO(Da)	MWCO(Da)	Water Permeability (mL/h/mmHg/m^2)	Sieving Coefficient		Pore Radius (nm)
				β2m	Albumin	
Low-flux	2000–3000	15,000	10–20	-	<0.010	2.0–3.0
High-flux	4000–10,000	15,000–16,000	200–400	0.7–0.8	<0.010	3.5–5.5
Medium cut-off	10,000–13,000	60,000–100,000	600–850	1	0.008	5.0
High cut-off	15,000–20,000	200,000–300,000	1100	1	0.200	8.0–12.0

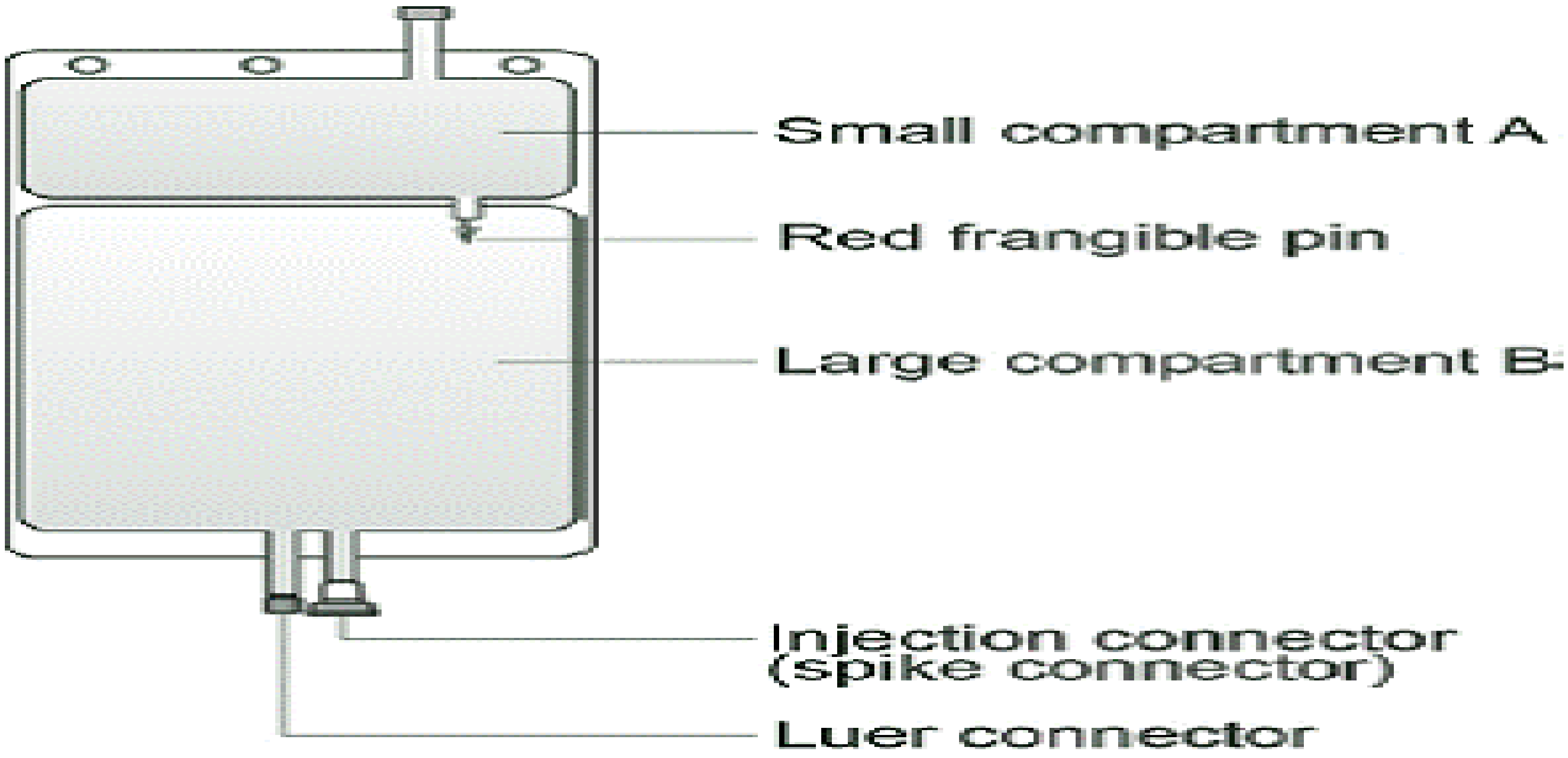
The membrane classification is based on the ultrafiltration coefficient (Kuf). The cut off value is defined by MWRO and MWCO. Abbreviations: MWRO, molecular weight retention onset; MWCO, molecular weight cut-off; β2m, beta-2 microglobulin.

Membrane (Protein-losing membranes)

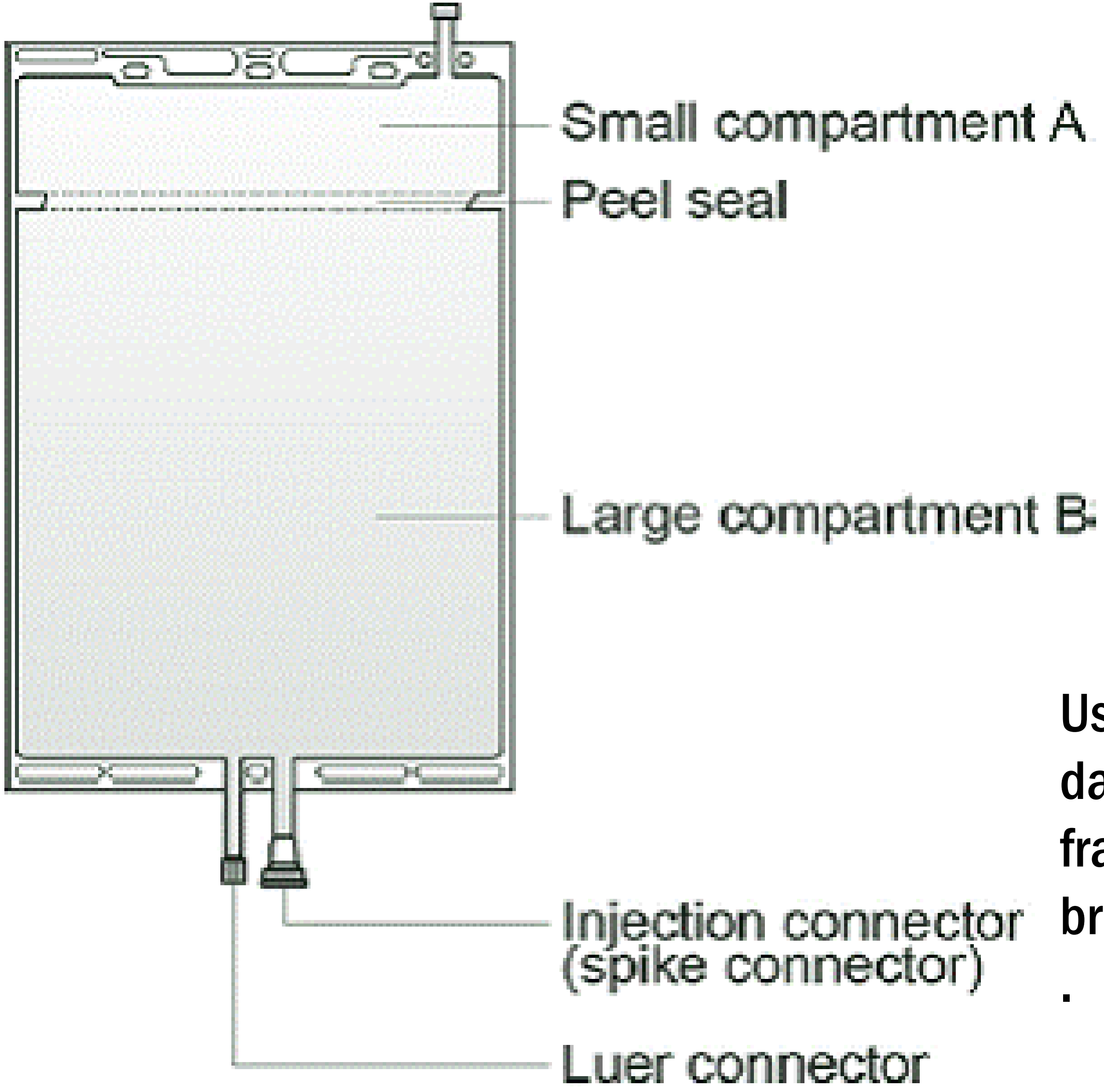
- Some uremic toxins are tightly bound to albumin
- Albumin is lost, but along with the albumin, protein-bound toxins would also be removed from the body
- Not routine usage
- Protein-leaking membranes are defined by a water permeability of >40 m/h/mmHg/m2, B2m SC of 0.9–1.0, and 2–6 g albumin loss

Composition of Some Continuous Renal Replacement Therapy Solutions

Component (mM)	Dialysis Machine Generated[a]	Peritoneal Dialysis Fluid[b]	Lactated Ringer Solution	B. Braun Duosol (5-L bag)	Baxter Accusol[b] (2.5-L bag)	Gambro Prismasol[c] (5-L bag)	Nxstage Pureflow[d] (5-L bag)
Sodium	140	132	130	136 or 140	140	140	140
Potassium	Variable	—	4	0 or 2	0 or 2 or 4	0 or 2 or 4	0 or 2 or 4
Chloride	Variable	96	109	107–111	109.5–116.3	106–113	111–120
Bicarbonate	Variable	—	—	25 or 35	30 or 35	32	25 or 35
Calcium	Variable	1.75 (3.5 mEq/L)	1.35 (2.7 mEq/L)	0 or 1.5 (0 or 3.0 (mEq/L)	1.4 or 1.75 (2.8 or 3.5 mEq/L)	0 or 1.25 or 1.75 (0 or 2.5 or 3.5 mEq/L)	0 or 1.25 or 1.5 (0 or 2.5 or 3.0 mEq/L)
Magnesium	0.75 (1.5 mEq/L)	0.25 (0.5 mEq/L)	—	0.5 or 0.75 (1.0 or 1.5 mEq/L)	0.5 or 0.75 (1.0 or 1.5 mEq/L)	0.5 or 0.75 (1.0 or 1.5 mEq/L)	0.5 or 0.75 (1.0 or 1.5 mEq/L)
Lactate	2	40	28	0	0	3	0
Glucose (mg/dL)	100	1,360	—	0 or 100	0 or 100	0 or 100	100
Glucose (mM)	5.5	75.5	—	0 or 5.5	0 or 5.5	0 or 5.5	5.5
Preparation method	6-L bag via membrane filtration	Premix	Premix	Two-compartment bag	Two-compartment bag	Two-compartment bag	Two-compartment bag
Sterility	No	Yes	Yes	Yes	Yes	Yes	Yes



•Small compartment A (250 mL) containing an electrolyte solution, and
•Large compartment B (4750 mL) containing the buffer solution.



Use only if the overwrap is not damaged, all seals are intact, frangible pin or peel seal is not broken, and the solution is clear.

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The solution may be warmed to 37°C

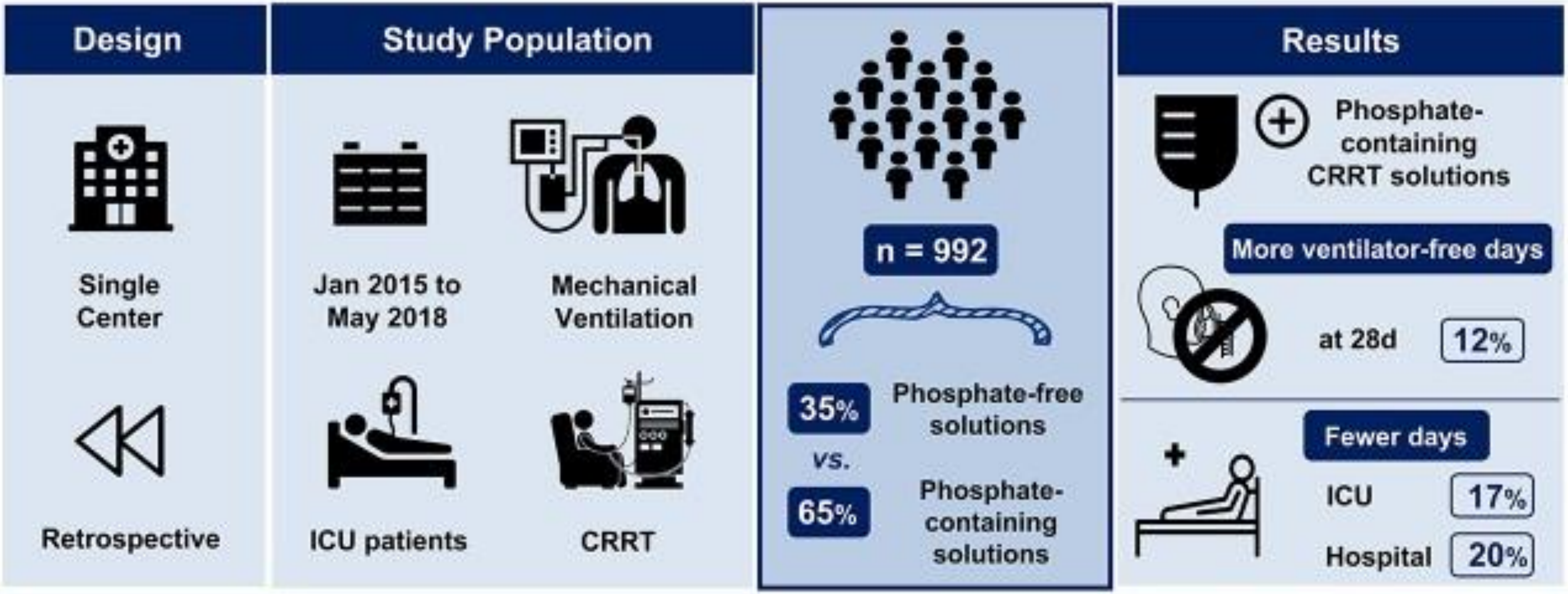
only dry heat should be used

Solutions should not be heated in water or in a microwave oven

After heating, verify that the solution remains clear and contains no particulate matter

Association of phosphate-containing versus phosphate-free solutions on ventilator days in critically ill patients requiring CRRT

CJASN
Clinical Journal of the American Society of Nephrology



Conclusions: The use of phosphate versus phosphate-free CRRT solutions was independently associated with fewer ventilator days and shorter stay in the ICU.

Melissa L. Thompson Bastin, Arnold J. Stromberg, Sethabhisha N. Nerusu, et al. ***Association of Phosphate-Containing versus Phosphate-Free Solutions on Ventilator Days in Patients Requiring Continuous Kidney Replacement Therapy***. CJASN doi: 10.2215/CJN.12410921. **Visual Abstract by José A. Moura-Neto, MD, FASN**

Dysnatremia

- patients with more extreme dysnatremias ([Na+] <120 mEq/L or [Na+] >165 mEq/L) are best treated using continuous renal replacement therapy (CRRT) with the occasional need for hypotonic or hypertonic CRRT solutions or intravenous infusion
- CRRT increase the safety margin for the rate of correction of sodium disorders in chronic dysnatremia

Managing severe hyponatremia

- Adequate pharmacy support to dilute CRRT fluid bags
- Infusing D5W water in conjunction with CRRT
- D5Wrate = CRRT[Na+] − target serum[Na+] / target serum[Na+] × (*QD* + *Q*RF))
- Effluent is often not fully saturated with diffusive clearance Therefore, the D5W rate required to keep serum sodium at target may be about 10% less than suggested by this formula
- **Administering hypotonic fluid via a separate infusion line**
- Adjusted every 6–8 h if needed to stay within the desired limits of correction

A patient with an initial serum sodium of 105 mEq/L, who is initiated on continuous venovenous hemodialysis with dialysate flow rate ~2000 ml/h, dialysate sodium 140 mEq/L.How many do you infuse DW5%?
435 ml/h of D5W (infused intravenously into the patient or into the return blood line of the CRRT circuit) will be needed to keep target sodium concentration less than or equal to ~115 mEq/L in the next 24 h

Administering a hypertonic infusion in a separate infusion line

- 3%saline infusion rate =Target serum [Na+] − CRRT[Na+] /513 − Target serum [Na+] × (QD + QRF)

- A patient with an initial sodium 180 mEq/L with target sodium concentration of no lower than 170 mEq/L who is initiated on CVVHD at dialysate flow rate of 2000 ml/h with CRRT fluid [Na +]= 140 mEq/L will require 3% saline infused at rate of ~175 ml/h
- The net ultrafiltration setting should be increased by the rate of 3% saline infusion (i.e. , ~175 ml/h) for isovolemic ultrafiltration

Any
Questions?

From: **Nomenclature of Extracorporeal Blood Purification Therapies for Acute Indications: The Nomenclature Standardization Conference**

Blood Purif. 2023;53(5):358-372. doi:10.1159/000533468