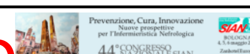
Concetti di base e tipologia di trattamento

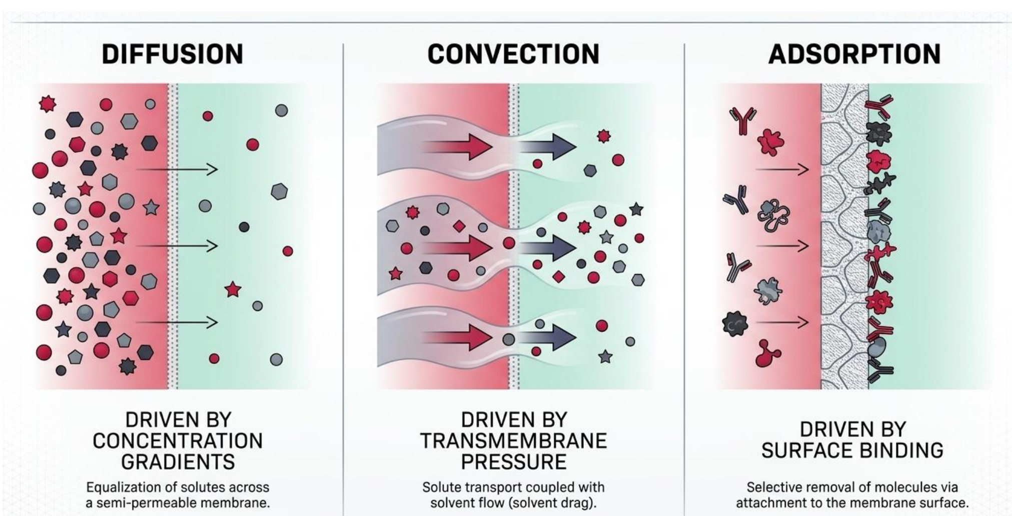
ZACCARIA RICCI

Meyer
Azienda Ospedaliero Universitaria

UNIVERSITÀ DEGLI STUDI FIRENZE
SCUOLA DI SPECIALIZZAZIONE IN
ANESTESIA, RIANIMAZIONE
TERAPIA INTENSIVA E DEL DOLORE



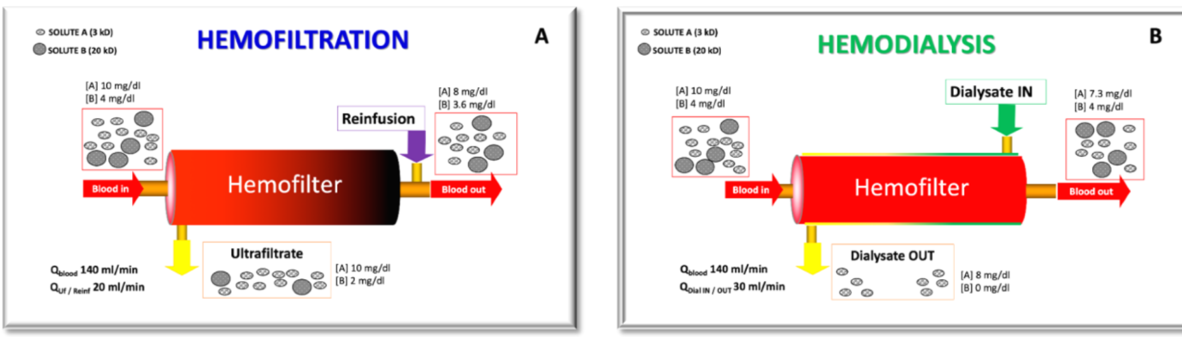
MECCANISMI DI TRASPORTO DEI SOLUTI

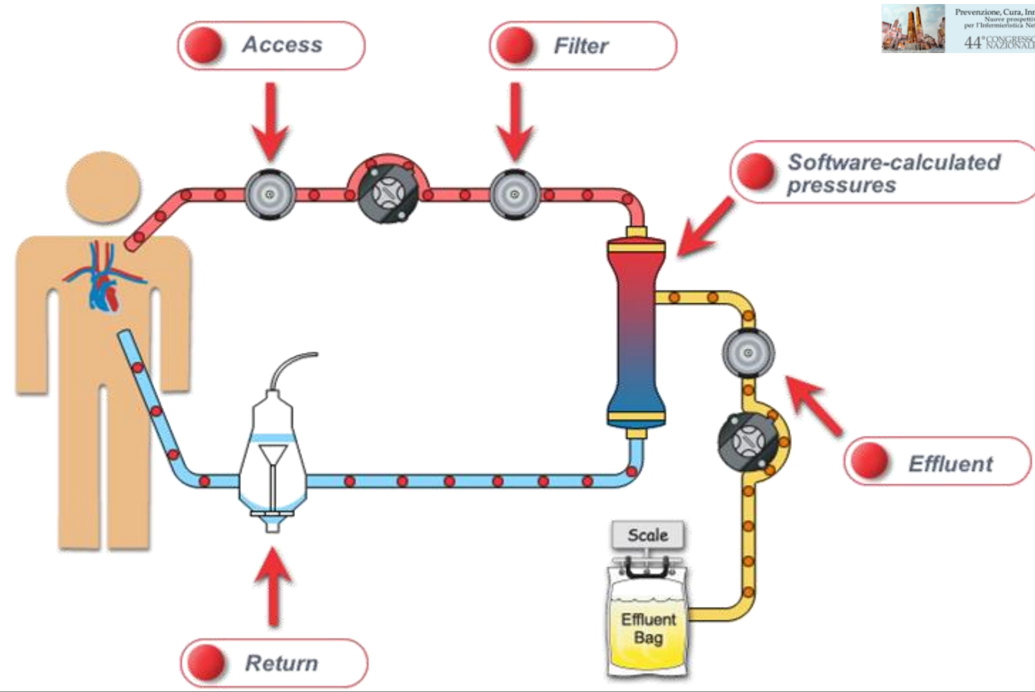


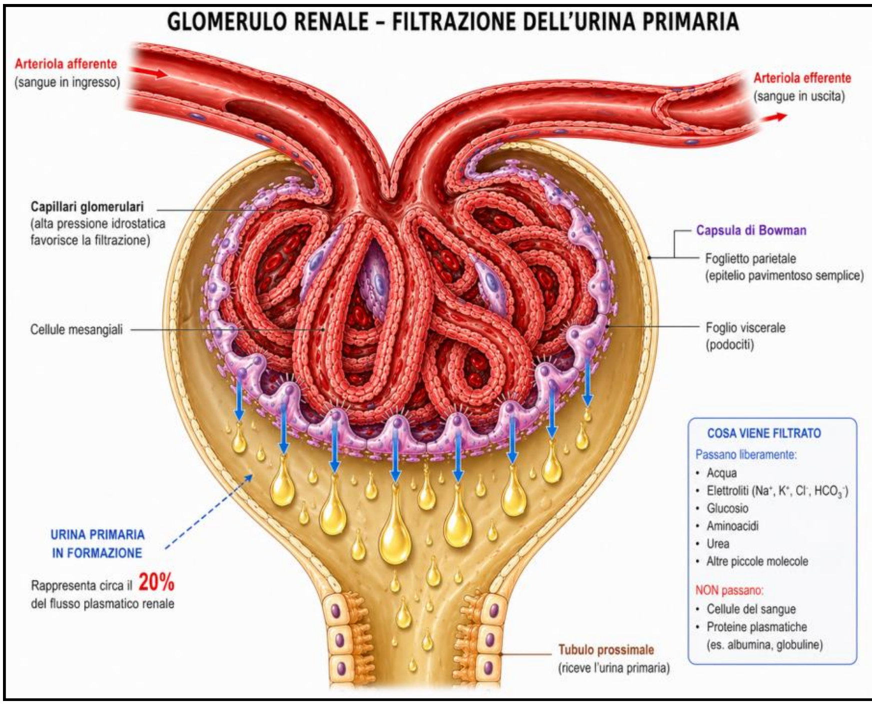
Nephrol Dial Transplant (2019) 1–3
doi: 10.1093/ndt/gfz022

Acute kidney injury: to dialyse or to filter?

Zaccaria Ricci[1,*], Stefano Romagnoli[2] and Claudio Ronco[3,4]
[1]Department of Cardiology and Cardiac Surgery, Pediatric Cardiac Intensive Care Unit, Bambino Gesù Children's Hospital, IRCCS, Rome, Italy, [2]Department of Anesthesiology and Intensive Care, Azienda Ospedaliero-Universitaria Careggi, Largo Brambilla, Florence, Italy, [3]Department of Nephrology, Dialysis and Transplantation, San Bortolo Hospital, Vicenza, Italy and [4]International Renal Research Institute of Vicenza, Vicenza, Italy



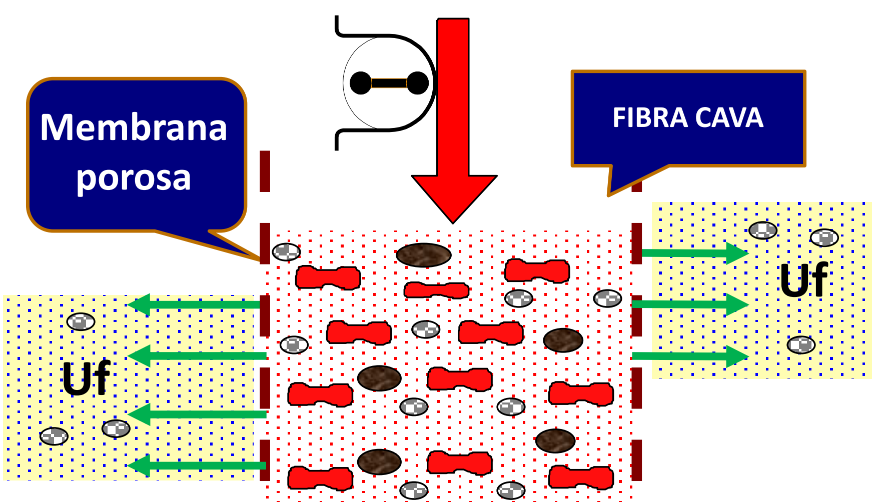




- ✓ **20% CO (5 L/min) -> RBF (1 L/min)**
- ✓ **Qp (30% hct) -> 700 ml/min**
- ✓ **20% di Qp -> 14[illegible]ml/min**

Glomerular Filtration Rate

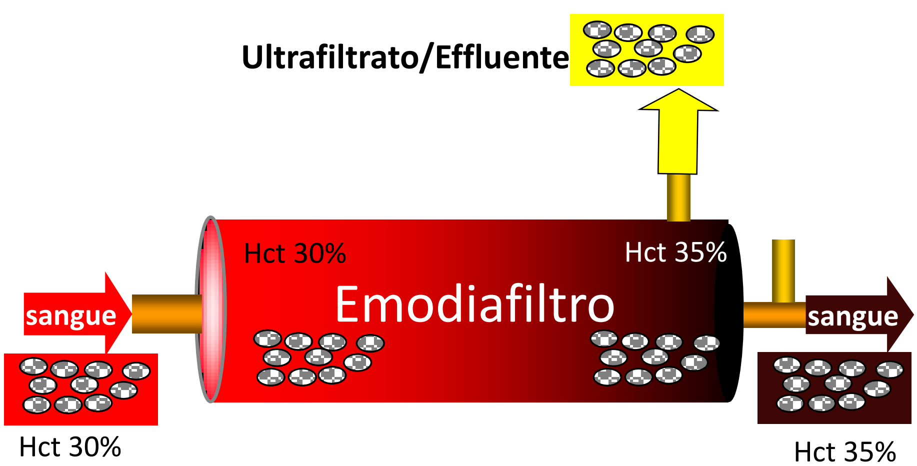
CONVEZIONE

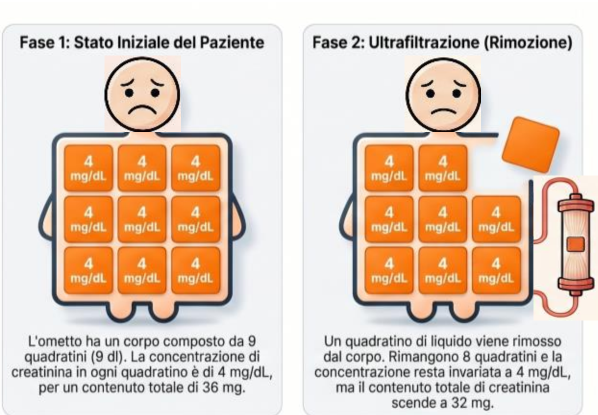


CONVEZIONE

ULTRAFILTRAZIONE (SCUF)

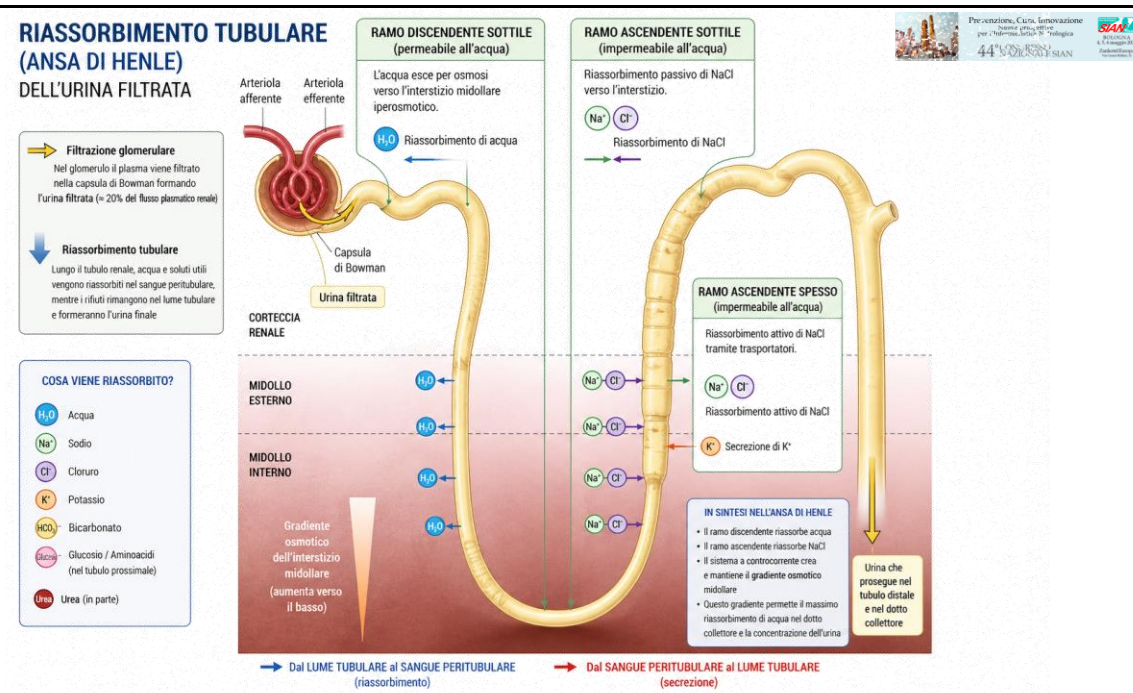
SCUF

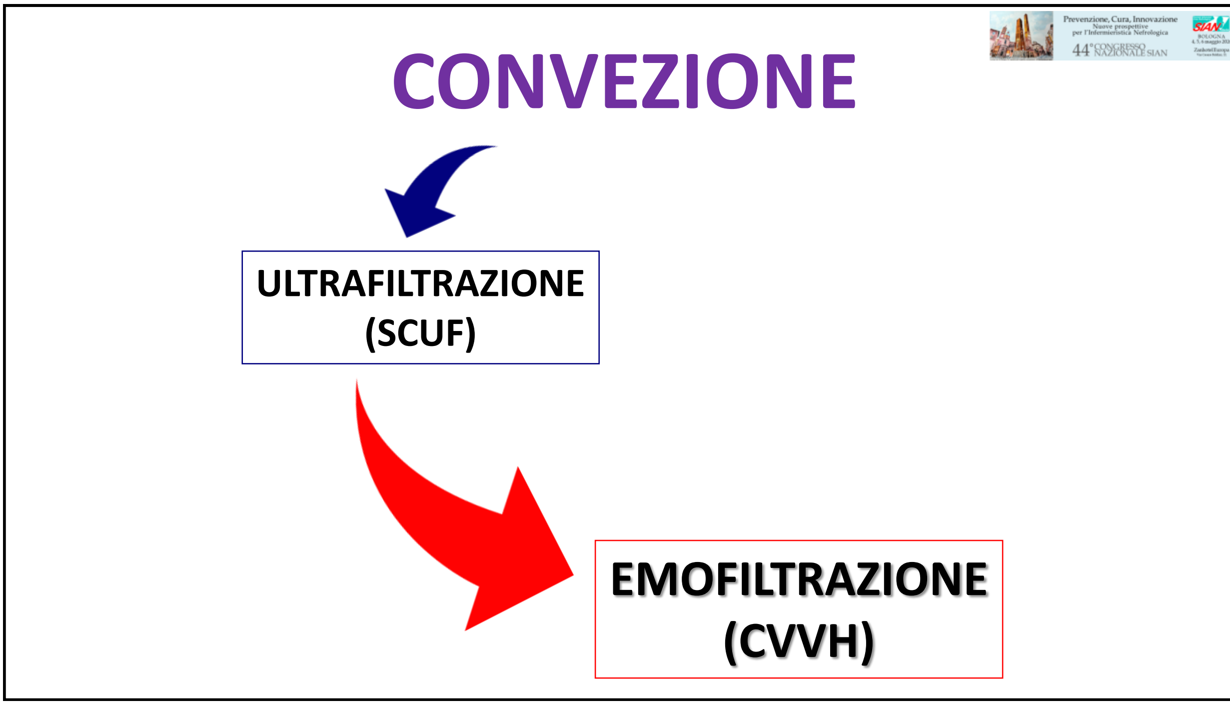


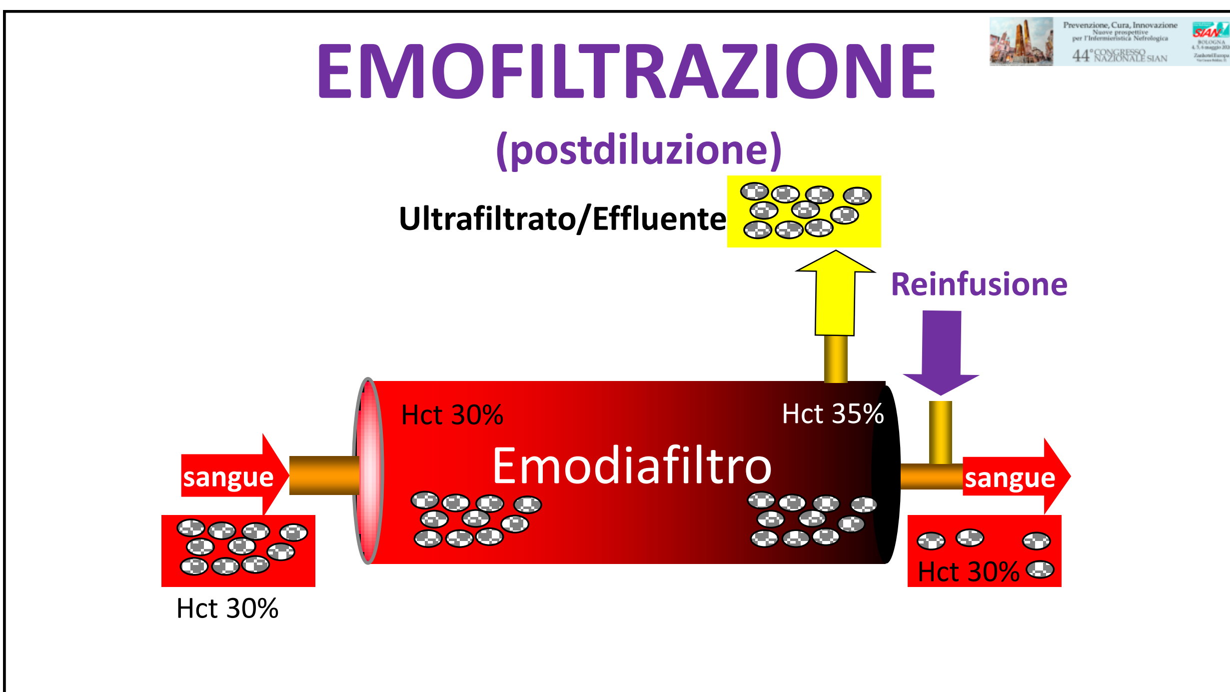


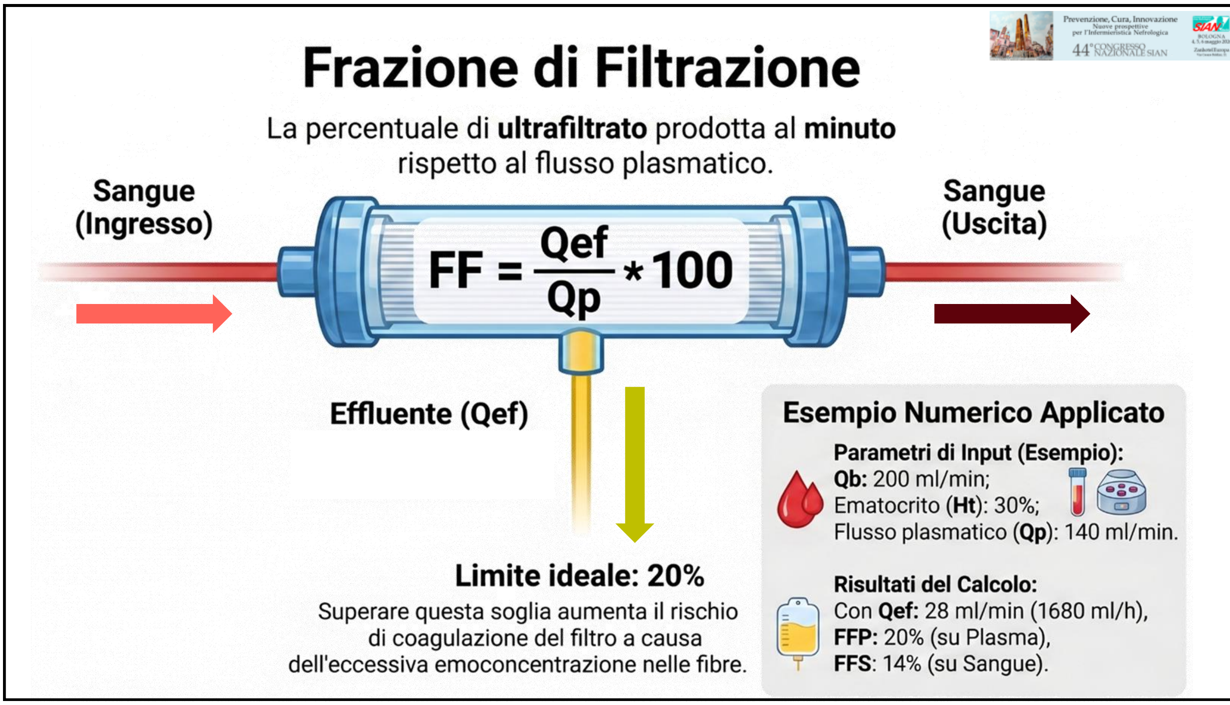
Riepilogo dei valori numerici durante il processo.

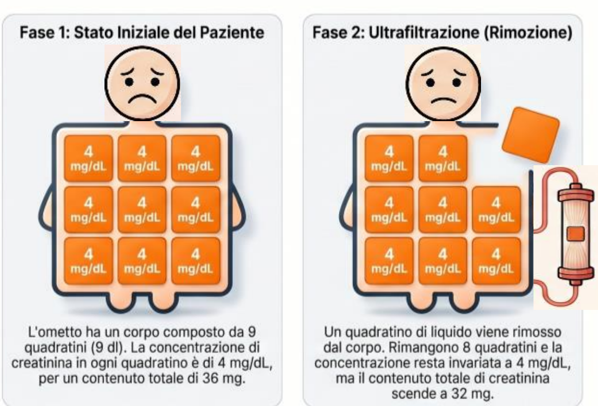
Fase	Volume Totale (Quadratini)	Concentrazione Creatinina	Contenuto Totale Creatinina
1. Inizio	9 dl	4 mg/dL	36 mg
2. Ultrafiltrazione	8 dl	4 mg/dL	32 mg




CONVEZIONE
ULTRAFILTRAZIONE (SCUF)
EMOFILTRAZIONE (CVVH)

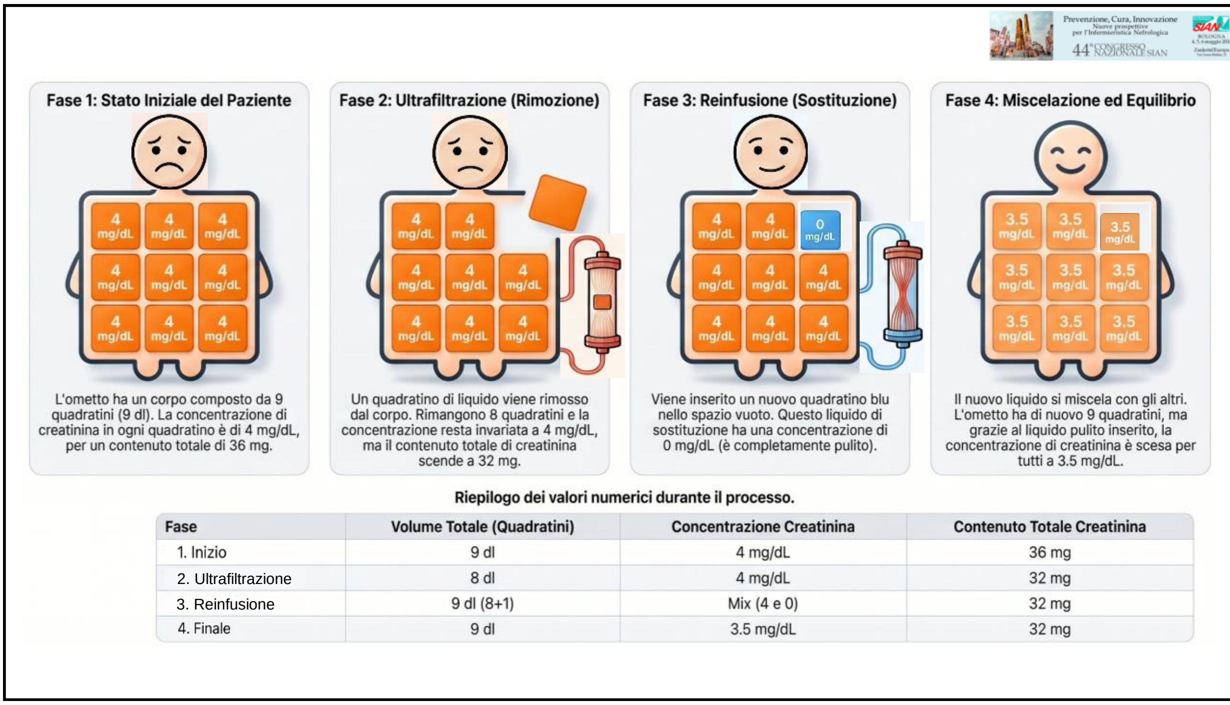

EMOFILTRAZIONE
(postdiluzione)
Ultrafiltrato/Effluente
Reinfusione
Hct 30%
Hct 35%
Emodiafiltro
sangue
sangue
Hct 30%
Hct 30%



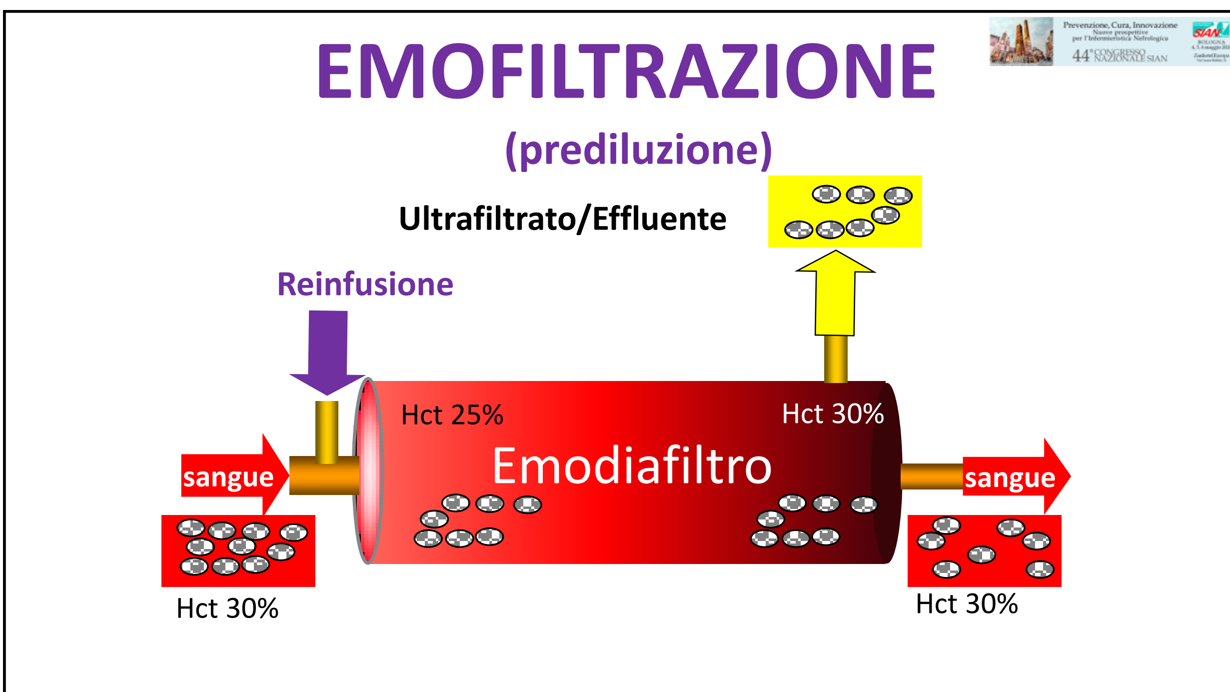


Riepilogo dei valori numerici durante il processo.

Fase	Volume Totale (Quadratini)	Concentrazione Creatinina	Contenuto Totale Creatinina
1. Inizio	9 dl	4 mg/dL	36 mg
2. Ultrafiltrazione	8 dl	4 mg/dL	32 mg



Fase	Volume Totale (Quadratini)	Concentrazione Creatinina	Contenuto Totale Creatinina
1. Inizio	9 dl	4 mg/dL	36 mg
2. Ultrafiltrazione	8 dl	4 mg/dL	32 mg
3. Reinfusione	9 dl (8+1)	Mix (4 e 0)	32 mg
4. Finale	9 dl	3.5 mg/dL	32 mg



PRE oppure POST DILUIZIONE?

PRO

PRE DILUIZIONE: Prediluisce il sangue migliorando la vita del filtro

POST DILUIZIONE: La concentrazione dei soluti nel filtro è uguale a quella sistemica.

CONTRO

PRE DILUIZIONE: Riduce la clearance convettiva dei soluti.

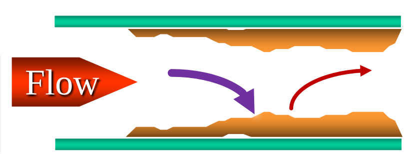
POST DILUIZIONE: Emoconcentra il sangue a livello dei capillari del filtro con rischio di attivare ulteriormente il processo coagulativo.

Frazione di filtrazione (postdiluzione)

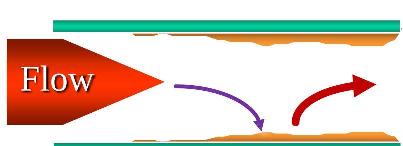
FF = Qef / Qp*100

Es. Qb: 200 ml/min, Hct 30% = Qp: 140 ml/min
Qef: 28 ml/min o 1680 ml/h
FF = 28/140*100 = 20

Range Ottimale = MAX 20% di Qp o 15% di Qb



Frazione di filtrazione (prediluzione)



FF = Qef / (Qp+Qrep)*100

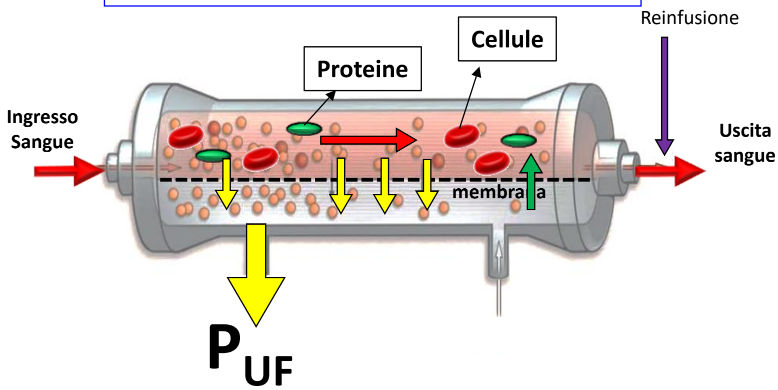
Es. Qb: 200 ml/min, Hct 30% = Qp: 140 ml/min
Qef e Qrep: 28 ml/min o 1680 ml/h
FF = 28/140+28*100 = 16

Range Ottimale = fino a 25% di Qp o 20% di Qb

 05/05/2026

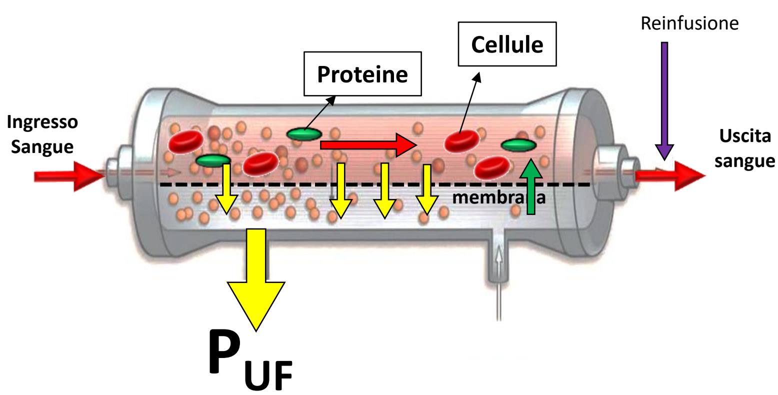
Pressione Transmembrana (TMP)

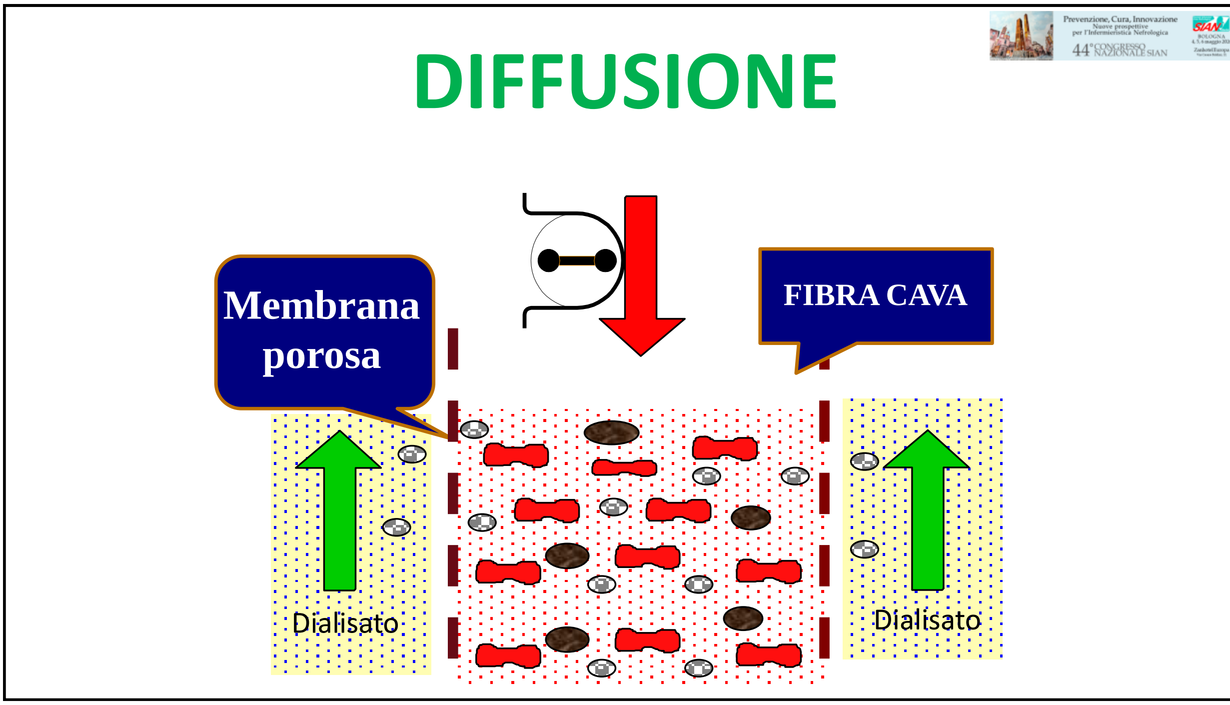
$$TMP = P_b - P_{ONC} - P_{UF}$$

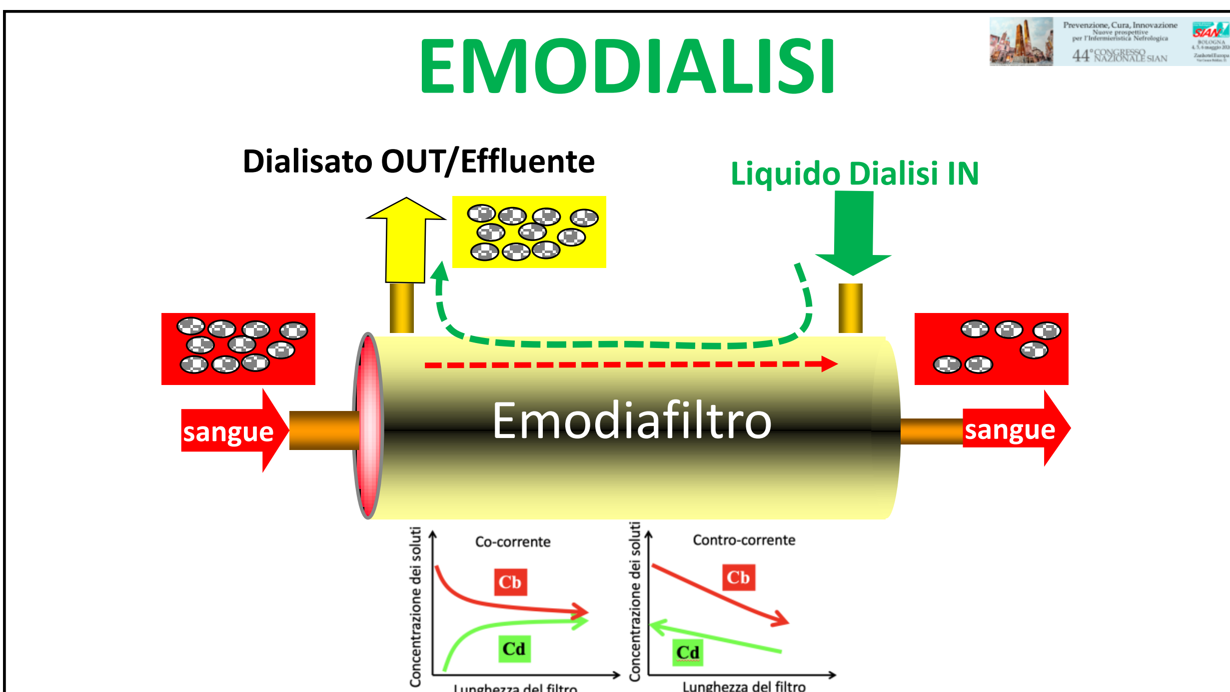


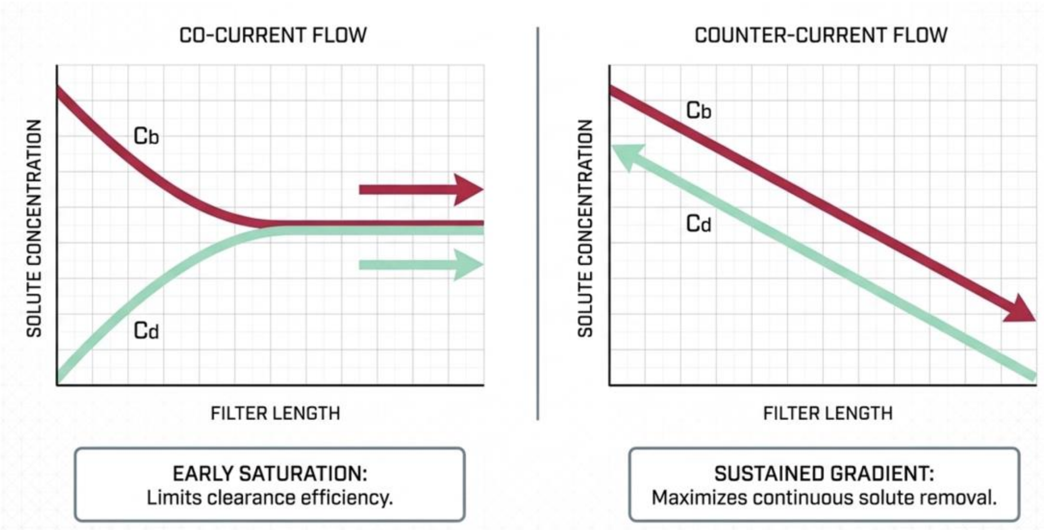
Pressione di Caduta (Drop Pressure)

$$DP = P_{in} - P_{out}$$

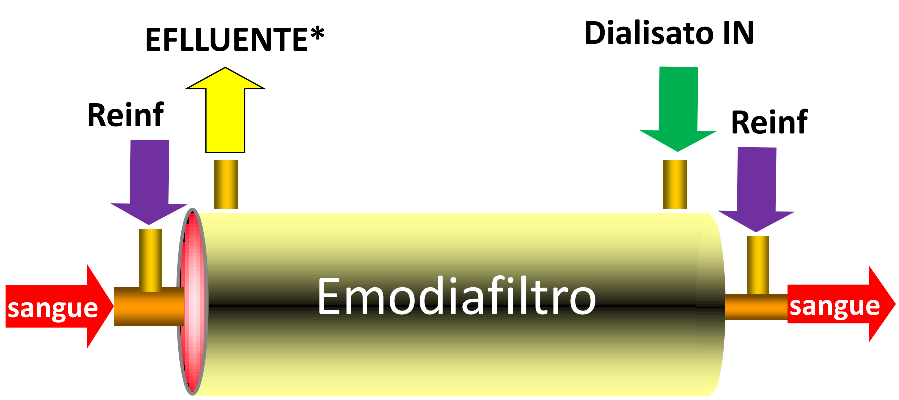



DIFFUSIONE
Membrana porosa
FIBRA CAVA
Dialisato
Dialisato


EMODIALISI
Dialisato OUT/Effluente
Liquido Dialisi IN
sangue
Emodiafiltro
sangue
Co-corrente
Cb
Cd
Concentrazione dei soluti
Lunghezza del filtro
Contro-corrente
Cb
Cd
Concentrazione dei soluti
Lunghezza del filtro



CVVHDF



***= Ultrafiltrato + Dialisato OUT + eventuale Ultrafiltrazione Netta**

QUALE TECNICA È MIGLIORE DELLE ALTRE??

2012

RESEARCH Open Access

Hemofiltration compared to hemodialysis for acute kidney injury: systematic review and meta-analysis

Jan O Friedrich[1,2,3,4,5*], Ron Wald[1,2,4], Sean M Bagshaw[6], Karen EA Burns[1,2,3,4,5] and Neill KJ Adhikari[1,5,7]

2012

RESE

n Access

Her

acu

met

Jan O Fr

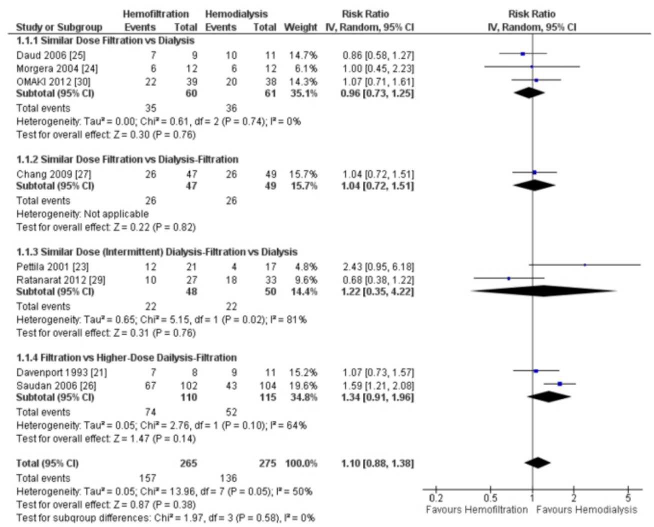


Figure 2 Effect of hemofiltration vs. hemodialysis RRT on mortality. The pooled risk ratio was calculated using a random-effects model. Weight refers to the contribution of each study to the overall estimate of treatment effect. Abbreviations: CI, confidence interval; IV, inverse variance.

2012

RESE

n Access

Her

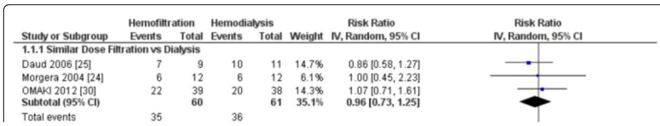


Table 4 Clearance measurements of hemofiltration vs.

Molecular substance	Number of trials; number of patients randomized	Change in clearance hemofiltration vs hemodialysis[a]: Effect estimate	95% confidence interval	P-value	Heterogeneity (I^2)
Smaller molecules					
Urea (60 Da)	4 [33,36-38]; 49	+1%[b]	-2% to +3%	0.60	0%
Phosphate (95 Da)	1 [37]; 18	0%[c]	-4% to +4%	1.00	n/a
Creatinine (113 Da)	3 [33,37,38]; 43	+1.8%[b]	-0.4% to +4.1%	0.12	0%
Uric acid (168 Da)	2 [33,37]; 28	+4%	+1% to +7%	0.01	0%
Larger molecules					
Vancomycin (1.8 kDa)	1 [33]; 10	+18%	+8% to +28%	0.0003	n/a
β_2-microglobulin (11.8 kDa)	2 [37,38]; 33	+94%[d]	+78% to +112%	<0.0001	0%
IL-1 Receptor Agonist (16-18 kDa)	1 [24]; 12	+77%[e,f]	+24% to +153%	0.002	n/a
Retinol Binding Protein (21.2 kDa)	1 [37]; 18	+42%	+4% to +94%	0.03	n/a
IL-6 (26 kDa)	2 [24,34]; 22	+6%[f,g]	-62% to +191%	0.91	89%

Weight refers to the contribution of each study to the overall estimate of treatment effect. Abbreviations: CI, confidence interval; IV, inverse variance.

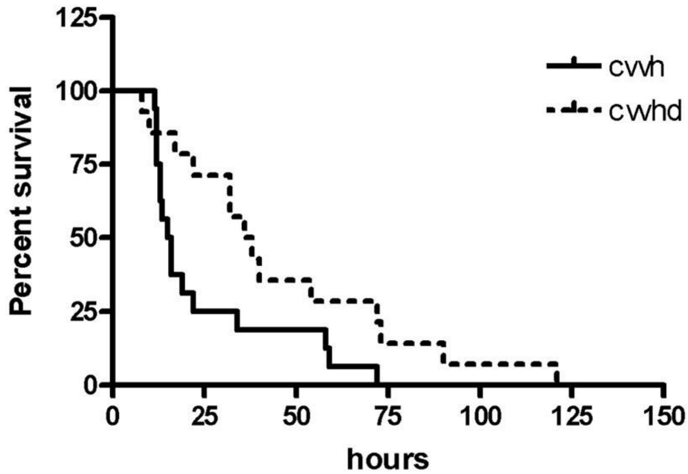
Research

Open Access

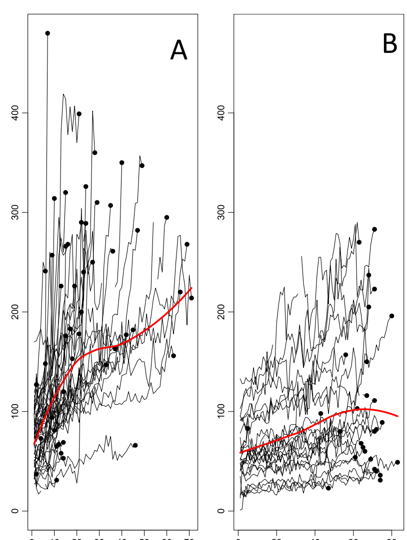
Solute removal during continuous renal replacement therapy in critically ill patients: convection versus diffusion

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]

Crit Care 2006



TMP monitoring



Panel A: clotted prematurely
Panel B: clotted after 72 hours
TMP on y axes
Hours on x axes

1. Should we really wait for TMP to increase up to the pressure limit for indicating a circuit change?
2. What is the limit?
3. Is the trend more important than absolute levels?

Kakajiwala A, et al Ped Neph 2017

- "In clinical practice, the intensivist will have to balance the desired intensity of treatment, in particular with regard to the removal of larger molecules, against clotting risk, filter life, and costs."
- "Inevitably, local experience and circumstances will also influence the choice of modality."
- "As the current UK Renal Association guidelines put it, 'choice of RRT modality should be guided by the individual patient's clinical status, medical and nursing expertise, and availability of modality'."

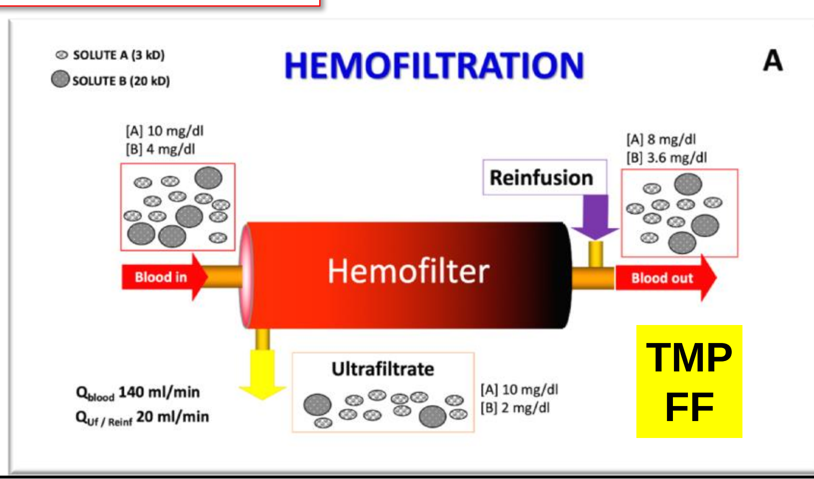
A. Jorres, Hemofiltration or hemodialysis for acute kidney injury? CC 2012


Nephrol Dial Transplant (2019) 1–3
doi: 10.1093/ndt/gfz022

ndt digest

Acute kidney injury: to dialyse or to filter?

Zaccaria Ricci[1,*], Stefano Romagnoli[2] and Claudio Ronco[3,4]
[1]Department of Cardiology and Cardiac Surgery, Pediatric Cardiac Intensive Care Unit, Bambino Gesù Children's Hospital, IRCCS, Rome, Italy, [2]Department of Anesthesiology and Intensive Care, Azienda Ospedaliero-Universitaria Careggi, Largo Brambilla, Florence, Italy, [3]Department of Nephrology, Dialysis and Transplantation, San Bortolo Hospital, Vicenza, Italy and [4]International Renal Research Institute of Vicenza, Vicenza, Italy

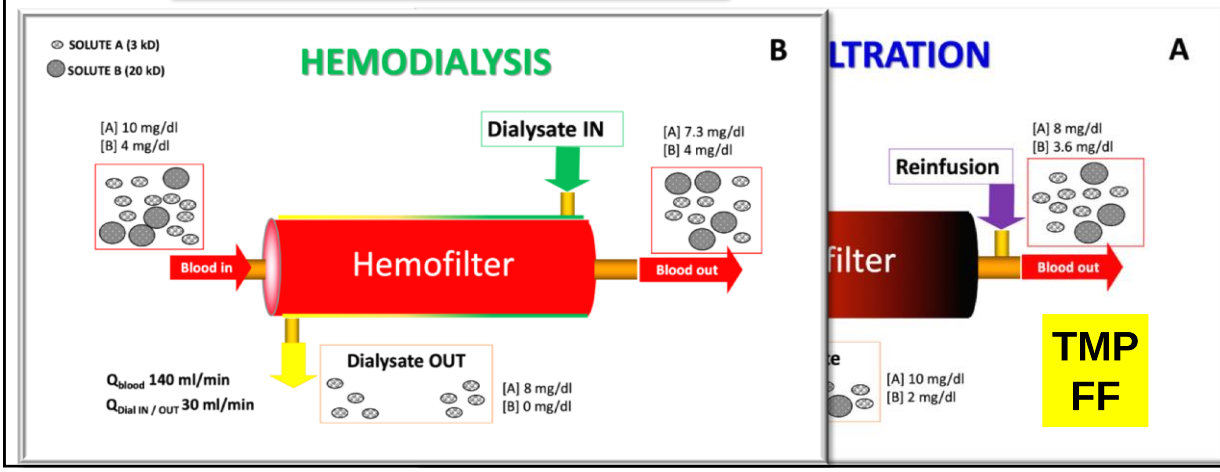



Nephrol Dial Transplant (2019) 1–3
doi: 10.1093/ndt/gfz022

Acute kidney injury: to dialyse or to filter?

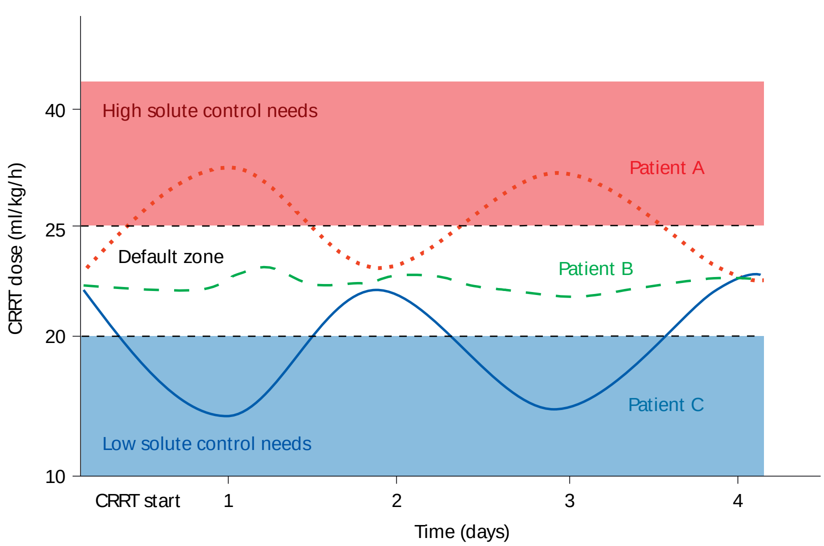
Zaccaria Ricci[1,*], Stefano Romagnoli[2] and Claudio Ronco[3,4]

[1]Department of Cardiology and Cardiac Surgery, Pediatric Cardiac Intensive Care Unit, Bambino Gesù Children's Hospital, IRCCS, Rome, Italy, [2]Department of Anesthesiology and Intensive Care, Azienda Ospedaliero-Universitaria Careggi, Largo Brambilla, Florence, Italy, [3]Department of Nephrology, Dialysis and Transplantation, San Bortolo Hospital, Vicenza, Italy and [4]International Renal Research Institute of Vicenza, Vicenza, Italy



Precision Continuous Renal Replacement Therapy and Solute Control

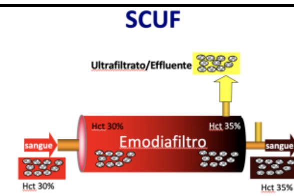
Blood Purification 2017

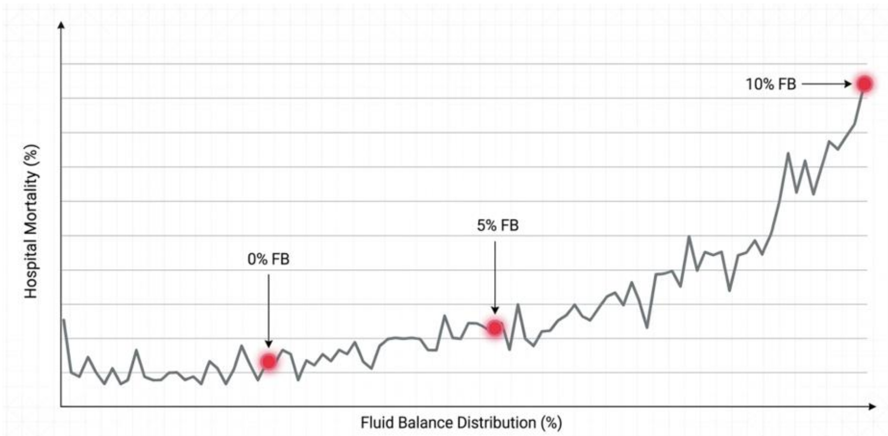


Both Positive and Negative Fluid Balance May Be Associated With Reduced Long-Term Survival in the Critically Ill

Vikram Balakumar, MD[1,2]; Raghavan Murugan, MD, MS, FRCP, FCCM[1,3]; Florentina E. Sileanu, MS[1]; Paul Palevsky, MD[1,4]; Gilles Clermont, MD, MSc[3]; John A. Kellum, MD, MCCM[1,3]

SCUF





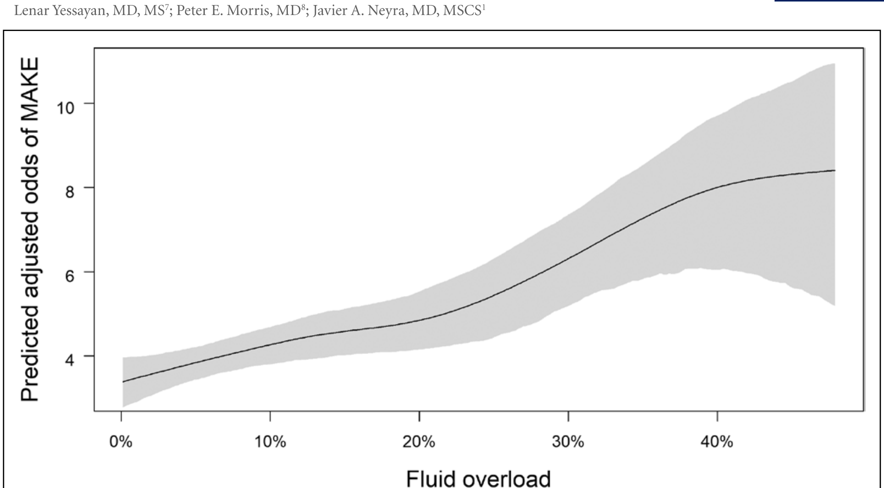
The Lethality of Accumulation: Hospital mortality climbs steadily as cumulative fluid balance crosses the 5% and 10% body weight thresholds.

Fluid Overload Associates With Major Adverse Kidney Events in Critically Ill Patients With Acute Kidney Injury Requiring Continuous Renal Replacement Therapy

CCM 2019

Connor W. Woodward, MD[1]; Joshua Lambert, PhD[2]; Victor Ortiz-Soriano, MD[1]; Ye Li, MS[3]; Marice Ruiz-Conejo, MD[4]; Brittany D. Bissell, PharmD, PhD[5]; Andrew Kelly, MS[6]; Paul Adams, MD[1]; Lenar Yessayan, MD, MS[7]; Peter E. Morris, MD[8]; Javier A. Neyra, MD, MSCS[1]

401 critically ill adults requiring CRRT for AKI



MAKE: all-cause mortality, RRT-dependence, inability to recover more than 50% of baseline eGFR (if not on RRT) up to 90 days following hospital discharge

NET ULTRAFILTRATION

Neri *et al. Critical Care* (2016) 20:318
DOI 10.1186/s13054-016-1489-9
Critical Care
REVIEW Open Access

Nomenclature for renal replacement therapy in acute kidney injury: basic principles

Mauro Neri[1,2], Gianluca Villa[1,3], Francesco Garzotto[1], Sean Bagshaw[4], Rinaldo Bellomo[5], Jorge Cerda[6], Fiorenza Ferrari[1], Silvia Guggia[1], Michael Joannidis[7], John Kellum[8], Jeong Chul Kim[9], Ravindra L. Mehta[10], Zaccaria Ricci[11], Alberto Trevisani[2], Silvio Marafon[12], William R. Clark[13], Jean-Louis Vincent[14], Claudio Ronco[1*] and on behalf of the Nomenclature Standardization Initiative (NSI) alliance

Net volume of fluid removed from the patient by the machine per unit of time

VERY DIFFERENT FROM FLUID BALANCE!

Table 2 Fluids and flows in continuous renal replacement therapy

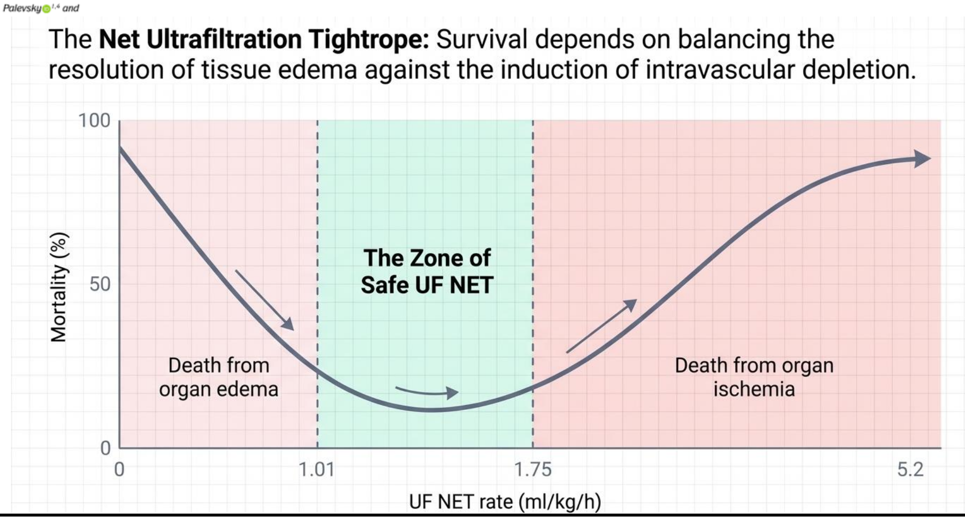
Flowrate	Symbol	Unit of measure	Definitions and comments
Blood flowrate	Q_B	ml/min	Depends on: - modality - vascular access - hemodynamic stability of the patient
Plasma flowrate	Q_P	ml/min	Approximated as: $Q_P = (1 - HCT)\quad Q_B$ where HCT = hematocrit
Ultrafiltration flowrate	Q_{UF}	ml/h	Total volume of fluid removed in the filter by positive TMP per unit of time: $Q_{UF} = Q_{UF}^{NET} + Q_R$ Depends on: - blood flow rate - filter and membrane design - transmembrane pressure (TMP) - membrane ultrafiltration coefficient and surface area
Net ultrafiltration flowrate (Δ weight flowrate) (weight loss flowrate)	Q_{UF}^{NET}	ml/h	Net volume of fluid removed from the patient by the machine per unit of time
Plasma ultrafiltration flow rate	$Q_{P\text{-}UF}$	ml/h	Total volume of plasma removed in the plasma filter by TMP per unit of time
Replacement flowrate (Substitution flow rate) (Infusion flowrate)	Q_R^{PRE} Q_R^{POST} $Q_R^{PRE/POST}$	ml/h	Sterile fluid replacement can be: - upstream of filter (pre-replacement, pre-infusion or pre-dilution): reduced depurative efficiency but better filter life - downstream of filter (post-replacement, post-infusion or post-dilution): higher depurative efficiency but lower filter life - both upstream and downstream of filter (pre-post replacement, pre-post infusion or pre-post dilution): compromise between the two modalities
Replacement plasma flow rate	$Q_{P\text{-}R}$	ml/h	Replacement of plasma downstream of the plasma filter
Dialysate flowrate	Q_D	ml/h	Volume of dialysis fluid running into the circuit per unit of time
Effluent flowrate	Q_{EFF}	ml/h	Waste fluid per unit of time coming from the outflow port of the dialysate/ultrafiltrate compartment of the filter: $Q_{EFF} = Q_{UF} + Q_D = Q_{UF}^{NET} + Q_R + Q_D$

REVIEWS

Nat Rev Nephrol 2021

Ultrafiltration in critically ill patients treated with kidney replacement therapy

Raghavan Murugan[1,2], Rinaldo Bellomo[3], Paul M. Palevsky[1,4] and John A. Kellum[1,2]



RENAL FAILURE
2025, VOL. 47, NO. 1, 2537810
https://doi.org/10.1080/0886022X.2025.2537810

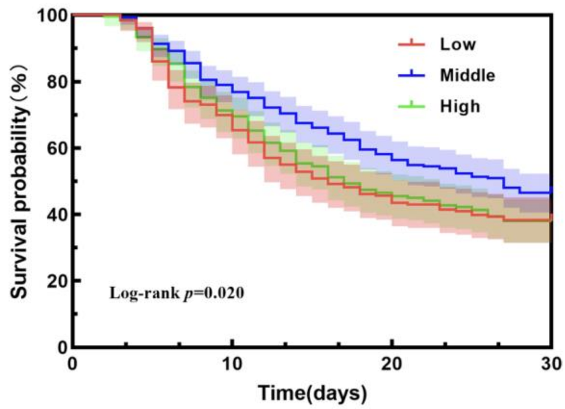
Taylor & Francis
Taylor & Francis Group

LABORATORY STUDY

OPEN ACCESS | Check for updates

The prognostic impact of net ultrafiltration intensity in critically ill patients receiving continuous renal replacement therapy: a multivariable and propensity-matched analysis

Lu Jin[a‡], Peiyun Li[a‡], Youli Tang[a,b], Wanhong Yin[c], Fang Wang[a] and Ling Zhang[a]



RENAL FAILURE
2025, VOL. 47, NO. 1, 2537810
https://doi.org/10.1080/0886022X.2025.2537810

Taylor & Francis
Taylor & Francis Group

LABORATORY STUDY

OPEN ACCESS | Check for updates

The prognostic impact of net ultrafiltration intensity in critically ill patients receiving continuous renal replacement therapy: a multivariable and propensity-matched analysis

Lu Jin[a‡], Peiyun Li[a‡], Youli Tang[a,b], Wanhong Yin[c], Fang Wang[a] and Ling Zhang[a]

Table 1. Baseline characteristics of each UF^{net} intensity group before CRRT.

	UF^{net} intensity category (72 h)			
Characteristics	<1.01 mL/kg/h (*n* = 193)	1.01–1.75 mL/kg/h (*n* = 277)	>1.75 mL/kg/h (*n* = 213)	*p* Value
Age (years)	54 (43–68)	55 (44–68)	58 (48–71)	.037
Male gender, *n* (%)	152 (78.8%)	220 (79.4%)	138 (64.8%)	<.001
Weight (kg)	70 (60–80)	70 (60–80)	60 (50–70)	<.001
BMI (kg/m²)	25.1 (22.2–28.0)	25.1 (22.4–27.7)	22.3 (19.2–24.9)	<.001
Pre-admission kidney function				
Creatinine (mmol/L)	224 (152–362)	281 (182–401)	245 (154–377)	.005
eGFR (mL/min/1.73 m²)	23.9 (15.0–40.9)	18.8 (12.8–33.2)	19.4 (12.7–40.3)	.006
Fluid balance in the 24 h before CRRT (mL)	1,800 ((894–2,999.3)	1,856 (995–2,737)	1,506.5 (748–2,908)	.375
Fluid overload >5%, *n* (%)	34 (17.6)	49 (17.7)	41 (19.2)	.883
Urine output at 24 h (mL)	650 (265–1,563)	575.5 (147.5–1,311.3)	490 (150–1,085)	.052
Oliguria, *n* (%)	69 (35.8)	115 (41.5)	90 (42.3)	.339
APACHE II score	21 (14–27)	22 (16–28)	21 (15–27)	.237
SOFA score	16 (14–18)	17 (15–19)	17 (15–18)	.232
GCS score	6 (4–7)	5 (4–8)	5 (4–7)	.987
Laboratory before CRRT				
Lactate (mmol/L)	2.3 (1.5–4.3)	2 (1.4–3.4)	2 (1.3–3.1)	.009
PaO_2/FiO_2	234.7 (144.5–327.6)	211.3 (146.2–303.3)	229 (156.2–312.1)	.428
MAP (mmHg)	84.3 (76–95.3)	85 (75.7–94.7)	86 (75.3–97)	.859
NT-proBNP	3,326 (993–9,412)	4,198 (1,260.3–11,262.8)	5423.5 (1,817.8–15,215)	.002
TBIL	24 (13.2–52.8)	21.1 (10.8–49.4)	20.3 (11.6–51.4)	.319
PLT	94 (53–167)	95 (53–154)	77 (43–139)	.032

Blood Purification

Critical Care Nephrology – Research Article

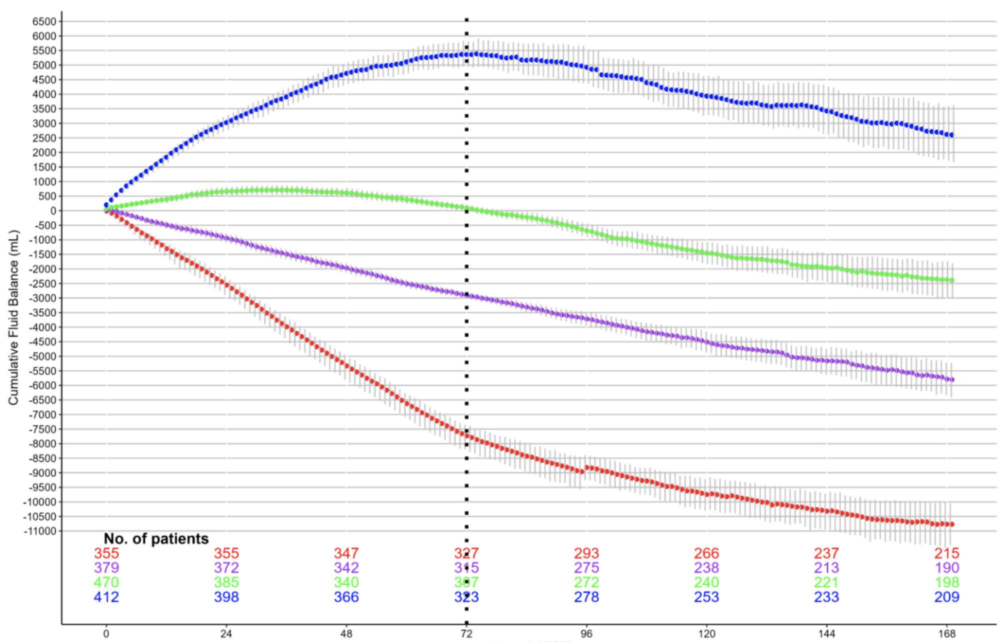
Blood Purif 2024;53:624–633
DOI: 10.1159/000538421

Received: December 20, 2023
Accepted: March 11, 2024
Published online: April 16, 2024

Current Fluid Management Practice in Critically Ill Adults on Continuous Renal Replacement Therapy: A Binational, Observational Study

Kyle C. White[a, b, c] Kevin B. Laupland[c, d] Marlies Ostermann[e]
Ary Serpa Neto[f, g] Michelle L. Gatton[c] Rod Hurford[a] Pierre Clement[d]
Barnaby Sanderson[e] Rinaldo Bellomo[h, i, j]

1616 patients from 3 ICUs and 2 countries



Wald et al. Critical Care (2022) 26:360
https://doi.org/10.1186/s13054-022-04229-0
Critical Care
RESEARCH Open Access

Fluid balance and renal replacement therapy initiation strategy: a secondary analysis of the STARRT-AKI trial

Ron Wald[1,2*], Brian Kirkham[3], Bruno R. daCosta[2,3], Ehsan Ghamarian[3], Neill K. J. Adhikari[4], William Beaubien-Souligny[5], Rinaldo Bellomo[6,7,8,9], Martin P. Gallagher[10], Stuart Goldstein[11], Eric A. J. Hoste[12,13], Kathleen D. Liu[14], Javier A. Neyra[15], Marlies Ostermann[16], Paul M. Palevsky[17], Antoine Schneider[18], Suvi T. Vaara[19] and Sean M. Bagshaw[20]

We evaluated the effect of accelerated RRT initiation on cumulative fluid balance over the course of 14 days following randomization using mixed models after censoring for death and ICU discharge. 2738 had available data on baseline fluid balance and 2716 (92.8%) had at least one day of fluid balance data following randomization.

Table 2 (continued)

	Quartile 1 N = 685	Quartile 2 N = 685	Quartile 3 N = 684	Quartile 4 N = 684	*p* value for trend
Outcomes					
90-day all-cause mortality	274 (40.0)	312 (45.5)	309 (45.2)	307 (44.9)	0.17
RRT dependence at 90 days	42 (10.2)	28 (7.6)	28 (7.5)	29 (7.8)	0.26
Ventilator-free days through day 28	18 (0–26)	12 (0–24)	12 (0–23)	6 (0–21)	< 0.01
Hospitalization-free days through day 90	34 (0–69)	7 (0–66)	0 (0–62)	0 (0–57)	< 0.01

All values expressed as medians with interquartile range or numbers (%)

The baseline serum creatinine level was defined as the most recent outpatient level obtained during the year preceding the current hospitalization. If this value was not available, the lowest serum creatinine level obtained during the current hospitalization was used to establish the baseline

‡ The estimated glomerular filtration rate was calculated with the use of the Chronic Kidney Disease Epidemiology collaboration equation, which incorporates the baseline serum creatinine level, age, sex, and black race

¶ Results for the Simplified Acute Physiology Score (SAPS) II range from 0 to 163, with higher scores indicating more severe disease and a higher risk of death

‖ Scores on the Sequential Organ Failure Assessment (SOFA) range from 0 to 24, with higher scores indicating more severe disease and a higher risk of death

Wald et al. Critical Care (2022) 26:360
https://doi.org/10.1186/s13054-022-04229-0
Critical Care
RESEARCH Open Access
Fluid balance and renal replacement therapy initiation strategy: a secondary analysis of the STARRT-AKI trial
Ron Wald[1,2*], Brian Kirkham[3], Bruno R. daCosta[2,3], Ehsan Ghamarian[3], Neill K. J. Adhikari[4], William Beaubien-Souligny[5], Rinaldo Bellomo[6,7,8,9], Martin P. Gallagher[10], Stuart Goldstein[11], Eric A. J. Hoste[12,13], Kathleen D. Liu[14], Javier A. Neyra[15], Marlies Ostermann[16], Paul M. Palevsky[17], Antoine Schneider[18], Suvi T. Vaara[19] and Sean M. Bagshaw[20]

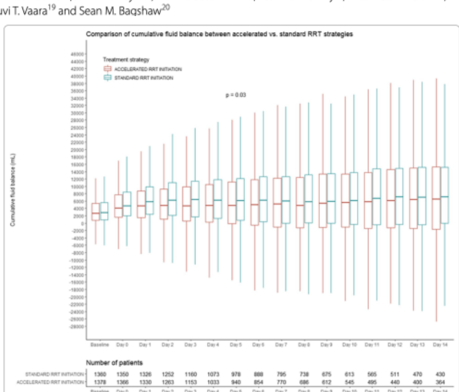


Fig. 1 Cumulative fluid balance between days 0 and 14 comparing standard and accelerated RRT strategies

Over the subsequent 14 days, participants allocated to the accelerated strategy had a lower cumulative fluid balance compared to those in the standard strategy (4509 (− 728 to 11,698) versus 5646 (0 to 13,151) mL, *p* = 0.03)

Wald *et al. Critical Care* (2022) 26:360
https://doi.org/10.1186/s13054-022-04229-0
Critical Care

RESEARCH Open Access

Fluid balance and renal replacement therapy initiation strategy: a secondary analysis of the STARRT-AKI trial

Ron Wald[1,2*], Brian Kirkham[3], Bruno R. daCosta[2,3], Ehsan Ghamarian[3], Neill K. J. Adhikari[4], William Beaubien-Souligny[5], Rinaldo Bellomo[6,7,8,9], Martin P. Gallagher[10], Stuart Goldstein[11], Eric A. J. Hoste[12,13], Kathleen D. Liu[14], Javier A. Neyra[15], Marlies Ostermann[16], Paul M. Palevsky[17], Antoine Schneider[18], Suvi T. Vaara[19] and Sean M. Bagshaw[20]

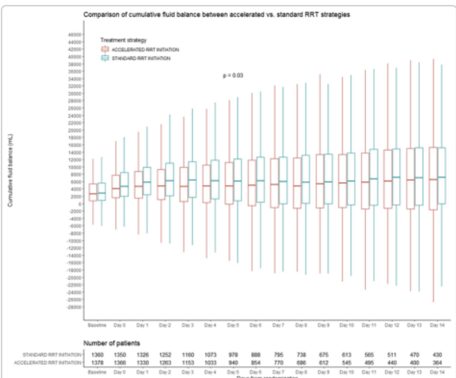


Fig. 1 Cumulative fluid balance between days 0 and 14 comparing standard and accelerated RRT strategies

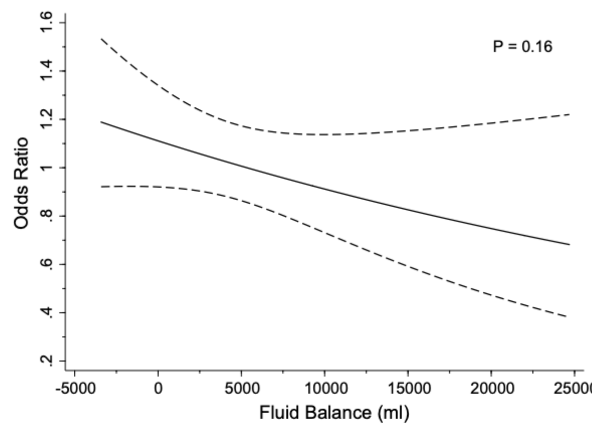


Fig. 3 The effect of accelerated RRT initiation, as compared to standard RRT initiation, on all-cause mortality across the spectrum cumulative fluid balance at randomization

Critical Care
https://doi.org/10.1186/s13054-026-06040-7

Article in Press

Alternative net ultrafiltration rate strategies in acute kidney injury: a feasibility randomized clinical trial

Received: 29 March 2026
Accepted: 15 April 2026
Published online: 22 April 2026

Cite this article as: Murugan R., Talisa V., Chang C.H. *et al.* Alternative net ultrafiltration rate strategies in acute kidney injury: a feasibility randomized clinical trial. *Crit Care* (2026). https://doi.org/10.1186/s13054-026-06040-7

Raghavan Murugan, Victor Talisa, Chung-Chou H. Chang, Nasrin Nikravangolsefid, Waryaam Singh, Brad W. Butcher, Ali Al-Khafaji, Scott Gunn, Firas Abdulmajeed, Phillip Lamberty, David Huang, Paul M. Palevsky, Kianoush Kashani, Michele Elder, Maham Raza, Denise Scholl, Tina Vita, William Sabol, Dan Ricketts, Thomas Mathie, Linda Stevanus-Schmadel, Anna Woodall, Mashiyat Ahmed, Jonathan Bishop, Justin Patri, Waaryam Singh, Andrea Katah, Supawadee Supadungsuk, Tom Sanger, Kathleen Liu, Ashita Tolwani, Manisha Jhamb, Dana Fuhrman, Hsing-Hua Sylvia Lin, Susan Sandusky, Sammy Massimino & Ivonne Schulman

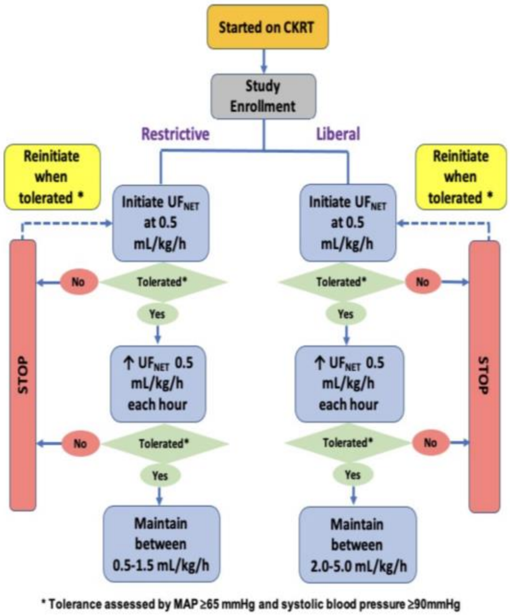


Table 1: Primary and Secondary Endpoints

Outcomes	All (N=97)	Liberal (N= 55)	Restrictive (N=42)	P value	Adjusted P value[b]
Primary					
Mean delivered UF_{NET} rate, mean (SD)[a]	1.95 (0.85)	2.05 (0.83)	1.81 (0.86)	0.1	0.4
Mean delivered UF_{NET} rate, median (IQR)	1.84 (1.36-2.44)	1.97 (1.41-2.62)	1.73 (1.22-2.14)	0.2	0.2
No. of participants with protocol deviation (%)	8 (8.25)	5 (9.09)	3 (7.14)	0.7	**
No. of episodes of protocol deviation, mean (SD)	0.09 (0.33)	0.11 (0.37)	0.07 (0.26)	**	**
Secondary					
Daily fluid balance including UF volume, mL, median (IQR)[c]	62.05 (-611.88-440.88)	82.40 (-796.65-418.37)	-22.58 (-545.39-490.73)	0.3	0.1
Cumulative fluid balance including UF volume, mL, median (IQR)*	379.20 (-4,795.10-4,908.00)	387.50 (-6,129.50-5,207.50)	-10.50 (-4,685.90-4,261.30)	0.3	0.4

CONCLUSIONI

- ✓ La conoscenza dei concetti di base del trasporto dei soluti è la base fondamentale necessaria prima di approcciare ogni terapia *dialitica* continua….
- ✓ Anzi, terapia di sostituzione renale continua (**CRRT**)

- ✓ CVVHD->Dialisi->Diffusione – NO FRAZ FILTRAZ
- ✓ CVVH->Emofiltrazione->Convezione (che è alla base anche dell'ultrafiltrazione) – DEPURAZIONE MOLECOLE PESO MOLECOLARE MAGGIORE
- ✓ CVVHDF-> compromesso
- ✓ UF NETTA -> rimozione/prevenzione di fluid overload