

# Důležitost modifikace režimů CRRT

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*ICU, Landesklinikum Baden bei Wien, Austria*

*conflict of interest:*

*Baxter*

# přehled

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1. principy CRRT
2. používané módy
3. prediluce vs postdiluce
4. léčebné modality
5. antikoagulace
6. substituce kalcia
7. stabilita, opakovaná CRRT
8. proč Baxter?

## intensive care

- **ICU:** incidence **AKI** překračuje i **50%**
- **etiologie:** sepse (40%), hypovolémie (34%), nefrotoxické látky (14%), kardiogenní šok (13%)
- cca **25 %** pacientů s AKI potřebují **RRT**
- **> 30%** pacientů na UPV potřebují **RRT**



# intensive care

- **90,9%** ICUs má možnost **CRRT**
- **80,2%** ICUs má možnost **IRRT**
- **35,4%** ICUs má možnost **PIRRT**
- **42,5%** ICUs má možnost ***cytokine removal therapy***
- **58,0%** ICUs má možnost **TP**
- **96,6%** ICUs má možnost **RRT 24/7**

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***přístroje  
na ICU***

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Baxter

≈ 70%



Braun

≈ 0%

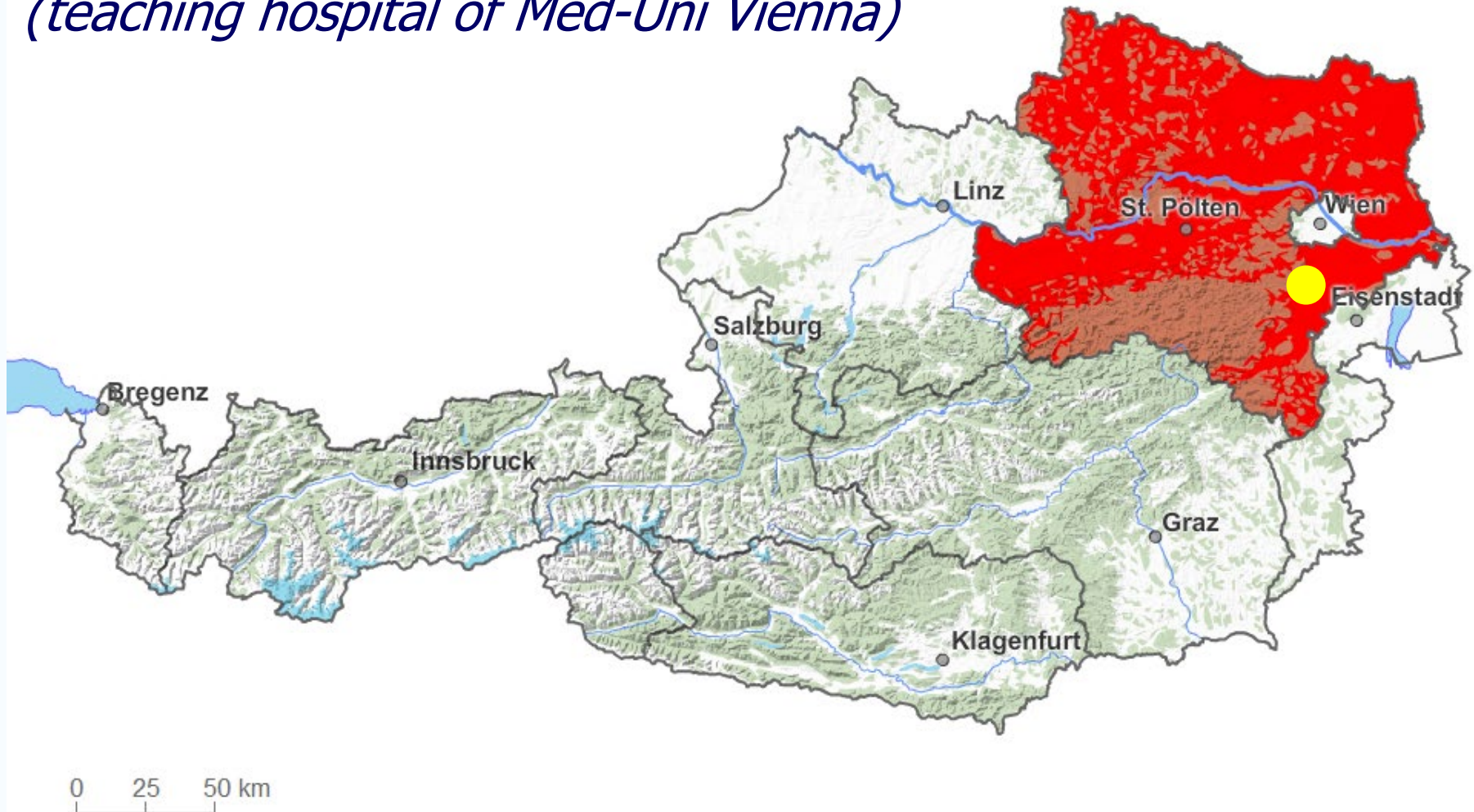


Fresenius

≈ 30%

Lower Austria has 27 Hospitals  
and 1,7 Mio of inhabitants

Landeskrlinikum **Baden bei Wien**  
(*teaching hospital of Med-Uni Vienna*)



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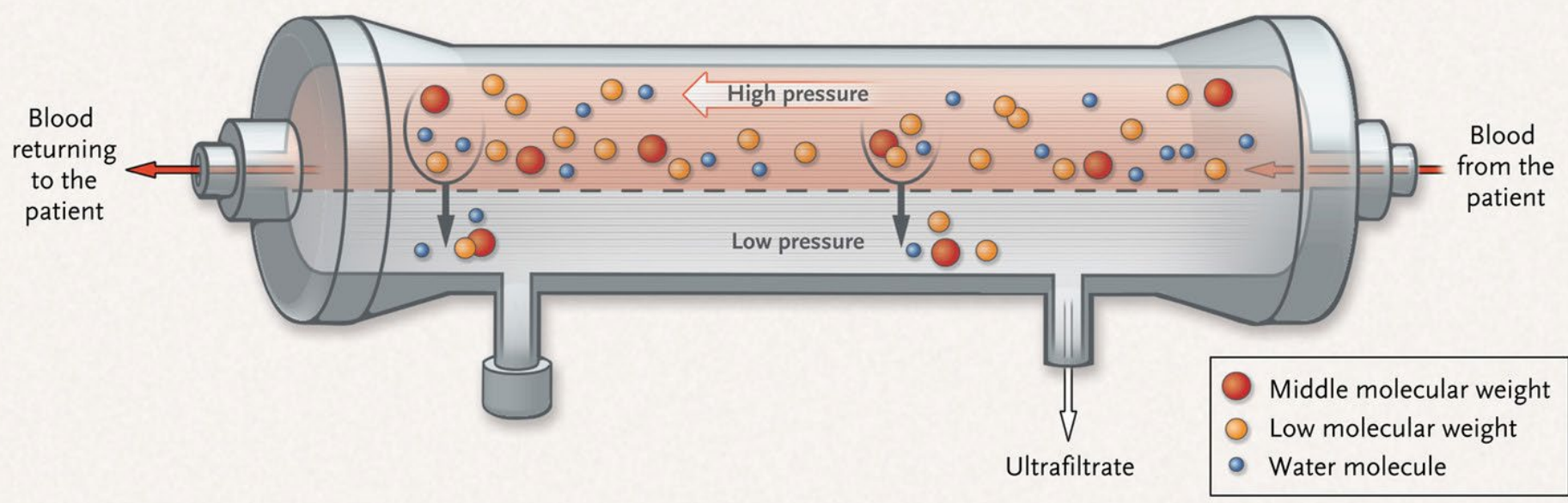
*principy*

*CRRT*

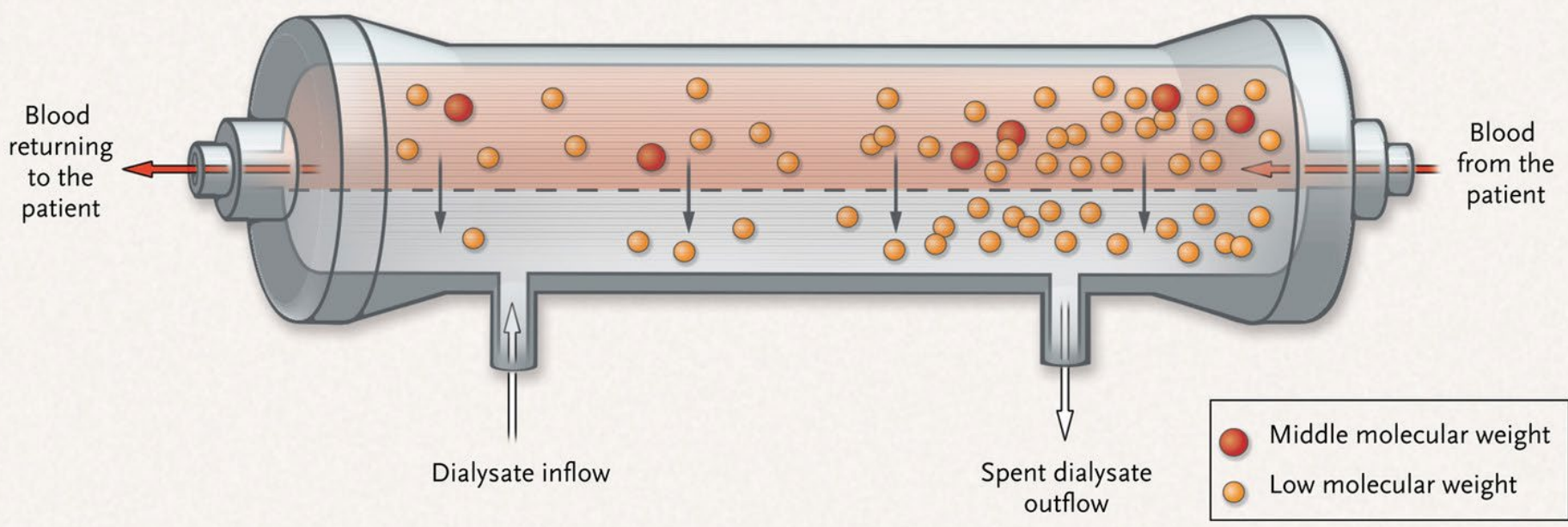
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**A** Convection



**B** Diffusion

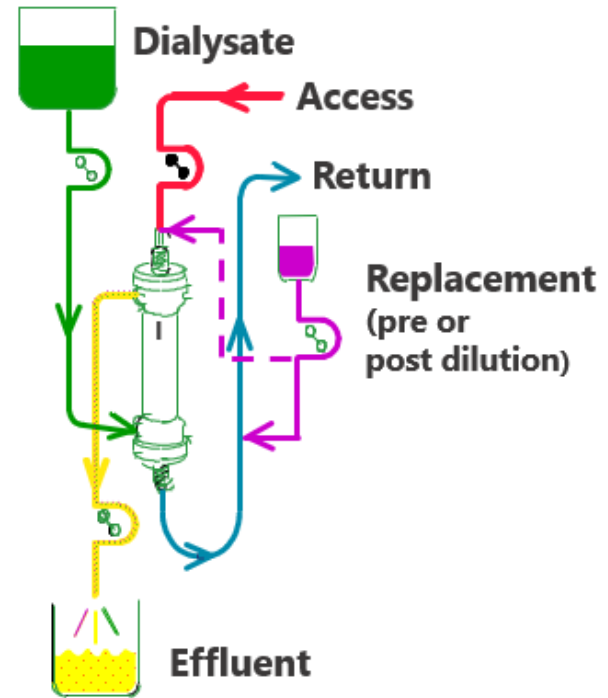
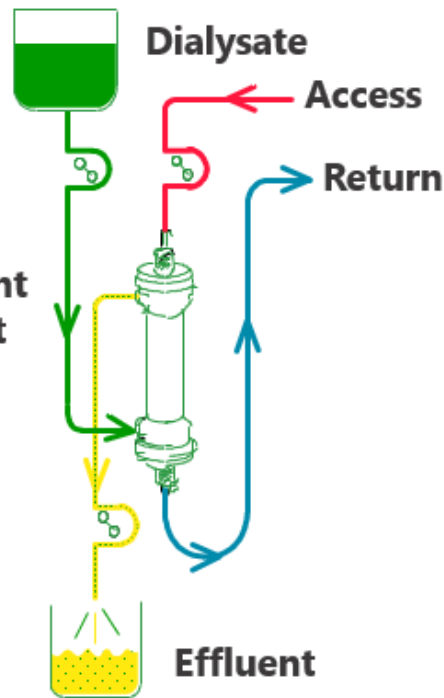
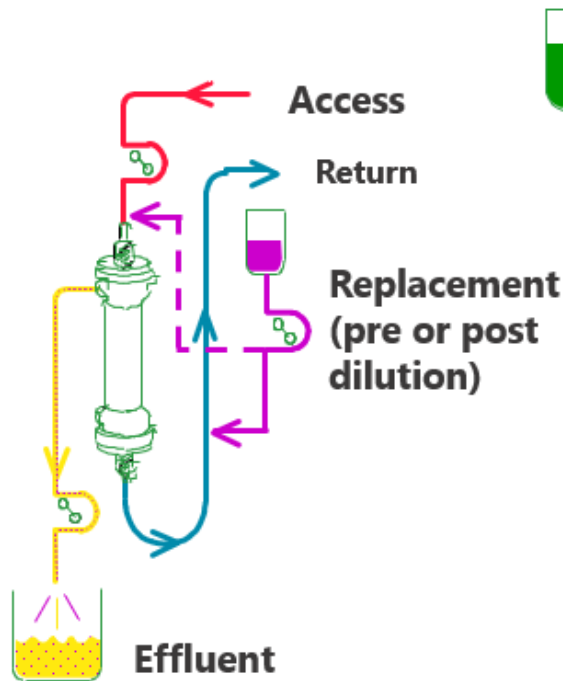


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*používané  
mody*

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# CRRT Modalities



CVVH

Solute clearance:  
convection;

Operative fluid: RF

CVVHD

Solute clearance:  
diffusion;

Operative fluid: dialysate

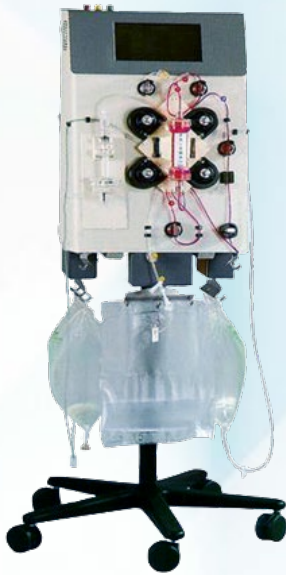
CVVHDF

Solute clearance: diffusion &  
convection;

Operative fluids: RF & dialysate



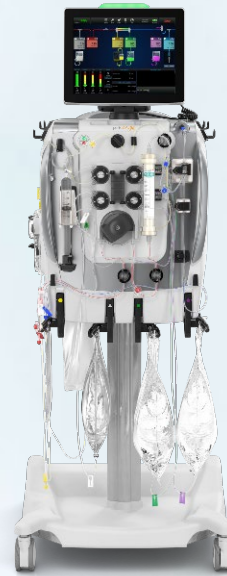
# Baxter



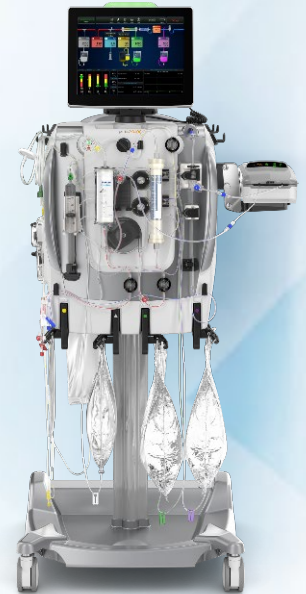
**Prisma**  
1996



**Prismaflex**  
2004



**PrisMax**  
2018



**PrisMax 2**  
2021

# Baxter - therapeutic modalities

- **CVVHDF** (*continuous venovenous hemodiafiltration*)
- **CVVHD** (*continuous venovenous hemodialysis*)
- **CVVH** (*continuous venovenous hemofiltration*)
- **PIRRT** (*prolonged intermittent RRT*)
- **TPE** (*therapeutic plasma exchange*)
- **HP** (*hemoperfusion*)
- **oXiris, Septex, LPS ...**
- **Cytosorb, Jafron ...**
- **MARS**

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***predilution***

***VS***

***postdilution***

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<b>Mode of HDF</b>	<b>Postdilution</b>	<b>Predilution</b>	<b>Mixed dilution</b>
<b>Advantages</b>	<ul style="list-style-type: none"> <li>• Effective in solute clearance &amp; removal</li> <li>• Decrease consumption of replacement solution</li> </ul>	<ul style="list-style-type: none"> <li>• Decrease hematocrit and TMP</li> <li>• Reduce the risks of clot formation and protein deposition in dialyzer</li> <li>• Is available in relatively low blood flow rate</li> <li>• Reduce membrane stress</li> </ul>	<ul style="list-style-type: none"> <li>• Avoid shortcomings of both predilution &amp; postdilution modes</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>• Increase hematocrit and TMP</li> <li>• Increase the risks of clot formation and protein deposition in dialyzer</li> <li>• Require relatively high blood flow rate</li> <li>• Increase membrane stress (potential albumin leakage)</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce solute clearance and removal</li> <li>• Increase consumption of replacement solution</li> </ul>	<ul style="list-style-type: none"> <li>• Require specific HDF machine with two infusion pumps</li> <li>• Require specific blood tubing set</li> </ul>

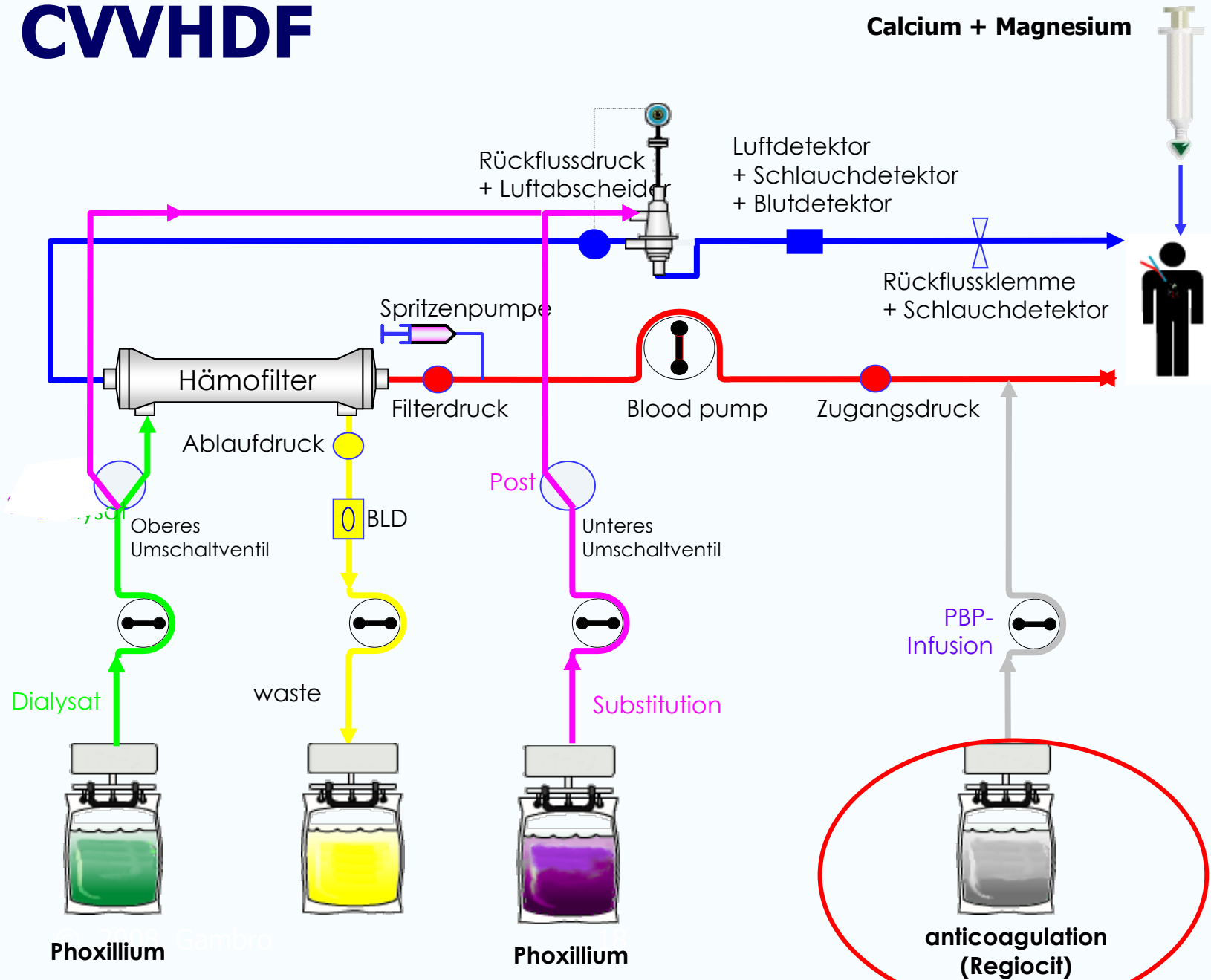
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***citrát***  
***(prediluce)***

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# CVVHDF

Calcium + Magnesium



Phoxillium Gambro

Phoxillium

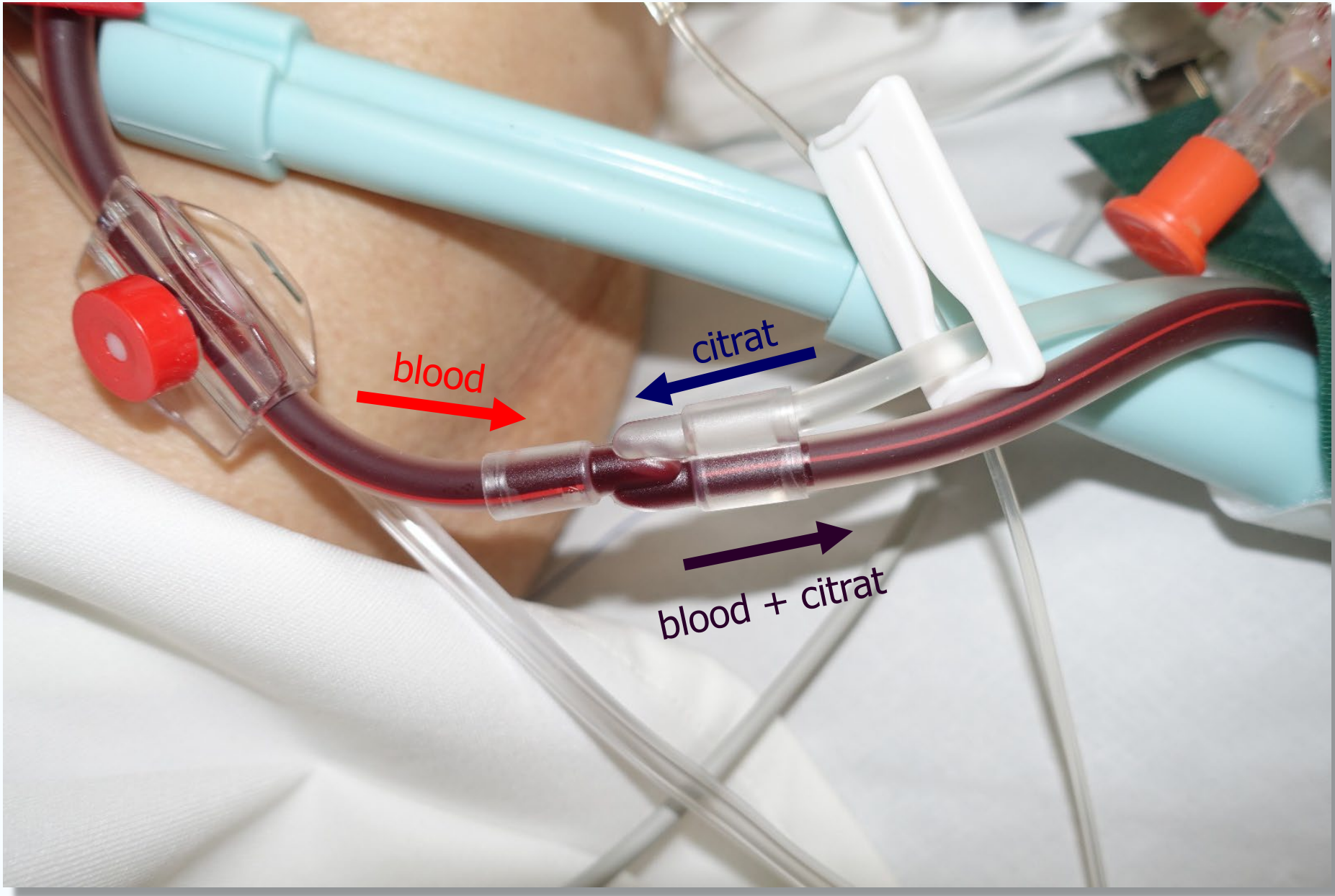
anticoagulation (Regiocit)

# Prismocitrate 18/0

Citrat	18 mmol/l
Citric acid	0 mmol/l
Calcium	0 mmol/l
Magnesium	0 mmol/l
Chloride	86 mmol/l
Sodium	140 mmol/l
Potassium	0 mmol/l







blood

citrat

blood + citrat

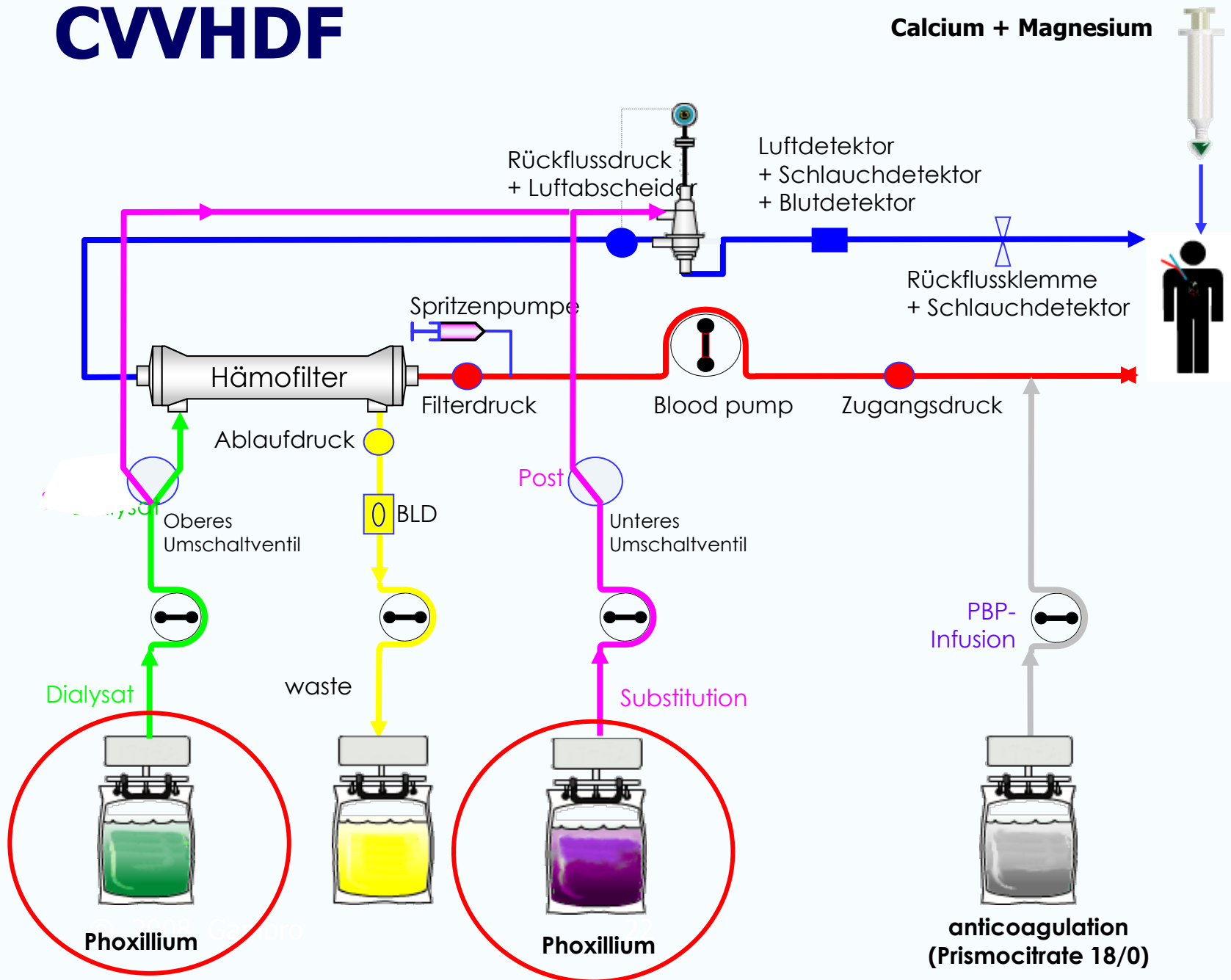


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*dialyzát*  
*a substituát*

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# CVVHDF



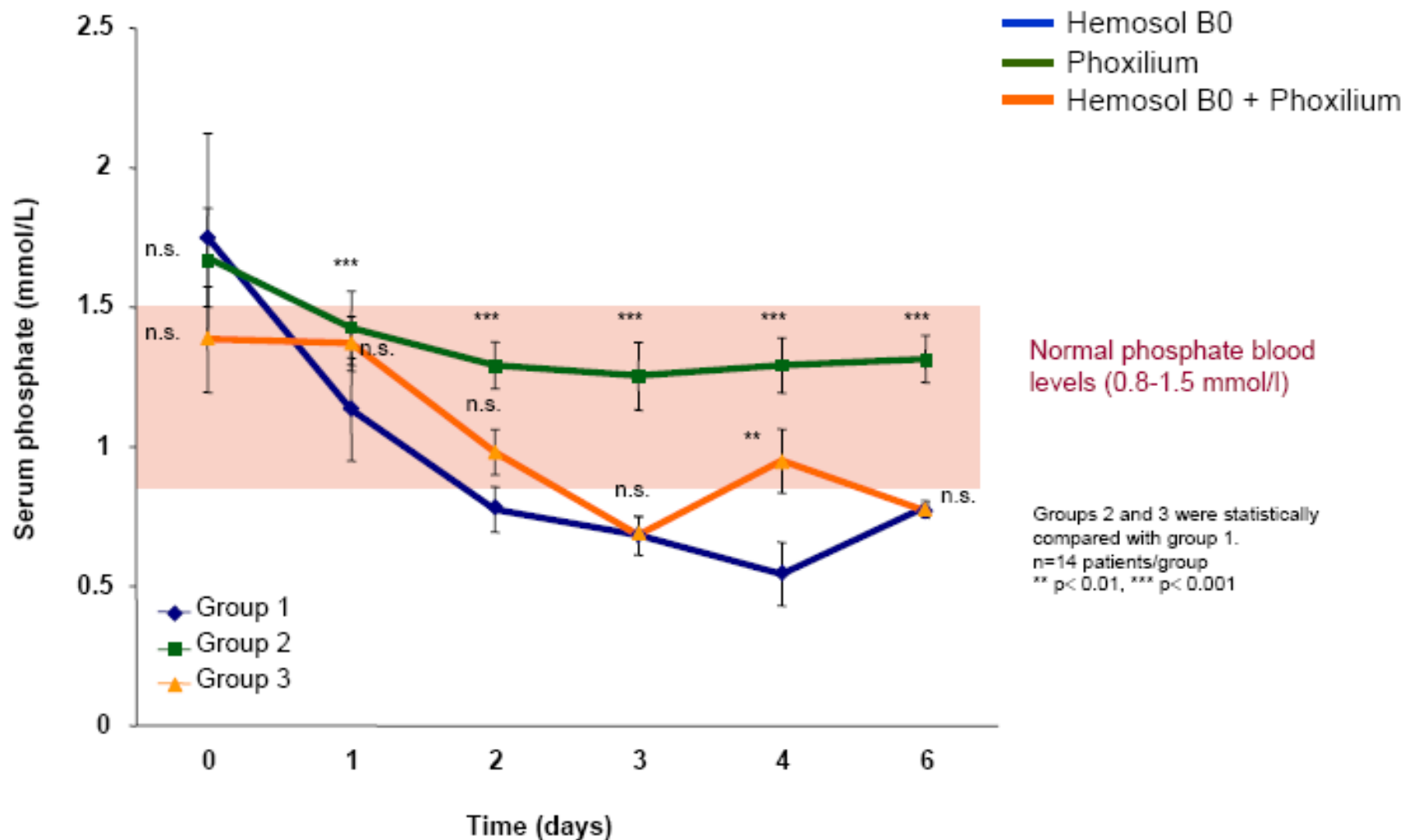
# Phoxilium

HCO <sup>3-</sup>	30 mmol/l
Calcium	1,25 mmol/l
Phosphate	1,2 mmol/l
Magnesium	0,6 mmol/l
Chloride	116 mmol/l
Natrium	140 mmol/l
Kalium	4 mmol/l
Glucose	0 mmol/l



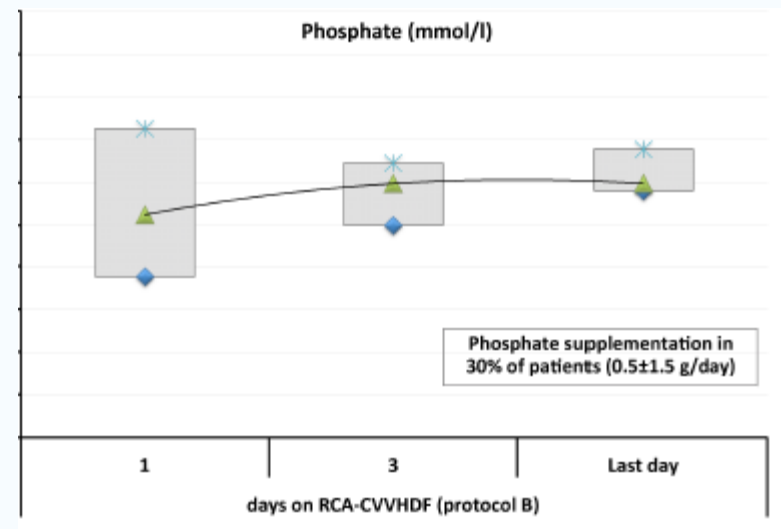
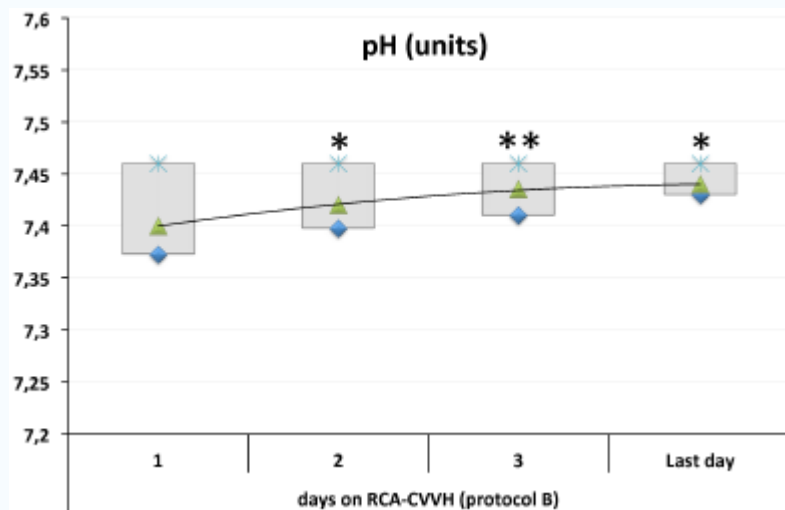
# Phosphate-containing dialysis solution

Broman et al., Acta Anesthesiol Scand 2011



# P-containing solutions

Morabito et al, BMC Nephrology, 2013



## Conclusions

The proposed RCA-CVVHDF protocol ensured appropriate acid–base balance without additional interventions, providing prolonged filter life despite adoption of a higher target circuit- $\text{Ca}^{2+}$ . The introduction of a phosphate-containing solution, in the setting of RCA, significantly reduced CRRT-related phosphate depletion.

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*počáteční  
problémy*

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## počáteční problémy

### - **Prismocitrat 10/2**

- nutnost výrazné substituce bikarbonátu
- metabolická poruchy ABR

### - přechod na **Prismocitrat 18/0 (nyní Regiocit)**

- bez metabolických poruch ABR
- prakticky nulová substituce bikarbonátu

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*substituce  
a monitorace  
kalcia*

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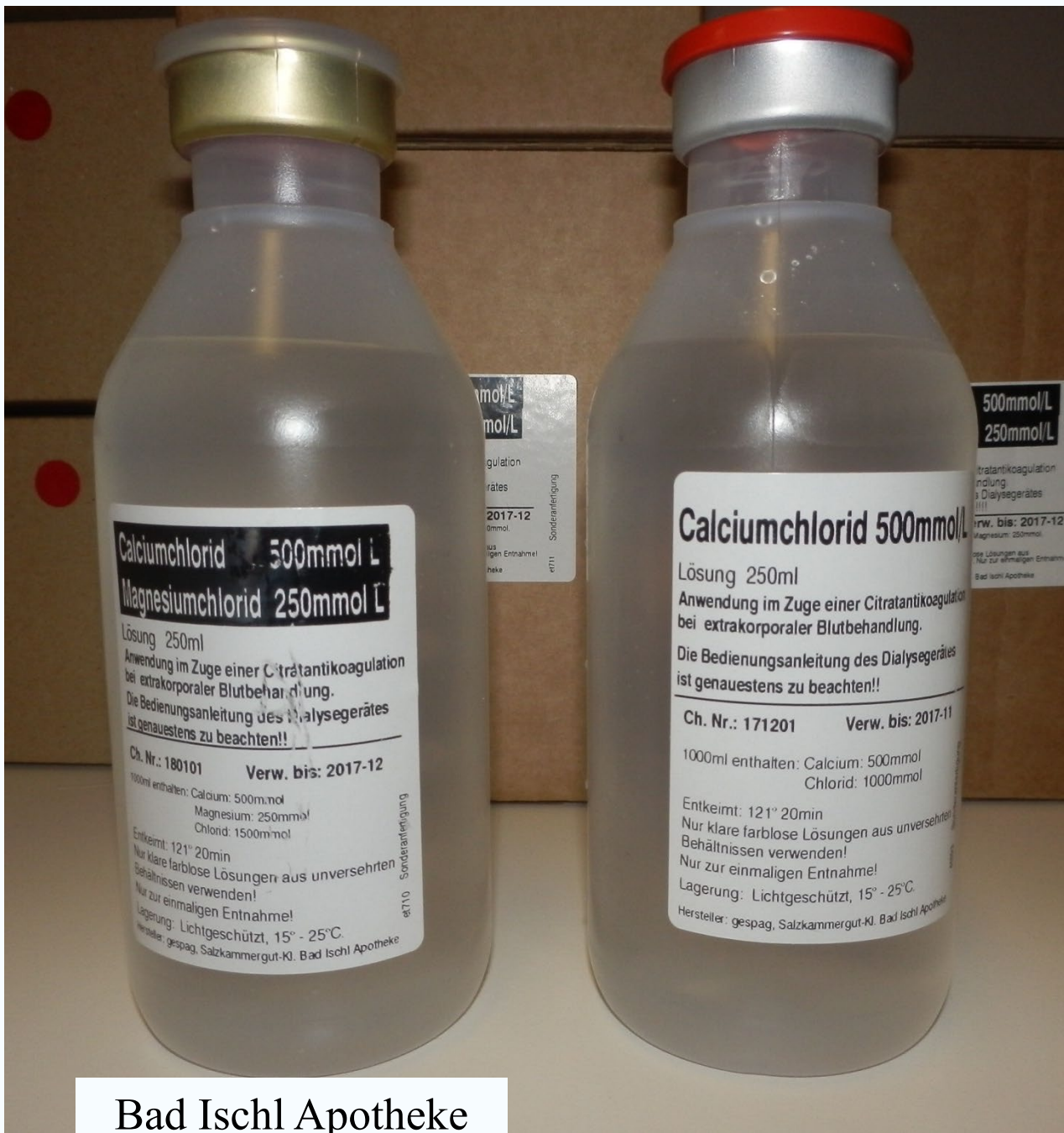
# substituce kalcia

## dříve:

- calcium chloride 10%
- 2x denně kontrola Ca, Na, K, P, Mg

## nyní:

- calcium : magnesium 2:1 mmol/l
- kontrola 1x denně (rutinní odběry)
- takřka odpadla nutnost substituce magnésia



Bad Ischl Apotheke

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*post-filter  
calcium*

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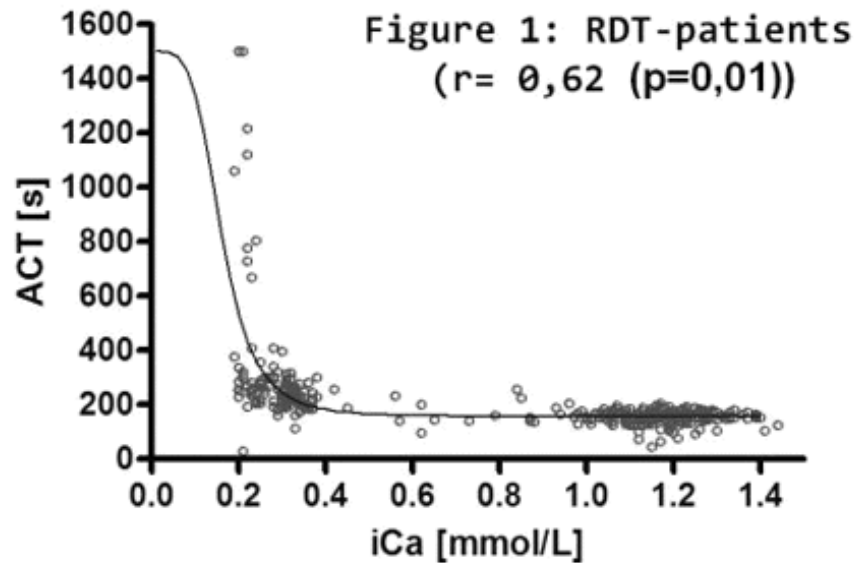
# post-filter calcium

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- cíl: **0,40 – 0,45 mmol/l**
- kontrola + 15min, + 1, 4, 8h
- proč hodnota 0,40 – 0,45?

# Extracorporeal dialysis: techniques and adequacy

*NDT Plus (2011) 4 (suppl 2)  
4.s2.37*



View larger version:

» In a new window

» Download as PowerPoint Slide

Figure

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*ionised-serum  
calcium*

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# ionised serum calcium

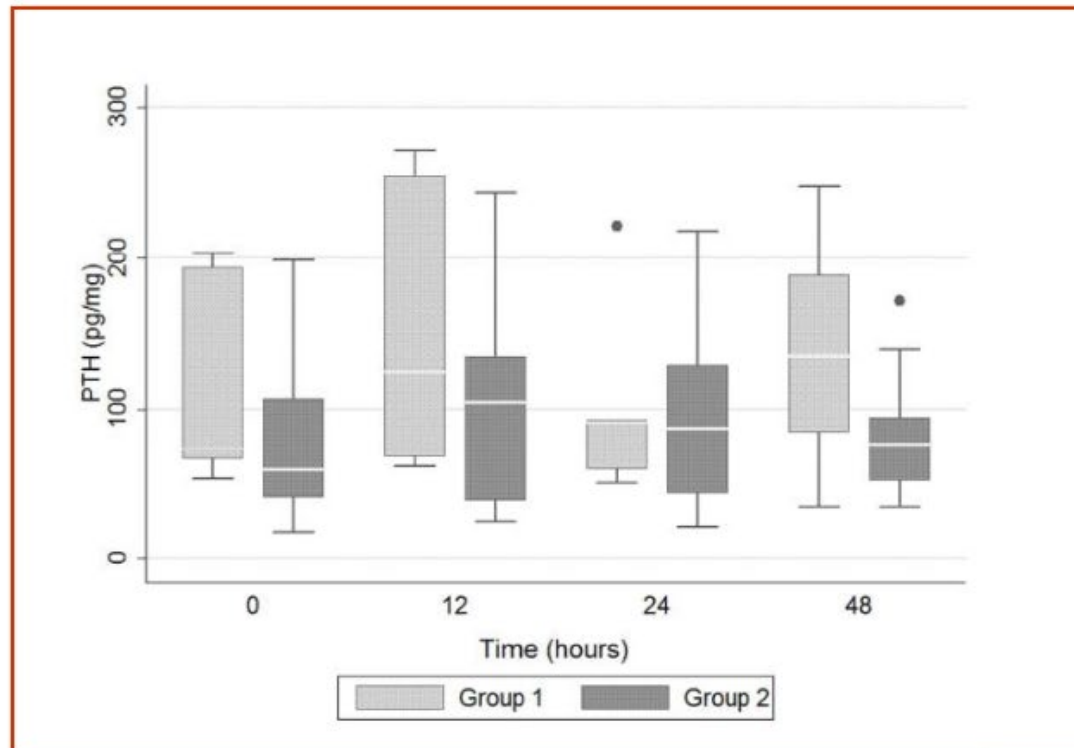
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- cíl: **1,15 – 1,20 mmol/l**
- kontrola + 15min, + 1, 4, 8h
- proč hodnota 1,15 – 1,20 mmol/l?
- < 1,12 mmol/l dochází k vzestupu hladiny parathormonu
- následuje resorpce kalcia z kostí (iatrogenní hyperparathyreoidismus)

# Maintaining normal levels of ionised calcium during citrate-based renal replacement therapy is associated with stable parathyroid hormone levels

Raimundo M. et al.

*Nephron Clin Pract 2013-e-pub*



Box-and-whiskers plots for serum PTHi levels for patients whose  $\text{Ca}_i$  decreased from normal to  $<1.12$  mmol/L at 12 h (Group 1) and patients in whom serum  $\text{Ca}_i$  was maintained within range  $1.12$ - $1.2$  mmol/L (Group 2).





***stabilita***





☑ CVVHDF

29.05.2015 00:00 - 04.06.2015 23:59

**05.06.2015 00:00 - 11.06.2015 23:59**

	05.06	06.06	07.06	08.06	09.06	10.06	11.06
CiConc [mmol/L]				18	18	18	18
CiDose [mmol/l]				4.4	4.5	3.8	4
	-						
Blutfluß [ml/min]				120	120	120	120
PBP Fl. [ml/h]				1760	1800	1520	1600
Dialysat Fl. [ml/h]				1200	1200	1200	1200
Substit. Fl. [ml/h]				300	300	300	300
Entzug/h (s)				50	50	50	50
CaComp [%]				100	85	105	105
	<b>BGA</b>						
#Ca postFilt [mmol/l]				0.36	0.35	0.31	0.4
#CCAI [mmol/l]	1.15	1.13	1.13	1.22	1.22		
CA [mmol/l]	2.32	2.34	2.41	2.47	2.66		
#HCO3I-A [mmol/l]	29.5	25.5	26.2	26.9	26.4		
#PHI-A	7.4	7.43	7.41	7.41	7.44		
#LAK-I-A [mmol/l]	1	2	2.4	1.4	2.1	1.2	1

**#Ca postFilt mmol/l**  
09.06.2015 10:30 0.36  
09.06.2015 14:07 **0.42**  
09.06.2015 18:20 0.35  
09.06.2015 21:42 0.35

#LAK-I-A [mmol/l]	1	2	2.4	1.4	2.1	1.2	1
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*opakovaná*  
*CRRT*

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# opakovaná CRRT

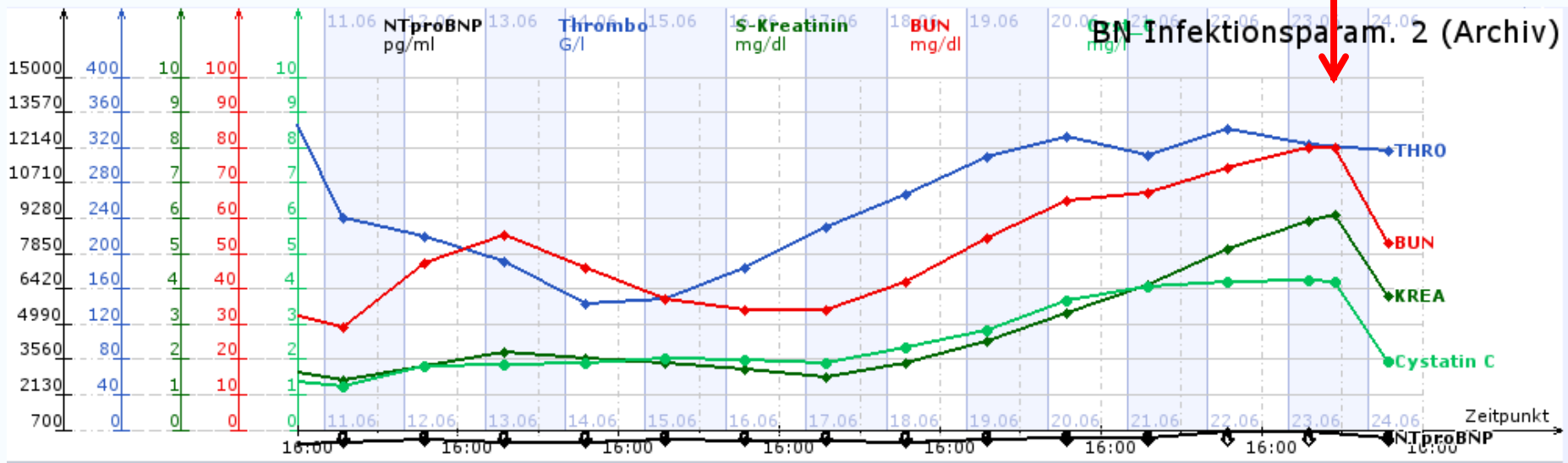
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hodnoty **citrátu** a **kompence kalcia**  
nastavit **stejně** jako na konci předchozí  
úspěšné CRRT

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*blood  
warmer*

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## Thermax Blood Warmer

- Enables precise control of blood return temperature between 35° C and 38° C, all managed through the PRISMAX System interface<sup>†</sup>
- Independent from fluid flow rates and therapy interruptions

<sup>†</sup> Cooling only through therapy fluids, no active cooling of blood through the warmer

- **ohřívá se krev** na zpáteční cestě k pacientovi
- **8 senzorů** sledujících teplotu krve
- **neohřívá se roztok** (>30°C bikarbonát vs CO<sub>2</sub> produkce?)





***HF-box***





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*terapeutické  
modality*

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# Baxter - therapeutic modalities

- **CVVHDF** (*continuous venovenous hemodiafiltration*)
- **CVVHD** (*continuous venovenous hemodialysis*)
- **CVVH** (*continuous venovenous hemofiltration*)
- **PIRRT** (*prolonged intermittent RRT*)
- **TPE** (*therapeutic plasma exchange*)
- **HP** (*hemoperfusion*)
- **oXiris, Septex, LPS ...**
- **Cytosorb, Jafron ...**
- **MARS**

# Continuous Renal Replacement Therapy Market Segment Analysis

The Continuous Renal Replacement Therapy market can be classified by the modality: Continuous Venovenous Hemofiltration (CVWH), Continuous Venovenous Hemodiafiltration (CVVHDF), Continuous Venovenous Hemodialysis (CVVHD), and Slow Continuous Ultrafiltration (SCUF). During the forecast period, the Continuous Venovenous Hemodiafiltration (CVVHDF) market is expected to grow at the fastest of all CRRT modalities. The rapid rise of the CVVHDF segment is due to its versatility compared to other CRRT modalities. Another important aspect driving its expansion is the ability of the CVVHDF modality to combine the advantages of convection and diffusion for solute removal.

## CVVHDF

- the continuous venovenous hemodiafiltration (**CVVHDF**) segment reached the **highest market share** in continuous renal replacement therapy (CRRT) **worldwide** in **2023**
- the dominance of this segment is mainly attributed to the **ability of CVVHDF to completely remove and replace solutes and fluids** from the patient's blood
- this therapy is an **ideal combination of diffusion and convection** to ensure clearance for a wide range of solutes
- therefore, **CVVHDF** is the **preferred method** in several **developed countries**



***TPE***



# TPE

- **therapeutic plasma exchange**

- odstraňuje se plazma pacienta obsahující **patogenní** komponenty, je nahrazována koloidními roztoky (plasma, albumin...)

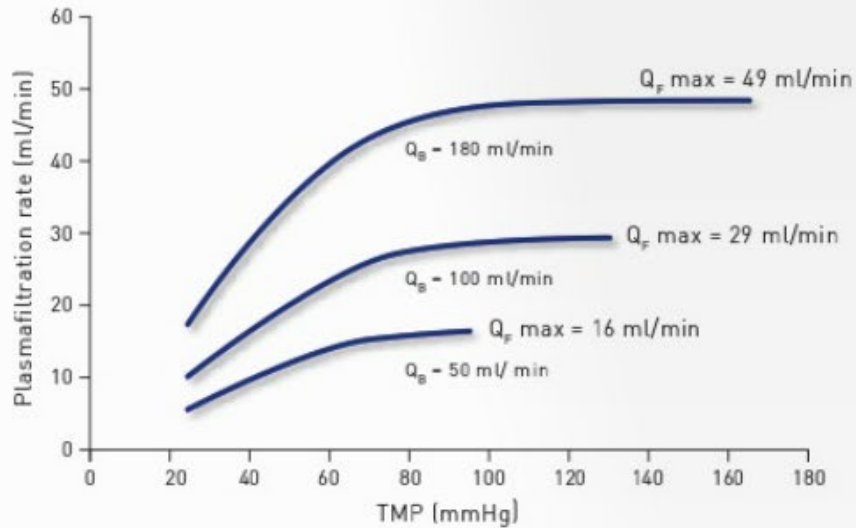
- nejúčinnější je výměna plasmy **1-1,5 násobku** celkového objemu plazmy pacienta

- speciální **sety** TPE 1000/2000

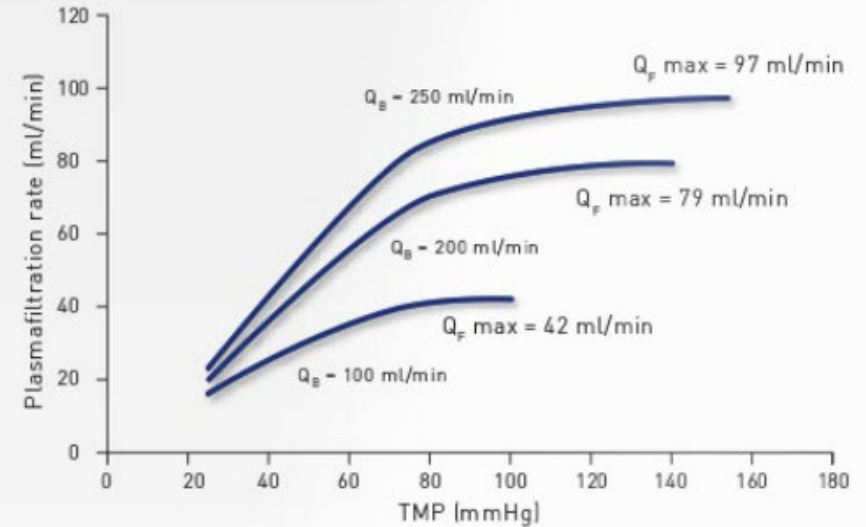
- terapeutická modalita na Prismaflex/Prismax



## Prismaflex TPE 1000 set



## Prismaflex TPE 2000 set





"in vitro" plasmafiltration with blood (values  $\pm 20\%$ ) (Bovine blood at 37°C, Htc 32%, Protein concentration 60 g/l) Plasmafiltration is controlled by the Prismaflex system.

Product name	Prismaflex TPE 1000 set	Prismaflex TPE 2000 set
Factory id	8320010	8320020
SAP number	107143	107144
Indication	Patient with body weight $> 20$ kg	Adult
Volume in set $\pm 10\%$	71 ml	125 ml
Effective surface area	0.15 m <sup>2</sup>	0.35 m <sup>2</sup>
Fiber membrane material	Polypropylene	Polypropylene
Fiber internal diameter (wet)	330 $\mu$ m	330 $\mu$ m
Fiber wall thickness	150 $\mu$ m	150 $\mu$ m
Blood volume in plasmafilter	23 ml $\pm 10\%$	41 ml $\pm 10\%$



# Status

  120 kg

00:31 ▶ 00:31 ⌚ 12:17

Betrieb TPE

## Verordnung

## Antikoagulation

Blut	120 ml/min	
Gesamtsubstitutvol.	3000 ml	
Substitut	750 ml/h	343 ml
Pat.-Plasmaverlust	0 ml/h	1 ml
Prä-Blutpumpe	0 ml/h	0 ml
Ablauf	750 ml/h	344 ml
Hkt vor Behandlung	38 %	
Hkt Post-Filter	42 %	
Filtrations-Fraktion	18 %	
TPE-Zeit	243 min	

EINSTELL

## Drücke ( mmHg )



Info

TMP

Nächster Einsatz in: 2 h 38 min  
Wegen: Ablaufbeutel voll.

STOP

BEUTEL  
WECHSEL

PEGEL  
EINSTELL.

SYSTEM  
INSTRUM.

HISTORIE  
DATEN

HILFE

☑ CVVHDF

29.05.2015 00:00 - 04.06.2015 23:59

	29.05	30.05	31.05	01.06	02.06	03.06	04.06
	-						
	<b>BGA</b>						
#CCAI [mmol/l]	1.08	1.07	0.99	1.05	1.08	1.13	1.16
CA [mmol/l]	2.24	2.12	2.14	2.09	2.06	2.2	2.31
#HCO3I-A [mmol/l]	31.2	33.9	32.2	36.6	37	33.7	33.1
#PHI-A	7.47	7.51	7.51	7.49	7.5	7.47	7.48
#LAK-I-A [mmol/l]	1.2	0.8	0.4	0.8	0.4	0.4	0.4

05.06.2015 00:00 - 11.06.2015 23:59

	05.06	06.06	07.06	08.06	09.06	10.06	11.06
CiConc [mmol/L]				75	75	75	
CiDose [mmol/l]				3.5	3.6	3.6	
	-						
Blutfluß [ml/min]				120	120	120	
PBP Fl. [ml/h]				223	229	229	
Dialysat Fl. [ml/h]				0	0	0	
Substit. Fl. [ml/h]				750	750	750	
Entzug/h (s)				0	0	0	
CaComp [%]				100	100	100	
	<b>BGA</b>						
#Ca postFilt [mmol/l]				0.36	0.35	0.37	
#CCAI [mmol/l]	1.14	1.15	1.14	1.21	1.17	1.15	1.09
CA [mmol/l]		2.35	2.38	2.76	2.66	2.62	2.28
#HCO3I-A [mmol/l]	30.2	35	33.9	34.9	34.5	35.3	34.3
#PHI-A	7.46	7.48	7.49	7.48	7.46	7.47	7.48
#LAK-I-A [mmol/l]	0.4	0.6	0.7	0.6	0.7	0.7	0.8

☑ Prismaflex Citrat 24h

10.06.2015 15:00 - 11.06.2015 02:59

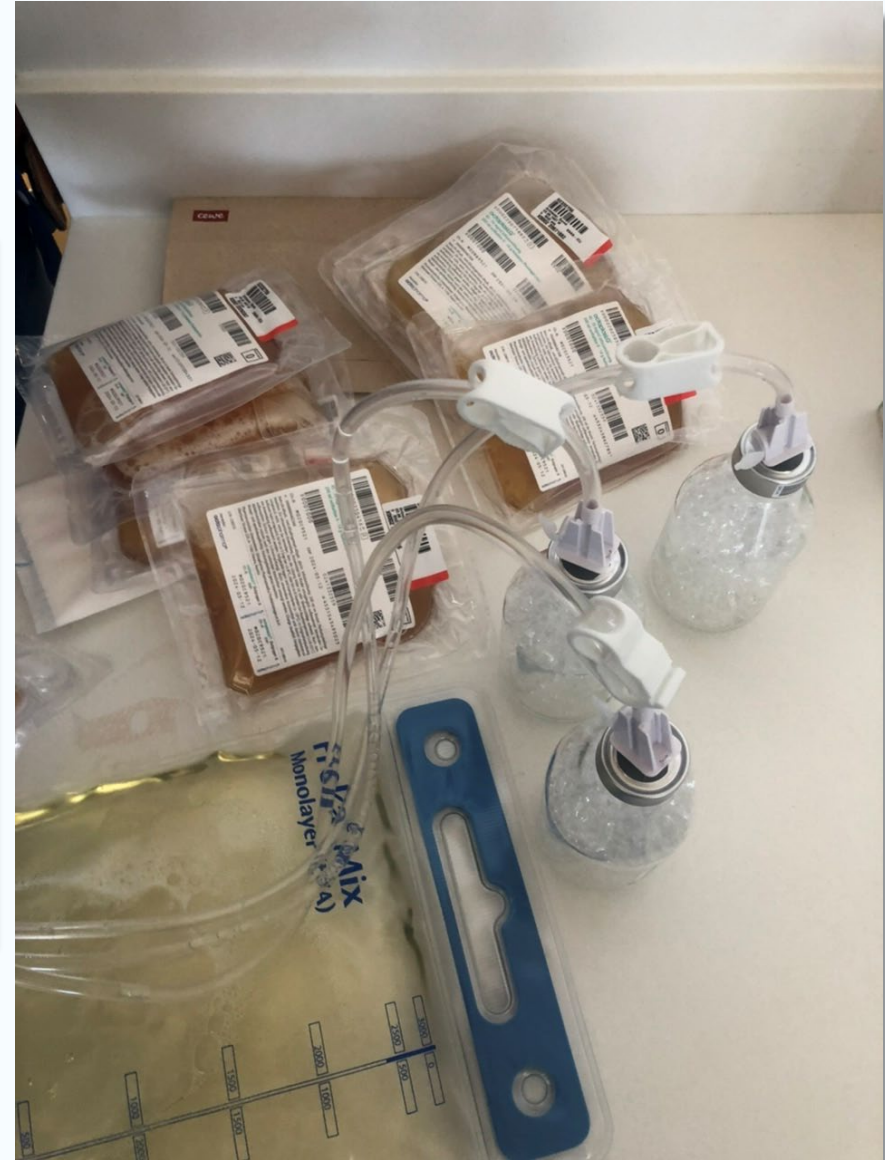
	15:00	16:00	17:00	18:00	19:00
CRRT Verfahren	Ther plasma exchange	Ther plasma exchange	Ther plasma exchange	Ther plasma exchange	
Blutfluß [ml/min]	120	120	120	120	
Entzug/h (s)	0	0	0	0	
Dialysat Fl. [ml/h]	0	0	0	0	
PBP Fl. [ml/h]	229	229	229	229	
Substit. Fl. [ml/h]	750	750	750	750	
Sub.pre Flow [ml/h]	0	0	0	0	
Ultra. Flow [ml/h]	750	750	750	750	
Zugangsdruck [mmHg]	-39	-30	-31	-35	
Filterdruck [mmHg]	81	78	73	70	
TMP - [mmHg]	25	26	22	23	
Rückfl.Druck [mmHg]	30	31	25	23	
Ablaufdruck [mmHg]	26	27	21	18	
FDP [mmHg]	28	24	21	20	
DialysatVolC [ml]	0	0	0	0	
Ultra. Volum [ml]				3000	
UltraFVolC [ml]	868	1631	2389	2982	
SubstPost C [ml]	884	1647	2405	2991	
SubstPrä C [ml]	0	0	0	0	
OUTdial(cm) [ml]	-16	-16	-16	-9	
#Ca postFilt [mmol/l]			0.37		
#Probearth		CICA	CICA	n. spez.	
BloodVol [L]	10	17	24	30	
CaComp [%]	100	100	100	100	
CaConc [mmol/L]	80	80	80	80	
CaFlow [mL/h]	0	0	0	0	
CiAcidConc [mmol/L]	38	38	38	38	
CiConc [mmol/L]	75	75	75	75	
CiDose [mmol/l]	3.6	3.6	3.6	3.6	
CiLoad [mmol/L]	20.3	20.3	20.3	20.3	
FluidRemoved [ml]	0	0	0	0	
UFratio [%]	10	10	10	10	
RelusIntroval [h]	6	6	6	6	

## 05.06.2015 00:00 - 11.06.2015 23:59

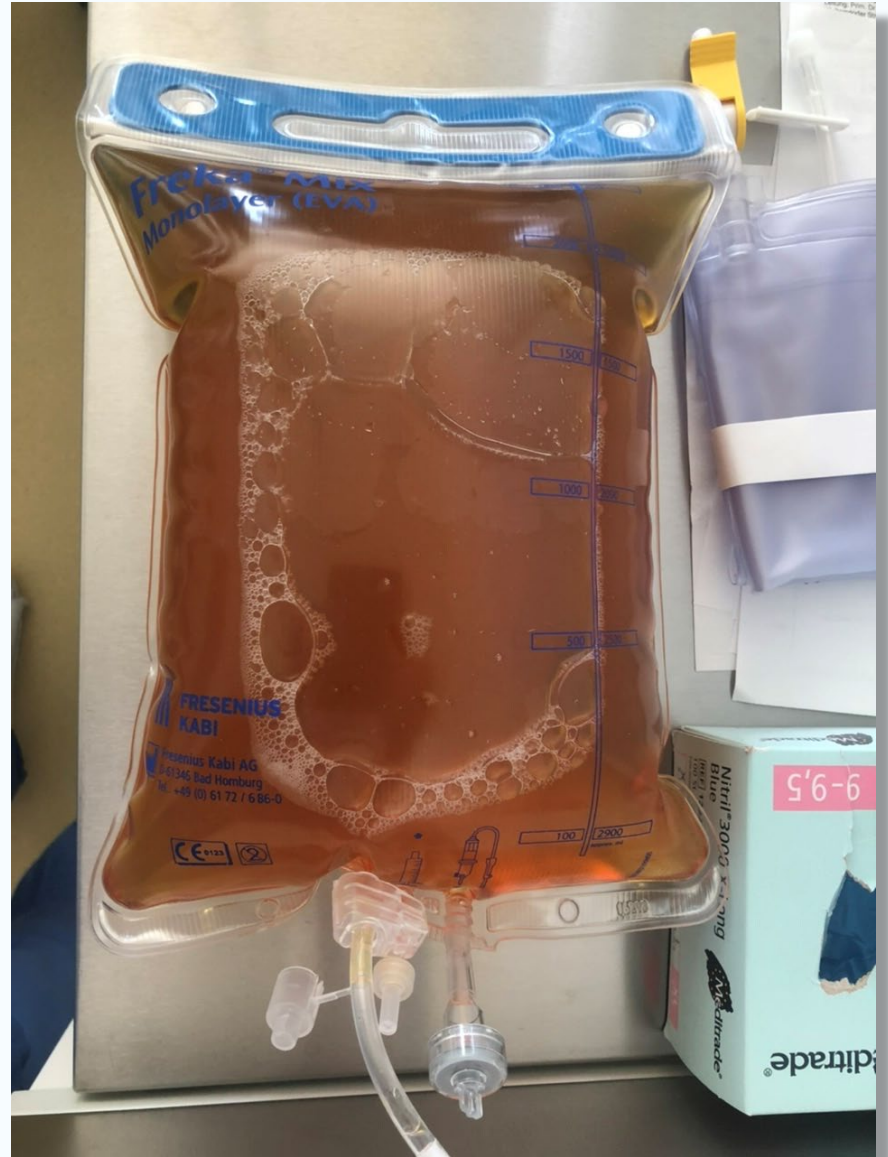
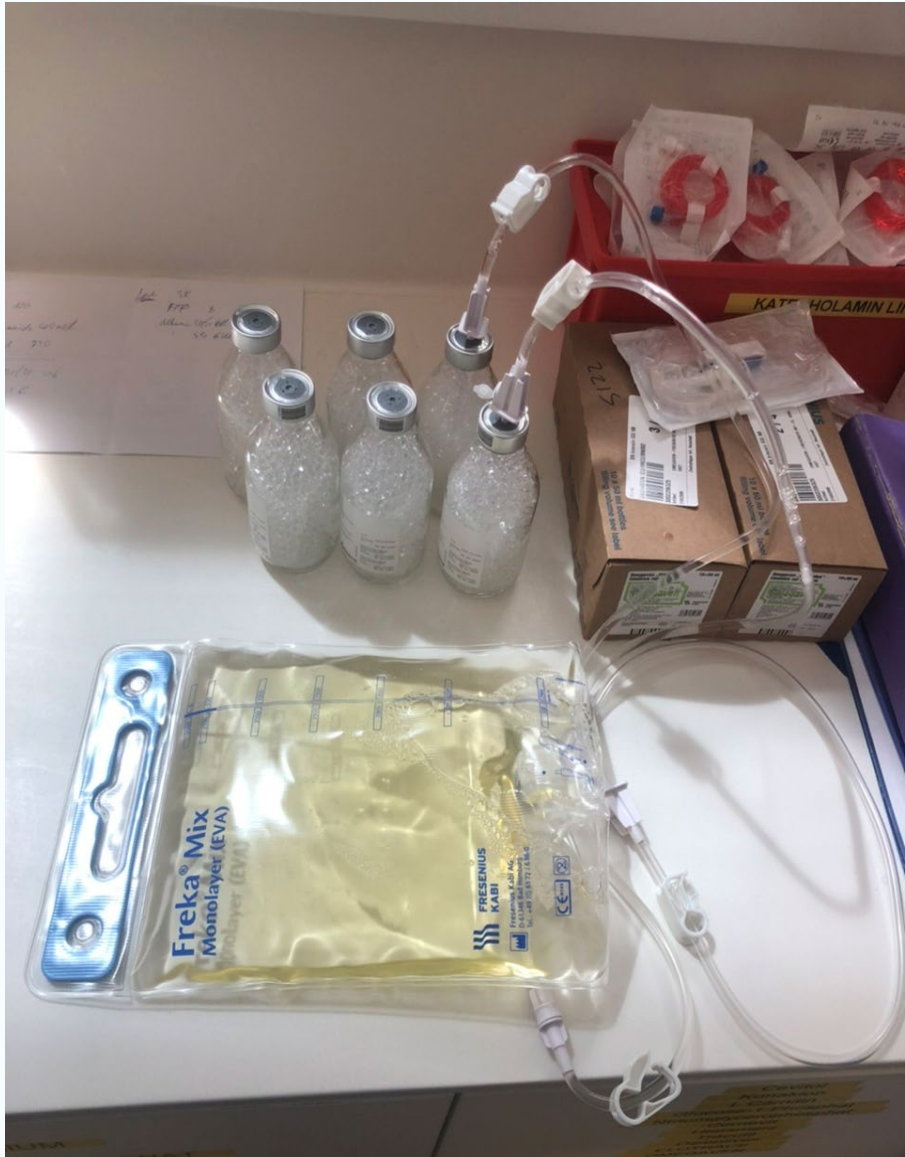
	05.06	06.06	07.06	08.06	09.06	10.06	11.06
CiConc [mmol/L]				75	75	75	
CiDose [mmol/l]				3.5	3.6	3.6	
	-						
Blutfluß [ml/min]				120	120	120	
PBP Fl. [ml/h]				223	229	229	
Dialysat Fl. [ml/h]				0	0	0	
Substit. Fl. [ml/h]				750	750	750	
Entzug/h (s)				0	0	0	
CaComp [%]				100	100	100	
	<b>BGA</b>						
#Ca postFilt [mmol/l]				0.36	0.35	0.37	
#CCAI [mmol/l]	1.14	1.15	1.14	1.21	1.17		
CA [mmol/l]		2.35	2.38	2.76	2.66		
#HCO3I-A [mmol/l]	30.2	35	33.9	34.9	34.5		
#PHI-A	7.46	7.48	7.49	7.48	7.46	7.47	7.48
#LAK-I-A [mmol/l]	0.4	0.6	0.7	0.6	0.7	0.7	0.8

### #Ca postFilt mmol/l

09.06.2015 15:35 0.28  
 09.06.2015 16:55 0.34  
 09.06.2015 18:41 0.35







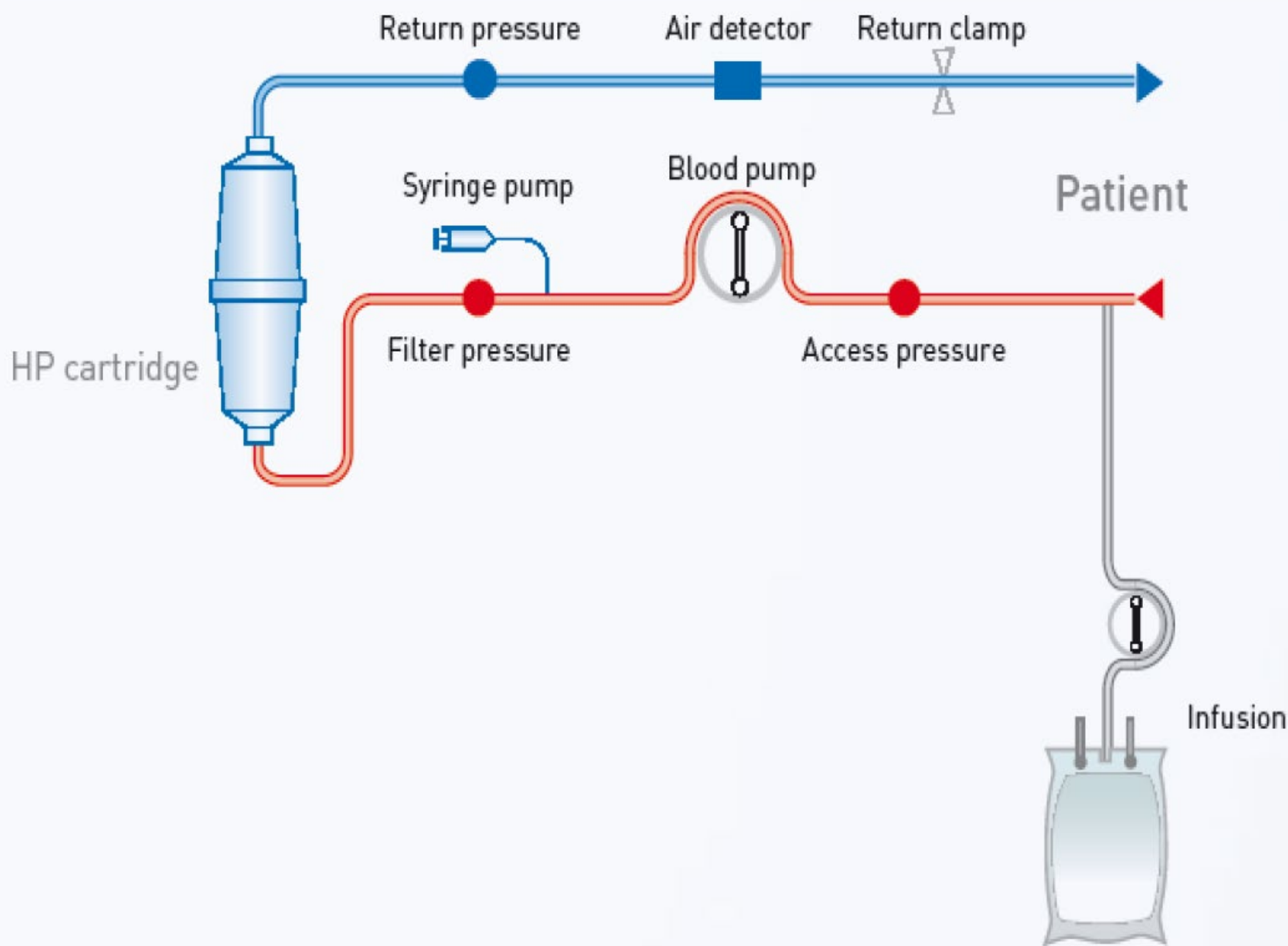
---

*hemoperfúze*

---

# hemoperfúze

- odstraňuje **patogenní komponenty**,  
které nejsou vázány na plasmatické proteiny
- **exotoxiny**, endotoxiny, zánětlivé mediátory...
- **HP** cartridge
- terapeutická modalita na Prismaflex/Prismax



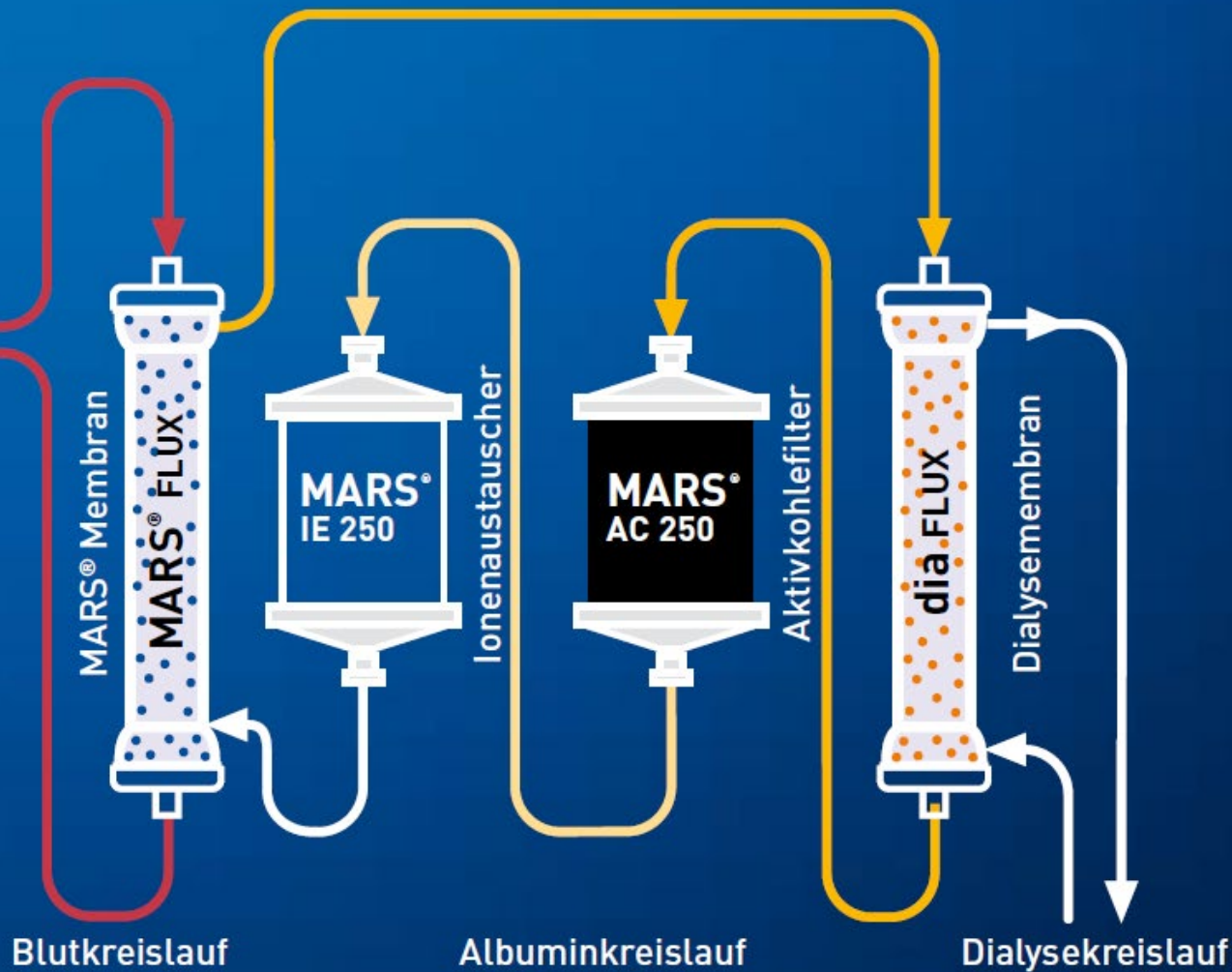




***MARS***

# MARS

- **Molecular Adsorbent Recirculating System**
- odstraňuje ve vodě rozpustné a na bílkoviny vázané toxiny pomocí **albuminové dialýzy**
- v praxi od r. **1993**
- používá se v cca **225** centrech **45** zemí (15.000 pts)
- terapeutická modalita na Prismaflex/Prismax
- možno i ostatními **systemy**  
(*Braun, Edwards, Fresenius, Kimal...*)



---

***cytokine  
removal  
therapy***

---

# cytokine removal therapy

- Cytosorb<sup>®</sup>



- Jafron<sup>®</sup>



- Oxiris<sup>®</sup>

- Septex<sup>®</sup>

- LPS<sup>®</sup> filter

- ...

## cartridges

### selective

cutoff point  $\approx$  60 kDa

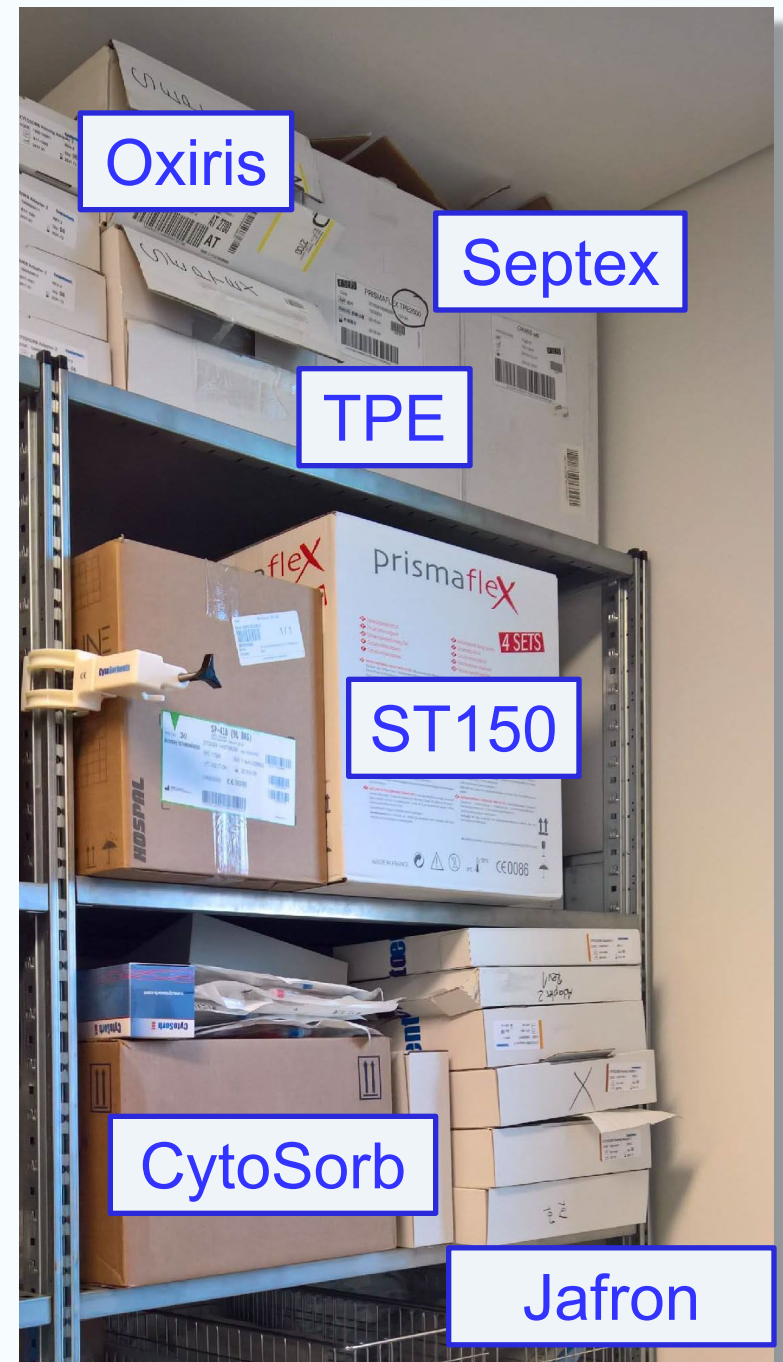
polymyxin B

### non-selective

cutoff point  $\approx$  100 kDa

Cytosorb<sup>®</sup> USA

Jafron<sup>®</sup> China



# cytokine removal therapy

- sepsis a septický šok
- rhabdomyolýza (*crush syndrom*)
- jaterní selhání
- intoxikace (lékové či jiné)
- SIRS (st.p. CPR, akutní pankreatitida)
- *many others ...*

obecně přijímané indikace neexistují



# Hemoadsorption

## with Jafron hemoperfusion cartridge HA330/HA380

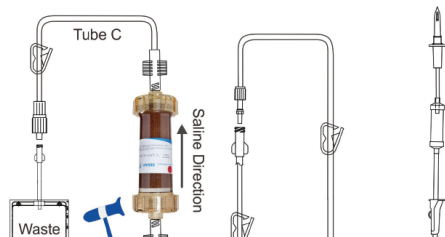
ON PRISMAFLEX OR PRISMAX WITH CITRATE ANTICOAGULATION

### Machine setup : CVVHDF therapy

- Set up as usual with a ST 150 dialyzer and citrate anticoagulation (Prismocitrate 18/0 mmol)
- **Timing:** Once the machine completes its first rinsing cycle, put it on hold and proceed with the steps below.

### Priming of the hemoperfusion cartridge

- Connect the male luer lock of the infusion line (with closed clamp) to the female connector of tube B (with closed clamp). Connect the other end of this infusion line to the physiological saline solution.
- Open the clamps on both tubes to fill the lines with physiological saline solution and remove all air bubbles. Once the tubes are filled with this saline solution, close the clamp on tube B.
- Open the inlet side of the HA330/HA380 cartridge (top) with the wrench provided in the packaging. Pay attention not to get air inside the cartridge. Connect the inlet side of the cartridge to tube B.
- Turn the cartridge upside down, open the outlet side of the HA330/HA380 cartridge (bottom) with the same wrench and connect to tube C. Connect the other end of tube C to the waste bag.
- Keeping the cartridge upside down, insert it on the cartridge holder. Open the clamp on tube B and prime the cartridge with 2 L of physiological saline solution. During the priming, tap the cartridge gently with the rubber hammer to facilitate air removal.
- After priming, close all clamps.



### GENERAL CHARACTERISTICS OF THE THERAPY

- Jafron hemoperfusion cartridge: HA330/HA380 (location: post-dialyzer)
- Dialyzer: standard dialyzer (e.g. ST 150 [AN 69, 1,5 m<sup>2</sup>])
- Blood flow: 120-130 ml/min
- Anticoagulant: Prismocitrate 18/0 mmol
- Dialysate/substitution fluid: Phoxilium (Ca<sup>++</sup> Mg<sup>++</sup> combination)
- Post-cartridge Ca<sup>++</sup> concentration: 0,25 – 0,30 mmol/L

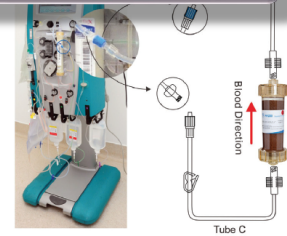
### MATERIALS REQUIRED FOR HEMOADSORPTION

- HA hemoperfusion cartridge + wrench (included in packaging)
- Rubber hammer

### Connection of the cartridge to PRISMAFLEX or PRISMAX

- Disconnect tube B from the infusion line.
- On the PRISMAFLEX or PRISMAX system, disconnect the male luer lock of the tube connected to the venous side of the dialyzer (going to the bubble trap). Now connect this male luer lock to the female connector of tube B. You have now connected the dialyzer to the hemoperfusion cartridge.
- Disconnect tube C from the waste bag and connect it to the line going to the venous bubble trap.

February '20



### Starting therapy

- After integrating the hemoperfusion cartridge into the extracorporeal circuit, start the second rinsing cycle of the machine with 1 L of physiological saline solution.
- Once the second rinsing cycle has completed, connect the patient and begin therapy

- Blood flow ≈ 80 ml/min
- Citrate ≈ 5,2-5,6 mmol/min
- Ca<sup>++</sup> compensation ≈ 100%
- Increase the blood flow to 120-130 ml/min

#### After 1 hour of therapy:

- Measure and adjust the citrate dose to a post-filter Ca<sup>++</sup> concentration of 0,25-0,30 mmol/L
- Measure and adjust the ionized body Ca<sup>++</sup> concentration to 1,15-1,25 mmol/L using a Ca<sup>++</sup> substitution

#### After 6-12 hours of therapy:

- Measure and adjust the values (defined above)

### Changing the hemoperfusion cartridge

#### Recommendation: “2+1+1” therapy

Day 1: 2 cartridges (1 every 12 hours) | Days 2-3: 1 cartridge (1 every 24 hours)

#### Day 1: The first and second hemoperfusion cartridges

- **Timing:** after 12 hours, rinse the extracorporeal circuit with physiological saline to flush the dialyzer and hemoperfusion cartridge
  - Change the hemoperfusion cartridge and its connectors. The CRRT system may be used up to 72 hours if there is no clotting.
  - However, if there are signs of clotting, change the entire CRRT system.

#### Day 2: The third hemoperfusion cartridge

- **Timing:** after 24 hours, repeat the steps defined for Day 1.

#### Day 3: The fourth hemoperfusion cartridge

- **Timing:** after 24 hours, repeat the steps defined for Day 1.
- If necessary, continue CVVHDF therapy.

### Stopping therapy

- **Timing:** after having performed the “2+1+1” therapy or when the desired goals have been achieved (e.g. a marked reduction of vasopressor)

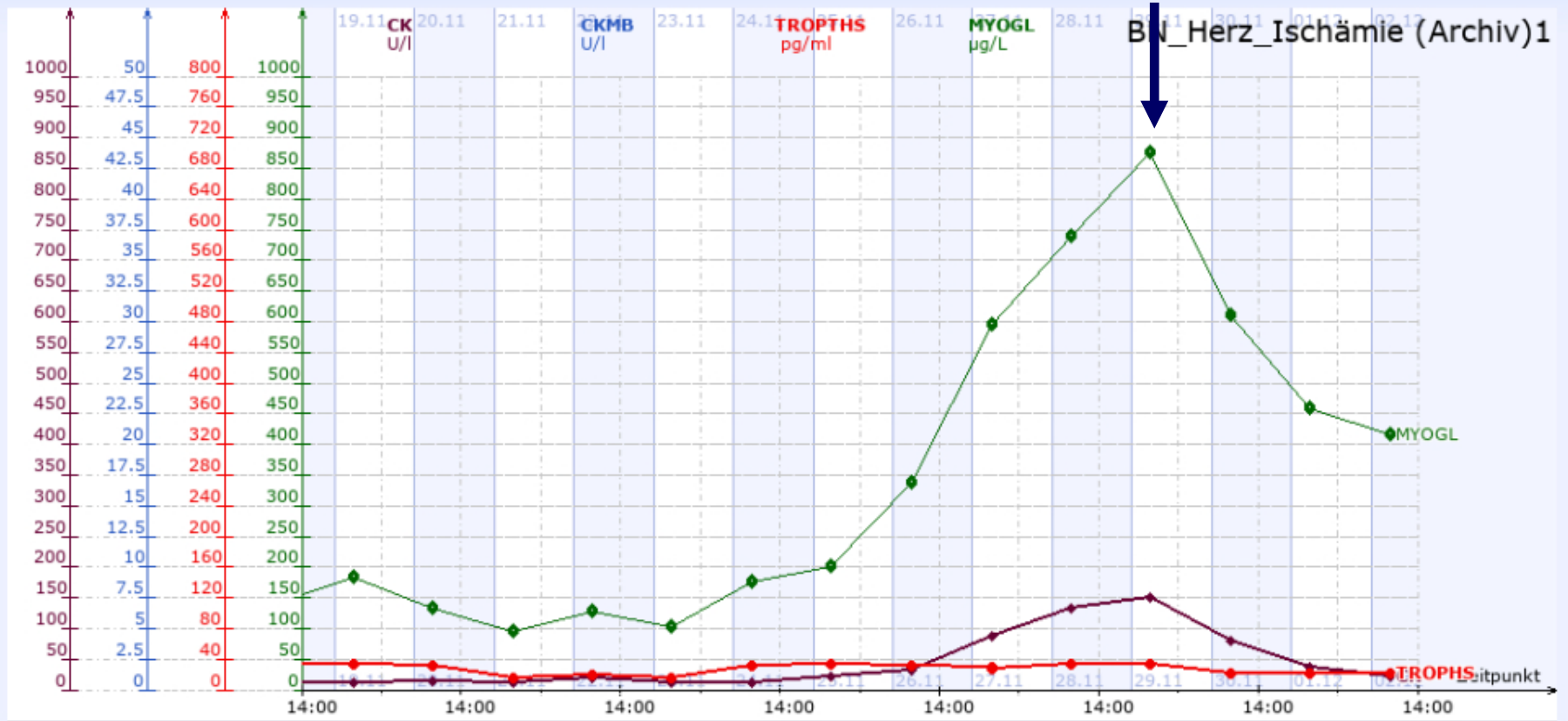




Herz\_Ischämie

18.11.2017 14:00 - 02.12.2017 14:00

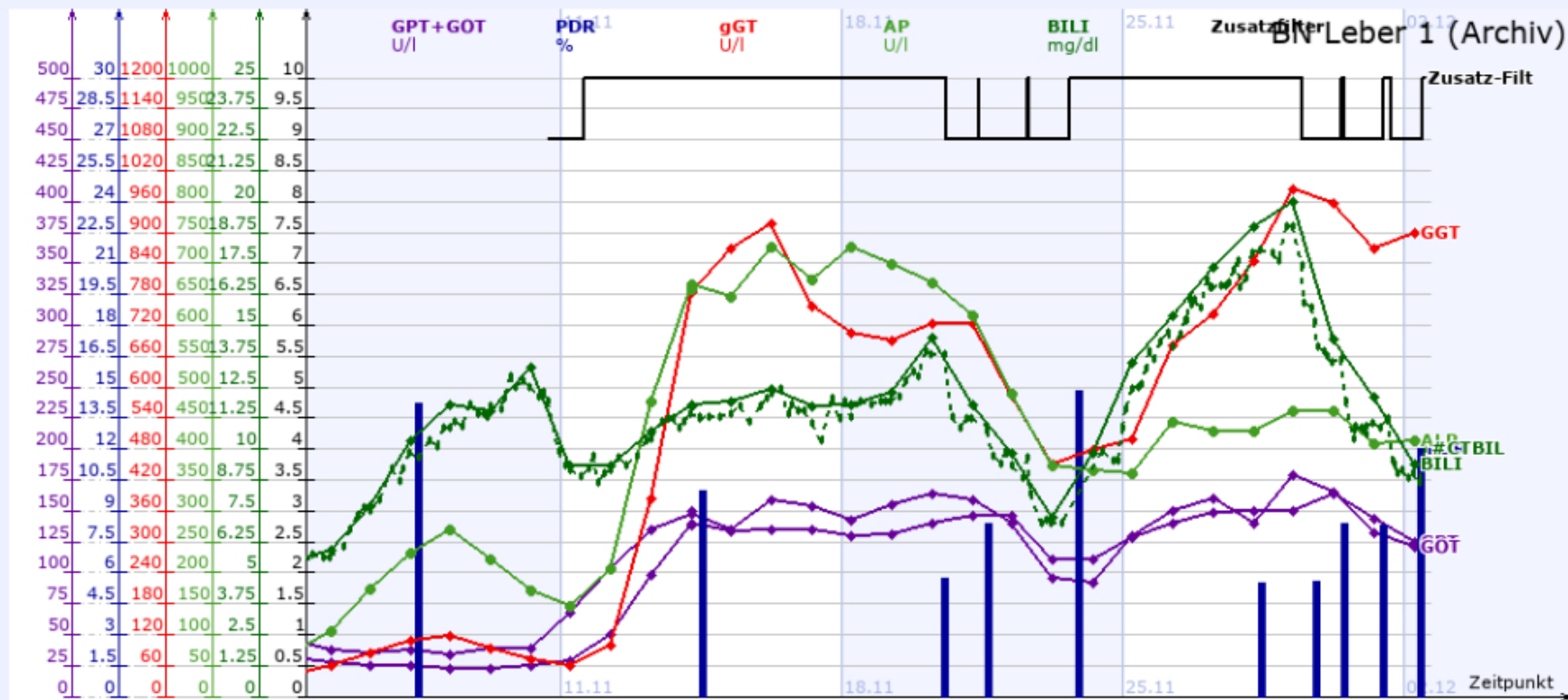
# Cytosorb



*crush syndrom*

Leber2

04.11.2017 15:00 - 02.12.2017 15:00



*liver failure - bridging*

---

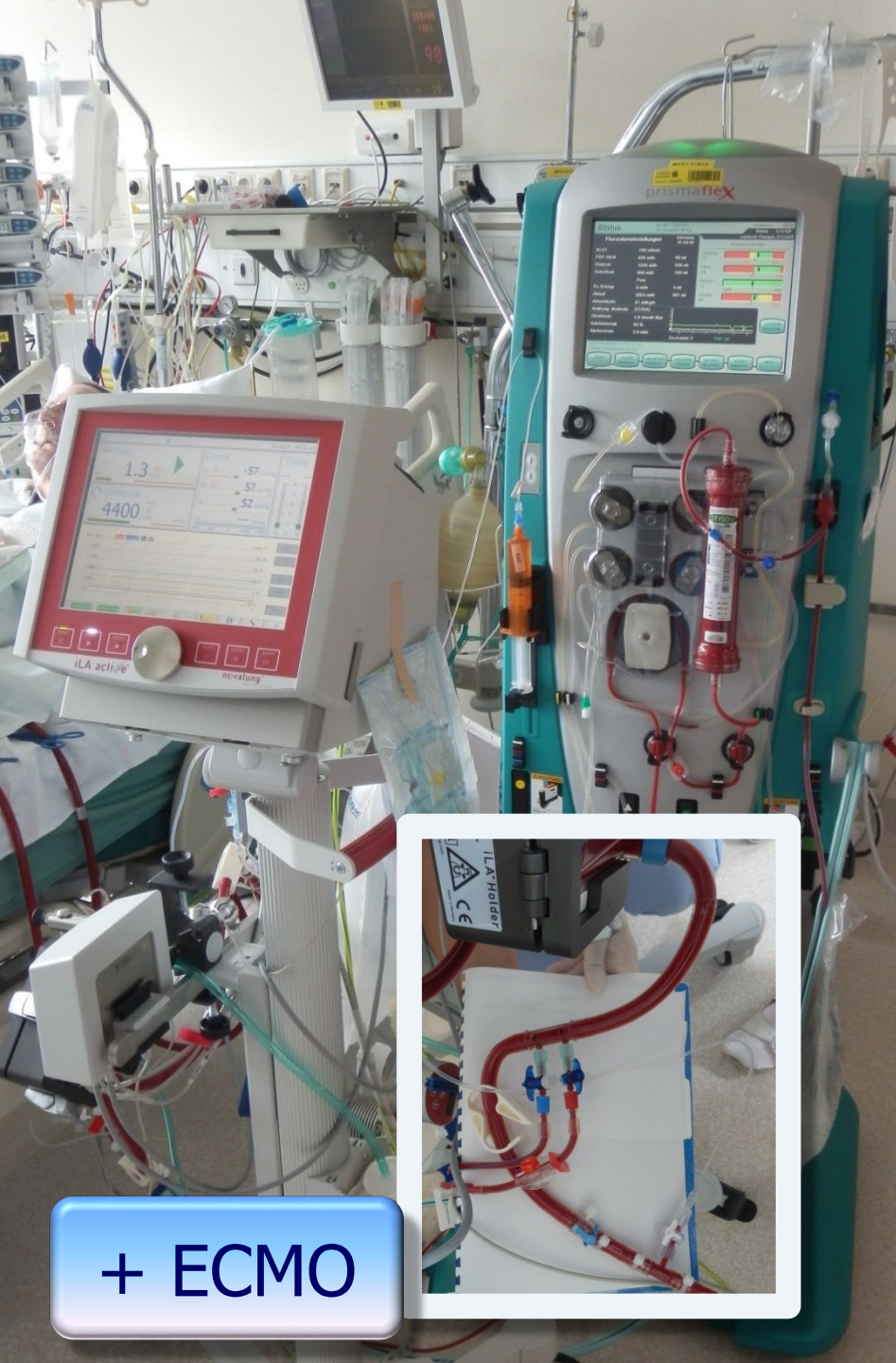
***CRRT***

***a***

***ECLS***

---

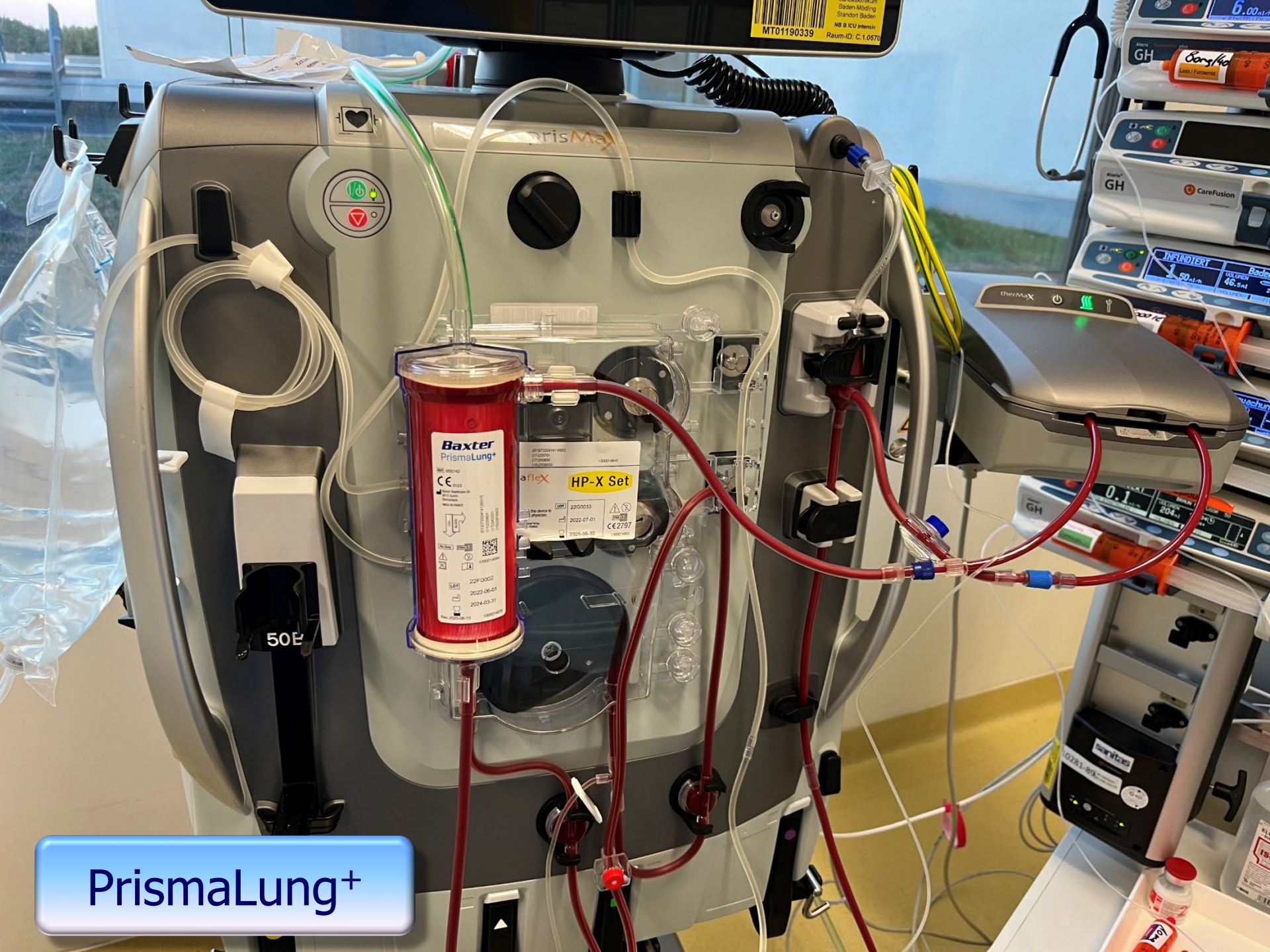




+ ECMO







MT01190339  
NB B ICU Intensiv  
Raum-ID: C.1.0570

50F

**Baxter**  
PrismaLung<sup>+</sup>

REF: 1965142  
CE  
Baxter Healthcare SA  
Bioscience  
Bioscience

ISO 13485  
1300000000

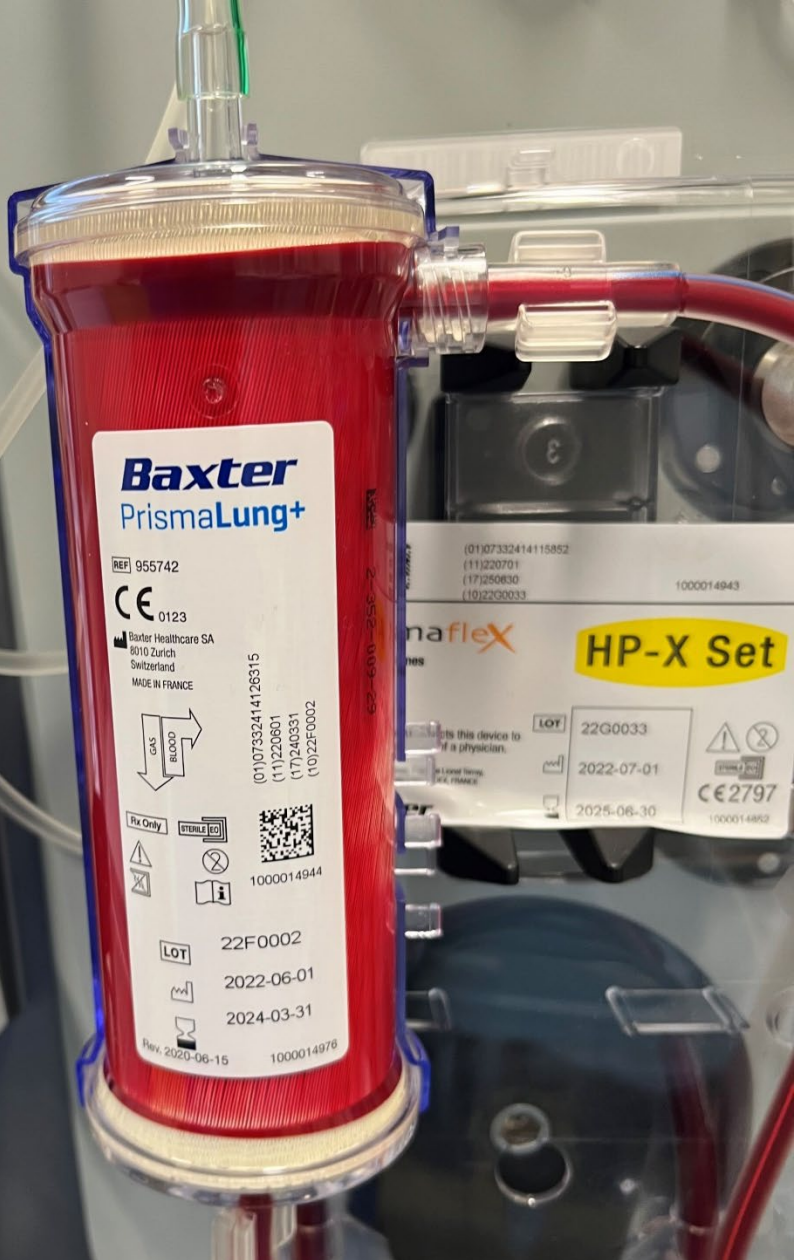
HP-X Set

LOT: 2200033  
EXP: 2022-07-01  
CE 2787  
190014602

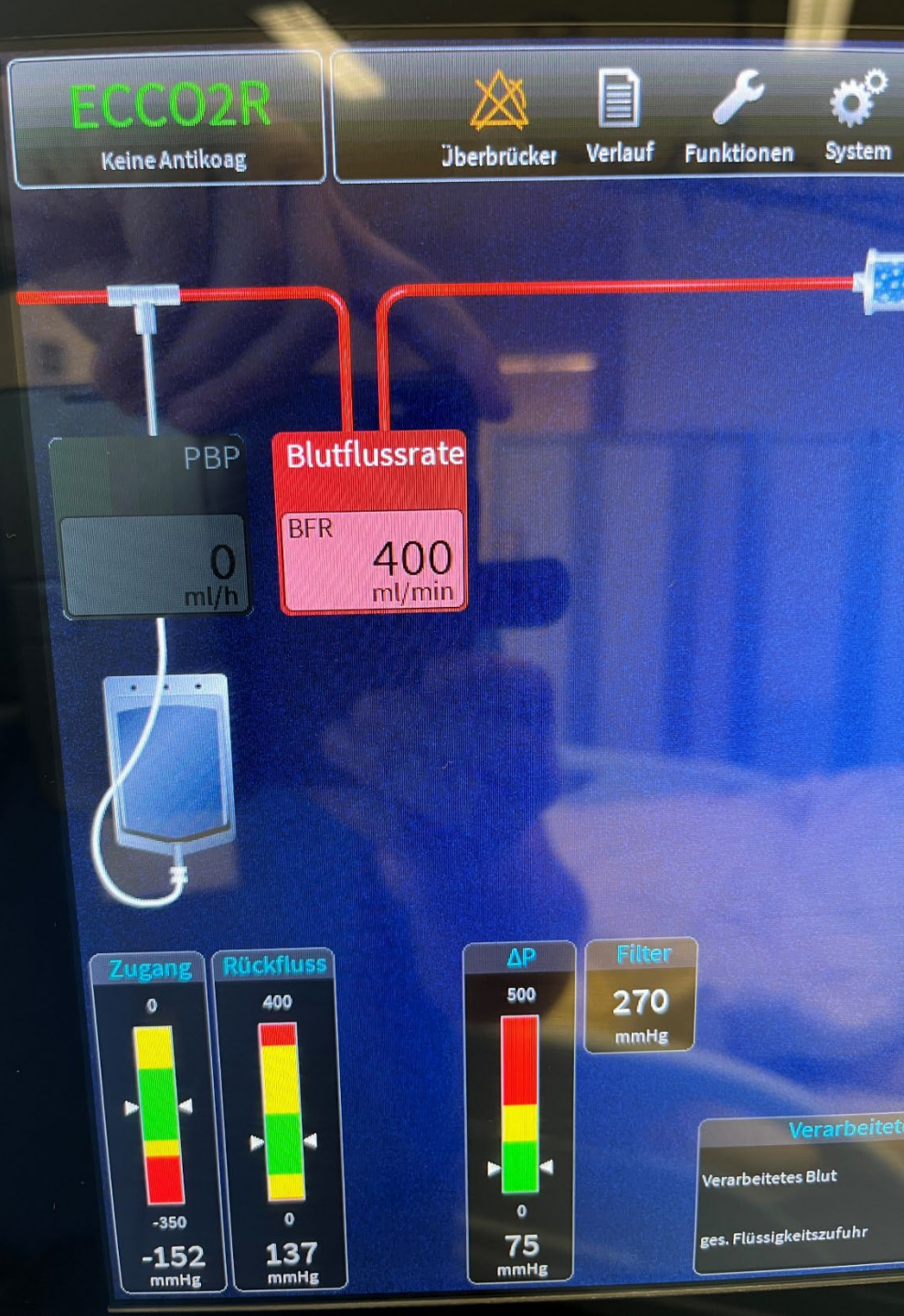
22F-0002  
2022-06-01  
2024-03-31

PrismaLung<sup>+</sup>





**PrismaLung<sup>+</sup>**





# ECCO2R

Keine Antikoag

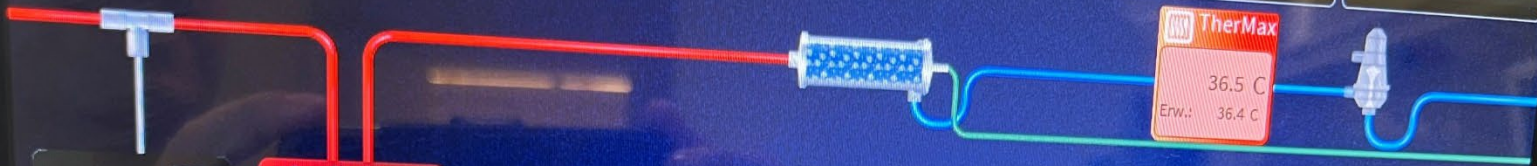
- Überbrücker
- Verlauf
- Funktionen
- System
- Sperren
- Hilfe

06 Sep 2023  
19:09:55



AC Strom

Stop



**TherMax**  
36.5 C  
Erw.: 36.4 C

**PBP**  
0 ml/h

**Blutflussrate**  
BFR  
400 ml/min



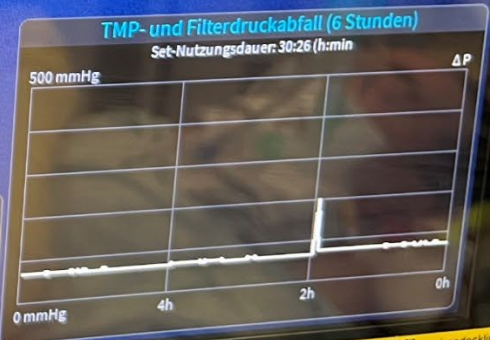
**Zugang**  
0  
-350  
-151

**Rückfluss**  
400  
0  
138 mmHg

**ΔP**  
500  
74 mmHg

**Filter**  
269 mmHg

**Verarbeitetes Blut**  
Verarbeitetes Blut 676 L  
ges. Flüssigkeitszufuhr 0 ml



Landeskrankenhaus  
Baden-Möding  
Standort Baden  
NB B ICU Intensiv  
Raum-ID: C.1.0570

MT01190339

# PrismaLung+

EDITORIAL

Open Access



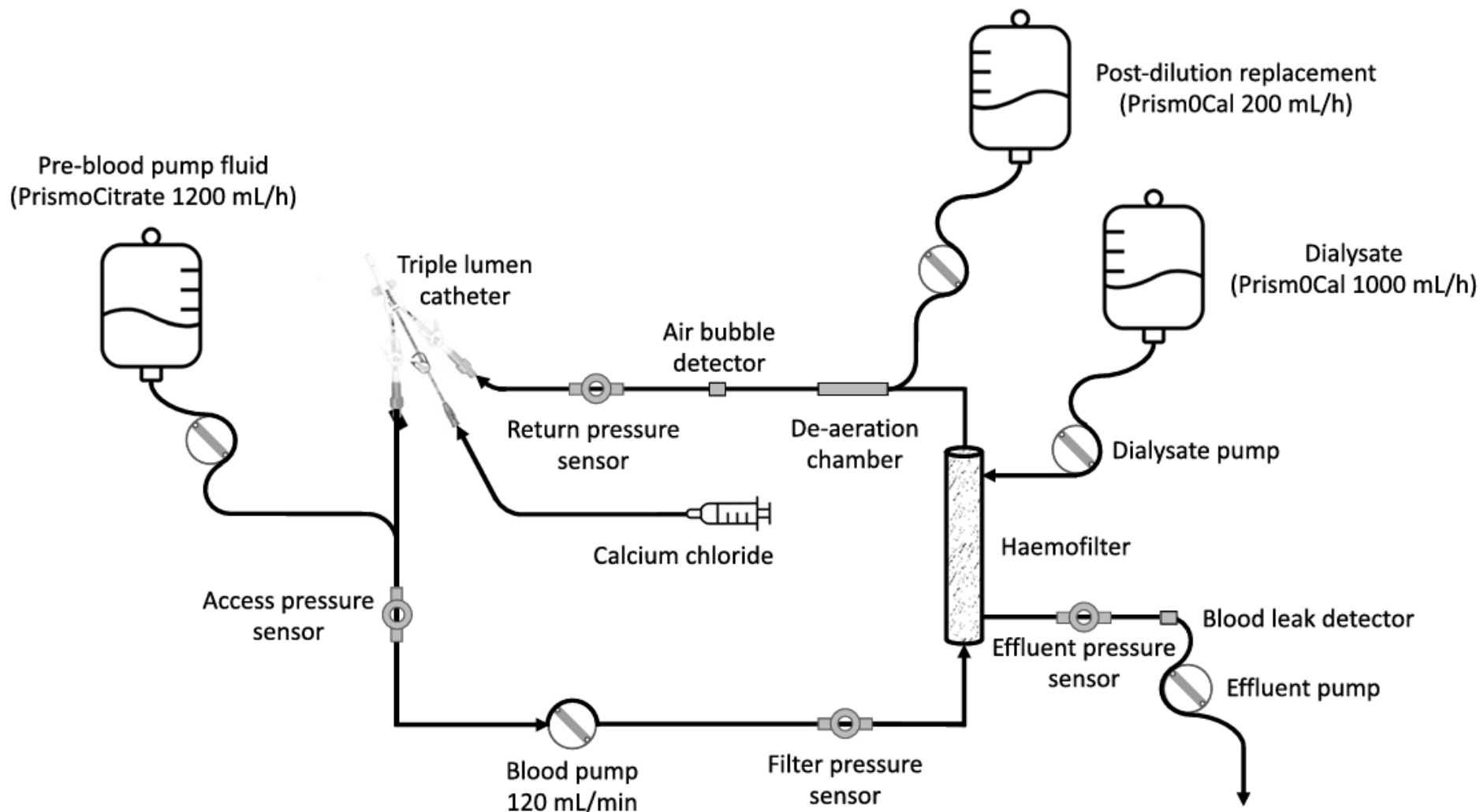
# How I prescribe continuous renal replacement therapy

Emily J. See<sup>1,2,3</sup> and Rinaldo Bellomo<sup>1,3,4,5\*</sup>

## CRRT modality

There are three key equivalent CRRT modalities (Fig. 1): Continuous venovenous haemofiltration (CVVH); continuous venovenous haemodialysis (CVVHD); and continuous venovenous haemodiafiltration (CVVHDF) [10]. Accordingly, modality selection is based on local expertise. We preferentially prescribe CVVHDF because it is the most well studied and because diffusion may prolong circuit life [11, 12].





**Fig. 1** Our typical CVVHDF circuit with regional citrate anticoagulation. This circuit can be altered for CVVH by removing the administration of dialysate or for CVVHD by removing the administration of pre-blood pump fluid and post-dilution replacement fluid



# How I prescribe continuous renal replacement therapy

Emily J. See<sup>1,2,3</sup> and Rinaldo Bellomo<sup>1,3,4,5\*</sup>

## Conclusions

We prefer CVVHDF with regional citrate anticoagulation via a triple lumen catheter inserted into the right internal jugular vein or the right femoral vein. Timing of initiation and cessation of CRRT is based on clinical judgement. We prescribe a blood flow rate of 120 mL/min and an effluent flow rate of 25 mL/kg/h with citrate anticoagulation. We avoid aggressive NUF unless clinically indicated. We adjust effluent flow rate for specific patients to target ammonia clearance. We monitor the safety and quality of CRRT and advocate for the use of protocolised care. Although intensivists prescribe CRRT in our unit, we acknowledge that collaborative and multidisciplinary prescription is common worldwide.



# How I prescribe continuous renal replacement therapy

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# Therapy

CVVHDF



History



Tools



System



Lock



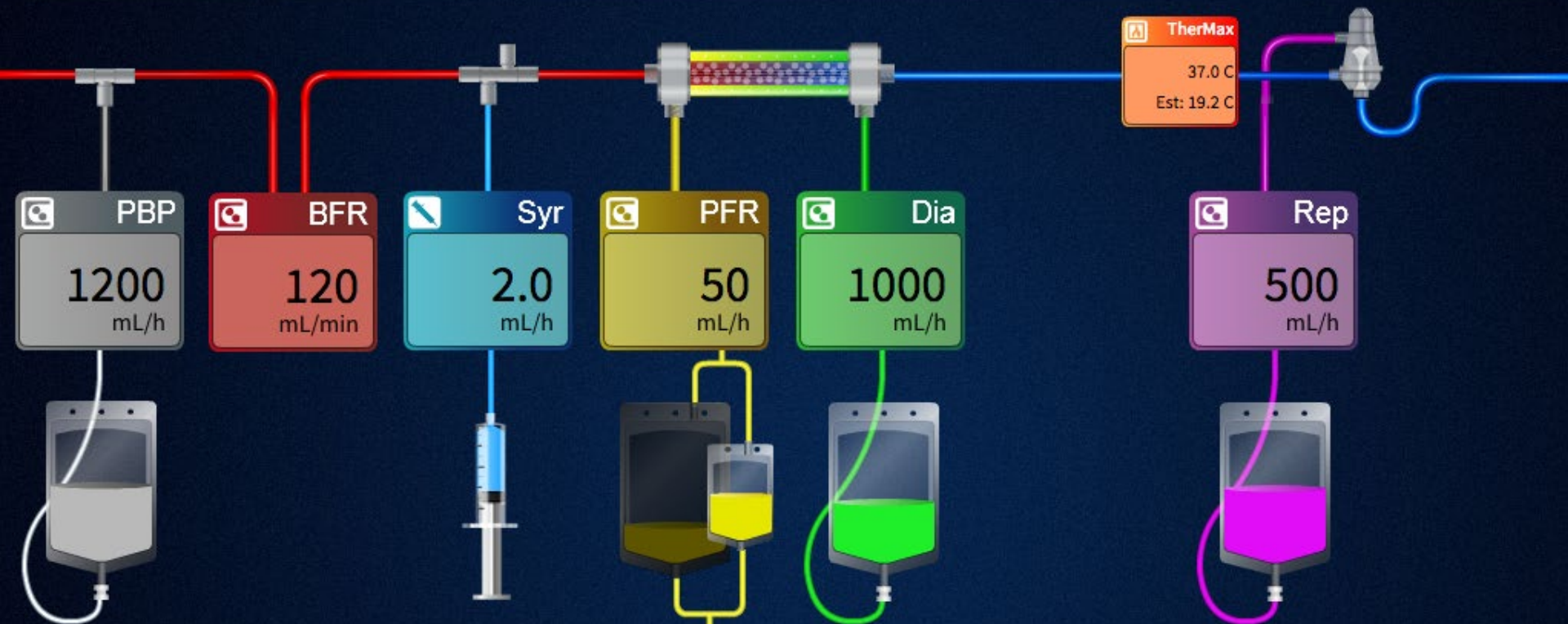
Help

Aug 30 2018  
2:59:18 pm



AC Power

Stop



## Access

450



0

25

mmHg

## Return

400



0

31

mmHg

## TMP

500



0

90

mmHg

## ΔP

500



0

14

mmHg

## Filter

70

mmHg

## Effluent

-56

mmHg

## PFHct

31

%

## PFR (15min)

Current Period 3 mL

Previous Period -3 mL

## Effluent Dose (8h)

Prescribed 28.9 mL/kg/h

Delivered 14.5 mL/kg/h

## Message Center

- 16:00: Alarm T0527 Cannot Monitor Return raised
- 15:59: Alarm T1279 Chamber Level Low raised
- 15:59: Alarm T1193 Effluent Low Flow Rate raised
- 15:58: Alarm T1193 Effluent Low Flow Rate raised
- 15:45: Alarm T1614 Return Line Clamped raised

Other Settings

---

*proč  
Baxter?*

---



	Baxter Healthcare, PrisMax 2	Fresenius Medicalcare, Multifiltrate Pro
Beim angebotenen Gerät handelt es sich um Hämodiafiltrationsgerät zur akuten Nierenersatztherapie CRRT	Ja	Ja
<b>Das angebotene Gerät verfügt über eine CE-Kennzeichnung nach MDR 2017/745</b>	<b>Eingereicht</b>	<b>Eingereicht</b>
Das Gerät verfügt über einen Touchscreen zu Bedienung	Ja , LCD Monitor 1024x768=> Prismax Manual S.375	Ja, 10,4" Display (High-Res) => MF Pro Broschüre
Das Gerät verfügt über eine Funktion zum Sperren des Touchscreens	Ja, Sperrmodus=> Prismax Manual S.21	Ja, Reinigungsmodus=> FMC MF Pro Manual S.238
Es können unterschiedliche Einstellungen durch Nutzer, Standort Experte oder Administrator gemacht werden. Kritische Einstellungen nur durch Experte oder Administrator	Ja => Prismax Manual S.23	?
Das Gerät verfügt über grammgenaue Waage	Ja , Auflösung der Waagen ist 1g	Ja , Auflösung der Waagen ist 1g
Das Gerät kann Zitrat, Dialysat, Substitutat und Ablauf mittels Waagen grammgenau überwachen	Ja, alle Lösungen die verwendet werden, werden an Waagen grammgenau überwacht=> Prismax Manual S.304	Nein, es gibt 2 Waagen die entweder beide für Dialysat oder für Dialysat und Substitutat verwendet werden können und eine Ablaufwaage. Keine Zitratwaage! Exakte Bilanzierung nicht möglich, da Tropfenzähler ungenau ist => FMC MF Pro Manual S.309
Die Waagen verfügen über eine LED-Farbkodierung zur eindeutigen Identifizierung und es kann immer nur 1 Beutel auf einmal gewechselt werden	Ja Farbkodierung für alle Waagen, Hinweis auf zu verwendende Lösung => Prismax Manual S.235	Keine Farbkodierung, die Anschlussstücke von Dialysat und Substitutat sind unterschiedlich, Platzierung auf der falschen Waage ist aber möglich => FMC MF Pro Manual S.19
Das System muss mit einer Blutwärmeeinheit geliefert werden	Ja, Thermax oder Barkey => Thermax Broschüre	Keine Bluterwärmung. Dialysat und Substitutatheizung, dadurch keine Messung der Bluttemperatur vorhanden! => FMC MF Pro Manual S.309
Heizung muss Blutrückflusstemperatur exakt (35-38°C; Genauigkeit +/- 1,5°C) steuern und überwachen	Heizung steuert Blutrückflusstemperatur auf +/-0,8-1,5 °C genau, keine Einschränkungen => Thermax Broschüre	Heizung von Dialysat und Substitutat bis maximal 39°C, bei Pädiatrie nur Dialysatheizung, Die maximale Dialysattemperatur liegt im idealen Betriebszustand bei 38°C=> eine Blutrückflusstemperatur von 38°C ist somit nicht realisierbar. bei Dialysatfluss >600ml/h wird eine Raumtemperatur >25°C empfohlen , FMC MF Pro Manual S.144

Alle Therapieformen (CVVHD, CVVHDF, CVVHF) müssen sowohl mit Heparin als auch mit Zitratantikoagulation möglich sein	Ja	Nein - Nur Heparinantikoagulation möglich und nur CVVHD => FMC MF Pro Manual S. 144
Setvolumen darf maximal 10% des Blutvolumens betragen (bei Kindern beträgt das Blutvolumen pro kg Körpergewicht 70-80ml)	kleinstes Set (HF20) zugelassen ab 8kg hat 58ml Volumen => 7,25-8,2kg (Referenz => HF 20 Broschüre )	Offiziell werden Therapien ab 8-16kg angegeben. Kleinstes Volumen ist aber AV-400s Membran + Paed Kit 52ml+61ml = 113ml => 14,13-16,14kg =>FMC MF Pro Manual S.156
Bei CRRT und TPE müssen verschiedene Zitratkonzentrationen einstellbar sein	Bei Baxter frei wählbar CRRT 10-600mmol/L TPE 50-300mmol/L => Baxter Prismax IFU S.395	Nur CiCa Lösung (4% => 133mmol/L) => FMC MF Pro Manual S.260
Es müssen alle Therapiemodalitäten (SCUF, CVVHF, CVVHDF, CVVHD,HP) verfügbar sein	Alle möglich	Alle möglich
Bei CVVHDF und CVVHF muss frei zwischen Prä- und Postdiultion gewechselt werden können	Frei wählbar bei CVVHDF und CVVH => Prismax Manual S.391	System auf Grund der Schlauchsets in CVVHDF entweder nur als Prä CVVHDF oder Post CVVHDF verwendbar=> MF, MF Pro Materialbroschüre S.6
Alle Therapiemodalitäten müssen sowohl mit Heparin, als auch mit Zitratantikoagulation verfügbar sein	Alle Therapieformen mit beiden Antikoagulationsmethoden möglich	Nur CVVHDF und CVVHD mit Zitrat möglich, keine CVVH mit Zitrat => FMC MF Pro Manual S.259
Grammgenaue Bilanzierung aller beteiligten Flüssigkeiten und Lösungen und Sicherheitsmechanismus der Abweichungen verhindert	Sämtliche Flüssigkeiten werden mit Waagen grammgenau überwacht, innerhalb der Therapie arbeiten die Waagen mindestens +/-7g genau, Bilanzabweichung kann konfiguriert werden, ab Werk 400ml/3h => Prismax Manual S.376	Citratpumpe und Kalziumpumpe fördern mit 10% Ungenauigkeit. Messung erfolgt über Tropfenzähler (1-4 Tropfen pro Sekunde). Daraus ergibt sich eine mögliche Abweichung bei der Flüssigkeitsbilanz, die nicht durch Waagen gemessen werden kann. Die Abweichung bei empfohlenen Einstellungen (100ml Blutfluss 4mmol/L Zitrat ergibt bis zu 1,4 Liter bei 72h Nutzungsdauer => FMC MF Pro Manual S.313
Das Gerät muss bei Stomausfall mindestens 30 Minuten, ohne Therapieverlust, im Akkubetrieb funktionieren	Bei einem Stomausfall wird für min. 30 Min eine uneingeschränkte Fortsetzung der Therapie garantiert. =>Prismax Manual S.210	Bei einem Stromausfall wird läuft nur die Antikoagulation und die Blutpumpe, aber sonst keine therapierelevanten Systeme (Dialysat, Substitutat). Die Bilanzierung ist ebenfalls vorübergehen nicht verfügbar. Weiters reicht die Akkukapazität für maximal 15 Minuten FMC MF Pro Manual S.233



**MAXIMISE  
SIMPLICITY**

**MAXIMISE  
EFFICIENCY**

**MAXIMISE  
ACCURACY  
& SYSTEM  
PERFORMANCE**

**MAXIMISE  
TREATMENT  
OPTIONS**

**SERVICE &  
SUPPORT**

**BROAD  
PORTFOLIO**

**TRAINING  
&  
EDUCATION**



# PrisMax

- vysoká **přesnost** (možno všechny věkové kategorie)
- kompletní **spektrum** terapeutických **modalit** (CVVHDF, TPE, HP, MARS ....)
- široká nabídka **filtrů** (vc. oXiris, SepteX)
- **bezproblémový** provoz (user-friendly)
- **minimální** vliv na **vnitřní prostředí** (Regiocit, Phoxilium, Ca<sup>2+</sup> a Mg<sup>2+</sup> substituce)
- rozšířenost (cca **70%** trhu v Rakousku)

# PrisMax

- **bezpečnost** (*bar-code scanner*)
- **jednoduchost** (1 set pro všechny modality léčby i oba typy antikoagulace)
- **malý objem** krve v setu
- možnost **prediluce** i **postdiluce** zároveň
- možnost kombinace i s **plicní ECLS** (Prismalung<sup>+</sup>, Novalung)
- **finanční úspora**



...děkuji Vám za pozornost