Multi organ support and beyond

Pr O. JOANNES-BOYAU

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Links of interest

JAFRON
Baxter
Bbraun

Fresenius (Kabi)
MSD
LFB
BioMérieux

Money

Bordeaux Hospital
Bordeaux University

Career
Publications
Academic competition

Group membership

Colleagues
Friends
Family

self-esteem
Fame
Prestige
media coverage

intellectual interest

justicier jalous
défense de valeurs

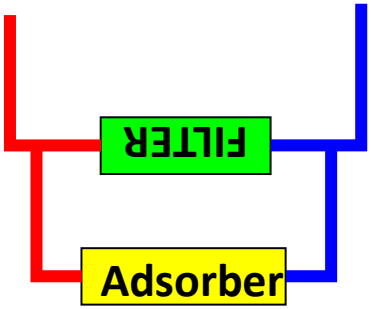
Affection
Love / hate

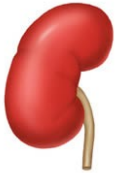
First Organ support

1959

Multi Organ support ?

Multi Organ support





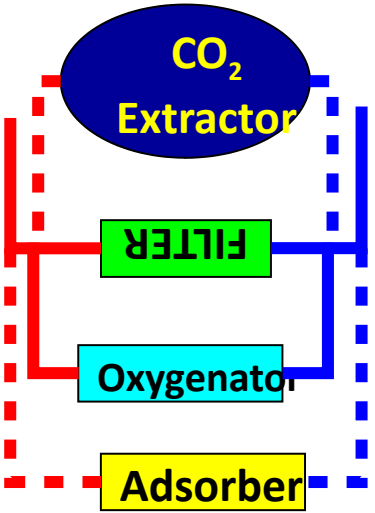
CRRT

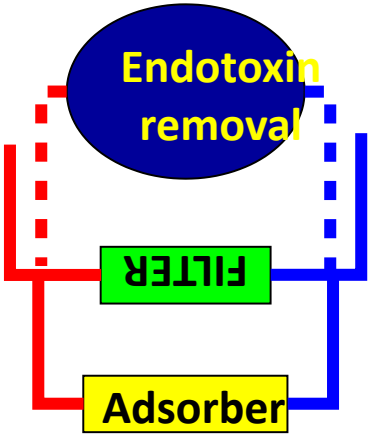
Adsorption

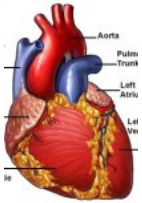
ECMO

CO_2removal

Adsorption

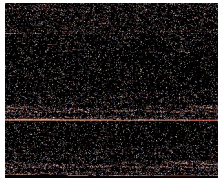






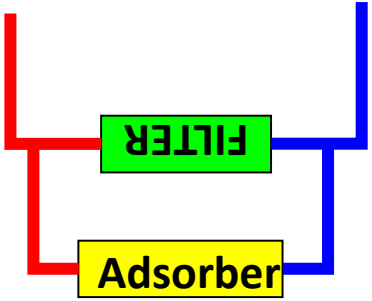
SCUF/CRRT

Adsorption

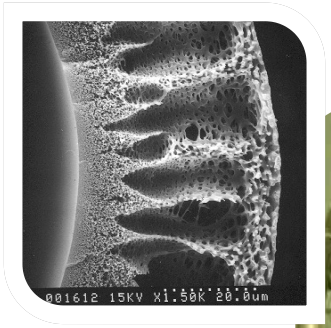


CRRT

Adsorption

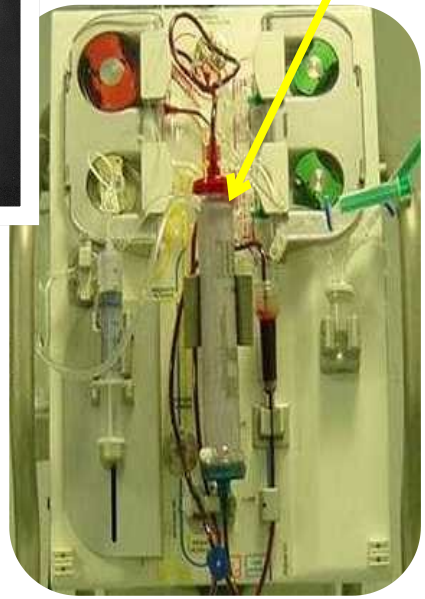


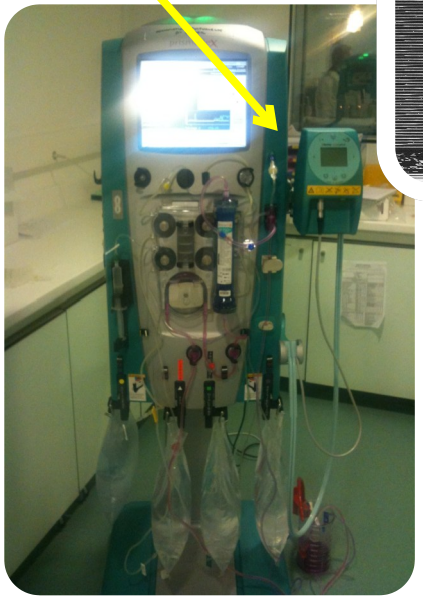
Adsorption

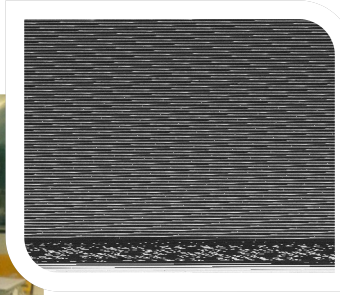


PES

Membrane



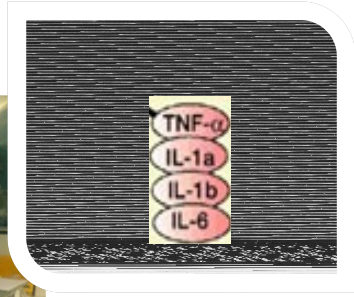




AN69

Adsorption or Absorption ?

Membrane

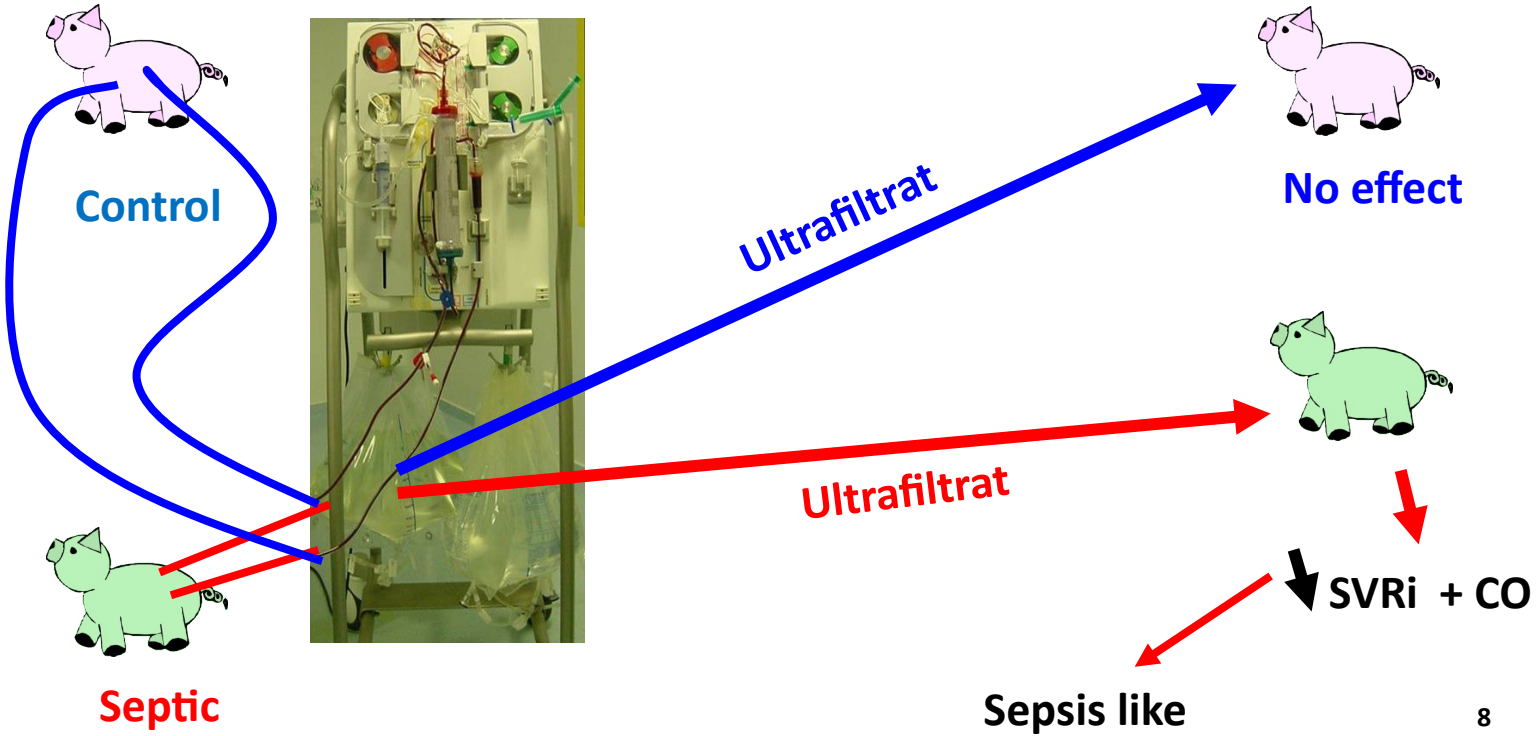


AN69

Infusion of ultrafiltrate from endotoxemic pigs depresses myocardial performance in normal pigs

1993

Albert F. Grootendorst, Eric F.H. van Bommel, Leo A.M.G. van Leengoed, Arthur R.H. van Zanten, Herman J.C. Huipen, A.B. Johan Groeneveld



In Vitro Evaluation of High Mobility Group Box 1 Protein Removal with Various Membranes for Continuous Hemofiltration

2011

Miho Yumoto,[1] Osamu Nishida,[1] Kazuhiro Moriyama,[1] Yasuyo Shimomura,[1]
Tomoyuki Nakamura,[1] Naohide Kuriyama,[1] Yoshitaka Hara,[1] and Shingo Yamada[2]

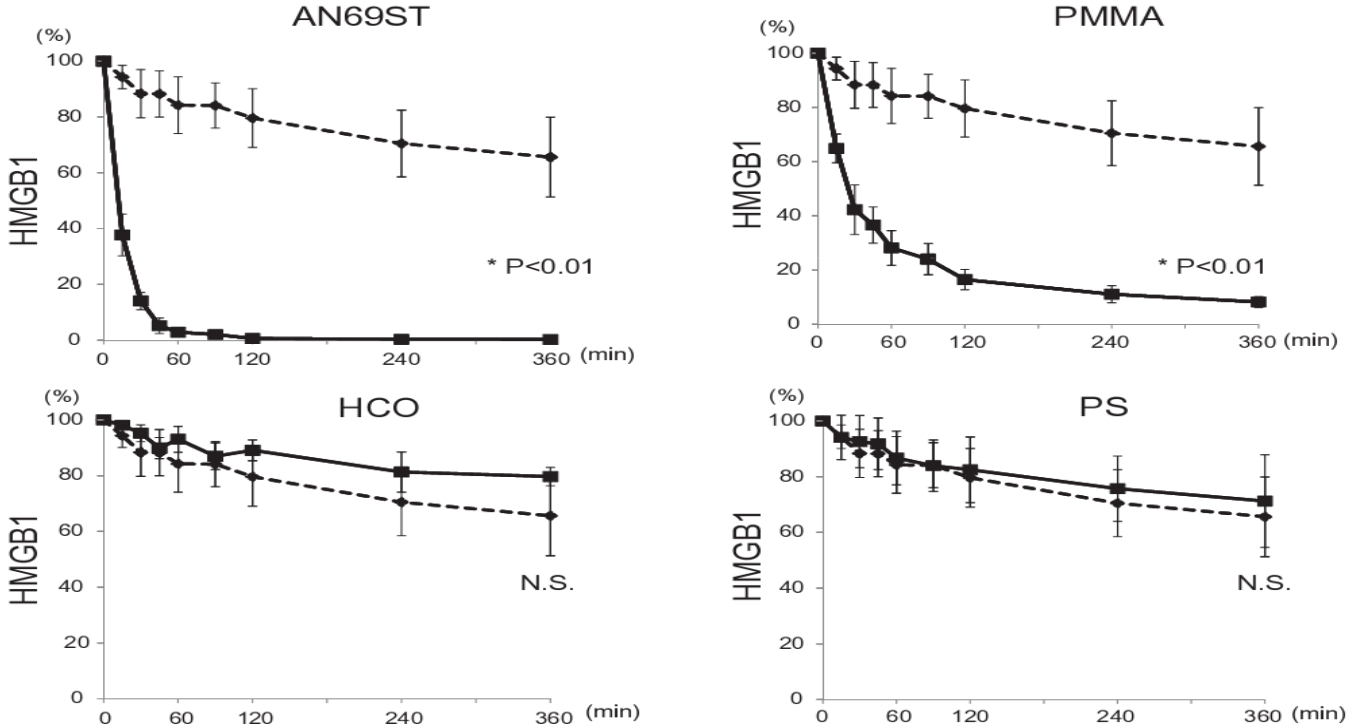
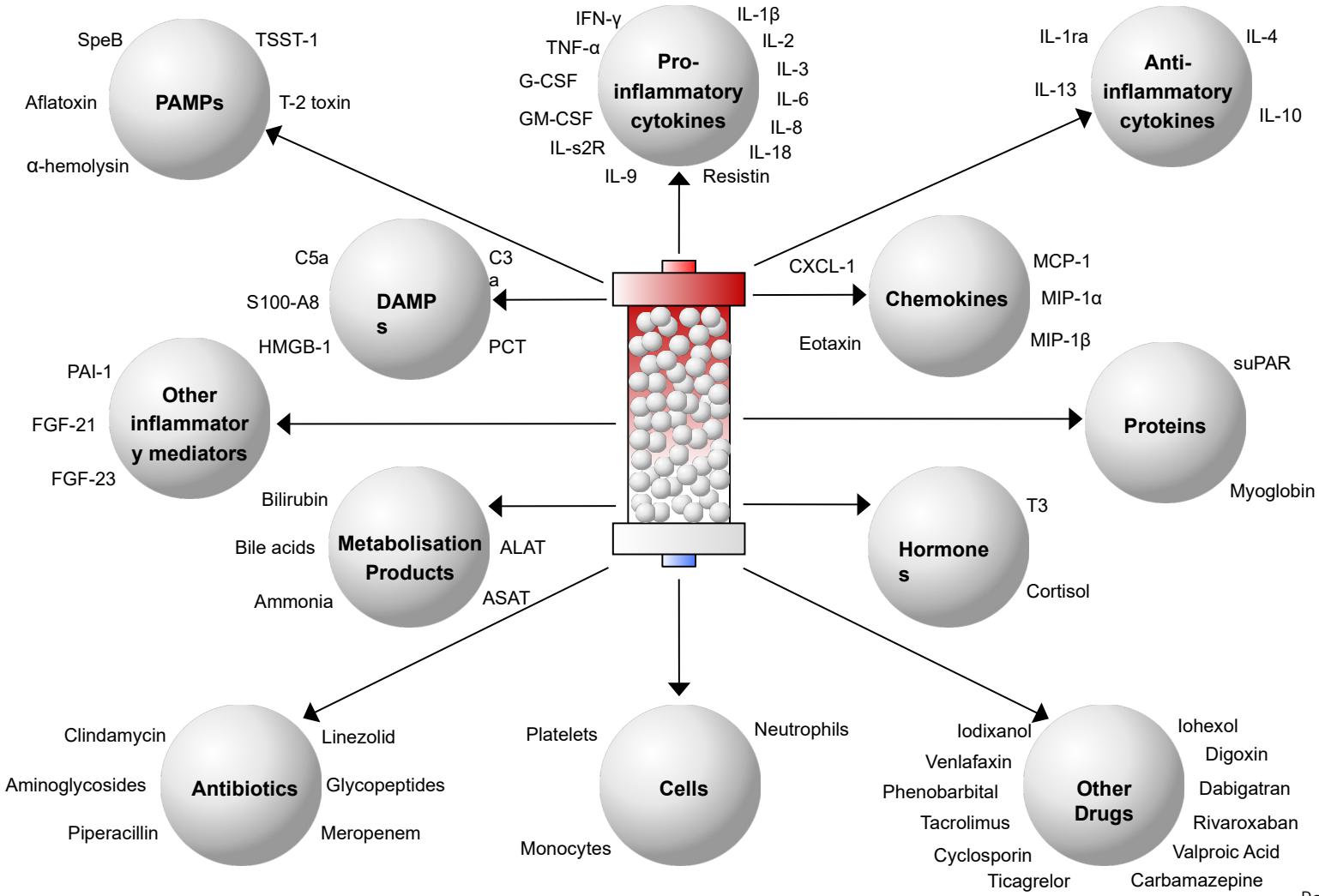


FIG. 4. Time course of high mobility group box 1 protein (HMGB1) levels in the test solution during hemofiltration. Results are shown as mean ± SD of four experiments. The values at time 0 represent 100%. Dotted line shows the tubing data. These two curves are significantly different from each other (*$P < 0.01$ vs. the tubing). AN69ST, surface-treated polyacrylonitrile; HCO, high cut-off membrane of polyarylethersulfone; PMMA, polymethylmethacrylate; PS, polysulphone.

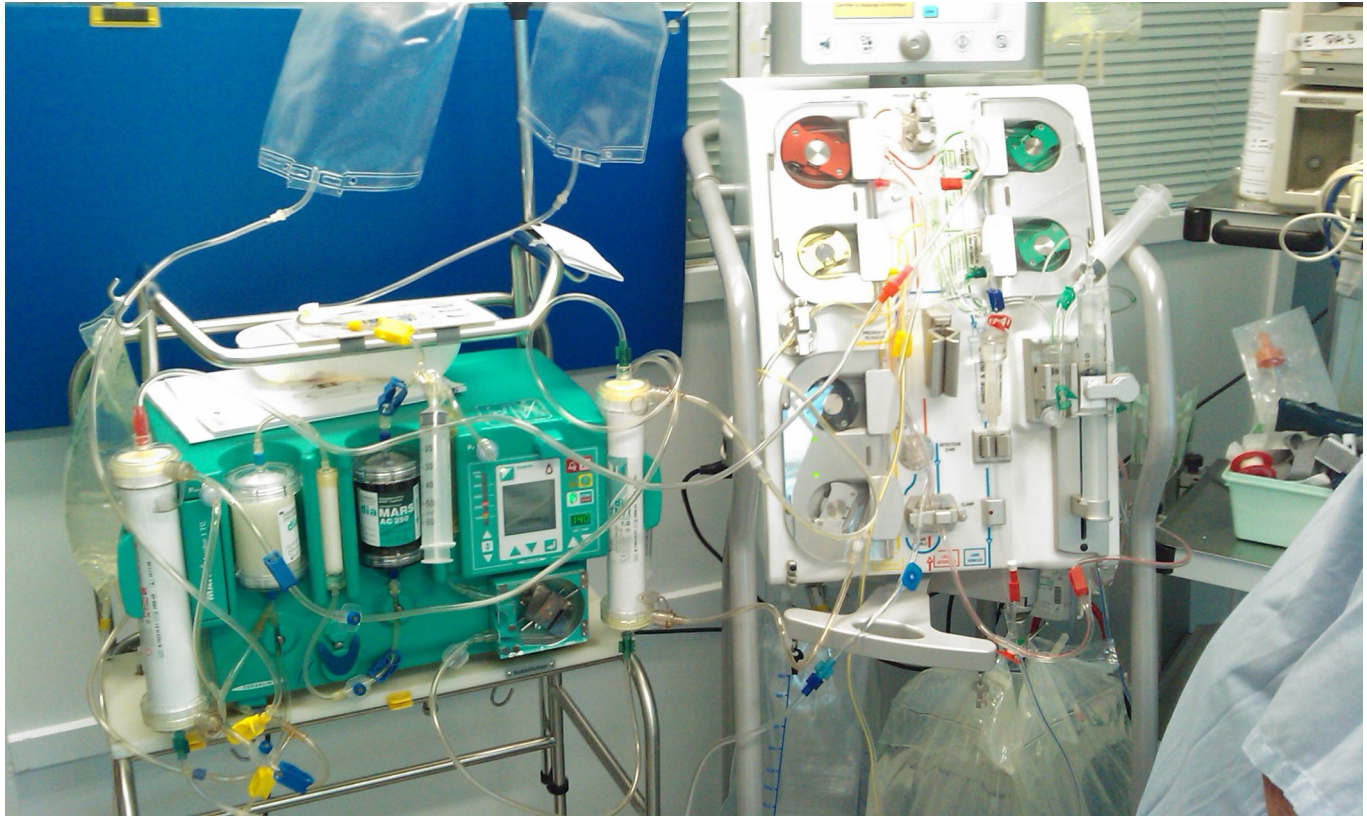


Poli et al. ICM 2018

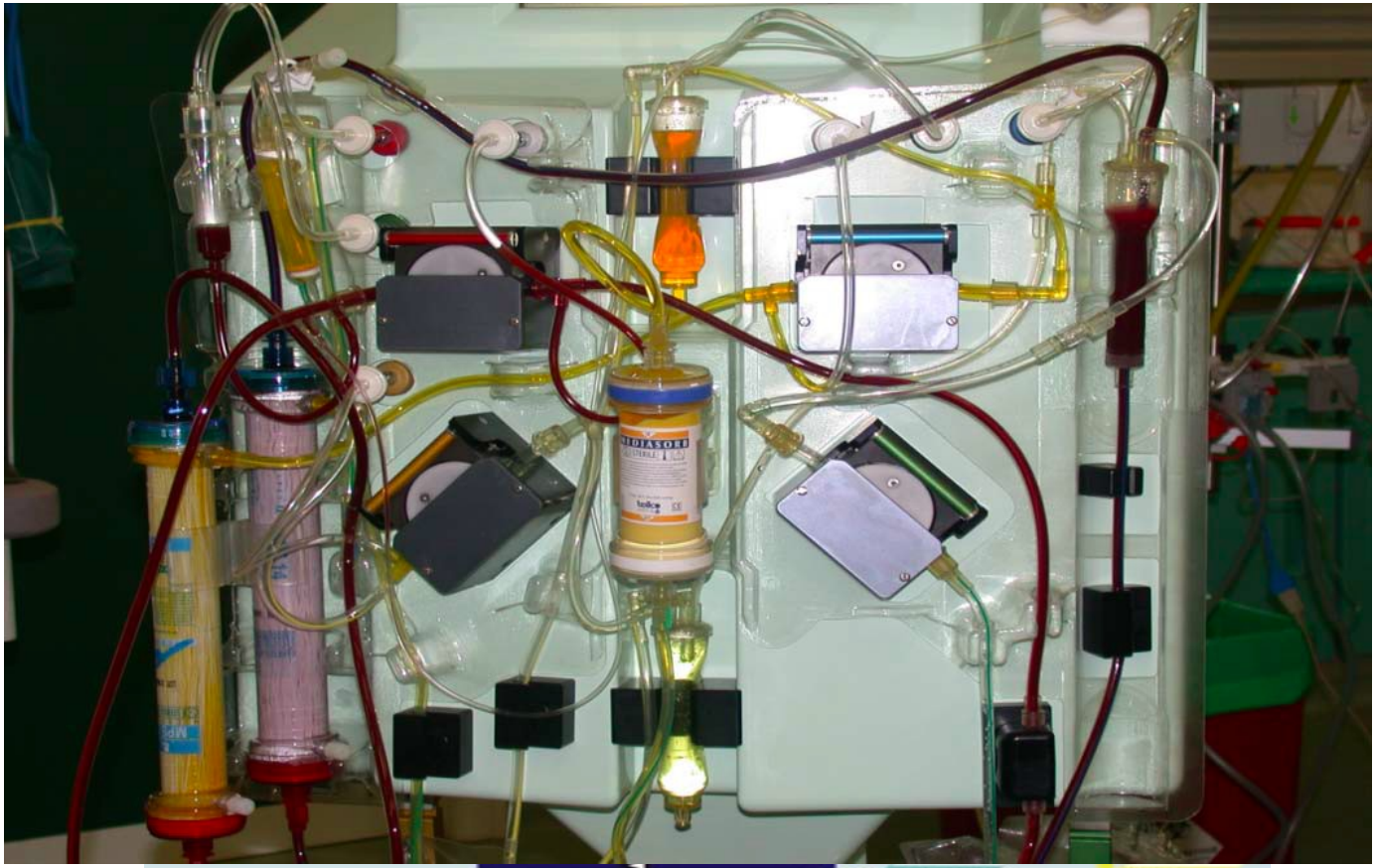
BUILD!

Nurses workload

MARS



CPFA



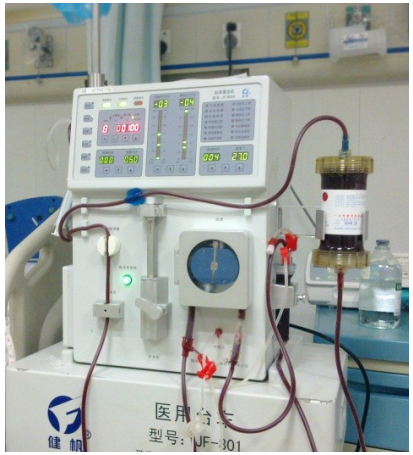
Product Parameter : HA330

Synthetic macroporous Resin cartridge

Loading capacitity(ml) : 330±3
Volumn(ml) : 185±5
Adsorbent material : Styrene divinylbenzene copolymers

Multiple Connections& Compatible Machines

Flexible& Compatible



Single HP treatment

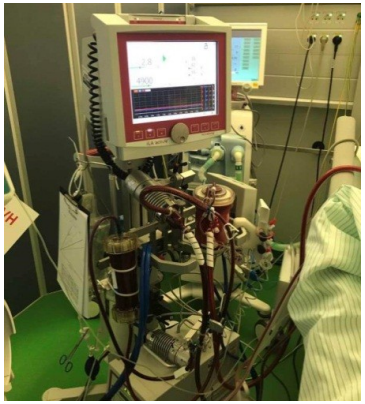
Multiple Connections& Compatible Machines

Flexible& Compatible

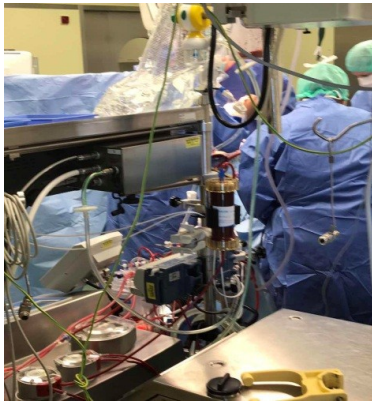
Hybrid treatment

HD+HP

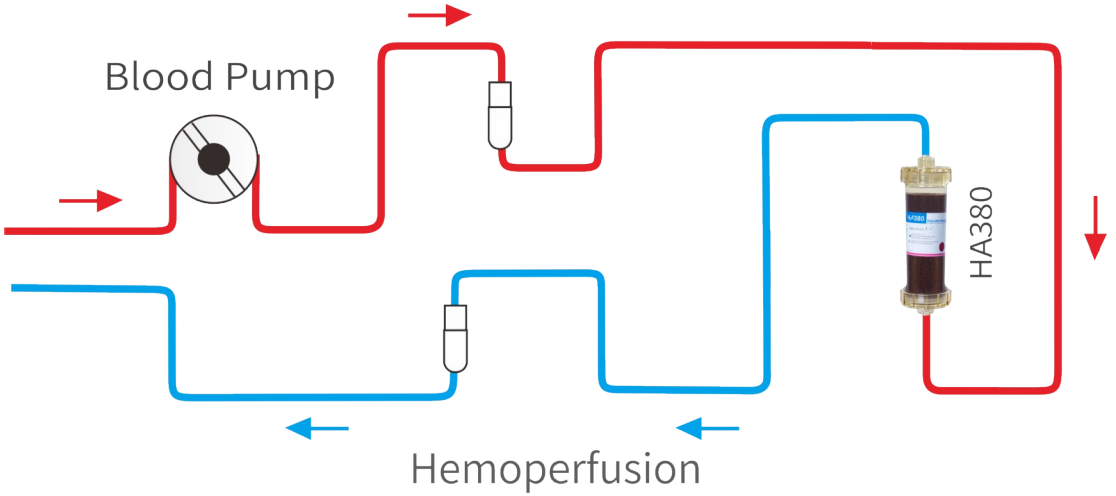
CRRT+HP

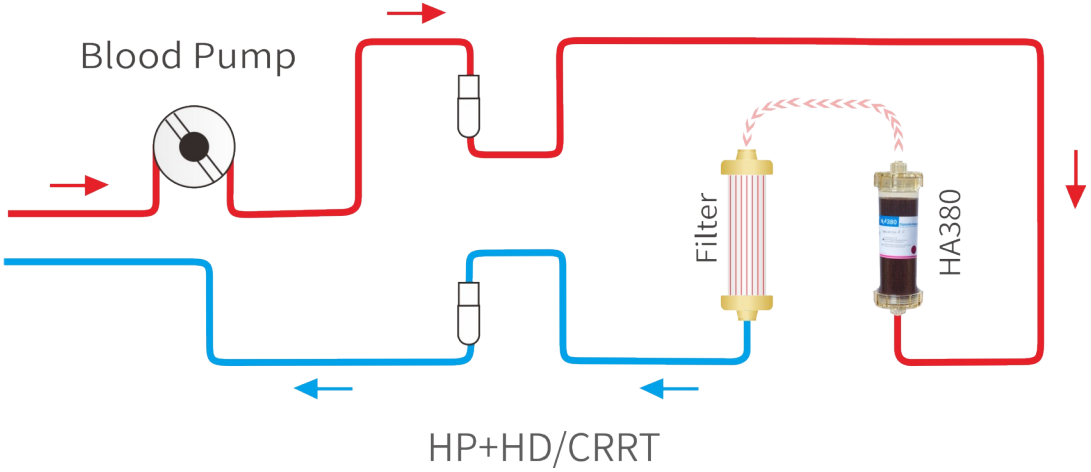


ECMO+HP



CPB+HP


Blood Pump
HA380
Hemoperfusion

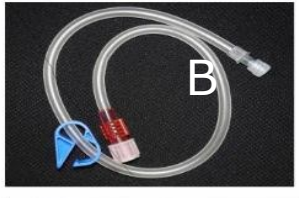

Blood Pump
Filter
HA380
HP+HD/CRRT

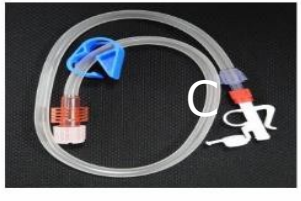
1. PRIMING

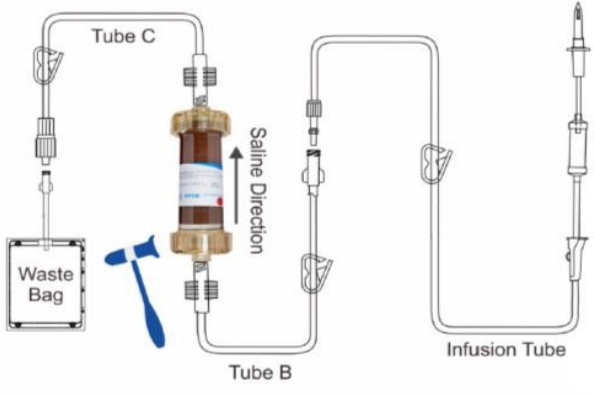
Material Preparation

- HA cartridge
- 12500U heparin
- Syringe
- Rubber hammer
- 3L saline
- Priming Tube Set

3L



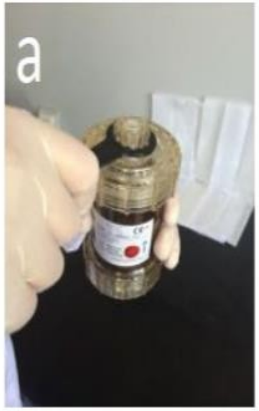




1. PRIMING

Statical Heparinization

- Inject 12500U heparin into the cartridge
- Turn the cartridge upside down for over 20 times
- Put the cartridge statically for 30 minutes



2. CONNECTION

Connection [Fig.3]

- Disconnect Luer Lock Connector after the filter
- Connect the Tube B+HA cartridge+Tube C into Prismaflex circulation

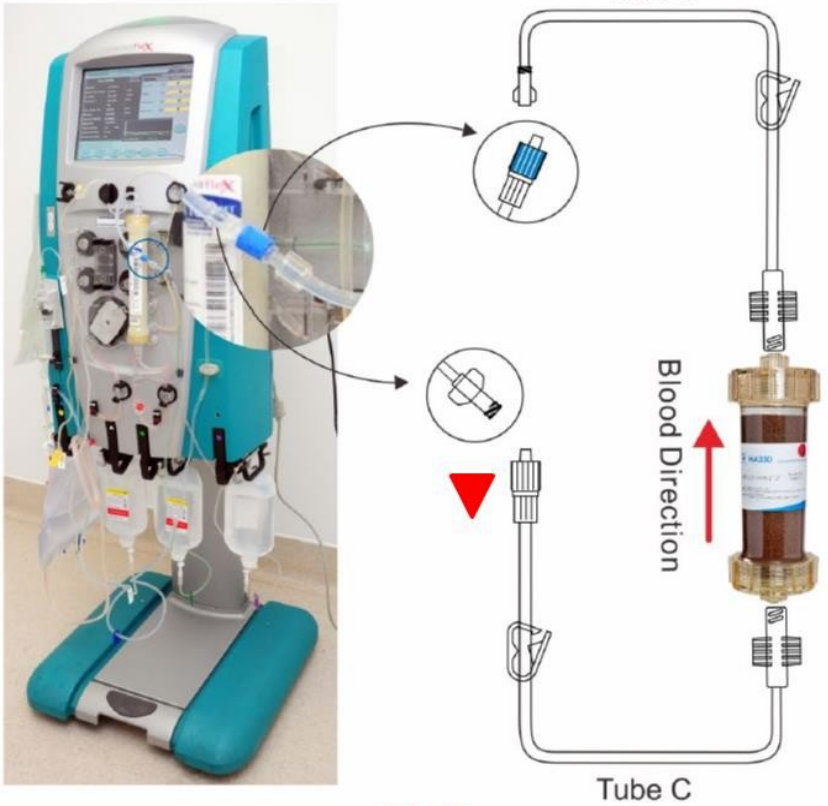


Fig.3

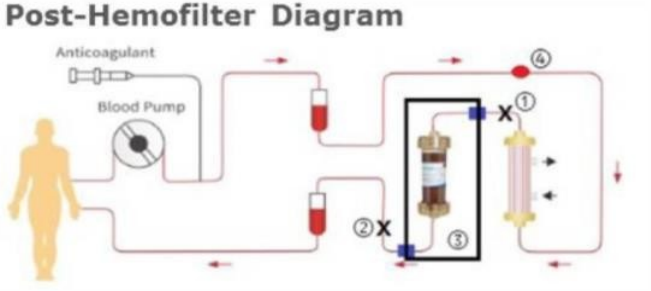
3. INSTALL THE HA CARTRIDGE

Step 1

Pause the machine and clip the blood line at both X points
before and after the **Luer Lock connector** behind the filter;

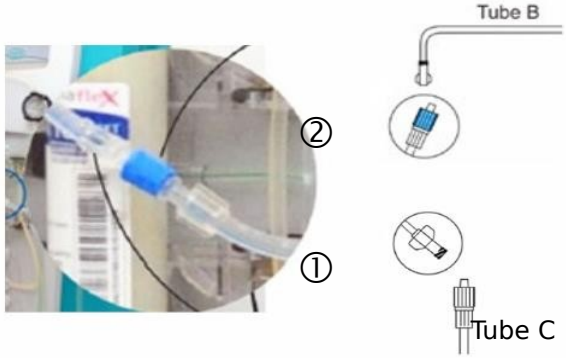
Note:

① X Point before the Luer Lock connector;
② X point after the Luer Lock connector



Step 2

Open the **Luer Lock connector** and connect the cartridge with Tube C & Tube B;



Step 3

Restart the blood circulation.

4. REMOVE THE HA CARTRIDGE

Step 1

Connect a saline bag (200-300ml) to injection port 4 and return the blood inside the cartridge;

Step 2

When the blood is diluted from the cartridge, pause the machine and clip the blood line at point ① & ②

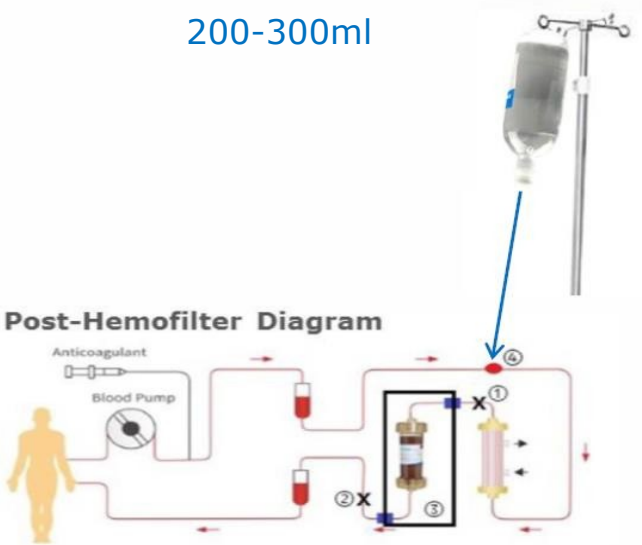
Step 3

Remove the cartridge and re-connect the **Luer Lock connector;**

Step 4

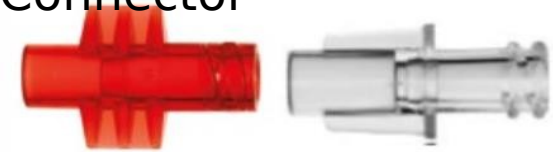
Restart the blood circulation.

200-300ml

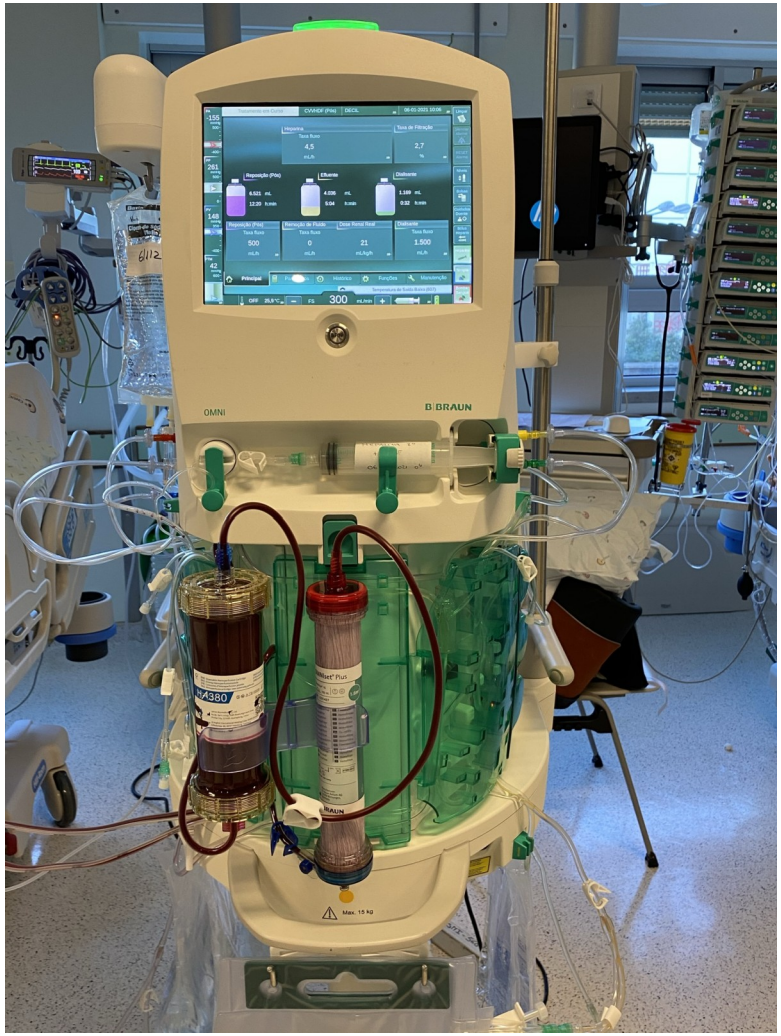


JAFRON TUBING FEATURE

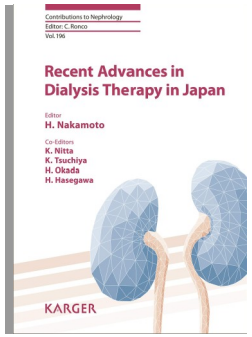
Tube B
1 Dialyzer Connector + 1 Female Connector



Tube C
1 Dialyzer Connector + 1 Rotated Male Luer Lock


OMNI
B|BRAUN
Max. 15 kg

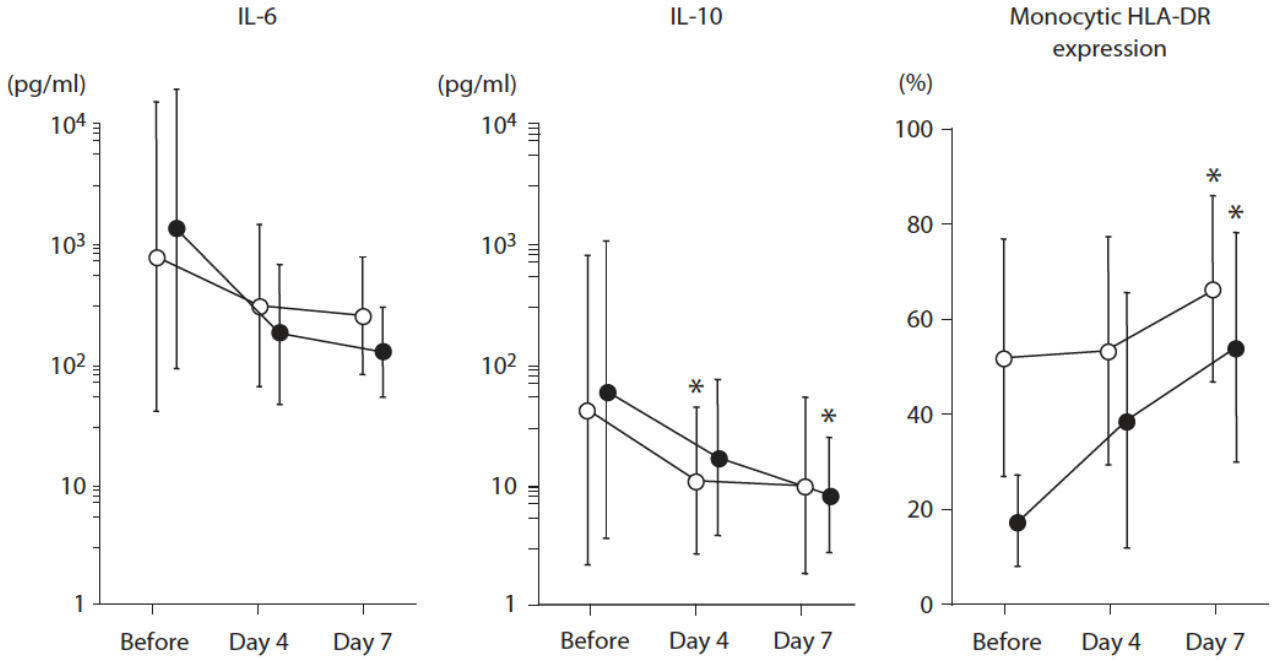
POOR
GOOD
gettyimages
enisaksoy
EFFICIENCY
542325530



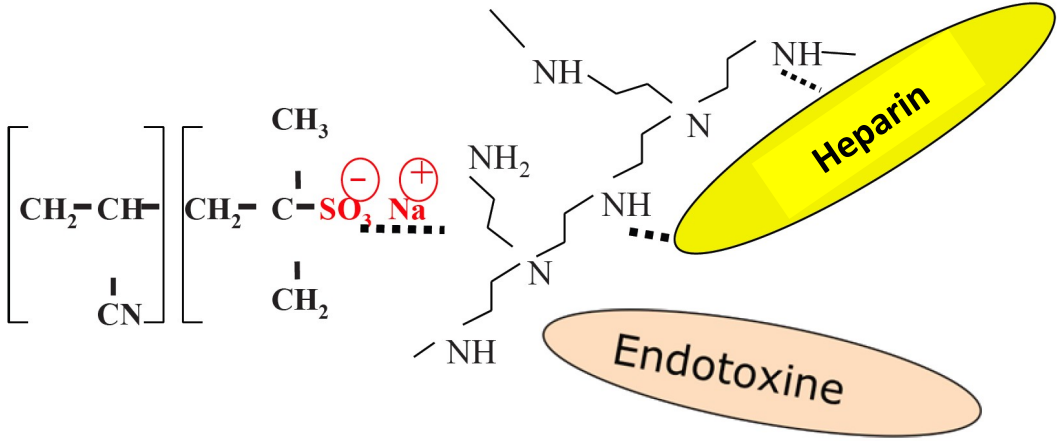
Treatment of Severe Sepsis and Septic Shock by CHDF Using a PMMA Membrane Hemofilter as a Cytokine Modulator

2010

Masataka Nakamura · Shigeto Oda · Tomohito Sadahiro · Yoh Hirayama · Eizo Watanabe · Yoshihisa Tateishi · Taka-aki Nakada · Hiroyuki Hirasawa



OXIRIS®

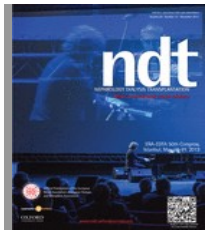


Base structure

AN69

Polycation :
Polyethyleneimine

Endotoxin adsorption (negatively charged)



High-volume haemofiltration with a new haemofiltration membrane having enhanced adsorption properties in septic pigs

Thomas Rimmelé[1,2,3], Abdulnasser Assadi[2], Mathilde Cattenoz[1], Olivier Desebbe[2,3], Corine Lambert[4], Emmanuel Boselli[1,3], Joëlle Goudable[3,5], Jérôme Étienne[3,6], Dominique Chassard[1,3], Giampiero Bricca[2,3] and Bernard Allaouchiche[1,2,3]

(2009)

Table 3. Mean ± SD haemodynamic and biochemical parameters after a 6-h HVHF session, at T6

	AN69 mb ($n = 10$)	Treated mb ($n = 10$)	P-value
HR (beats/min)	138 ± 20	148 ± 16	0.23
MAP (mmHg)	64 ± 6	59 ± 8	0.13
SPAP (mmHg)	39 ± 9	30 ± 8	0.029
MPAP (mmHg)	34 ± 8	24 ± 7	0.008
PCWP (mmHg)	12 ± 3	11 ± 4	0.53
CO (l/min)	6.9 ± 4.8	5.5 ± 2.8	0.44
SAR (dyn/s/cm^5)	672 ± 205	797 ± 346	0.34
PAR (dyn/s/cm^5)	325 ± 186	234 ± 148	0.24
Epinephrine (mg)	3.27 ± 3.02	2.11 ± 1.05	0.27
Crystalloids (ml)	7587 ± 1456	5937 ± 1588	0.026
Hydroxyethylstarch (ml)	1912 ± 538	1437 ± 320	0.027
pH	7.10 ± 0.07	7.20 ± 0.11	0.026
Lactate (mmol/l)	14.11 ± 3.36	9.61 ± 4.47	0.02

Table 4. Mean ± SD serum endotoxins levels (EU/ml)

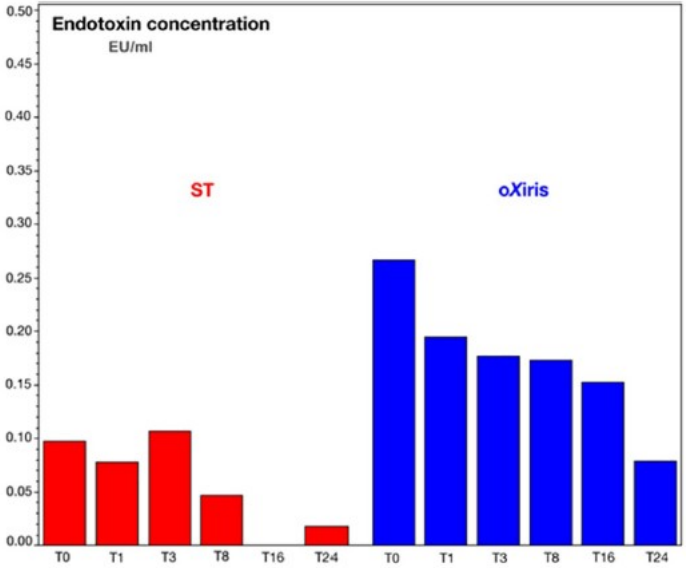
	AN69 mb ($n = 10$)	Treated mb ($n = 10$)
T0	3.98 ± 3.31	4.26 ± 7.68
T1	11.07 ± 10.64	1.91 ± 1.19[a]
T6	2.96 ± 2.75	2.26 ± 2.39

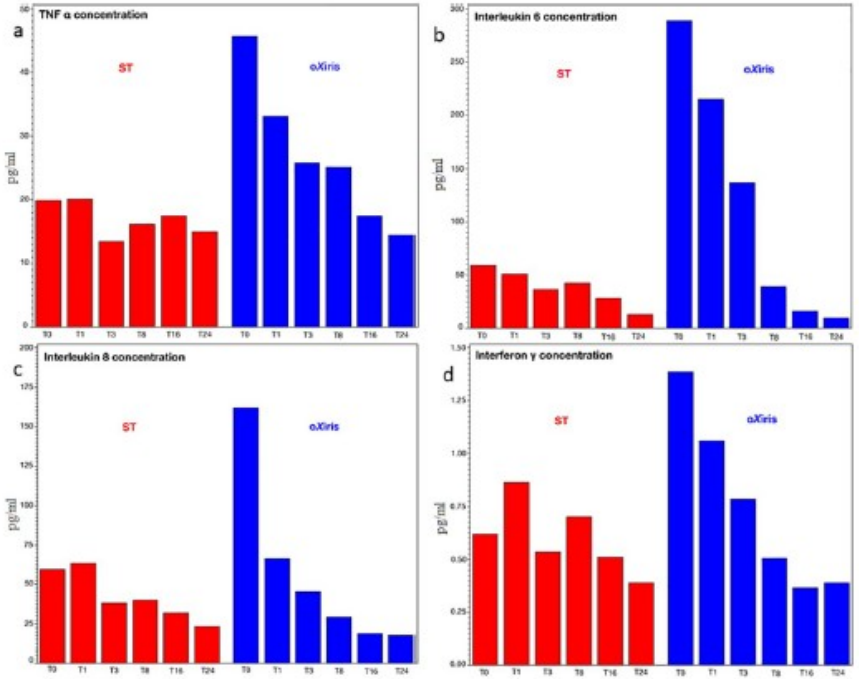
From T. Rimmelé

Endotoxin and cytokine reducing properties of the oXiris membrane in patients with septic shock: A randomized crossover double-blind study

2019

Marcus E. Broman[1], Fredrik Hansson[2], Jean-Louis Vincent[3]*, Mikael Bodelsson[1]

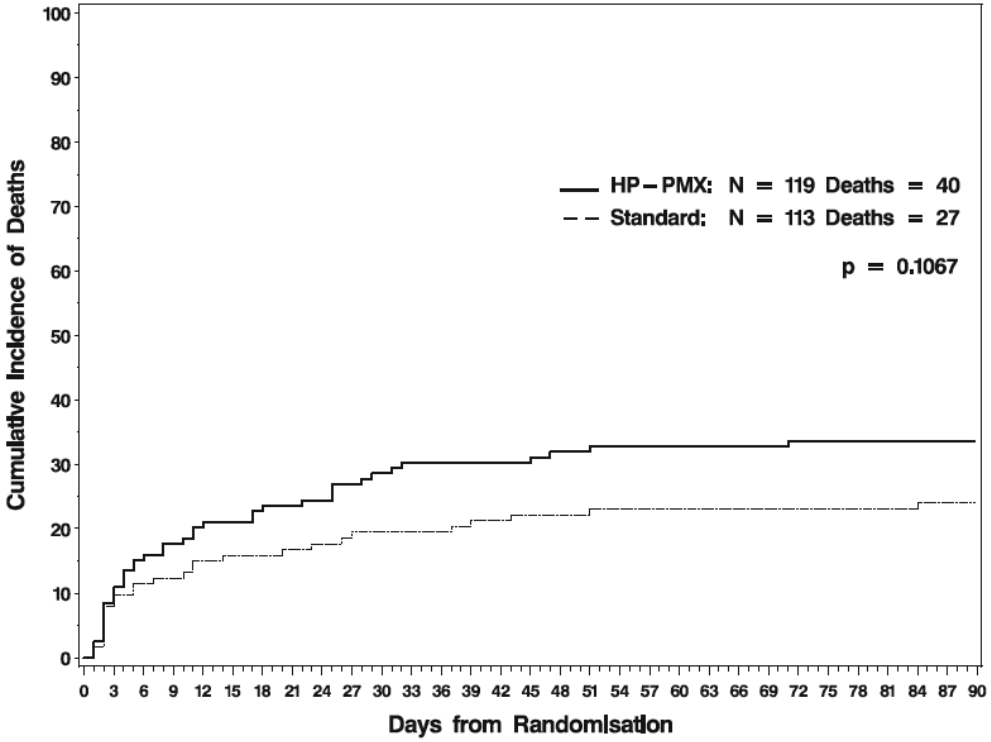




Early use of polymyxin B hemoperfusion in patients with septic shock due to peritonitis: a multicenter randomized control trial

Didier M. Payen
Joelle Guilhot
Yoann Launey
Anne Claire Lukaszewicz
Mahmoud Kaaki
Benoit Veber
Julien Pottecher
Olivier Joannes-Boyau
Laurent Martin-Lefevre

2015



Effect of Targeted Polymyxin B Hemoperfusion on 28-Day Mortality in Patients With Septic Shock and Elevated Endotoxin Level

The EUPHRATES Randomized Clinical Trial

2018

R. Phillip Dellinger, MD, MSc; Sean M. Bagshaw, MD, MSc; Massimo Antonelli, MD; Debra M. Foster, BSc; David J. Klein, MD, MBA; John C. Marshall, MD; Paul M. Palevsky, MD; Lawrence S. Weisberg, MD; Christa A. Schorr, DNP, MSN, RN; Stephen Trzeciak, MD, MPH; Paul M. Walker, MD, PhD; for the EUPHRATES Trial Investigators

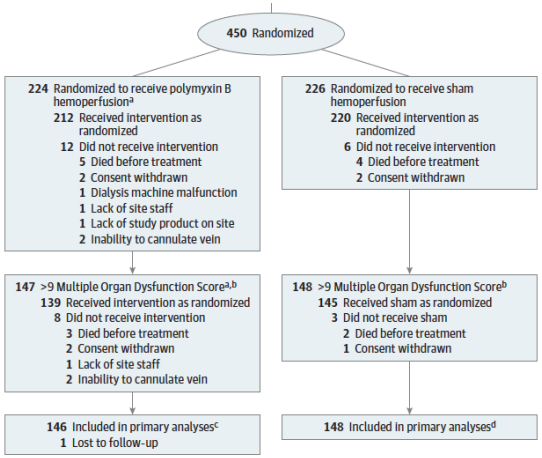


Table 2. Summary of the Primary End Point of 28-Day Mortality for All Participants and for Patients With MODS of More Than 9

	No./Total (%)		(95% CI)		
	Polymyxin-B Hemoperfusion	Sham	Risk Difference	Risk Ratio	*P* Value[a]
All Participants	84/223 (37.7)	78/226 (34.5)	3.15 (−5.73 to 12.04)	1.09 (0.85 to 1.39)	.49
>9 MODS[b]	65/146 (44.5)	65/148 (43.9)	0.60 (−10.75 to 11.97)	1.01 (0.78 to 1.31)	.92

Blood Purification With CytoSorb in Critically Ill Patients: Single-Center Preliminary Experience

*Maria Grazia Calabrò, *Daniela Febres, *Gaia Recca, *Rosalba Lembo, *Evgeny Fominskiy, *Anna Mara Scandroglio, *†Alberto Zangrillo, and *†Federico Pappalardo

2018

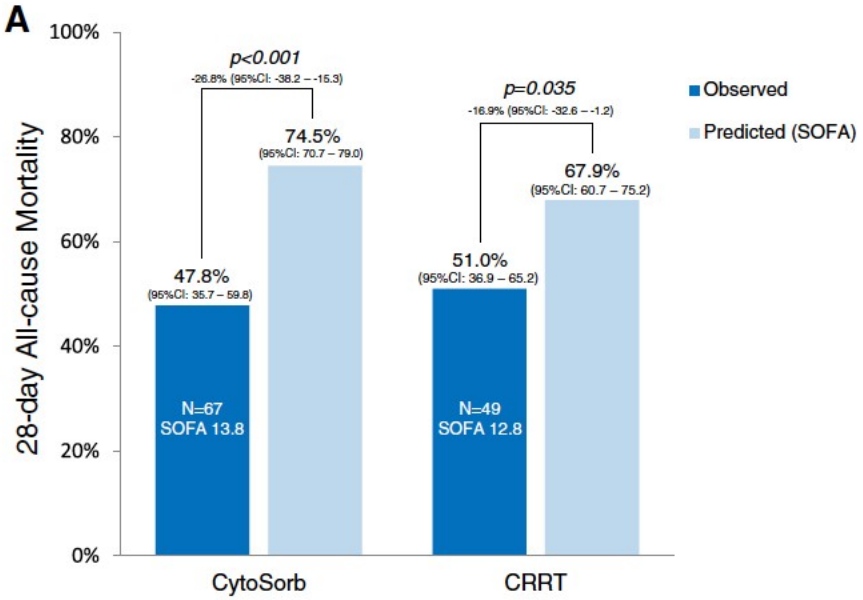
Values	Peak during treatment	End of treatment	*P* value
Total bilirubin (mg/dL)	11.6 ± 9.2	6.8 ± 5.1	0.005
Lactate (mmol/L)	12.1 ± 8.7	2.9 ± 2.5	<0.001
CPK (U/L)	2416 (670–8615)	281 (44–2769)	<0.001
LDH (U/L)	1230 (860–3157)	787 (536–1148)	<0.001

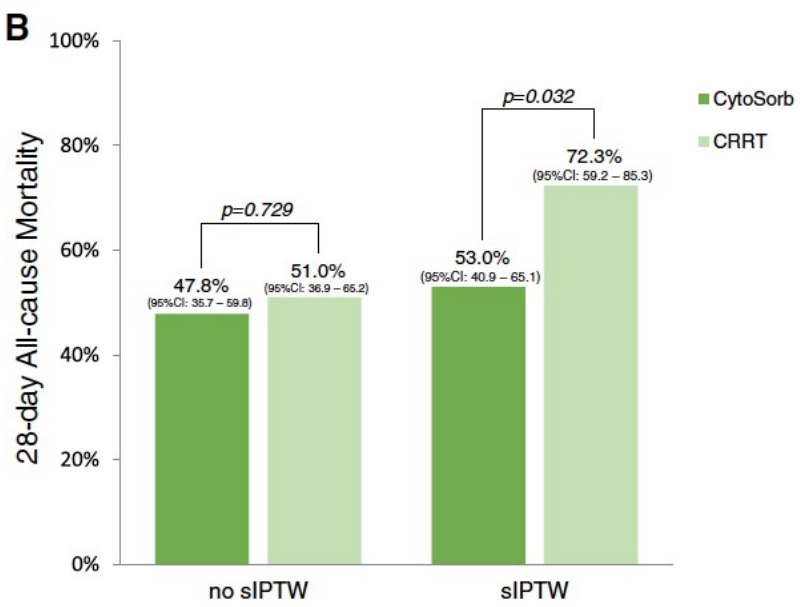
CRITICAL CARE

Hemoadsorption with CytoSorb shows a decreased observed versus expected 28-day all-cause mortality in ICU patients with septic shock: a propensity-score-weighted retrospective study

Willem Pieter Brouwer[1,2*], Servet Duran[3], Martijn Kuijper[4] and Can Ince[5]

2019





In vitro comparison of the adsorption of inflammatory mediators by blood purification devices

(2018)

Benjamin Malard[1*], Corine Lambert[1] and John A. Kellum[2]

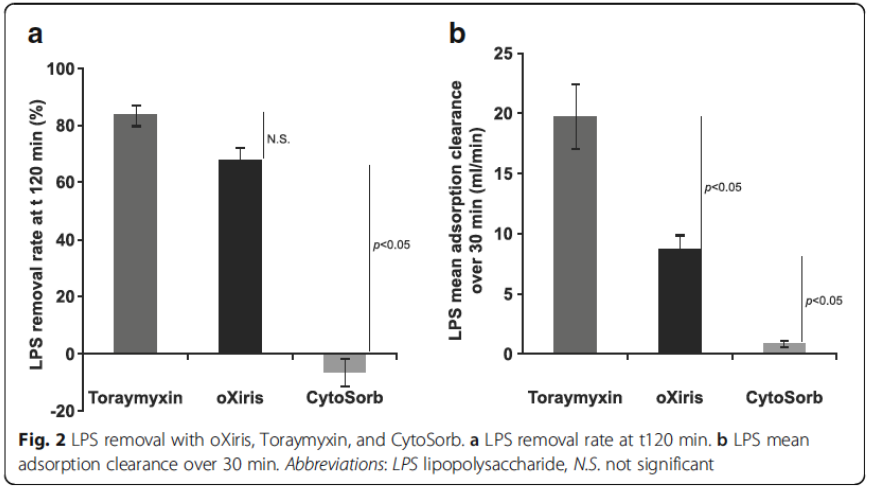
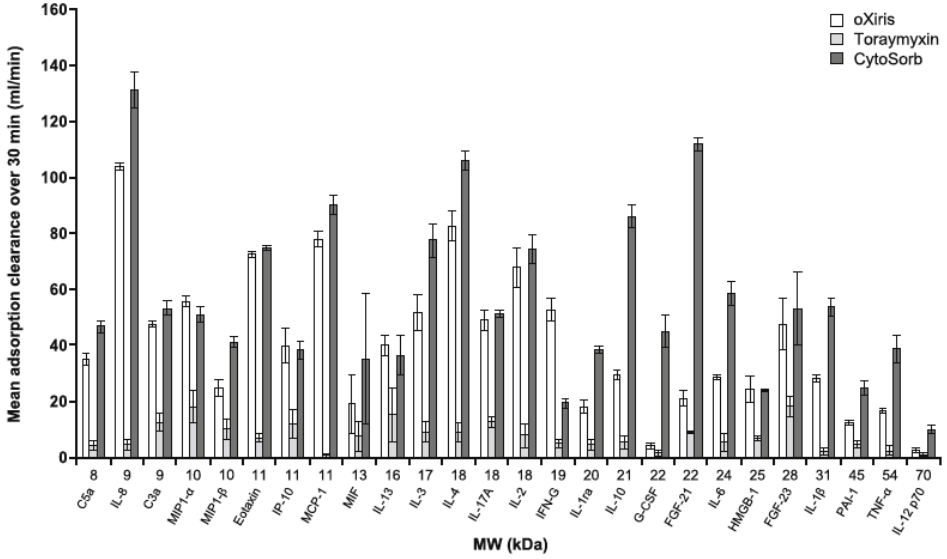


Fig. 2 LPS removal with oXiris, Toraymyxin, and CytoSorb. **a** LPS removal rate at t120 min. **b** LPS mean adsorption clearance over 30 min. *Abbreviations*: *LPS* lipopolysaccharide, *N.S.* not significant



HEMOPERFUSION WITH *JAFFRON HA330* AS LIFE-SAVING TREATMENT IN *COVID-19* PATENTS: 2 CASE REPORTS

A. Guglielmi [a], A. Carletti [a], C.N.J. Colombo [a], Giovanni Maria Mazza [a], Mara De Amici [b], C. Ronco [c, d], F. Mojoli [a], M. Belliato [e], F. Ferrari [d, f].*

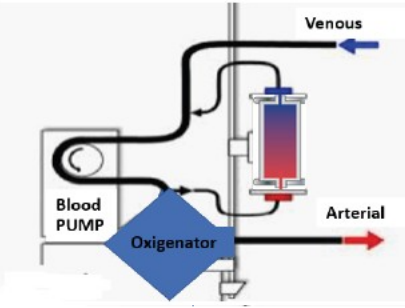
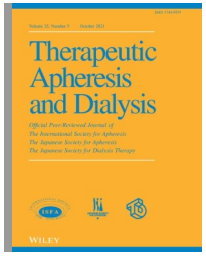


Figure I – Connection of HP cartridge to ECMO circuit in patient 1

	Patient 1		Patient 2	
Variables	Pre-HP	Post-HP	Pre-HP	Post-HP
NK	29	170	69	100
CD4+ cells/μL	212	858	293	500
CD8+ cells/μL	80	300	28	125
PCT (ng/mL)	3.85	2.38	7.12	1.65
Lactate (mmol/L)	4.8	2.2	2.1	1.8
IL-2 (pg/mL)	67.41	14.1	67.41	0.1
IL6 (pg/mL)	425.15	259.47	325.75	259.47
IL-10 (pg/mL)	221.11	171.4	161.11	186.66



Effect on Extrapulmonary Sepsis-Induced Acute Lung Injury by Hemoperfusion With Neutral Microporous Resin Column

2012

Zhao Huang, Si-rong Wang, Zi-li Yang, and Ji-yun Liu

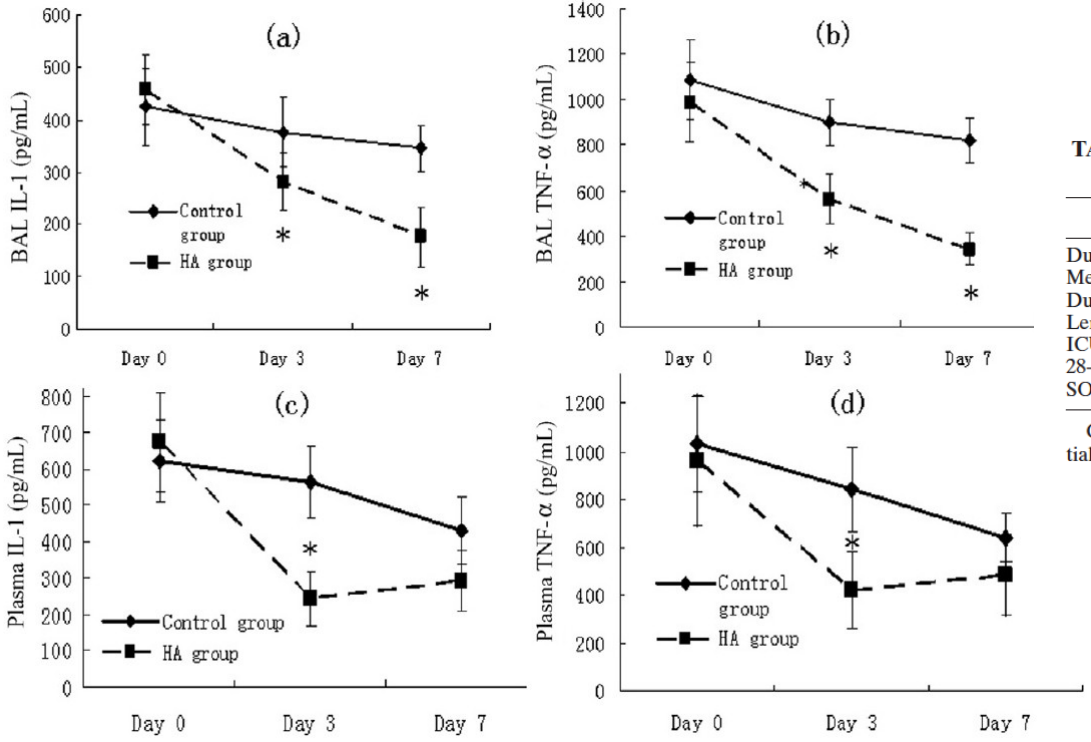


TABLE 5. *Duration of mechanical ventilation and length of stay in survivors; ICU and 28-day mortality*

Variables	Control group	HA group	*P*-value
Duration of mechanical ventilation, days	13.6 ± 3.2	9.2 ± 2.3	0.01
Mechanical ventilation-free days to day 28	14.7 ± 5.5	19.6 ± 4.7	0.03
Duration of CRRT, hours	65.7 ± 14.6	18.6 ± 5.1	0.005
Length of ICU stay, day	19.4 ± 3.1	15.5 ± 4.0	0.04
ICU mortality No. (%)	12/21 (57.14)	6/25 (24)	0.02
28-day mortality No. (%)	14/21 (66.7)	7/25 (28)	0.009
SOFA at 14 day	8.9 ± 2.5	6.1 ± 1.2	0.047

CRRT, continuous renal replacement therapy; ICU, intensive care unit; SOFA, Sequential Organ Failure Assessment.

(HA330)

Medicine
Wolters Kluwer

Clinical effects of hemoperfusion combined with pulse high-volume hemofiltration on septic shock

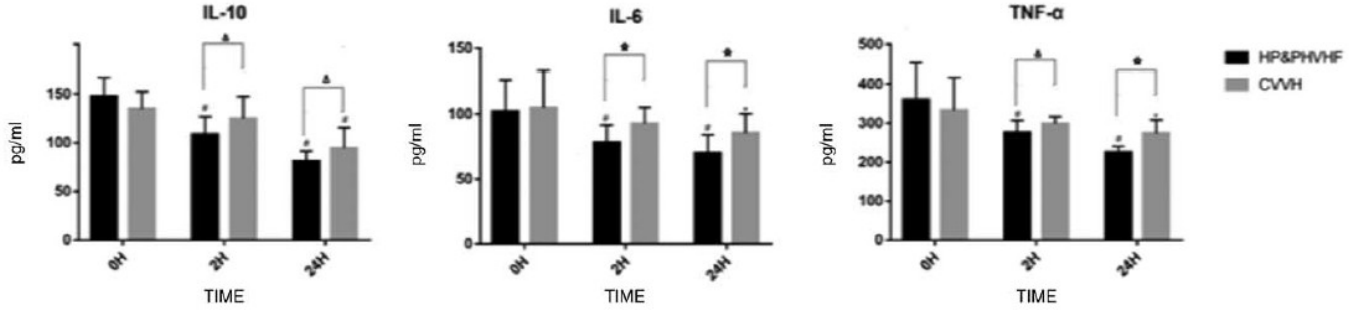
Laping Chu, MS[a], Guangyao Li, MS[b], Yafen Yu, MD[a,*], Xiaoyan Bao, BS[a], Hongyi Wei, BS[c], Minhong Hu, BS[c]

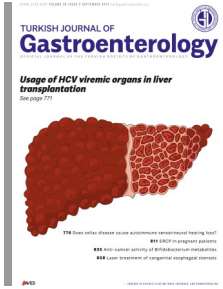
2020

Table 3

Laboratory and physiological variables before and after treatment in two groups (mean ± SD, n = 15).

	HP&PHVHF		CVVH	
Group	**0 h**	**72 h**	**0 h**	**72 h**
WBC (10^9/L)	17.02 ± 3.09	11.16 ± 3.74$^{\#\Delta}$	17.82 ± 4.17	13.98 ± 3.65$^{\#}$
CRP (mg/L)	70.2 ± 16.06	40.07 ± 10.59$^{\#\star}$	63.13 ± 19.46	52.27 ± 11.85*
PCT (μg/L)	19.58 ± 14.66	5.73 ± 6.06$^{\#\Delta}$	18.42 ± 14.79	11.69 ± 8.12*
Lactic acid (mmol/L)	3.40 ± 0.76	2.12 ± 0.93$^{\#}$	3.72 ± 0.81	2.04 ± 0.77$^{\#}$
Creatinine (μmol/L)	404.1 ± 161.5	250.53 ± 101.0$^{\#}$	365.73 ± 113.79	238.7 ± 97.9$^{\#}$
APACHE II	22.33 ± 4.50	13.5 ± 2.78$^{\#\star}$	21.27 ± 4.85	17.67 ± 3.09$^{\#}$
SOFA	11.33 ± 3.13	6.87 ± 2.2$^{\#\Delta}$	11.87 ± 3.31	8.7 ± 1.67*





Effects of hemodialysis combined with hemoperfusion on severe acute pancreatitis

Zhehne Li[1], Guixi Wang[2], Guodong Zhen[1], Yuliang Zhang[2], Jiaqiang Liu[2], Shanmei Liu[2]

2018;

(HA330)

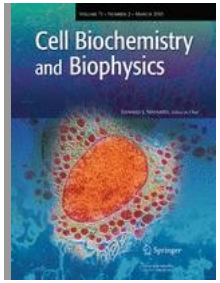
Table 1. Basic information of patients

Terms		Group O	Group C	p
Number		37	31	
Age		32.5±8.2	32.3±9.4	0.795
Gender	male	28	26	0.406
	female	9	5	
Weight (kg)		62.0±12.40	63.60±11.5	0.354
Leukocyte ($\times 10^9$/L)		17.1±2.9	16.9±3.2	0.731
Neutrophil percentage		0.83±0.07	0.84±0.05	0.676
AMY (U/L)		1005±146	996±139	0.096
BUN (mmol/L)		29.7±3.2	31.5±2.9	0.230
Cr (μmol/L)		277±40	265±43	0.089
TBIL (mmol/L)		69±14	65±17	0.152

Table 3. The symptoms and complications in patients after treatment

Terms		Group O	Group C	p
Symptom disappear (day)		3.01±1.02	5.56±1.88	4.31×10^{-21}
Complications	Acute renal failure	1	4	0.024
	Multiple organ failure	0	2	
Mortality		0	0	

The statistical analysis of complications was performed with Chi-squared test. $p<0.05$ indicates a statistically significant difference



Hemodiafiltration Combined with Resin-Mediated Absorption as a Therapy for Hyperlipidemic Acute Pancreatitis

(2014)

Mao-qin Li · Zai-xiang Shi · Ji-yuan Xu · Bo Lu · Jia-qiong Li · Yan-jun Xu · Xiao-meng Wang · Song-mei Li · Xun Mo

Table 2 Changes in lipid levels after a single hemoperfusion ($x \pm s$)

Index (measurement)	Before perfusion	After perfusion	Change rate (%)	*t* Value	*P* value
TG (mmol/L)	13.77 ± 3.91	9.67 ± 2.31	29.78	3.84	≤0.01
TC (mmol/L)	7.93 ± 1.91	5.98 ± 1.32	24.59	4.11	≤0.01

TG triglyceride, *TC* total cholesterol

Table 3 Changes in lipid levels after HP + CVVHDF treatment (mean, mmol/L)

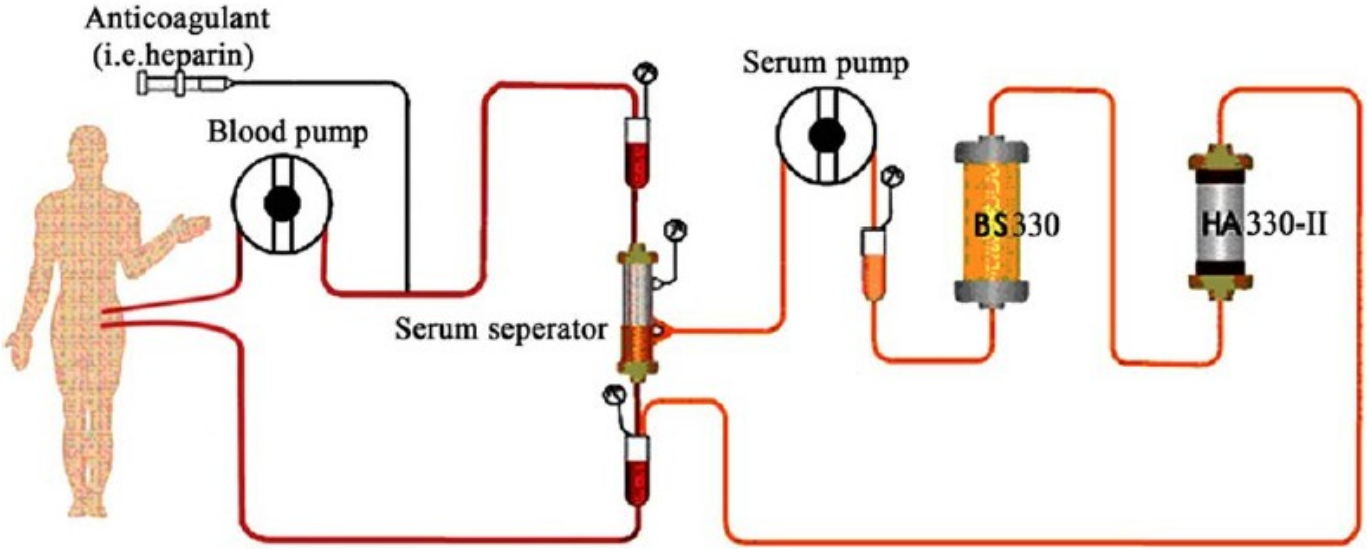
Index (measurement)	Before treatment	Day 1	Day 2	Day 3
TG (mmol/L)	13.77	7.02 (49.02 %)	5.12 (62.81 %)	4.19 (69.57 %)
TC (mmol/L)	7.62	4.75 (37.66 %)	4.01 (47.37 %)	3.85 (49.47 %)

Journal of Clinical Apheresis
VOLUME 36 • ISSUE 4 • 2021
The Official Journal of ASFA the American Society for Apheresis
WILEY

Therapeutic plasma exchange versus double plasma molecular absorption system in hepatitis B virus-infected acute-on-chronic liver failure treated by entercavir: A prospective study

Yue-Meng Wan[1,2] | Yu-Hua Li[1] | Zhi-Yuan Xu[1] | Jing Yang[1] | Li-Hong Yang[1] | Ying Xu[1] | Jin-Hui Yang[1]

2017



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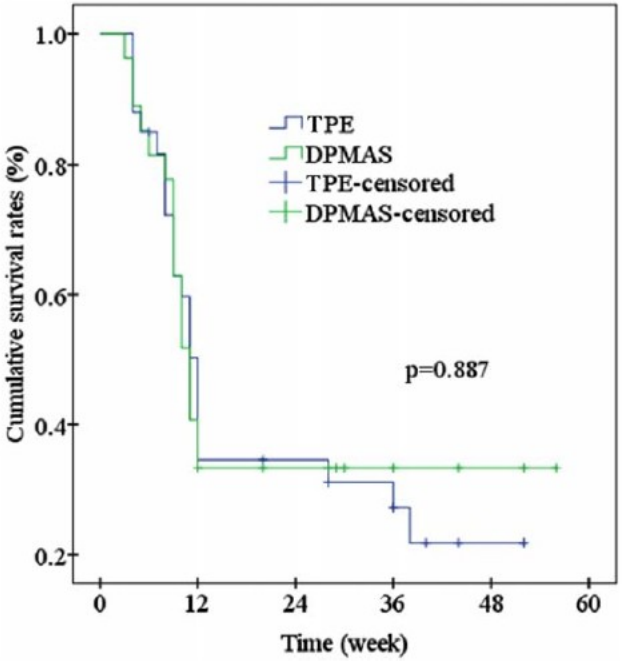
2017



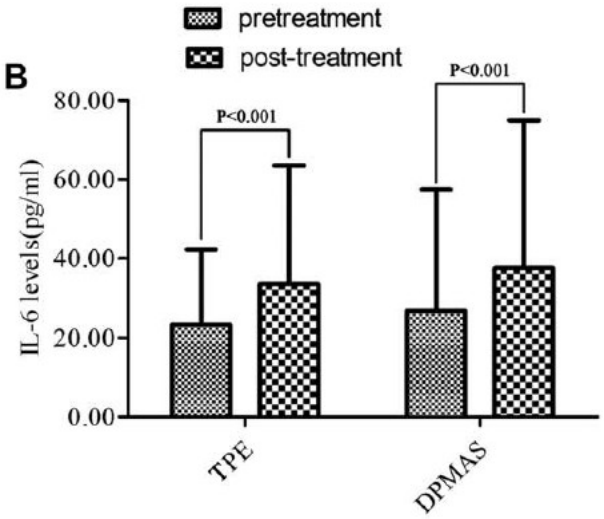
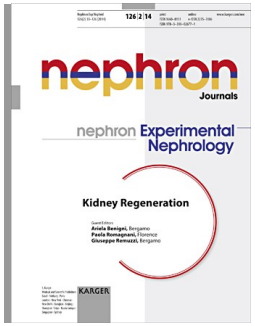


TABLE 4 Univariate and multivariate analysis for predictors of 12-week survival

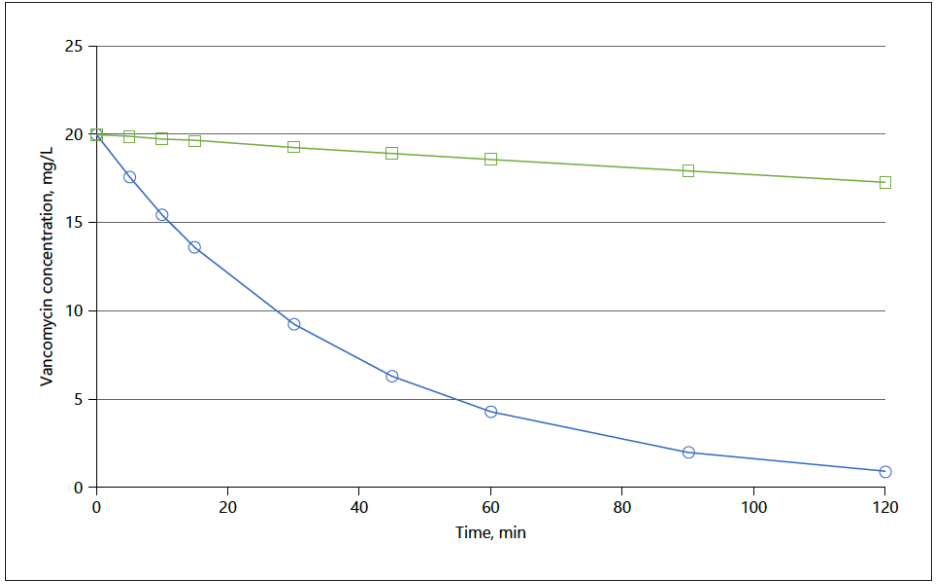
	Univariate			Multivariate		
Factors	RR	95%CI	*P*	RR	95%CI	*P*
Hospital stay (day)	1.066	1.026-1.108	.001	1.062	1.011-1.115	.016
PT (s)	1.308	1.140-1.500	.000	1.346	1.077-1.726	.010
INR	0.281	0.062-1.272	.090	0.013	0.006-0.788	.041
ALT (U/l)	0.998	0.997-1.000	.009			
AST (U/l)	0.998	0.997-1.000	.035			
TBIL (μmol/l)	1.004	1.001-1.007	.009			
DBIL (μmol/l)	1.005	1.001-1.009	.007			
CTP score	1.246	1.003-1.584	.047			

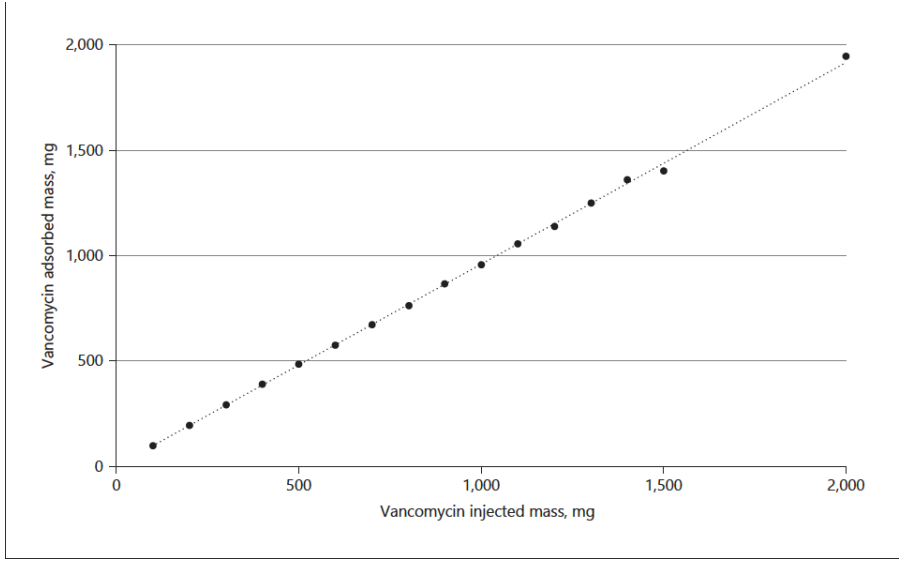


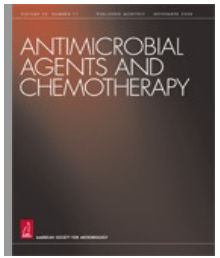
Vancomycin Adsorption During in vitro Model of Hemoperfusion with HA380 Cartridge

2021

Ilaria Godi[a, b] Anna Lorenzin[b] Silvia De Rosa[b, c] Gianlorenzo Golino[a, b]
Maira Knust[b] Ana Gaspar[b] Alessandra Sandini[d] Francesco Fiorin[d]
Massimo de Cal[b, e] Paolo Navalesi[a] Claudio Ronco[b, e, f]







Adsorption of Amikacin, a Significant Mechanism of Elimination by Hemofiltration[▽]

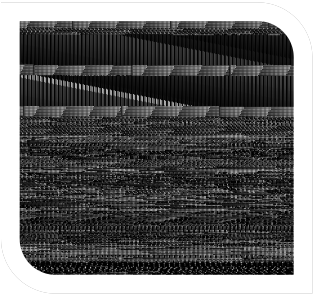
Qi Tian,[1] Charles D. Gomersall,[1]* Margaret Ip,[2] Perpetua E. Tan,[1]
Gavin M. Joynt,[1] and Gordon Y. S. Choi[1]

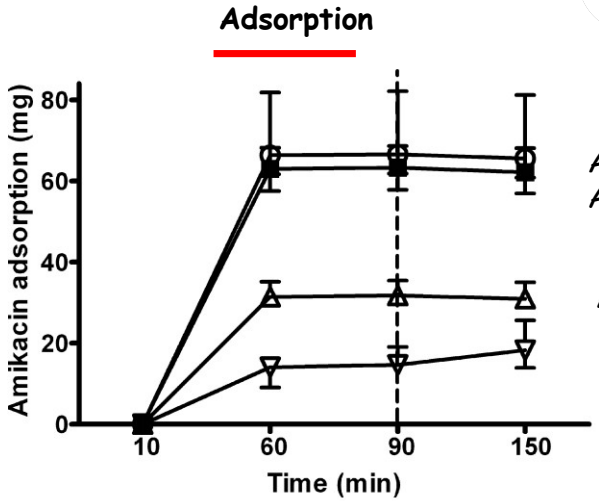
2008

PH independent (6,8 vs 7,4)
Surface independent (0,6 vs 0,9 m^2)
AN69 >> PS

Irreversible
Dose dependent
Saturate

Capacity maximal (0,6 m2) = 550 mg



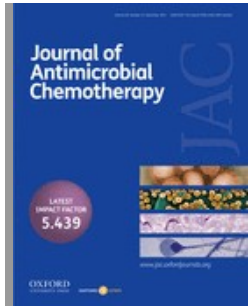


AN69

AN69 / pH 7,4 / 70mg
AN69 / pH 6,8 / 70mg

AN69 / pH 7,4 / 35mg

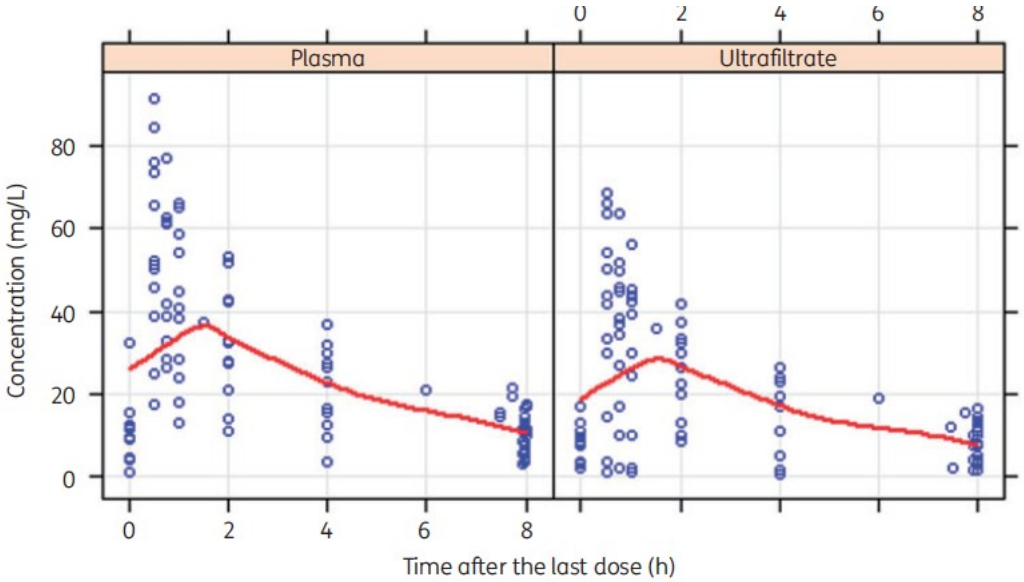
PS / pH 7,4 / 70mg

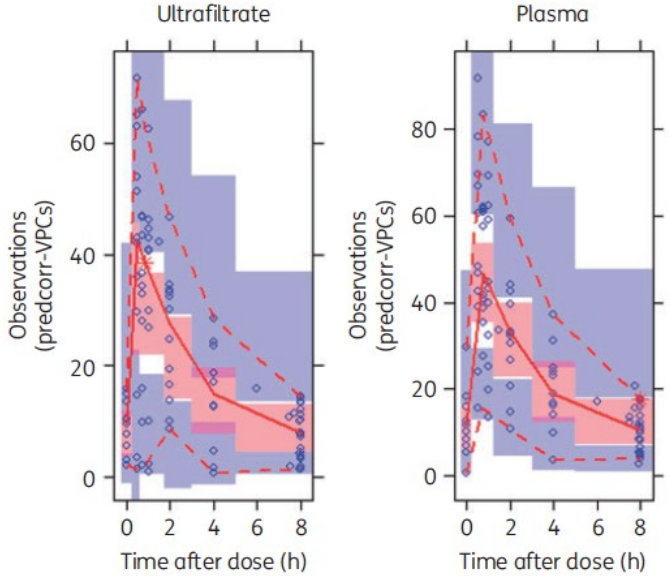


Optimized meropenem dosage regimens using a pharmacokinetic/pharmacodynamic population approach in patients undergoing continuous venovenous haemodiafiltration with high-adsorbent membrane

2019

A. Padullés Zamora[1,2], R. Juvany Roig[1,2]*, E. Leiva Badosa[1,2], J. Sabater Riera[2,3], X. L. Pérez Fernández[2,3], P. Cárdenas Campos[2,3], R. Rigo Bonin[2,4], P. Alía Ramos[2,4], F. Tubau Quintano[2,5], E. Sospedra Martinez[1,2] and H. Colom Codina[2,6]





Take home message

- MOST is a global approach
- Adsorption may be a master piece
- Nurses workload is an issue
- All the filters are not equal
- Filters have an impact on molecules removal
- What molecules we have to remove ?
- Which molecules we'll remove but we don't want ?
- Studies are warranted to use them in routine