Blood purification in sepsis

Joannes-Boyau O
Dept of anesthesiology and intensive care, University Hospital of Bordeaux, France
Types of Blood Purification

- **hemofilters**
  - regular pore size ($MW < 40,000D$)
    - Low flux
    - High flux
  - large pore filtration ($MW < 100,000D$)
- **open pore plasma filters**
  - plasma exchange
  - Plasmapheresis
- **adsorption**
- **coupled plasma filtration / adsorption**
Plasmafiltration

Blood pump

Veno-venous catheter

Plasmafilter

Plasma

Substitute Plasma

PFC Albumine colloids

- Plasma (Filtrat)
Cascade filtration
CPFA
Sepsis
Interest of CRRT

- Renal replacement therapy
- Regulation of electrolyte, acid-base equilibration
- Volume balance, avoid volume overload
- Removal of immunological and biological active molecules, re-establish of immune homeostasis
- Regulation of body temperature
Immuno-modulation concept

- Non-selective removal of cytokines by hemofiltration
- Equilibration between pro- and anti-inflammatory cytokines and mediators
- Down-regulation

Skerrett S.J. et al. *Journal of Infectious Diseases*. 1997
Peak-Concentration Hypothesis


---

**Sepsis and CRRT: The Peak Concentration Hypothesis**

- Pro-inflammatory mediators: TNF, IL-1
- Anti-inflammatory mediators: PAF, IL-10
- High dose steroids
- Antimicrobial agents

---

**Pro/Anti-inflammatory mediators**

- Which pharmacological therapy?

---

**Immunohomeostasis**
Removal of cytokines and activated complement components in an experimental model of continuous plasma filtration coupled with sorbent adsorption

Ciro Tetta¹, Jean M. Cavaillon⁵, Matthias Schulze⁸, Claudio Ronco⁶, Paolo M. Ghezzi⁷, Giovanni Camussi⁵, Anna Maria Serra³, F. Curti⁴ and Gerhard Lonnemann⁸


**Fig. 4.** Assessment of the 1% leakage of various cytokines to different linear velocities using Amberlite® XAD 1600 (■) and Amberchrome® CG300md (♦). Each point is the mean of six experiments performed in triplicate. Bars indicate standard deviation of the mean.
## Plasmapheresis: Clinical Studies

### Animal Studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Results</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Busund 91</td>
<td>no survival advantage</td>
<td>Arch Surg</td>
</tr>
<tr>
<td>Natanson 93</td>
<td>no survival advantage</td>
<td>Transfusion</td>
</tr>
</tbody>
</table>

### Human Studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Type of Study</th>
<th>Results</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Deuren 92</td>
<td>observational</td>
<td>no benefit</td>
<td>Clin Infect Dis</td>
</tr>
<tr>
<td>Reeves 95</td>
<td>retrospective</td>
<td>no benefit</td>
<td>Int Care Med</td>
</tr>
<tr>
<td>Berlot 97</td>
<td>observational</td>
<td>no benefit</td>
<td>Blood Purif</td>
</tr>
<tr>
<td>Kumar 98</td>
<td>observational</td>
<td>no benefit</td>
<td>Nephrol Dial Trans</td>
</tr>
<tr>
<td>Reeves 99</td>
<td>RCT</td>
<td>no benefit</td>
<td>Crit Care Med</td>
</tr>
<tr>
<td>Schmidt 2000</td>
<td>observational</td>
<td>no benefit</td>
<td>Int Care Med</td>
</tr>
</tbody>
</table>
Plasmapheresis in severe sepsis and septic shock: a prospective, randomised, controlled trial

CPFA: Experimental Studies

- **In-Vitro studies**
  - much more efficient clearance of cytokines

- **Animal Studies**
  - rabbit model of LPS septic shock (*Tetta C, Crit Care Med 2000*)
    - 85% survival in rabbits supported with CPFA
    - 80% mortality in control rabbits

- **Human Clinical Study** (*Brendolan A, J Am Soc Nephrol 1998*)
  - improved hemodynamics SVR
  - reduced inotrope requirements
  - improved monocyte responsiveness
New filtration techniques:
PFAD (Plasma filtration adsorption dialysis)
Hemoadsorption removes tumor necrosis factor, interleukin-6, and interleukin-10, reduces nuclear factor-κB DNA binding, and improves short-term survival in lethal endotoxemia

John A. Kellum, MD, FCCM; Mingchen Song, MD, PhD; Ramesh Venkataraman, MD

Crit Care Med 2004
Hemofiltration for cytokine-driven illnesses: The mediator delivery hypothesis

J.V. Di Carlo¹, S.R. Alexander²

The International Journal of Artificial Organs / Vol. 28 / no. 8, 2005.
Effects of different doses in continuous veno-venous haemofiltration on outcomes of acute renal failure: a prospective randomised trial

Claudio Ronco, Rinaldo Bellomo, Peter Homel, Alessandra Brendolan, Maurizio Dan, Pasquale Piccinni, Giuseppe La Greca

![Graph showing survival rates at different ultrafiltration rates (20 ml/kg/hr, 35 ml/kg/hr, 45 ml/kg/hr). The graph indicates a significant difference in survival rates with a p-value of < 0.0016.](image)
Prospective evaluation of short-term, high-volume isovolemic hemofiltration on the hemodynamic course and outcome in patients with intractable circulatory failure resulting from septic shock

Patrick M. Honore, MD; Jean Jamez, MD; Michel Wauthier, MD; Patrice A. Lee, PhD; Thierry Dugernier, MD; Bruno Pirenne, MD; Genevieve Hanique, MD; James R. Matson, MD

20 patients, Refractory septic shock

PAM < 55 mm Hg, IC < 2,5 l/mn/m², catécho doses max., PAPO > 16 mmHg, SvO2 < 55 %, pH < 7,15, lactates > 5mmol/l, PaO2/FiO2 < 100

4 h HFHV (9l/h) isovolumic + 4 days (minimum) of CVVH

Responders

Non Responders

CI ≥ 50 % H2, SVO2 ≥ 25 % H2
pH > 7.30 H4, Adré ≤ 50 % H4
Prospective evaluation of short-term, high-volume isovolemic hemofiltration on the hemodynamic course and outcome in patients with intractable circulatory failure resulting from septic shock

Patrick M. Honore, MD; Jean Jamez, MD; Michel Wauthier, MD; Patrice A. Lee, PhD; Thierry Dugernier, MD; Bruno Pirenne, MD; Genevieve Hanique, MD; James R. Matson, MD

- Predictable Mortality: 79%
- Observed Mortality:
  - Global patients: 55%
  - Responders: 18.1%
  - Non responders: 100%

- Survival associated factors
  - Weight and real UF (0.53 vs 0.43 l/kg)
  - Start time: 6.5 h (3.25-12) vs 13.8 h (9.6-17.5) p < 0.01
Impact of High Volume Hemofiltration on Hemodynamic Disturbance and Outcome during Septic Shock

Olivier Joannes-Boyau, Stephane Rapaport, Romain Bazin, Catherine Fleureau, and Gerard Janvier

ASAIO Journal 2004

SAP (mmHg)

CI (L/mn/m²)

ND (µg/kg/mn)

Systolic blood pressure (SAP)
Cardiac index (CI)
noradrenaline doses (ND)

Time (Hour)
With HVHF we can see:

- Increase of Hemodynamics parameters
- Important decrease of catecholamines doses

Observed Mortality 46% VS Predictable Mortality 70% (p<0.075)
High-volume hemofiltration as salvage therapy in severe hyperdynamic septic shock

Intensive Care Med. 2006 Mar 21

Rodrigo Cornejo
Patricio Downey
Ricardo Castro
Carlos Romero
Tomas Regueira
Jorge Vega
Luis Castillo
Max Andresen
Alberto Dougna
Guillermo Bugedo
Glenn Hernandez

![Graphs showing NE dose and MAP over time](image-url)
High-volume hemofiltration as salvage therapy in severe hyperdynamic septic shock

Intensive Care Med. 2006 Mar 21

- Increase of Hemodynamics parameters
- Important decrease of catecholamines doses

Observed Mortality 40%

VS

Predictable Mortality 63%

(p<0.03)

Responders 18% Vs Non Responders 67%
A pilot randomized study comparing high and low volume hemofiltration on vasopressor use in septic shock

5220-112-3212-028-2005-

- 19 patients Randomized
- 35 ml/kg/h Vs 65 ml/kg/h during 4 days.
- Global mortality at D28 = 47%
- Specific mortality: LVH = 50% vs HVH = 44%

<table>
<thead>
<tr>
<th>Time (h)</th>
<th>LVHF</th>
<th></th>
<th>HVHF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-responders n = 6</td>
<td>Responders n = 4</td>
<td>Non-responder n = 1</td>
</tr>
<tr>
<td>0</td>
<td>0.99 (0.54–1.17)</td>
<td>0.38 (0.26–0.44)</td>
<td>2.38</td>
</tr>
<tr>
<td>6</td>
<td>0.94 (0.78–1.5)</td>
<td>0.28 (0.17–0.39)</td>
<td>1.19</td>
</tr>
<tr>
<td>12</td>
<td>0.81 (0.43–1.69)</td>
<td>0.2 (0.1–0.3)</td>
<td>0.95</td>
</tr>
<tr>
<td>18</td>
<td>0.73 (0.35–2.66)</td>
<td>0.04 (0.01–0.1)</td>
<td>0.83</td>
</tr>
<tr>
<td>24</td>
<td>0.56 (0.27–2.77)</td>
<td>0 (0–0.05)</td>
<td>0.95</td>
</tr>
</tbody>
</table>
A pilot randomized study comparing high and low volume hemofiltration on vasopressor use in septic shock


Nicolas Boussekey
Arnaud Chiche
Karine Faure
Patrick Devos
Benoit Guery
Thibaud d’Escrivan
Hugues Georges
Olivier Leroy
Delivered dose of renal replacement therapy and mortality in critically ill patients with acute kidney injury

Sergio Vesconi\textsuperscript{1*}, Dinna N Cruz\textsuperscript{2*}, Roberto Fumagalli\textsuperscript{3}, Detlef Kindgen-Milles\textsuperscript{4}, Gianpaola Monti\textsuperscript{1}, Anibal Marinho\textsuperscript{5}, Filippo Mariano\textsuperscript{6}, Marco Formica\textsuperscript{7}, Mariano Marchesi\textsuperscript{8}, Robert René\textsuperscript{9}, Sergio Livigni\textsuperscript{10}, Claudio Ronco\textsuperscript{2} for the DOse REsponse Multicentre International collaborative Initiative (DO-RE-MI Study Group)

\textit{Critical Care} 2009,
Delivered dose of renal replacement therapy and mortality in critically ill patients with acute kidney injury

Sergio Vesconi, Dinna N Cruz, Roberto Fumagalli, Detlef Kindgen-Milles, Gianpaola Monti, Anibal Marinho, Filippo Mariano, Marco Formica, Mariano Marchesi, Robert René, Sergio Livigni, Claudio Ronco for the DOse REsponse Multicentre International collaborative Initiative (DO-RE-MI Study Group)

*Critical Care 2009,*

<table>
<thead>
<tr>
<th>ICU length of stay and ventilation days by RRT dose</th>
<th>Total</th>
<th>CRRT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 35 ml/kg/hour</td>
<td>≥ 35 ml/kg/hour</td>
</tr>
<tr>
<td>Length of ICU stay (days)</td>
<td>13 (6.5 to 26)</td>
<td>15 (9 to 28)</td>
</tr>
<tr>
<td>Patients who survived</td>
<td>19 (11 to 32)</td>
<td>19.5 (12 to 33.5)</td>
</tr>
<tr>
<td>Patients who died</td>
<td>10 (4 to 19)</td>
<td>12 (6 to 20)</td>
</tr>
<tr>
<td>Duration of MV (days)</td>
<td>10 (4 to 19)</td>
<td>12 (5 to 21)</td>
</tr>
<tr>
<td>Patients who survived</td>
<td>14 (4.5 to 22)</td>
<td>14 (5 to 24)</td>
</tr>
<tr>
<td>Patients who died</td>
<td>8.5 (3 to 17)</td>
<td>10 (5 to 18)</td>
</tr>
</tbody>
</table>
### Figure 29: Forest plot of mortality at Day 90 by subgroup

<table>
<thead>
<tr>
<th>Number (% of patients with event)</th>
<th>Favours Lower Intens.</th>
<th>Favours Higher Intens.</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patients met criteria for Sepsis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>145/379 (38.3%)</td>
<td>154/362 (42.5%)</td>
<td>0.84 (0.62 to 1.12)</td>
</tr>
<tr>
<td>Yes</td>
<td>186/363 (51.2%)</td>
<td>168/359 (46.8%)</td>
<td>1.19 (0.89 to 1.60)</td>
</tr>
<tr>
<td><strong>Patients with at least one non-renal organ failure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>25/93 (26.9%)</td>
<td>23/93 (24.7%)</td>
<td>1.12 (0.58 to 2.16)</td>
</tr>
<tr>
<td>Yes</td>
<td>306/649 (47.2%)</td>
<td>299/628 (47.6%)</td>
<td>0.98 (0.79 to 1.22)</td>
</tr>
<tr>
<td><strong>Patients with SOFA cardiovascular score of 3-4</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>75/194 (38.7%)</td>
<td>74/210 (35.2%)</td>
<td>1.16 (0.77 to 1.74)</td>
</tr>
<tr>
<td>Yes</td>
<td>254/546 (46.5%)</td>
<td>247/510 (48.4%)</td>
<td>0.93 (0.73 to 1.18)</td>
</tr>
<tr>
<td><strong>Patients with eGFR &lt; 60ml/min</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>105/222 (47.3%)</td>
<td>114/250 (45.6%)</td>
<td>1.07 (0.75 to 1.54)</td>
</tr>
<tr>
<td>Yes</td>
<td>81/185 (43.8%)</td>
<td>81/157 (51.6%)</td>
<td>0.73 (0.48 to 1.12)</td>
</tr>
</tbody>
</table>

Death at Day 90: 332/743 (44.7%) 322/721 (44.7%) 1.00 (0.81 to 1.23)
Future ?
Prospective randomized multinational simple blind study evaluating the adequate dose of continuous high volume haemofiltration in the early treatment « phase » of Septic Shock patients with Acute Renal Failure.

→ Should defined the adequate « Septic Dose » of CRRT during Septic Acute Renal Failure in ICU.
Any dose of vasopressors (Noradrenaline) or > 5µg/kg/m of Dopamine

- Oliguria < 0.5 ml/kg/h
- Creatinine X 2

RIFLE Injury

Randomization within 24 hours of ICU admission (! Early septic shock)

patients with Septic Shock and Acute Renal Failure

Mortality

D28
D90
The “Depletion syndrome”

Albumin (Carriers)

Microconutrients

Energy

Macronutrients

Trace Elements

Hydrosolubles Vitamines

Amino-Acids

Catecholamines

Drugs Antibiotics

Risk

Injury

Failure

Loss

ESKD

Increased creatinine x1.5 or GFR decrease > 25%

UO < .5ml/kg/h x 6 hr

Increased creatinine x2 or GFR decrease > 50%

UO < .5ml/kg/h x 12 hr

Increase creatinine x3 or GFR decrease > 75%

UO < .3ml/kg/h x 24 hr or Anuria x 12 hrs

Persistent ARF** = complete loss of kidney function > 4 weeks

End Stage Kidney Disease (> 3 months)

High Sensitivity

High Specificity

RIFLE Criteria

GFR Criteria

Urine Output Criteria
Early isovolaemic haemofiltration in oliguric patients with septic shock

Timing of Renal Replacement Therapy Initiation in Acute Renal Failure: A Meta-analysis


Effect on mortality
Timing of Renal Replacement Therapy Initiation in Acute Renal Failure: A Meta-analysis

Seabra VF et al.  
Am J Kidney Dis 2008; 52: 272-84

Effect on renal recovery
Correlation between parameters at initiation of renal replacement therapy and outcome in patients with acute kidney injury

Marlies Ostermann\(^1\) and René WS Chang\(^2\)

*Critical Care* 2009, 13:R175

### Characteristics of patients on RRT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ICU Survivors (n = 848)</th>
<th>ICU Non-survivors (n = 999)</th>
<th>(P)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oligoanuria (urine (\leq 400) ml/hr)</td>
<td>402 (47.3%)</td>
<td>597 (59.8%)</td>
<td>(&lt;0.0001)</td>
<td>1.65 (1.37-1.98)</td>
</tr>
</tbody>
</table>

### Parameters at initiation of RRT and ICU outcome

<table>
<thead>
<tr>
<th>Variables on day of RRT</th>
<th>Incidence (n = 1847)</th>
<th>ICU mortality</th>
<th>(P)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;400 ml/24 hours</td>
<td>994 (53.8%)</td>
<td>595 (59.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\geq 400) ml/24 hours</td>
<td>853 (46.2%)</td>
<td>404 (47.4%)</td>
<td>(&lt;0.0001)</td>
<td>1.66 (1.38-1.99)</td>
</tr>
</tbody>
</table>
Correlation between parameters at initiation of renal replacement therapy and outcome in patients with acute kidney injury

Marlies Ostermann¹ and René WS Chang²

Critical Care 2009, 13:R175

Multivariate analysis: parameters on day of RRT affecting ICU outcome of patients with AKI treated with RRT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>B</th>
<th>SE</th>
<th>P</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH on day of RRT</td>
<td>-3.719</td>
<td>0.448</td>
<td>&lt;0.0001</td>
<td>.024</td>
<td>0.01-0.06</td>
</tr>
<tr>
<td>(creatinine) on day of RRT</td>
<td>-0.002</td>
<td>0.000</td>
<td>&lt;0.0001</td>
<td>.998</td>
<td>0.997-0.998</td>
</tr>
<tr>
<td>(urea) on day of RRT</td>
<td>0.004</td>
<td>0.001</td>
<td>&lt;0.0001</td>
<td>1.004</td>
<td>1.002-1.005</td>
</tr>
<tr>
<td>Age</td>
<td>0.026</td>
<td>0.004</td>
<td>&lt;0.0001</td>
<td>1.026</td>
<td>1.02-1.03</td>
</tr>
<tr>
<td>CVS failure on day of RRT</td>
<td>0.261</td>
<td>0.127</td>
<td>0.039</td>
<td>1.299</td>
<td>1.01-1.66</td>
</tr>
<tr>
<td>Oligoanuria on day of RRT</td>
<td>0.469</td>
<td>0.115</td>
<td>&lt;0.0001</td>
<td>1.599</td>
<td>1.28-2.00</td>
</tr>
</tbody>
</table>

- In patients receiving renal support, failure of other organ systems, oligo-anuria and acidosis at time of initiation of RRT and pre-existing chronic illnesses were independent risk factors for ICU and hospital mortality.

The decision when to start RRT for acute kidney injury should be guided more by associated dysfunction of other organ systems, urine output and serum pH rather than absolute serum creatinine and/or urea levels.
Late initiation of renal replacement therapy is associated with worse outcomes in acute kidney injury after major abdominal surgery.

Chih-Chung Shiao¹, Vin-Cent Wu², Wen-Yi Li³, Yu-Feng Lin², Fu-Chang Hu⁴, Guang-Huar Young⁵.

Critical Care 2009, 13:R171

![Graph showing the comparison between early and late dialysis with a Log Rank P value of 0.022.](image)
Late initiation of renal replacement therapy is associated with worse outcomes in acute kidney injury after major abdominal surgery
Chih-Chung Shiao¹, Vin-Cent Wu², Wen-Yi Li³, Yu-Feng Lin², Fu-Chang Hu⁴, Guang-Huar Young⁵

Relative risk (RR) for in-hospital mortality using Cox proportional hazards model

<table>
<thead>
<tr>
<th>RIFLE categories</th>
<th>Patient number (%)</th>
<th>RR*</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIFLE - R</td>
<td>29 (29.6)</td>
<td>1.000</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>RIFLE - I</td>
<td>27 (27.6)</td>
<td>2.121</td>
<td>0.913-4.927</td>
<td>0.080</td>
</tr>
<tr>
<td>RIFLE - F</td>
<td>20 (20.4)</td>
<td>3.194</td>
<td>1.262-8.085</td>
<td>0.014</td>
</tr>
</tbody>
</table>

Late initiation of RRT defined by RIFLE-I or RIFLE-F is an independent predictor for in-hospital mortality in the current study. Our findings support early initiation of RRT, and also underscore the importance of predicting prognoses of patients with AKI by using RIFLE classification.
A proposed algorithm for initiation of renal replacement therapy in adult critically ill patients

Sean M Bagshaw¹*, Dinna N Cruz²*, RT Noel Gibney¹ and Claudio Ronco²

Critical Care 2009, 13:317

A summary of absolute or ‘rescue therapy’ indications for initiation of renal replacement therapy in critically ill patients

<table>
<thead>
<tr>
<th>Category</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolic</td>
<td></td>
</tr>
<tr>
<td>Azotemia</td>
<td>Serum urea ≥36 mmol/L (100 mg/dL)</td>
</tr>
<tr>
<td>Uremic complications</td>
<td>Encephalopathy, pericarditis, bleeding</td>
</tr>
<tr>
<td>Hyperkalemia</td>
<td>K+ ≥6 mmol/L and/or electrocardiogram abnormalities</td>
</tr>
<tr>
<td>Hypermagnesemia</td>
<td>≥4 mmol/L and/or anuria/absent deep tendon reflexes</td>
</tr>
<tr>
<td>Acidosis</td>
<td>Serum pH ≤7.15</td>
</tr>
<tr>
<td>Oligo-anuria</td>
<td>Urine output &lt;200 mL/12 h or anuria</td>
</tr>
<tr>
<td>Fluid overload</td>
<td>Diuretic-resistant organ edema (that is, pulmonary edema) in the presence of acute kidney injury</td>
</tr>
</tbody>
</table>
Patient admitted to ICU

Absolute indications?

YES

AKI present?

YES

*Optimize Resuscitation:
- Intravascular volume
- Cardiac output
- Mean arterial pressure
- Intra-abdominal pressure

**Severe AKI?**
- RIFLE-F/ AKIN III or Anuria

Assess:
- AKI severity & trend
- Illness severity & trajectory
- Initial response to above therapy

Consider initiating RRT

NO

Potential non-renal indications?
- Refractory fluid overload
- Refractory septic shock
- Acute liver failure
- Severe tumor lysis syndrome
- Severe electrolyte disturbances
- Dysthermia
- Selected toxins

Consider adjuvant role of RRT

Monitor and reassess clinical status

NO

Any of the following?
- Rapidly worsening AKI
- Rapidly worsening illness severity
- Hypercatabolic state
- Refractory fluid overload
- and/or accumulation
- Severe sepsis
- Permissive Hypercapnea
- Reduced renal reserve
- Low probability for early renal recovery

Mild/Moderate AKI?
- RIFLE-R or -I
- AKIN I or II

YES

YES

YES

NO
Impact of continuous venovenous hemofiltration on organ failure during the early phase of severe sepsis: A randomized controlled trial

Didier Payen, MD, PhD; Joaquim Mateo, MD; Jean Marc Cavaillon, PhD; François Fraisse, MD; Christian Floriot, MD; Eric Vicaud, MD, PhD; for the Hemofiltration and Sepsis Group of the Collège National de Réanimation et de Médecine d’Urgence des Hôpitaux extra-Universitaires

Crit Care Med 2009
Early Use of Polymyxin B Hemoperfusion in Abdominal Septic Shock
The EUPHAS Randomized Controlled Trial

JAMA. 2009.
Summary

- Very interesting techniques in septic patients
- Immuno-modulator effect and homeostasis recovery
- Maximum effect with high volume and fast start
- Some place for plasmapheresis but...
- Adsorption the missing piece?

But:
  - Some technical problems
  - What do we use? (continuous, intermittent, volume, etc...)