MOST: Why does the combination of CRRT with hemoadsorption seem to be a Plus?

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Lyon 1

Atelier Jafron – CAPSO 2021 - Bordeaux

Hôpitaux de Lyon

Conflicts of Interest

Scientific partnership with the following companies:

- Baxter
- BBraun
- Biomérieux
- Estor/Toray
- Exthera
- Fresenius Medical Care
- Infomed
- Jafron
- Medtronic
- Nikkiso

SIX reasons why we will be slowly moving from standard RRT to MOST (Multi Organ Support Therapy)

1) In 2021, It is mandatory that, in your unit, on a regular basis, CRRT is stable, continuous (I mean really continuous!….), and effective.

No excuse anymore!

How to obtain a continuous, stable and predictable session ?

How to obtain a continuous, stable and predictable session ?

1) Good doctors and good nurses (team work +++) who work with protocols made from guidelines

2) Good products (CRRT machine, biocompatible circuit)

3) Good management of circuit anticoagulation

4) Filter Performance optimized over time

5) Good dialysis catheter

Correct management of the « package » (anticoag – mb/FF – catheter)

continuous, stable and predictable CRRT session

Ready to work on a more complex extracorporeal treatment session

IJAO
ISSN 0391-3988

Int J Artif Organs 2017; 40(6): 257-264
DOI: 10.5301/ijao.5000610

REVIEW

Open Access

Continuous renal replacement therapy: forty-year anniversary

Claudio Ronco[1,2]

[1] Department of Nephrology, Dialysis and Transplantation, St. Bortolo Hospital, Vicenza - Italy
[2] International Renal Research Institute of Vicenza (IRRIV), St. Bortolo Hospital, Vicenza - Italy

2) Our patients who need CRRT are most of the time the sickest ICU patients = Patients with MOF

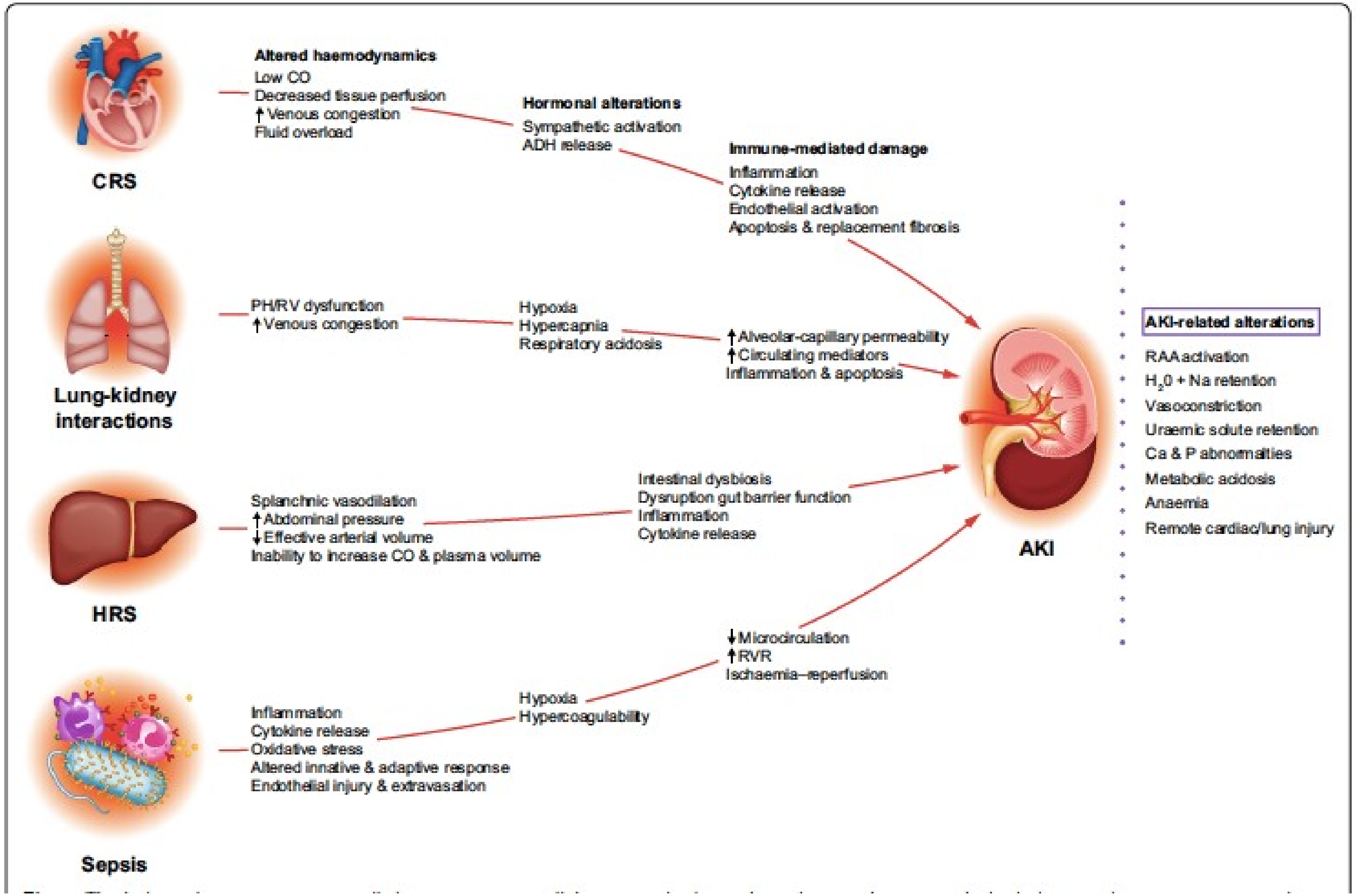
- Renal dysfunction

+

- Respiratory dysfunction
- Hemodynamic dysfunction
- Neurologic dysfunction
- Liver dysfunction

= very poor prognosis

3) Organ Cross-talks



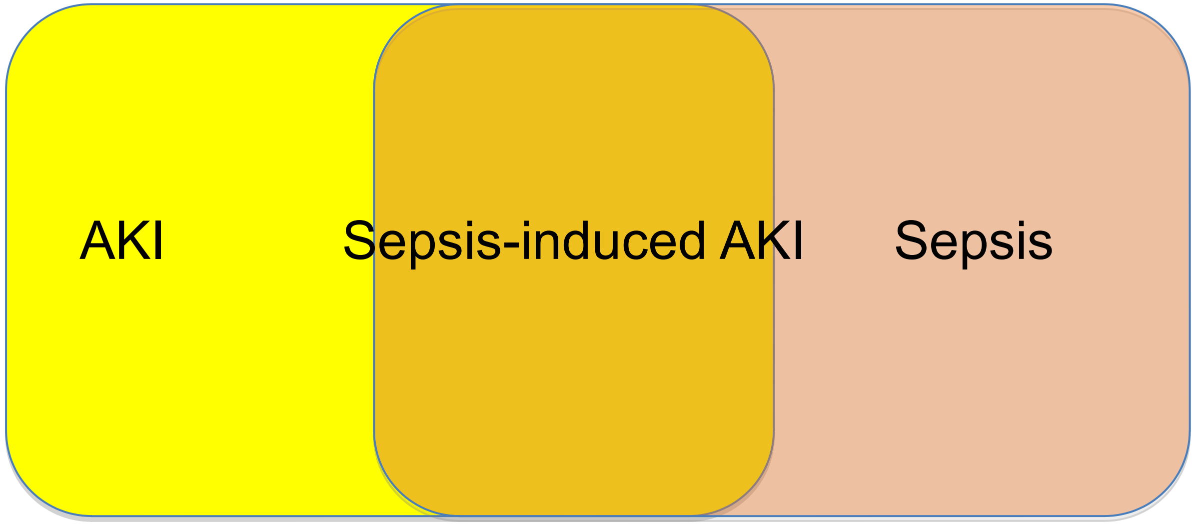
Husain-Syed et al. Intensive Care Med 2018

4)

Approx. 50% of AKI in the ICU are related to sepsis!

Table 2 Variables at the time of acute kidney injury ($n = 666$)

Etiology of AKI	
Sepsis	271 (40.7 %)
Hypovolemia	227 (34.1 %)
Drug related	96 (14.4 %)
Cardiogenic shock	88 (13.2 %)
Hepatorenal syndrome	21 (3.2 %)
Obstruction of the urine outflow tract	9 (1.4 %)
Predisposing factors for AKI	
Diuretic treatment	216 (32.4 %)
NSAID administration	79 (11.9 %)
Aminoglycoside administration	45 (6.8 %)
Glycopeptide administration	9 (1.4 %)
Amphotericin administration	0 (0 %)
Radiocontrast media administration	14 (2.1 %)
Organ dysfunction at time of AKI	
Mechanical ventilation	
Invasive	185 (27.8 %)
Non-invasive	33 (5.0 %)
FiO_2	0.4 (0.3, 0.6)
PaO_2	90 (471, 114)



Hoste et al. Intensive Care Med 2015

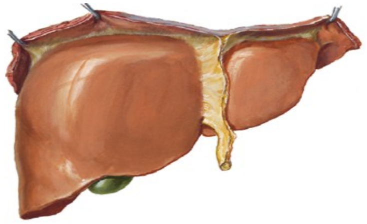
5)

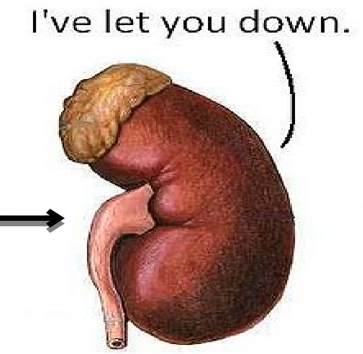
Industry is ready!

Blood purification for sepsis

Burns

« Liver dialysis »



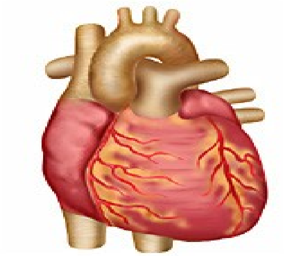


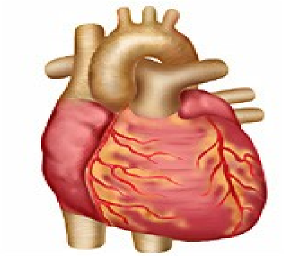
CO2 removal

RRT

SCUF

ECMO





6)

The NEW ENGLAND JOURNAL of MEDICINE

SOUNDING BOARD

2015

Precision Medicine — Personalized, Problematic, and Promising

J. Larry Jameson, M.D., Ph.D., and Dan L. Longo, M.D.

Blood Purification

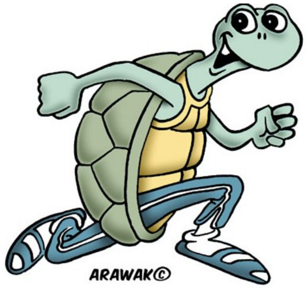
2016

The 17th Acute Disease Quality Initiative International Consensus Conference: Introducing Precision Renal Replacement Therapy

John A. Kellum[a] Claudio Ronco[b]

[a]Center for Critical Care Nephrology, CRISMA, Department of Critical Care Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Pa., USA; [b]Department of Nephrology, Dialysis and Transplantation, International Renal Research Institute of Vicenza, San Bortolo Hospital, Vicenza, Italy

But be careful!



Medical knowledge

Technological progress

Past

Future

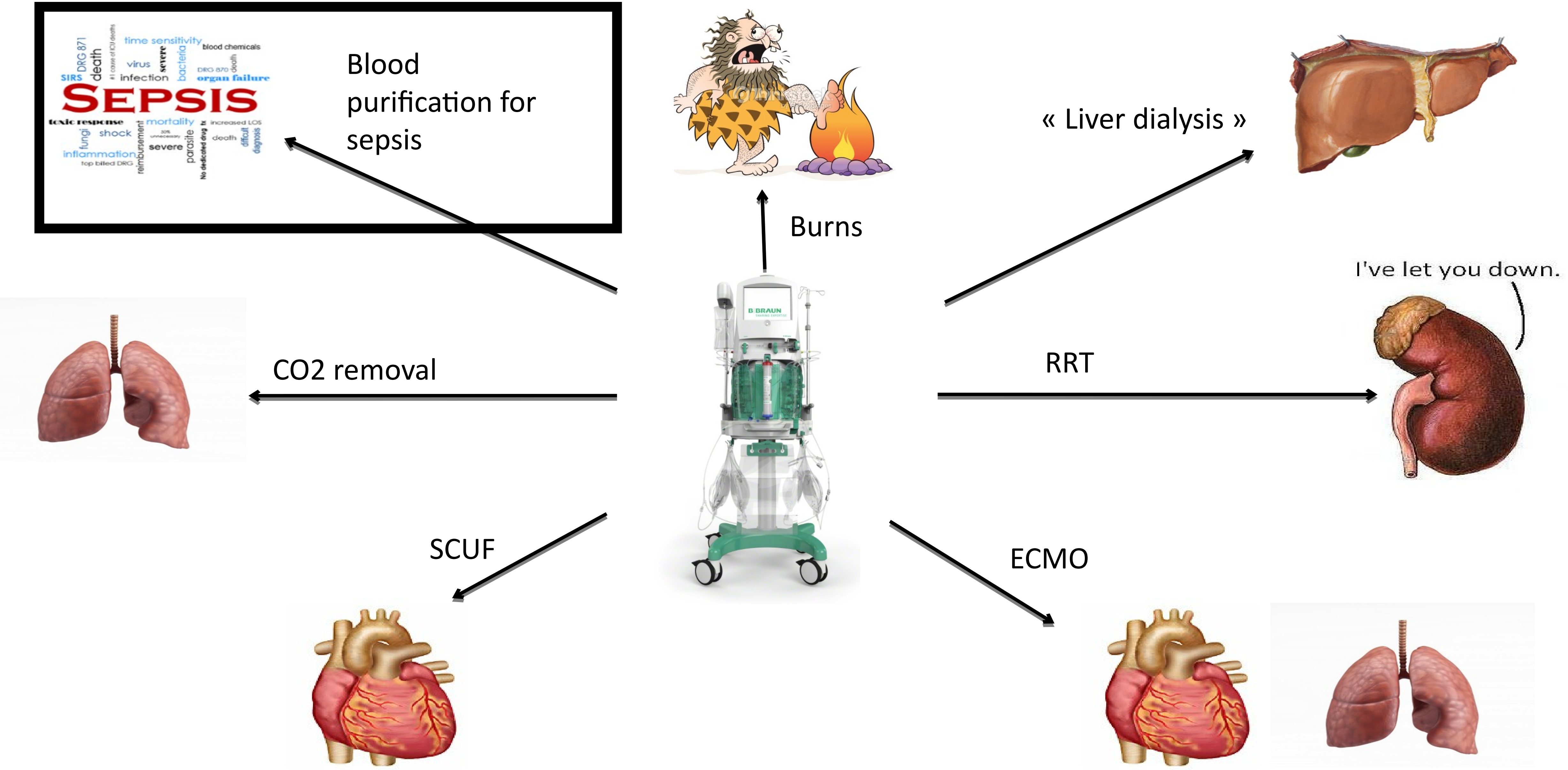
<u>MANY UNANSWERED QUESTIONS :</u>

Which patients exactly?

Which Timing?

How do these therapies exactly work?

What to ultimately remove?


SEPSIS
time sensitivity
death
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organ failure
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inflammation
Blood purification for sepsis
Burns
« Liver dialysis »
I've let you down.
RRT
CO2 removal
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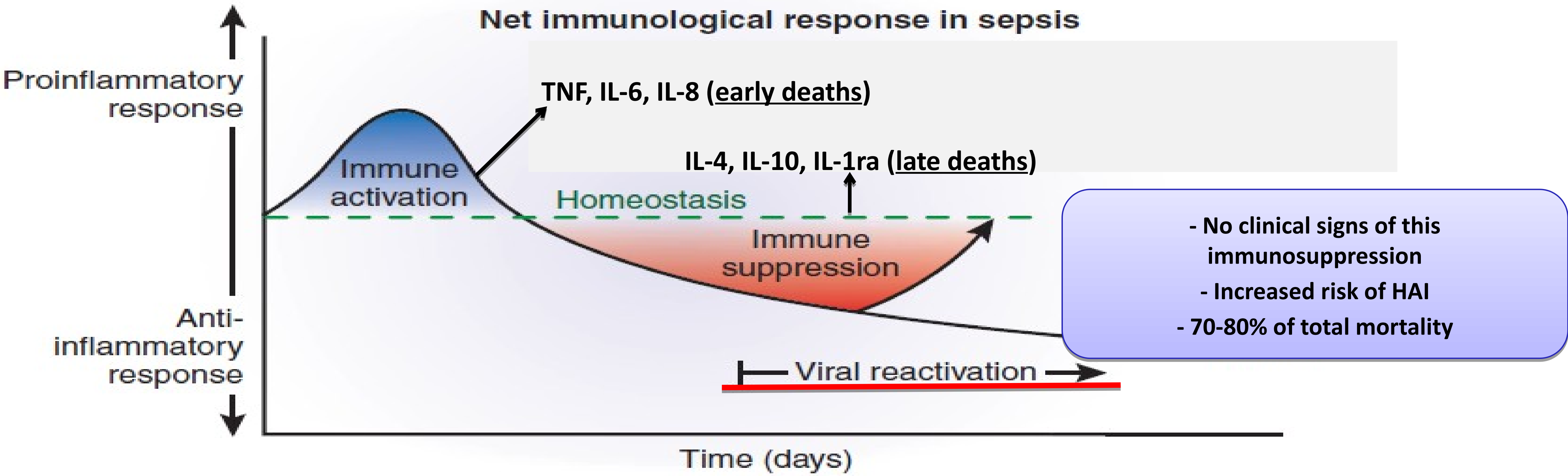
ECMO

Septic shock: Hyperinflammation followed by severe immunosuppression



Hotchkiss et al. Nat Med 2009

EXTRACORPOREAL BLOOD PURIFICATION TECHNIQUES AVAILABLE IN 2021

- High-volume hemofiltration and Cascade hemofiltration

- Plasma exchanges

Now available concomitantly to RRT!

- Coupled Plasma Filtration Adsorption

- Hemoperfusion: PMX-B (Toray), Cytosorb (Cytosorbents), LPS adsorber (Alteco), HA330 (Jafron), HA380 (Jafron)

- New membranes: high adsorptive hemofiltration (oXiris, Baxter) and high cut-off membranes (Emic2, Fresenius Medical Care)

Is hemoperfusion a safe therapy regarding adverse events?

Yes it is a safe therapy!

	Context	Study type	Sample Size	Modality	Adverse Events / Safety Issues
Nemeth 2018	Cardiac Transplantation	Case series	16 (vs 16 controls)	Within CPB Mean = 203 min	No difference in adverse events observed
Friesecke 2017	Sepsis / Cardiac surgery / Others	Observational	198	With CRRT / Within CPB or hemoperfusion Range from 8 to 60.8 hrs hrs	No device-associated side effect
Träger 2016	Cardiac Sx (Endocarditis)	Case series	39 (28 hist. controls)	During CPB Median= 132 min.	No mention of adverse events
Träger 2017	Post-CPB SIRS	Case series	16	With CRRT Range: 5-88 h	No mention of adverse events
Kogelmann 2017	Septic shock	Case series	26	With CRRT	No device-related adverse events during or after the treatment sessions
Friesecke 2017	Septic shock	Case series	20	With CRRT	No serious adverse effects of the therapy were observed

Asgharpour et al. BMC Nephrology (2020) 21:356
https://doi.org/10.1186/s12882-020-02020-3

BMC Nephrology

RESEARCH ARTICLE Open Access

Effectiveness of extracorporeal blood purification (hemoadsorption) in patients with severe coronavirus disease 2019 (COVID-19)

Masoumeh Asgharpour[1], Hamed Mehdinezhad[1], Masoumeh Bayani[2], Mahmoud Sadeghi Haddad Zavareh[2], Seyed Hossein Hamidi[3], Roghayeh Akbari[4], Reza Ghadimi[5], Ali Bijani[5] and Simin Mouodi[5*]

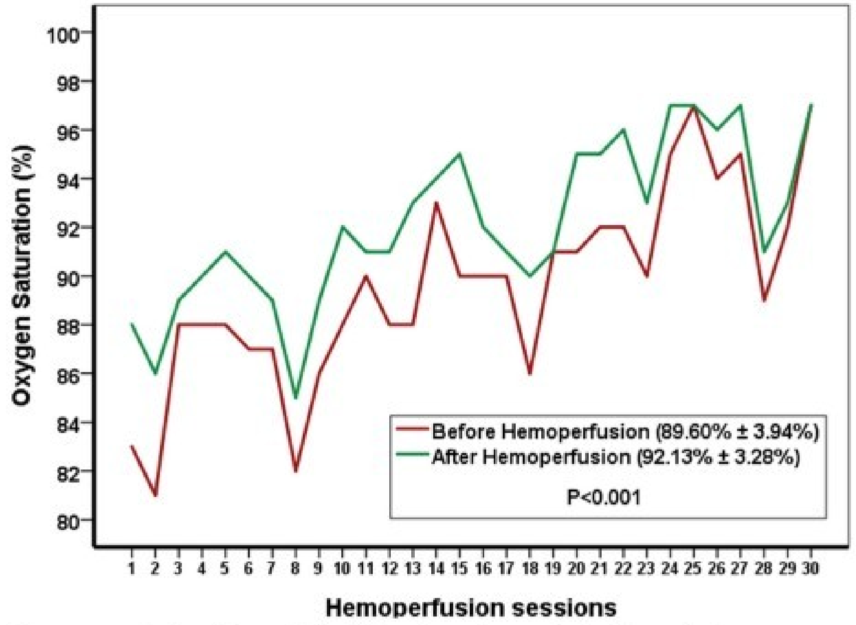


Fig. 2 Peripheral capillary oxygen saturations before and after thirty sessions of hemoperfusion in ten patients

- Critically ill COVID-19 patients
- Babol University of Medical Sciences, IRAN
- Inclusion: patients with no positive clinical improvement after antiviral and antibacterial drugs
- 10 patients underwent 3 sessions of hemoperfusion (cartridges HA-280 and HA-230 - Jafron Biomedical, CHINA) with CVVH (B.Braun)

SpO2 improved (figure)
IL-6: 139 +/- 105. to 72 +/- 65 pg/ml

Asgharpour et al. BMC Nephrol 2020

International Journal of Infectious Diseases 96 (2020) 618–620

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Case Report

Successful recovery of severe COVID-19 with cytokine storm treating with extracorporeal blood purification

Qiang Wang[a], Zhao Hu[b,*]

[a] Department of Nephrology, Qilu Hospital (Qingdao), Cheeloo College of Medicine, Shandong University, Qingdao, China
[b] Department of Nephrology, Qilu Hospital, Cheeloo College of Medicine, Shandong University, Ji'nan 250012, China

A 62-year-old male with severe SARS-CoV-2 infection

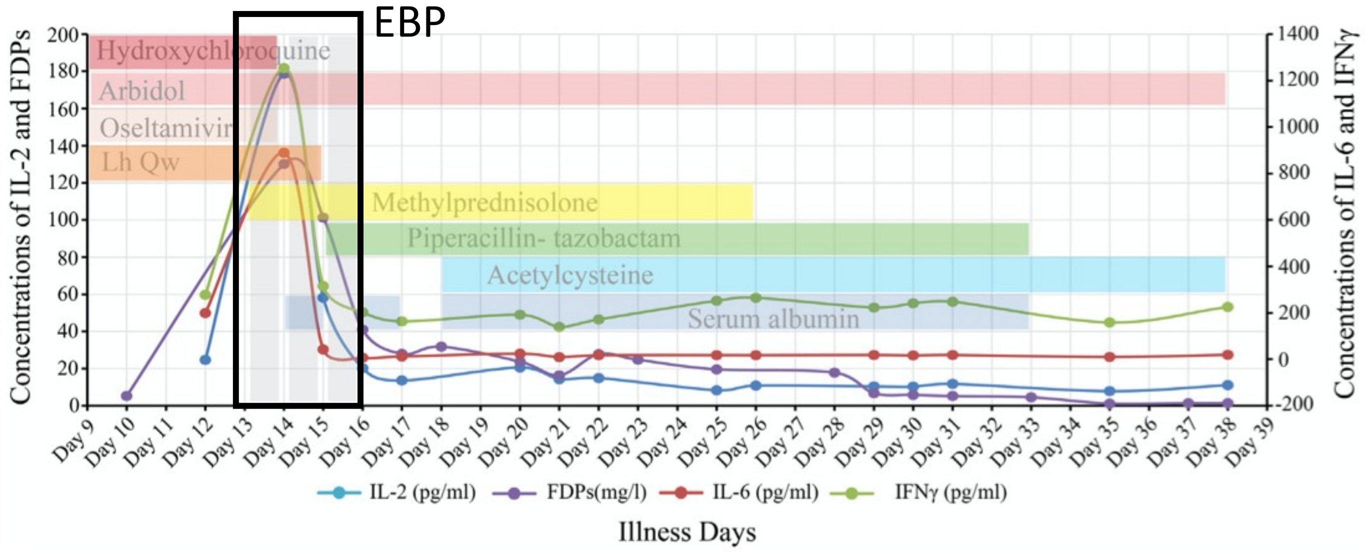


Figure 1. The changes of cytokines and FDPs and the medications applied. The left vertical axis represents the levels of interleukin 2 (IL-2, blue dot) and fibrinogen degradation products (FDPs, purple dot). The right vertical axis represents the levels of interleukin 6 (IL-6, red dot) and interferon γ (INF γ, green dot). The horizontal axis shows the illness days. The gray vertical bar shows the artificial liver therapy. The horizontal bars with different colors represent the medications, and the lengths represent the corresponding duration. Lh Qw denotes the Lianhua Qingwen capsule.

EBP
=
HA 330
+
BS 330
+
Plasma exchanges

Wang et al. Int J Infect Dis 2020

Blood Purification

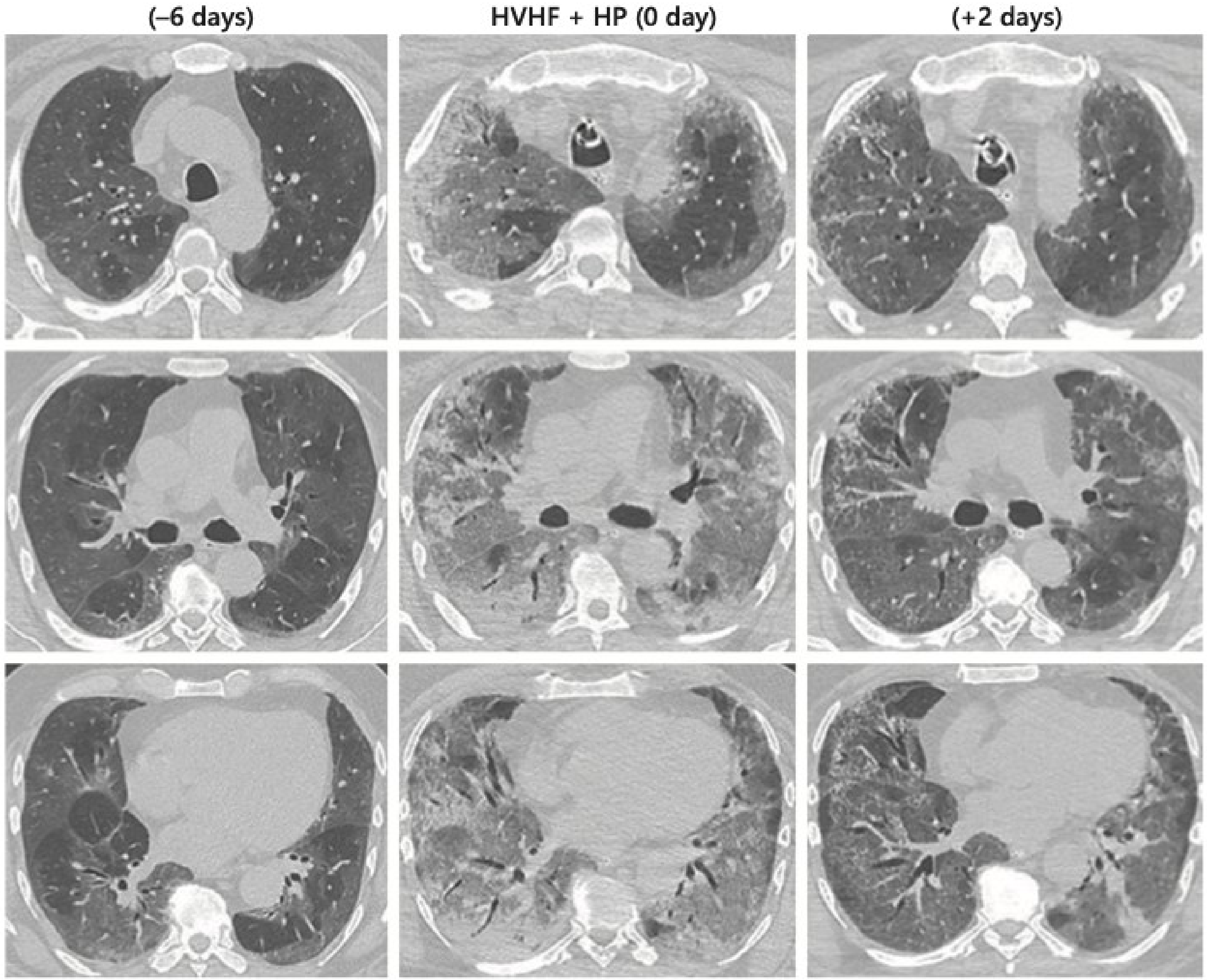
Case Report

Blood Purif
DOI: 10.1159/000512982

Early Cytokine Removal in Critical COVID-19 Patients with Extracorporeal Therapies (HA-380 plus High Volume Hemofiltration) May Prevent Progression of Acute Respiratory Distress Syndrome: Case Report

Gonzalo Ramírez-Guerrero[a, b] Vicente Torres Cifuentes[a, b]
Romyna Baghetti Hernández[a] Francisco Villagrán Cortés[a, b]
Simón Rojas Doll[a] Rocio Oliva Alarcón[a] Cristian Lucero Córdova[a]
Pablo Flores Fernandez[a] Osvaldo Garay Coloma[a]

[a]Critical Care Unit, Carlos Van Buren Hospital, Valparaíso, Chile; [b]Dialysis and Renal Trasplant Unit, Carlos Van Buren Hospital, Valparaíso, Chile



59 year old man
EBP : HP (HA-380, Jafron biomedical) + HVHF 70 ml/kg/h

Ramirez-Guerrero et al. Blood Purif 2020

Journal of Global Antimicrobial Resistance 21 (2020) 340–341

Contents lists available at ScienceDirect

Journal of Global Antimicrobial Resistance

journal homepage: www.elsevier.com/locate/jgar

ELSEVIER

Short communication

Continues renal replacement therapy (CRRT) with disposable hemoperfusion cartridge: A promising option for severe COVID-19

Check for updates

Farzaneh Dastan[a,b], Ali Saffaei[c], Seyed Mehdi Mortazavi[b], Hamidreza Jamaati[b], Nadia Adnani[d], Sasan Samiee Roudi[e], Arda Kiani[f], Atefeh Abedini[b], Seyed MohammadReza Hashemian[b,*]

[a] Department of Clinical Pharmacy, School of Pharmacy, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[b] Chronic Respiratory Diseases Research Center (CRDRC), National Research Institute of Tuberculosis and Lung Diseases (NRITLD), Shahid Beheshti University of Medical Sciences, Tehran, Iran
[c] Student Research Committee, Department of Clinical Pharmacy, School of Pharmacy, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[d] Nephrology Research Center, Department of Nephrology, School of Medicine, Alborz University of Medical Sciences, Karaj, Iran
[e] Infectious Research Center, Department of Infectious Disease, School of Medicine, Iran University of Medical Sciences, Tehran, Iran
[f] Tracheal Diseases Research Center, National Research Institute of Tuberculosis and Lung Diseases (NRITLD), Shahid Beheshti University of Medical Sciences, Tehran, Iran

F. Dastan et al. / Journal of Global Antimicrobial Resistance 21 (2020) 340–341

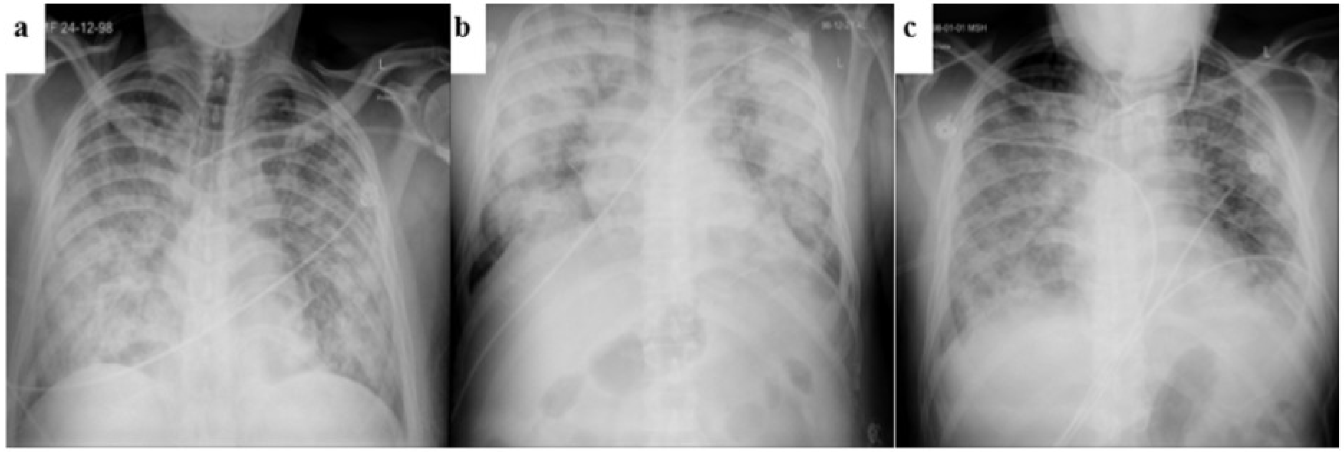


Fig. 1. The chest X-ray of the patient during hospitalization (a; admission time, b; before hemoperfusion, c; after hemoperfusion).

A 54 year old man

EBP: CRRT + HA 380

IL-1: 523 pg/mL to 38 pg/ml

Dastan et al. Journal of Global Antimicrobial Resistance 2020

K. BLOOD PURIFICATION

1. **We make no recommendation regarding the use of blood purification techniques.**

Rationale Blood purification includes various techniques, such as high-volume hemofiltration and hemoadsorption (or hemoperfusion), where sorbents, removing either endotoxin or cytokines, are placed in contact with blood; plasma exchange or plasma filtration, through

because of clotting of the circuit, which raises doubts about CPFA feasibility.

In consideration of all these limitations, our confidence in the evidence is very low either in favor of or against blood purification techniques; therefore, we do not provide a recommendation. Further research is needed to clarify the clinical benefit of blood purification techniques.

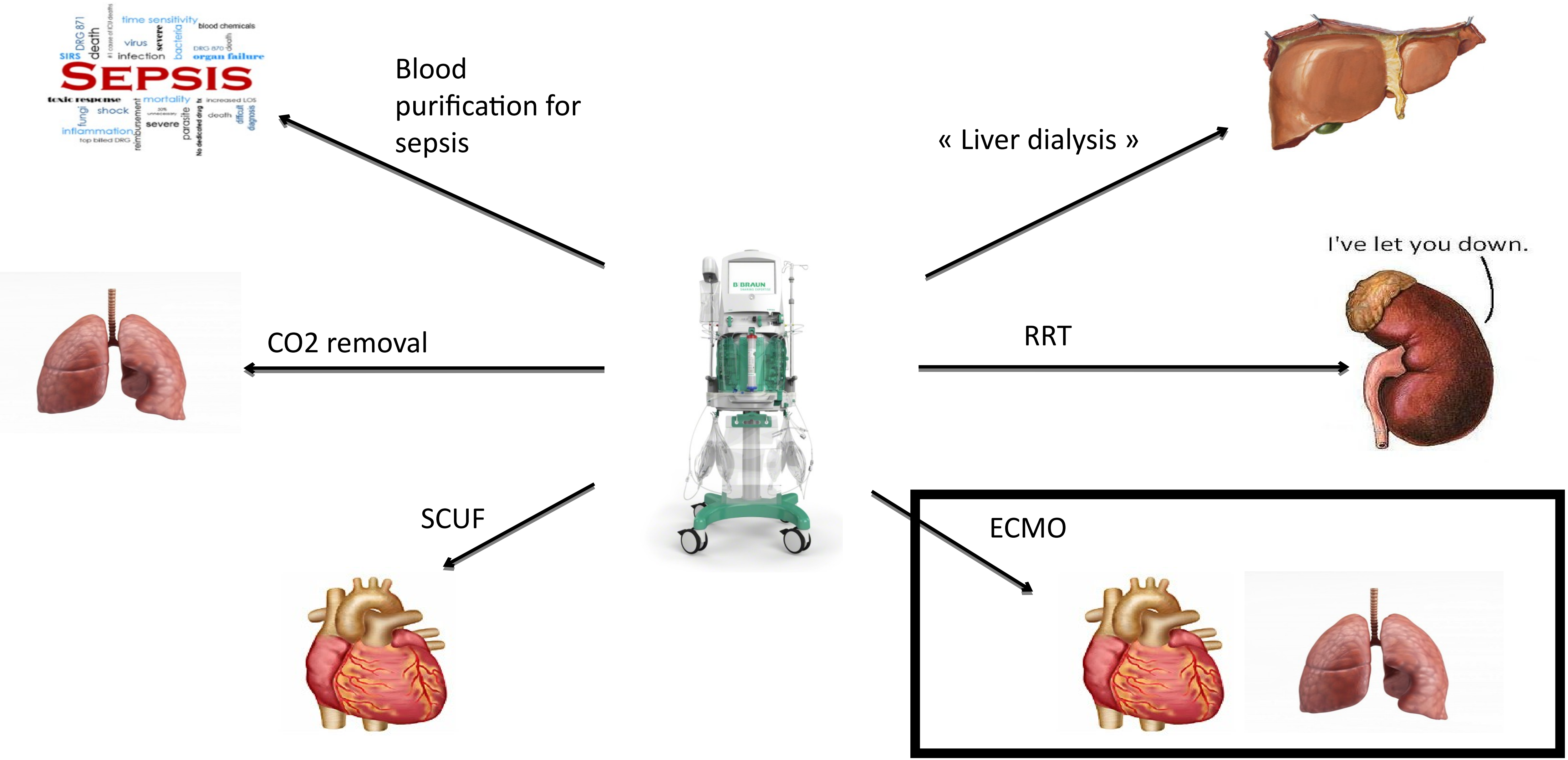
Rhodes et al. *Intensive Care Med* 2017

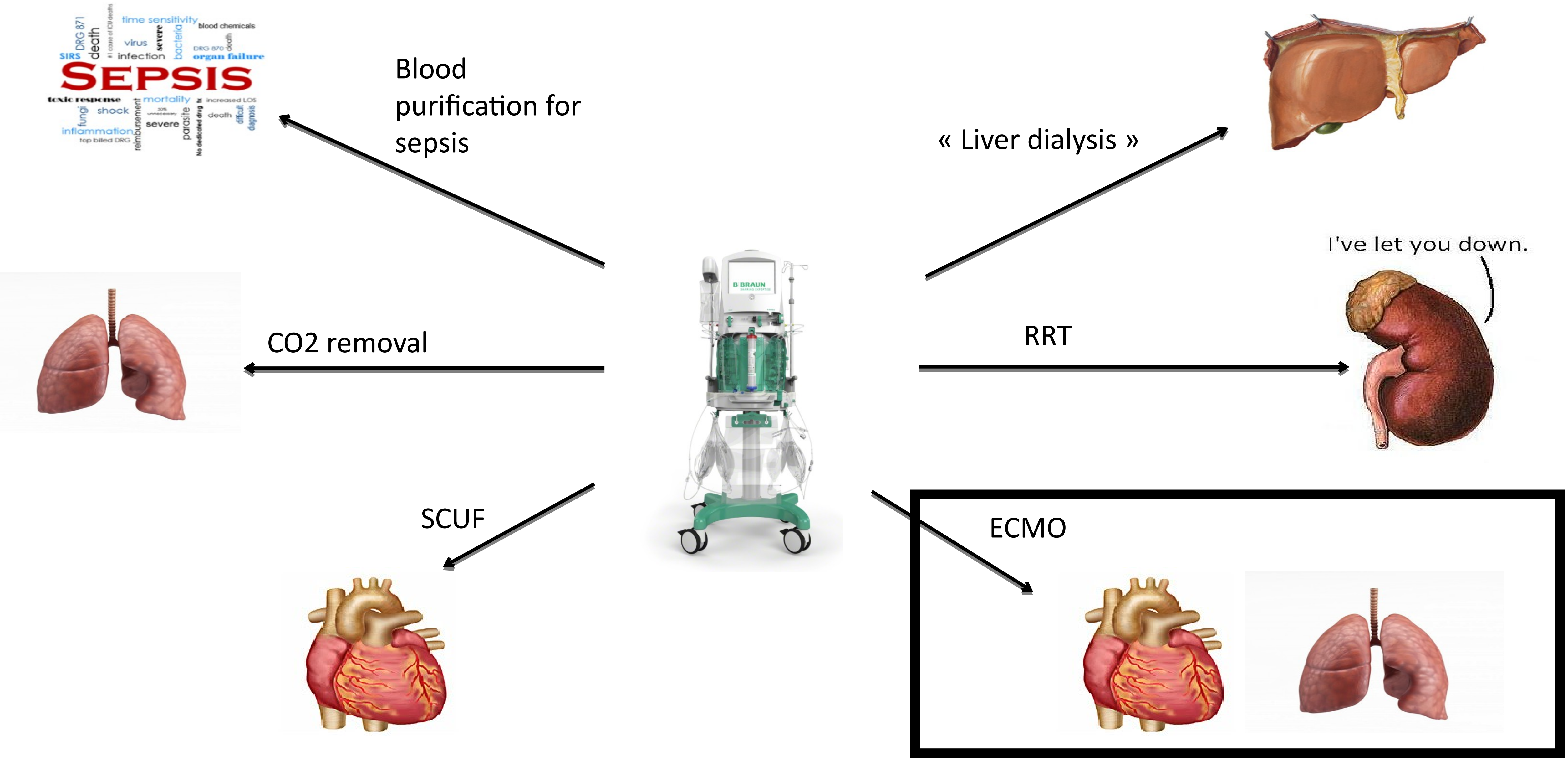
Blood Purification

Recommendations
59. For adults with sepsis or septic shock, we **suggest against** using polymyxin B haemoperfusion *Weak recommendation; low quality of evidence*
60. There is **insufficient evidence to make a recommendation** on the use of other blood purification techniques

Further research is needed to determine the effect of various blood purification techniques on patient outcomes.

Evans et al. *Intensive Care Med* 2021


Blood purification for sepsis
SEPSIS
« Liver dialysis »
CO2 removal
RRT
I've let you down.
SCUF
ECMO
B BRAUN



time sensitivity
blood chemicals
SIRS
death
virus
infection
bacteria
organ failure
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toxic response
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shock
fungi
severe
parasite
inflammation
Blood
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sepsis
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ECMO

Continuous renal replacement therapy during extracorporeal membrane oxygenation: why, when and how?

2018

Marlies Ostermann[a], Michael Connor Jr[b,c], and Kianoush Kashani[d]

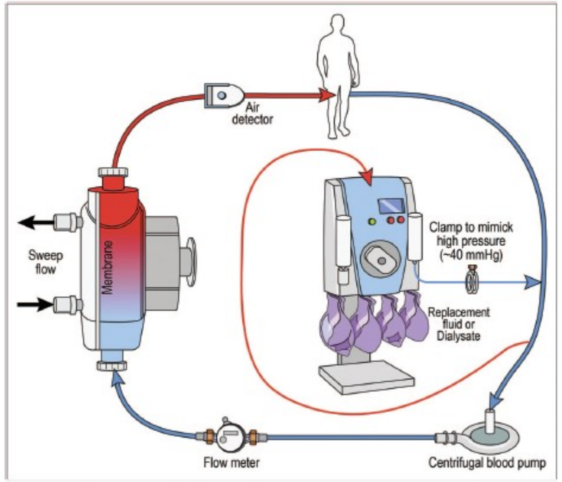


FIGURE 4. Integrated continuous renal replacement therapy venous port – negative pressure. CRRT, continuous renal replacement therapy.

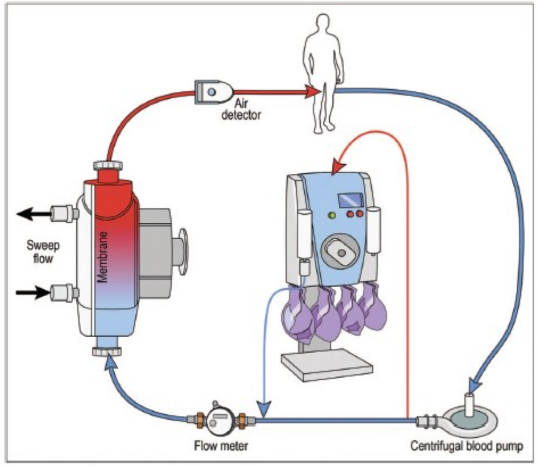


FIGURE 5. Integrated continuous renal replacement therapy venous port – positive pressure. CRRT, continuous renal replacement therapy.

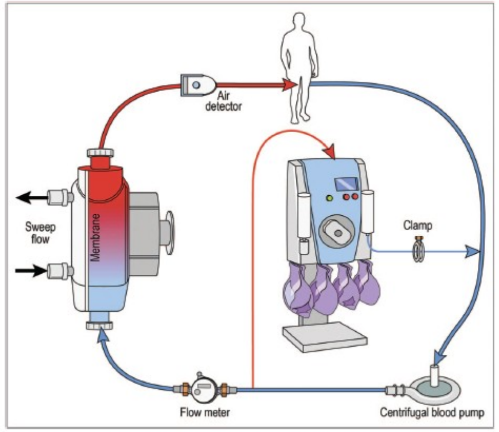


FIGURE 6. Integrated continuous renal replacement therapy hybrid ports. CRRT, continuous renal replacement therapy.

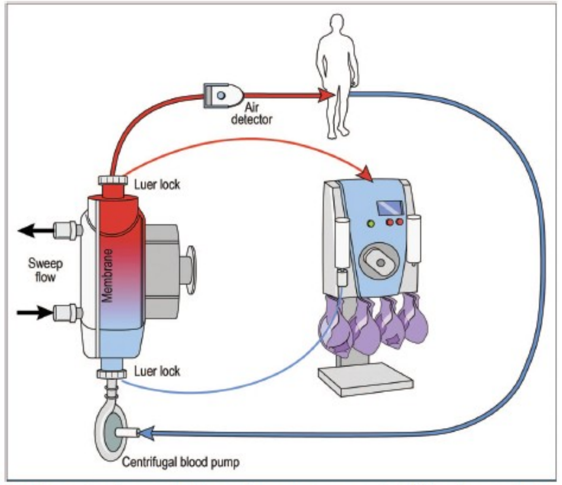


FIGURE 7. Integrated continuous renal replacement therapy oxygenator connection. CRRT, continuous renal replacement

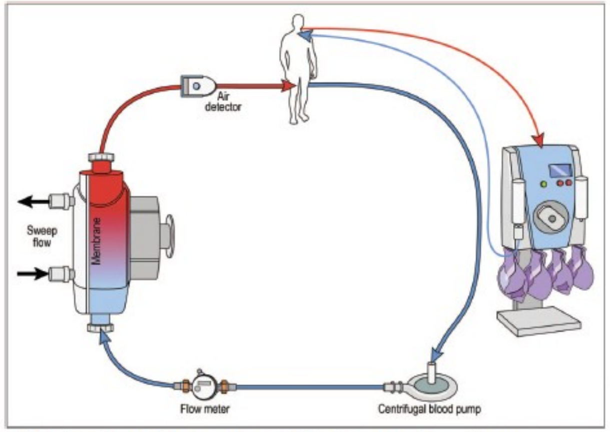


FIGURE 8. Parallel continuous renal replacement therapy. CRRT, continuous renal replacement therapy.

Anaesth Crit Care Pain Med 40 (2021) 100971

2021

Contents lists available at ScienceDirect

Anaesthesia Critical Care & Pain Medicine

journal homepage: www.elsevier.com

Original Article

Renal replacement therapy in extra-corporeal membrane oxygenation patients: A survey of practices and new insights for future studies

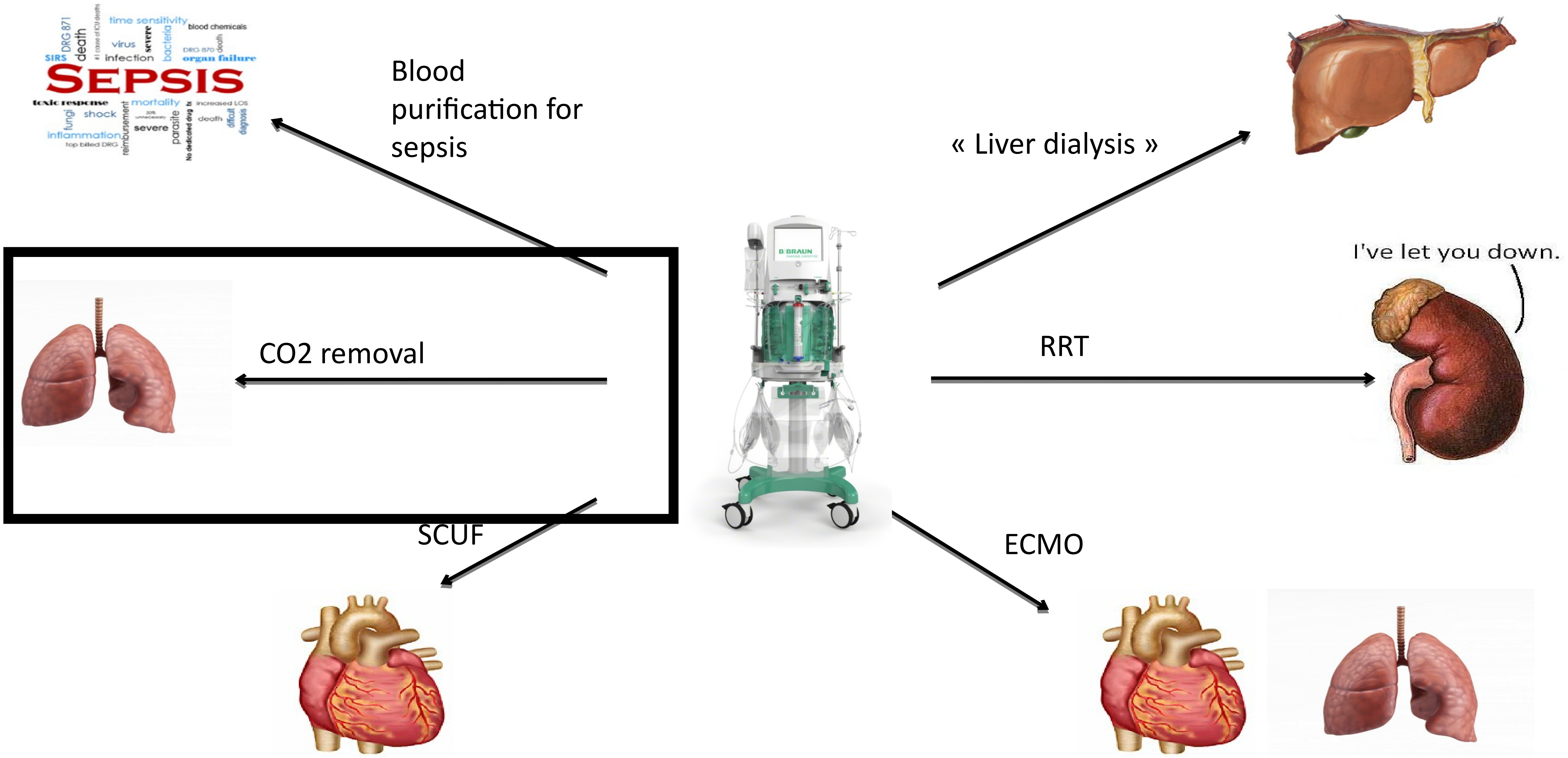
Frank Bidar [a,b,*], Charles-Edouard Luyt [c,d], Antoine Schneider [e], Marlies Ostermann [f], Philippe Mauriat [g], Etienne Javouhey [b,h], Jean-Luc Fellahi [i,j], Thomas Rimmelé [a,b] for the ARCOTHOVA Group

Table 3
Configurations of RRT device connection and pressure alarms encountered.

	VA-ECMO n = 85, respondents	VV-ECMO n = 82, respondents
Configuration of RRT device connection		
Integration of RRT device in the ECMO circuit	34 (40)	36 (43.9)
Connection of RRT device *via* separate vascular access	24 (28)	29 (32.2)
Integration of RRT device in ECMO circuit or connection of RRT device *via* a separate vascular access	27 (32)	17 (18.9)
When RRT is integrated in the ECMO the circuit		

	VA-ECMO n = 61, respondents	VV-ECMO n = 53, respondents
RRT connection modality		
Connection of inlet and outlet line after the ECMO pump (Fig. 1b)	35 (57)	29 (55)
Connection of inlet and outlet line before the ECMO pump (Fig. 1c)	11 (18)	10 (19)
Connection of inlet line after the pump and the outlet line before the ECMO pump (Fig. 1d)	8 (13)	5 (9)
Connection on the ECMO oxygenator (Fig. 1e)	8 (13)	8 (15)
Other	3 (5)	3 (6)

Bidar et al. *Anesth Crit Care Pain Med* 2021



time sensitivity
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death
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infection
DRG 870
organ failure
SEPSIS
toxic response
mortality
increased LOS
shock
fungi
death
severe
parasite
inflammation
reimbursement
difficult diagnosis
top billed DRG
Blood purification for sepsis
« Liver dialysis »
I've let you down.
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RRT
B BRAUN
SCUF
ECMO

■ CRITICAL CARE MEDICINE

Anesthesiology 2009; 111:826–35

Tidal Volume Lower than 6 ml/kg Enhances Lung Protection

Role of Extracorporeal Carbon Dioxide Removal

Pier Paolo Terragni, M.D., Lorenzo Del Sorbo, M.D.,* Luciana Mascia, M.D., Ph.D.,* Rosario Urbino, M.D.,* Erica L. Martin, Ph.D.,* Alberto Birocco, M.D.,† Chiara Faggiano, M.D.,† Michael Quintel, M.D.,‡ Luciano Gattinoni, M.D.,§ V. Marco Ranieri, M.D.‖*

Background: Tidal hyperinflation may occur in patients with acute respiratory distress syndrome who are ventilated with a tidal volume (V_T) of 6 ml/kg of predicted body weight develop a plateau pressure (P_{PLAT}) of $28 \leq P_{PLAT} \leq 30$ cm H_2O. The authors verified whether V_T lower than 6 ml/kg may enhance lung protection and that consequent respiratory acidosis may be managed by extracorporeal carbon dioxide removal.

cytokines concentration ($P < 0.01$) were observed after 72 h of ventilation with V_T lower than 6 ml/kg. No patient-related complications were observed.

Conclusions: V_T lower than 6 ml/Kg enhanced lung protection. Respiratory acidosis consequent to low V_T ventilation was safely and efficiently managed by extracorporeal carbon dioxide removal.

Anesthesiology 2009; 111:699–700

Ventilator-induced Lung Injury

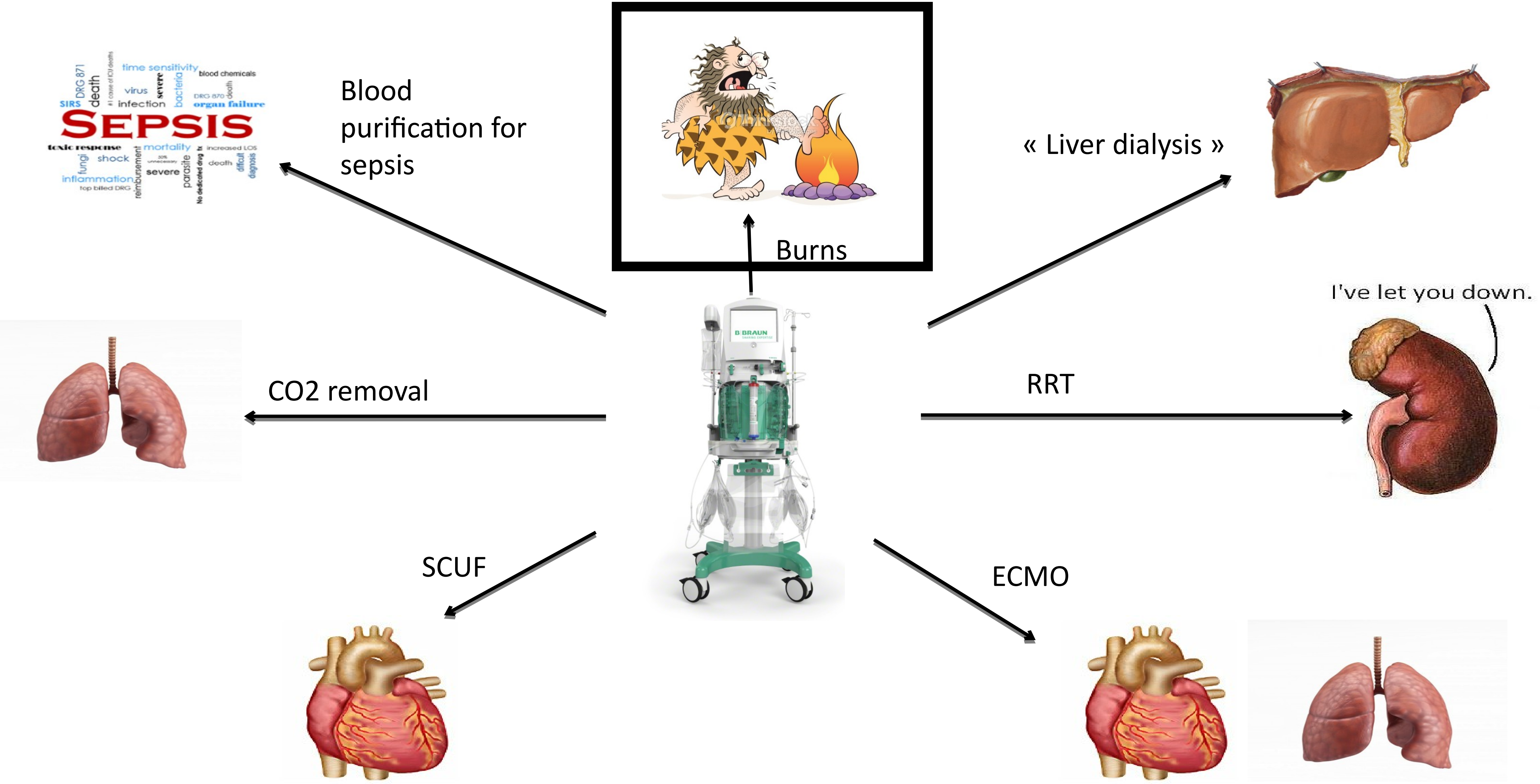
Less Ventilation, Less Injury

THE publication of the seminal article by the Acute Respiratory Distress Syndrome Network (ARDSNet) on ventilation with lower tidal volumes in 2000 has changed the way we ventilate patients with ARDS.[1,2] The use of low tidal volumes was the first therapy ever proven to improve survival of patients who were diagnosed with ARDS. Despite initial reluctance and even open criticism,[3,4] clinicians across the world have embraced this practice,[5] and ventilation with a tidal volume of 6 ml/kg of ideal body weight has become the standard of care for patients with acute lung injury and ARDS of various etiologies.[6,7,8]

Remarkably, evidence is accumulating that ventilation may inflict damage to the injured lung, even with these small tidal volumes. The reason lies in the anatomical inho-

turns out to be between 200 and 250 ml. The consequent increase of the Pa_{CO_2} was predictable, and the authors prospectively planned to remove the excess carbon dioxide through an extracorporeal circuit modified from a standard continuous veno-venous hemofiltration setup. The intervention was safe and produced notable physiologic improvements. As this approach will undoubtedly be investigated further, a number of considerations seem important.

When should carbon dioxide removal be initiated? Growing evidence suggests that hypercapnic acidosis is well tolerated (permissive hypercapnia),[16] and it may even be beneficial. A *post hoc* analysis of the ARDS-Net low tidal volume study suggested that hypercapnic aci-


SEPSIS
Blood
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TRUE STORY: Mr G, a peaceful retired grandpa…

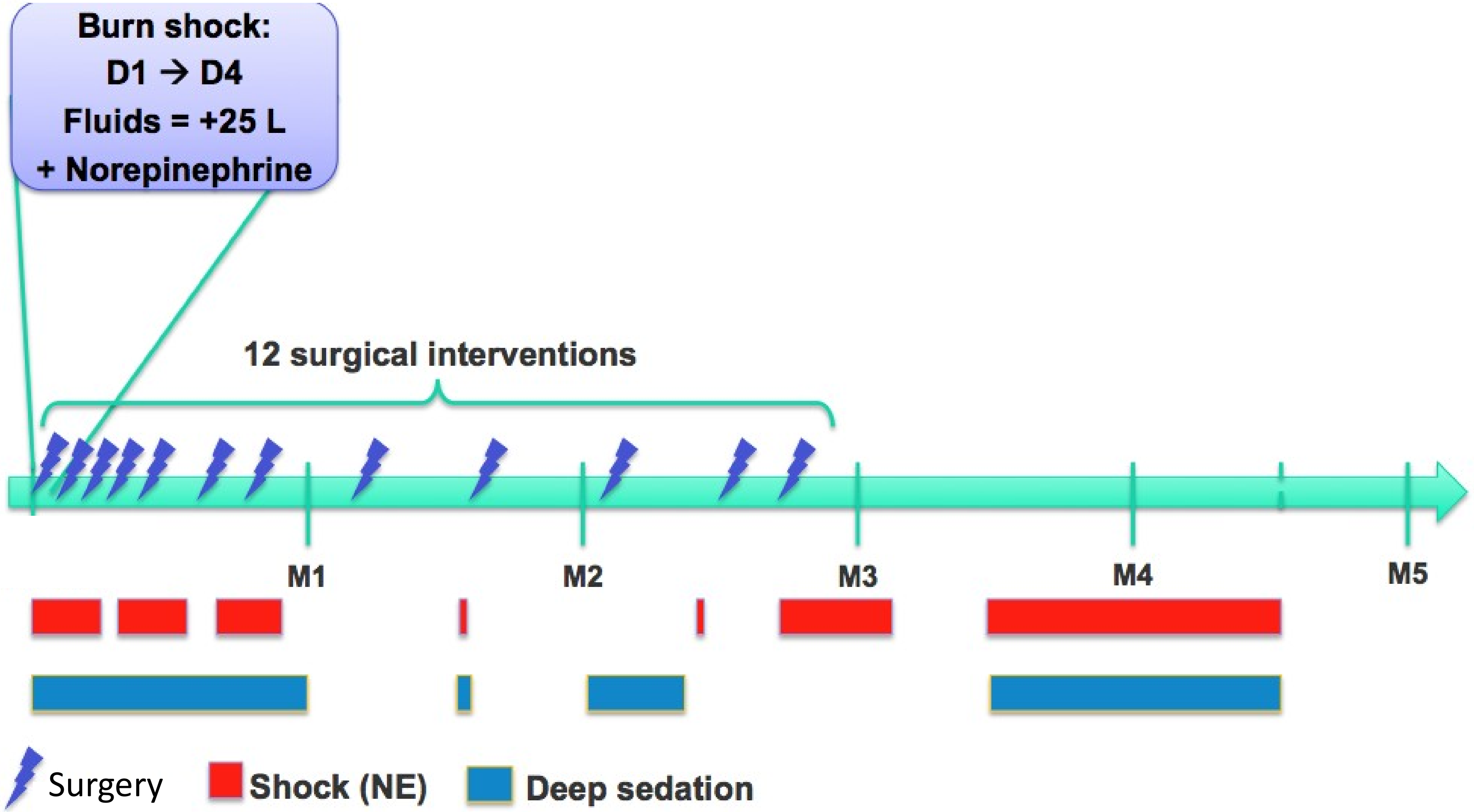
- Man, 68 years old, 1 m 71 – 84 kg

- Past medical history:
  High blood pressure
  Mild Chronic Kidney Disease (stable)

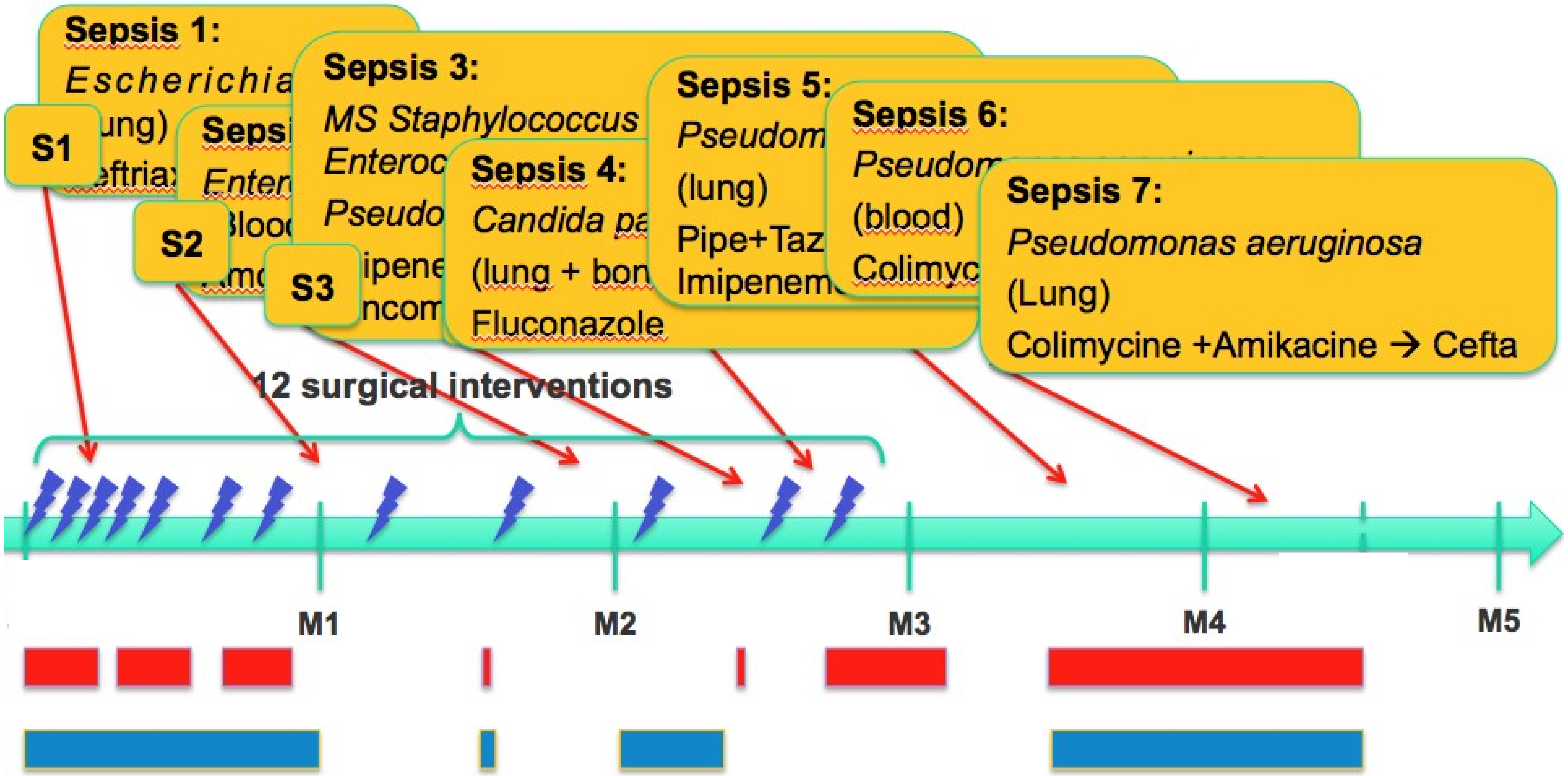
- Admitted to the burn ICU due to:

- **Domestic accident – Fire burn**
  - Total burn surface area = 50% (3rd degree = 45%)
  - Face, back, thorax, upper limbs and both hands

Mr G, a peaceful retired grandpa...



Mr G, a peaceful retired grandpa…



Mr G, a peaceful retired grandpa…

Mr G, a peaceful retired grandpa…

mHLA DR 10 days after admission

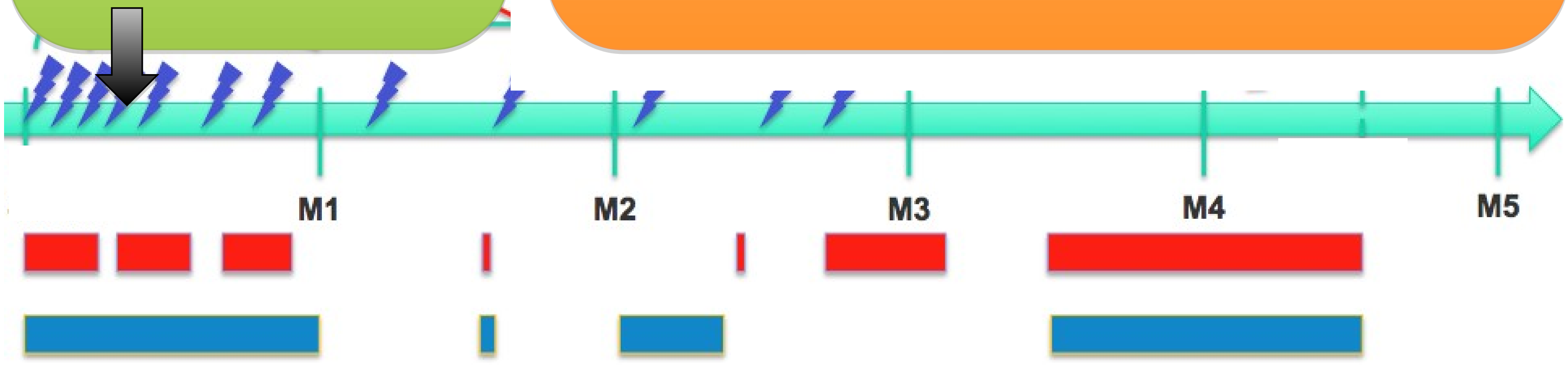
=

2568 AB/C

<u>mHLA-DR : robust maker of immunosuppression</u>

mHLA DR

- > 20 000 AB/C = Normal
- 15 000 to 20 000 AB/C = Grey zone
- 10 000 to 15 000 AB/C = Light immunosuppression
- 5 000 to 10 000 AB/C = Moderate immunosuppression
- < 5 000 AB/C = Severe immunosuppression



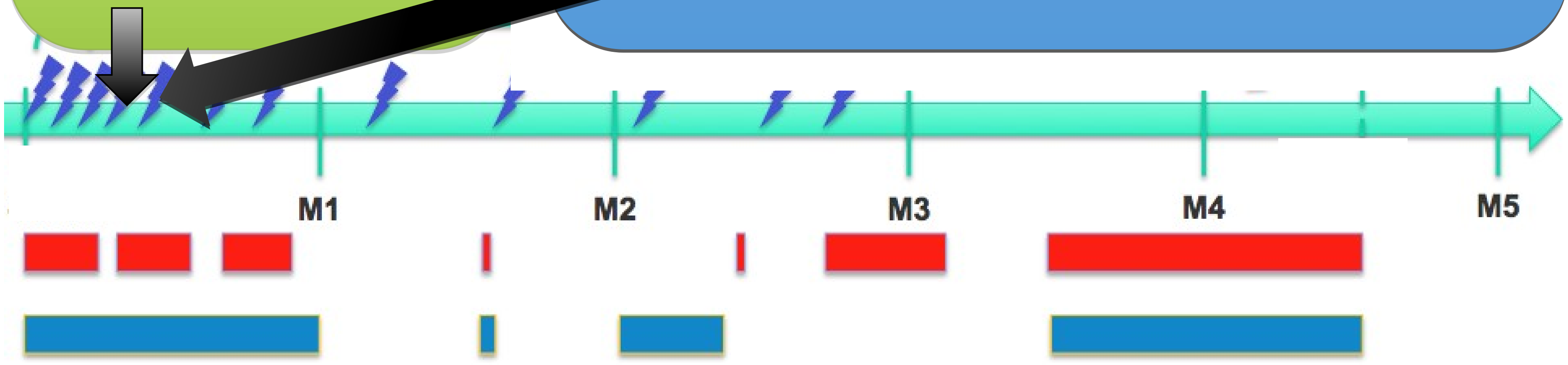
Mr G, a peaceful retired grandpa…

mHLA DR 10 days after admission

=

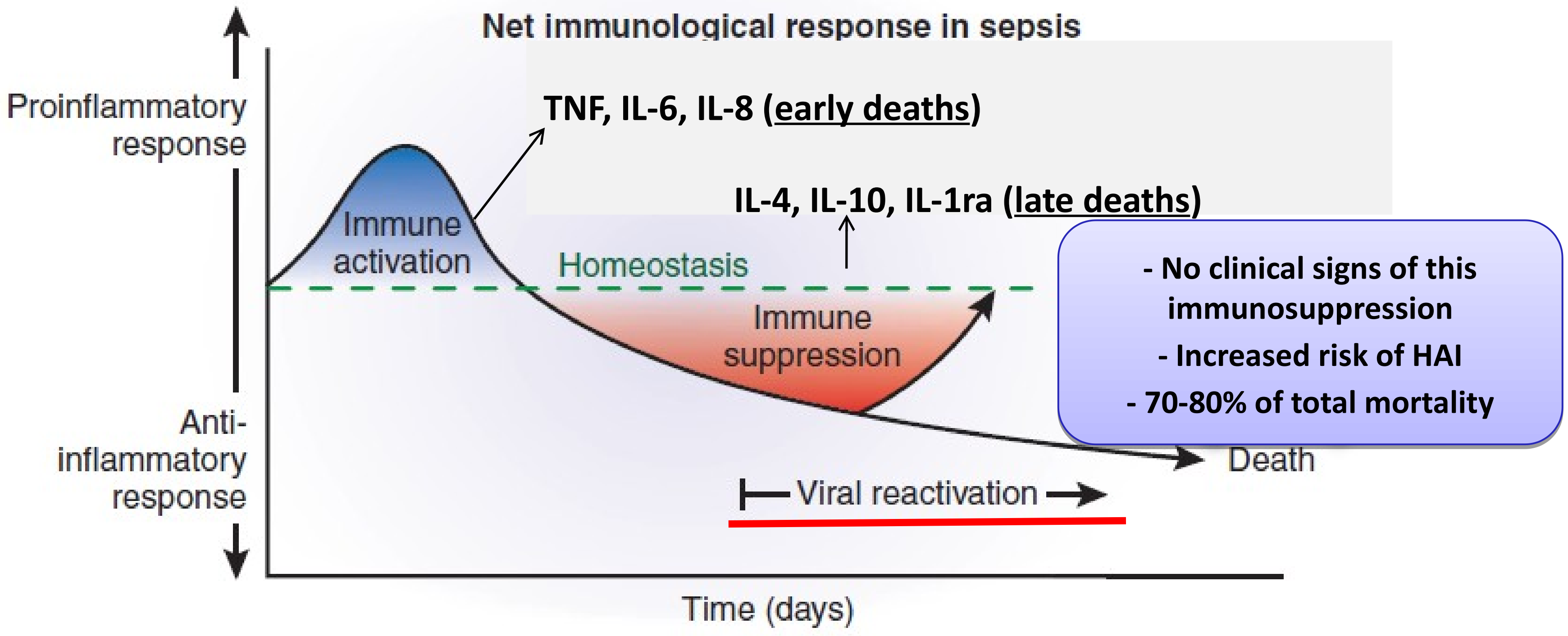
2568 AB/C

Would an early treatment applied within the first days post ICU admission be able to avoid many sepsis, save thousands of dollars/euros and keep the patient alive at the end?



Burns: **a sepsis-like syndrome!**

Hyperinflammation followed by severe immunosuppression



Hotchkiss et al. *Nat Med* 2009

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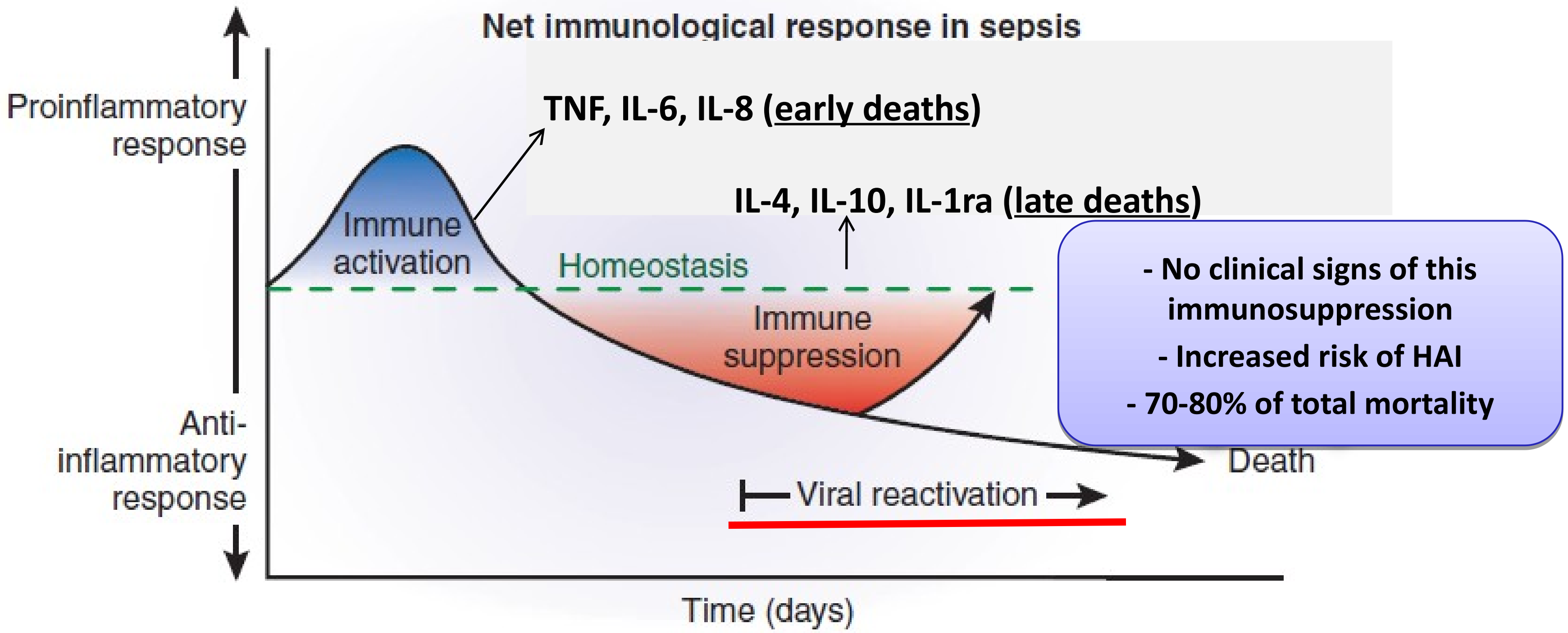

Hotchkiss et al. *Nat Med* 2009

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BURNS

Review

Extracorporeal blood purification in burns: A review

Katharina Linden [a,*], *Ian J. Stewart* [b], *Stefan F.X. Kreyer* [a], *Vittorio Scaravilli* [a], *Jeremy W. Cannon* [b,c], *Leopoldo C. Cancio* [a,d], *Andriy I. Batchinsky* [a], *Kevin K. Chung* [a,c]

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[b] *San Antonio Military Medical Center, Fort Sam Houston, San Antonio, TX 78234, United States*

Table 1 – Examples, technical details, and studies for a selection of membranes designed for cytokine removal.

Name	SepteX® Gambro	oXiris® Gambro	PMMA different Toray membranes	Polymyxin B Toraymyxin®, Toray	CytoSorb® CytoSorbents	CPFA® Bellco
Type	High cutoff membrane	Adsorptive membrane	Adsorptive membrane	Adsorptive membrane	Adsorbing column	Coupled plasma filtration and adsorption
Use	As CRRT in sepsis manufacturer recommends CVVHD; study planned in CVVH	As CRRT in sepsis Use in CVVH or CVVHDF modes	As CRRT In different modes	Sepsis/endotoxemia hemoperfusion	Cytokine hemoperfusion	In multi-organ failure and/or sepsis CPFA
Fibers	Polyarylether-sulfon	Acrylonitril + natrium-methallyl-sulfonat-copolymer + polyethylenimin	Polymethylmetha-crylate	Polymyxin B covalently immobilized; polystyrene derived	Cross-linked divinylbenzene/ polyvinylpyrrolidone beads	Reverse-phase styrenic polymer resin
Surface	1.1 m^2	1.5 m^2	1–2.1 m^2	N/A	850 m^2/g	600–800 m^2/g
Studies/reviews in burn patients	N/A Might play a role in removing myoglobin [2,23]	N/A	Case report [44] reduction of IL-6	Reduction of endotoxin, IL-1ß, IL-6, IL-8, and TNF-α; no different outcomes compared to no treatment [41]	N/A Might be able to remove myoglobin	N/A
Studies/reviews in septic patients	Greater relative decrease of IL-6 than with high-flux membrane [54] Preliminary results of HICOSS no difference in mortality, duration of ICU-stay, need of catecholamines compared to conventional CVVHD membrane [2]	No studies in humans	Removed cytokines effectively and improved hemodynamics (CHDF mode) [43]	EUPHAS: improved hemodynamics, organ dysfunction, 28-day mortality in intra-abdominal Gram-negative infections [38]	CytoSorb's European Sepsis Trial: reduction in IL-6, MCP-1, IL-1ra and IL-8. No IL-10, 28-day, and 60-day mortality reduction. No removal of endotoxin [51]	Improved hemodynamics (CPFA + HD) compared to CVVHDF; may restore leukocyte responsiveness [58]

Linden et al. *Burns* 2014

Burn pigs

- **15 pigs with 40% total body surface area deep burn (9 Hemoadsorption vs 6 in sham group)**

- **6-hour HA session or sham session at day 1 day 2 and day 3**

- **Significant removal of IL 1b, IL 6, IL 10 et myoglobine by the device but no significant systemic or pulmonary reductions**

SHOCK, Vol. 44, No. 5, pp. 487–495, 2015

EVALUATION OF THE CYTOSORB[TM] HEMOADSORPTIVE COLUMN IN A PIG MODEL OF SEVERE SMOKE AND BURN INJURY

Katharina Linden,[*§] Vittorio Scaravilli,[*¶] Stefan F.X. Kreyer,[*||] Slava M. Belenkiy,[*] Ian J. Stewart,[‡] Kevin K. Chung,[*†] Leopoldo C. Cancio,[*†] and Andriy I. Batchinsky[*]

(Looking for centers interested in participating in a multicenter study on hemoperfusion in burn patients)

Linden et al. *Shock* 2015

Systematic Review and Meta-Analysis

Medicine®

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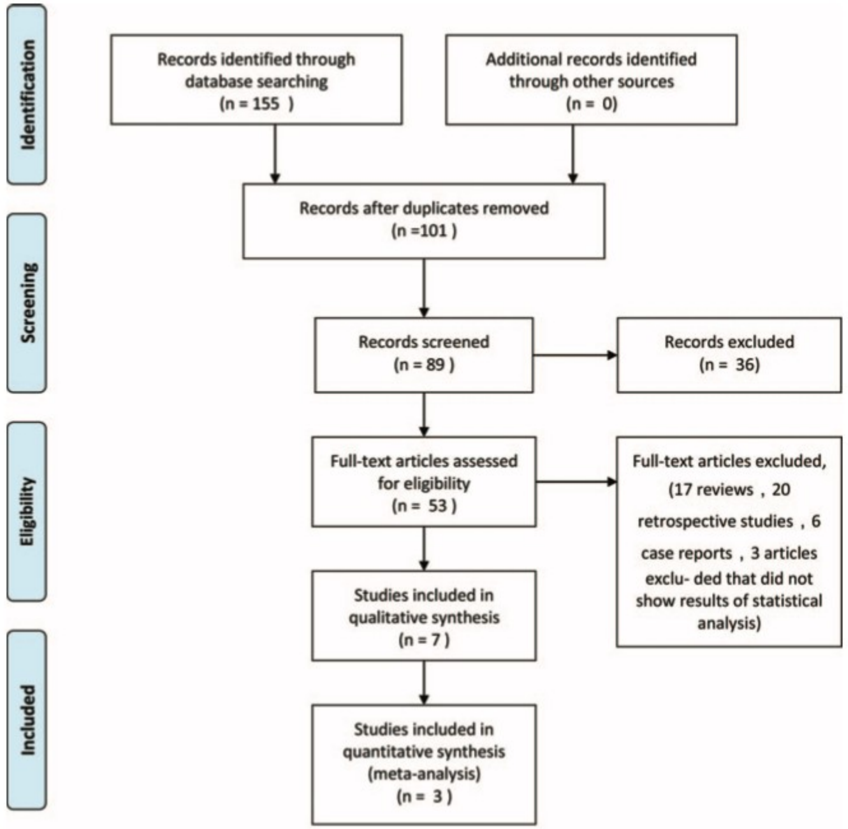
Efficacy and safety of blood purification in the treatment of deep burns

A systematic review and meta-analysis

Gaofei Zhang, MM[a], Wenjun Liu, MD, PhD[b,*], Jiamei Li, MM[b], Di Wang, MM[b], Jianxing Duan, MM[b], Hanxiao Luo, MM[b]



3.3.3. Safety (vital signs and routine blood laboratory results). Three studies concluded that blood purification treatment for severe burns had no adverse effect on patient vital signs and was safe and feasible [7,9,11]. No systemic adverse events were observed.

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Chung, K,2009	11	29	20	28	23.5%	0.53 [0.32, 0.89]
Chung, K.2017	5	23	5	14	7.2%	0.61 [0.21, 1.73]
Liu, F, 2016	7	20	9	21	10.2%	0.82 [0.38, 1.77]
Lyu, T, 2018	3	43	11	43	12.7%	0.27 [0.08, 0.91]
You, B, 2018	9	41	13	41	15.0%	0.69 [0.33, 1.44]
Zu, H, 2015	20	98	27	97	31.4%	0.73 [0.44, 1.22]
Total (95% CI)		**254**		**244**	**100.0%**	**0.62 [0.47, 0.82]**
Total events	55		85			

Heterogeneity: Chi² = 3.12, df = 5 (P = 0.68); I² = 0%
Test for overall effect: Z = 3.31 (P = 0.0009)

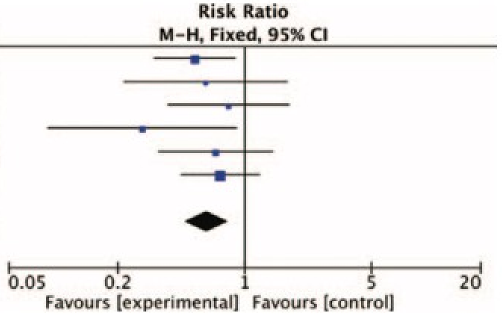


Figure 3. Meta-analysis of 28-day mortality in both groups.

Zhang et al. *Medicine* 2021

CONCLUSION

1) MOST: New concept facilitating organ support management

2) Therapies are under scientific investigation

3) Interesting for precision, individualised medicine in the ICU

4) Strong rationale to deeply assess these extracorporeal therapies

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