Pratiques satellites de la CEC

DU Circulation Extra-Corporelle en chirurgie cardiaque et en suppléances d'organes

08/01/2026

Gaspard Cadier , Service d'Anesthésie-Réanimation GH Sud

Conflit d' intérêt

- Aucun

Plan

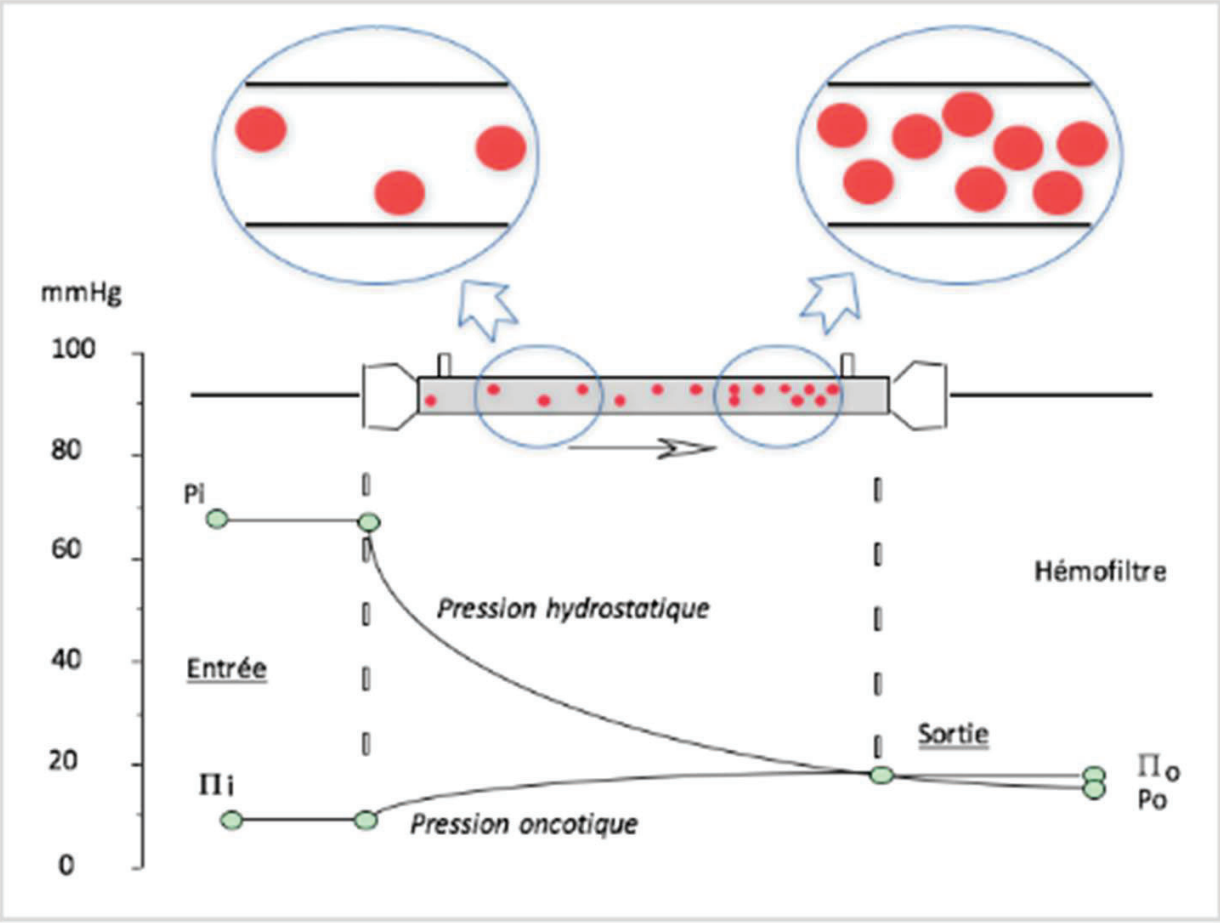
- Hémofiltration per CEC
- Adsorption per CEC
- Adjonction de CO_2 per CEC

Hémofiltration

Principe

- Principe de convection, le plasma sanguin est filtré à travers une membrane semi-perméable grâce à une différence de pression transmembranaire.
- Les solutés de taille inférieure aux pores de la membrane (électrolytes, cytokines…) sont ainsi éliminés avec l'eau plasmatique, tandis que les cellules sanguines et les protéines de grande taille, sont retenues par la membrane.

Principe



D. Journois in vivo CRRT

Principe

- Élimination de l'eau, des électrolytes et des petites molécules fonction:

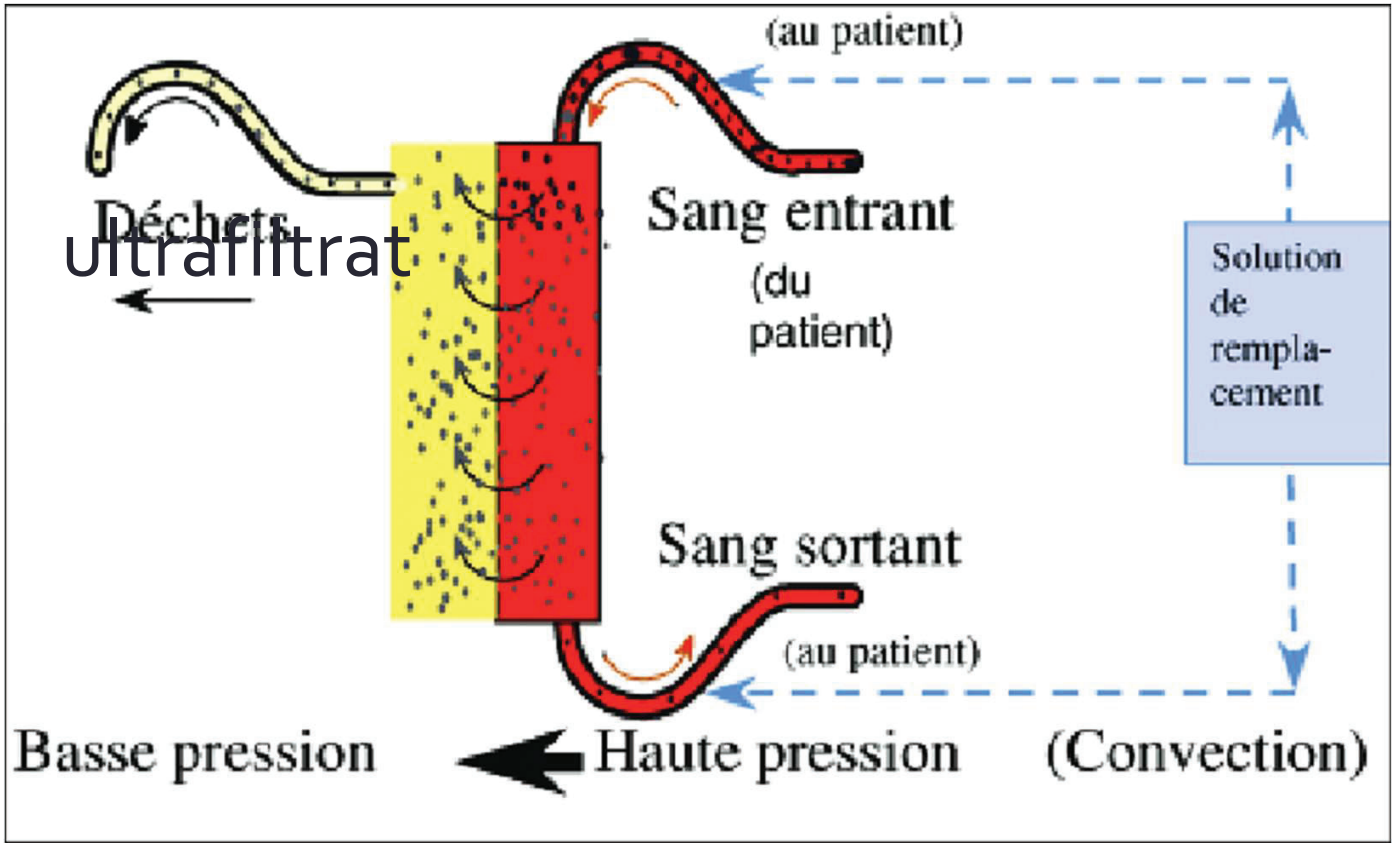
-1)Pression hydrostatique (En pratique la pression hydrostatique dépendra principalement du débit sanguin que l'on appliquera)

-2)taille des pores=point de coupure (poids moléculaire < 30-50 k Daltons)

- Quantité de volume ainsi éliminé est nommé: « UF » pour UltraFiltrat

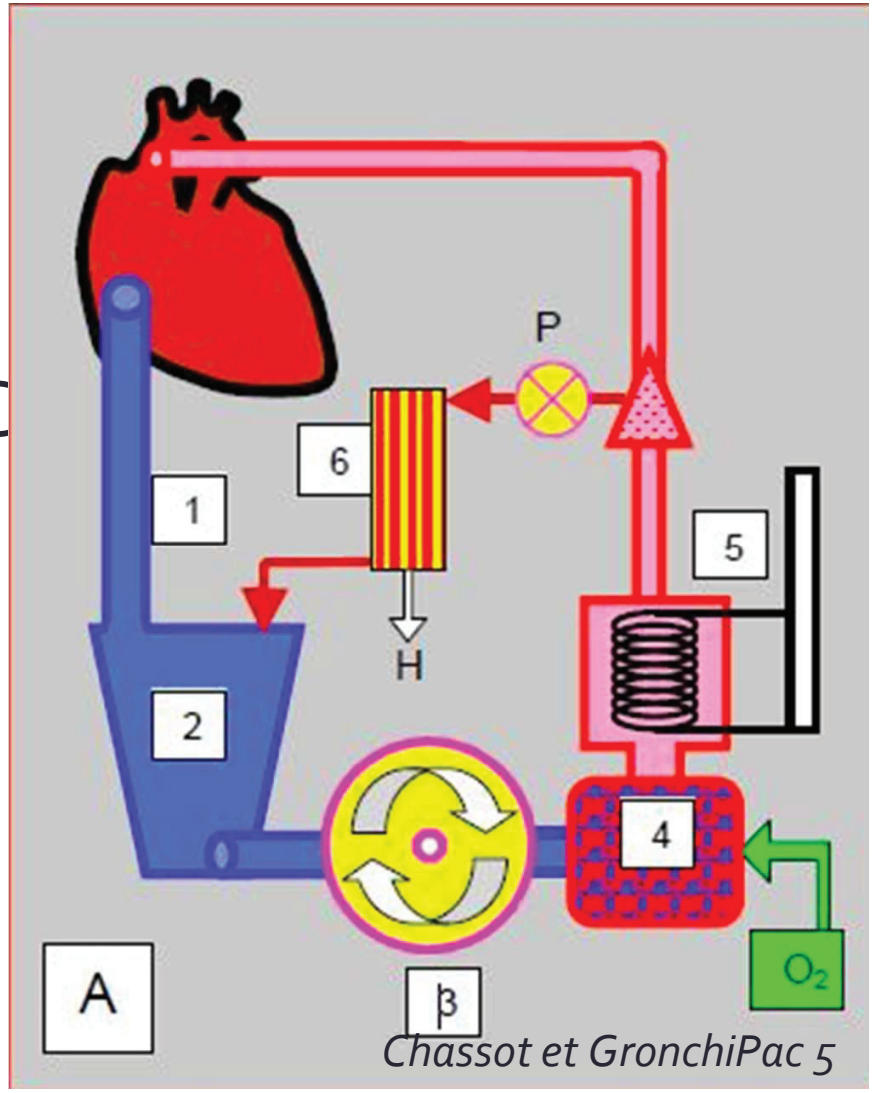
Principe

- Branchement du filtre sur pompe dédiée qui alimente ce dernier en sang



A) Hémofiltration conventionnelle

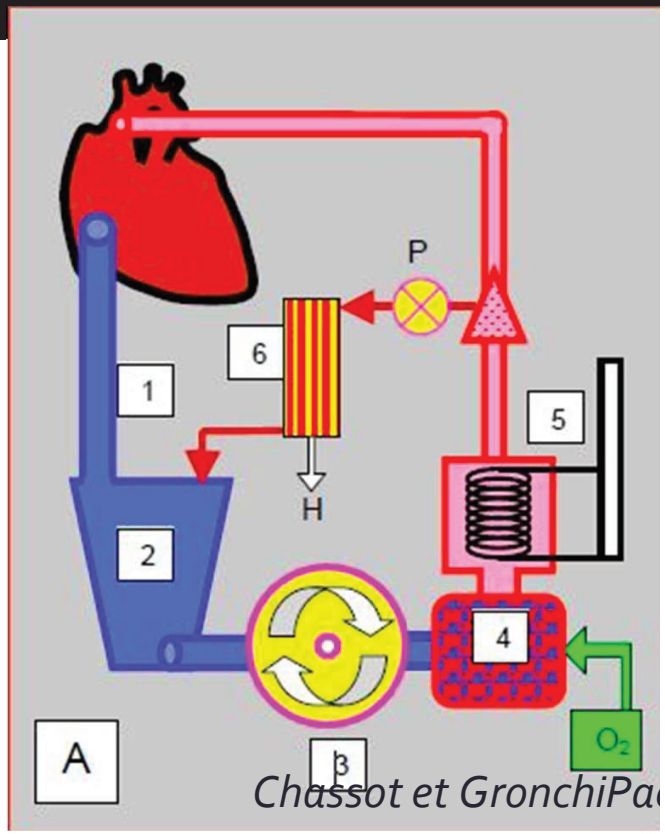
-Per CEC
-Perte d'eau et électrolytes
-hémoconcentration perCEC
-Perte de poids



Chassot et GronchiPac 5

A')Hémofiltration « balance Zéro »

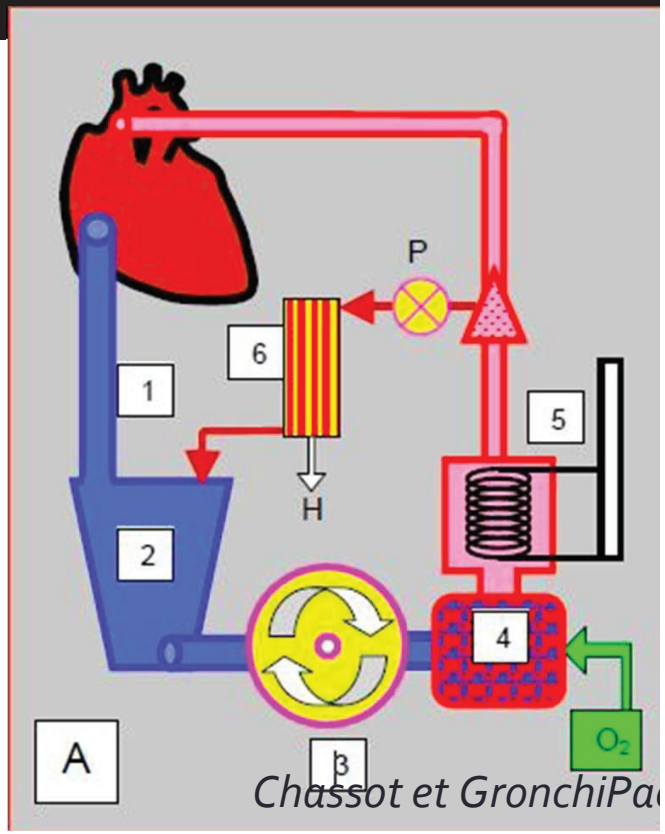
-Per CEC
-Perte d'eau et electrolytes
-Compensée par ajout d'un soluté cristalloïde (ou autre)



Chassot et GronchiPa

A')Hémofiltration « balance Zéro »

-Per CEC
-Perte d'eau et electrolytes
-Compensée par ajout d'un Soluté cristalloide
-épuration de hauts volumes
-Pas d' hémoconcentration
-Pas de perte de poids
-« Renouvellement » plasma « débarrassé » de petites molécules potentiellement délétère.

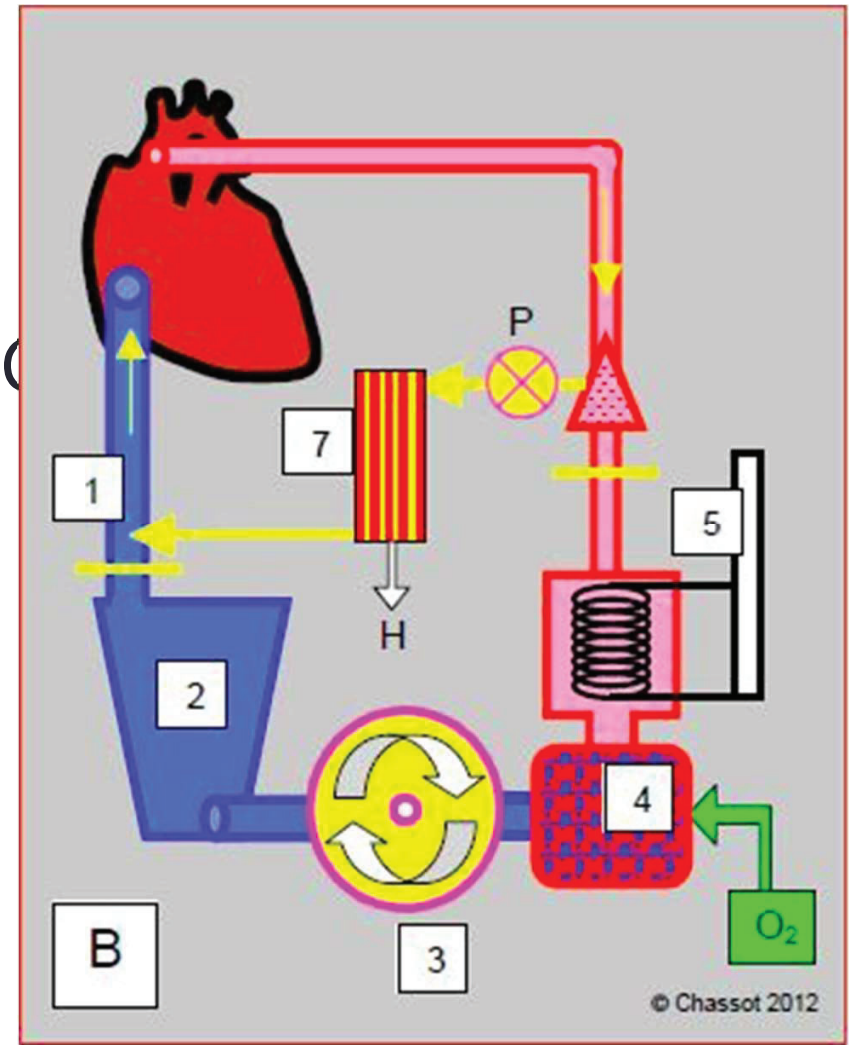


Chassot et GronchiPa

B) Hémofiltration modifiée (MUF)

-En fin de CEC
-Perte d'eau et electrolytes
-hémoconcentration post CEC
-débit sang 150mL/min

-stratégie diurétique/ d'hémoconcentration de fin de CEC



17. Groom RC, Akl BF, Albus RA, et al. Alternative method of ultrafiltration after cardiopulmonary bypass. *Ann Thorac Surg*. 1994;58:573–574.

Indications hémofiltration

- Evidentes: Surcharge volémique avec hémodilution et oedème interstitiel (souffrance multi organe), désordre électrolytique ou élimination d'un toxique hémofiltrable (taille et liaison protéiques)

- Supposée: Bénéfice à l'élimination de molécules pro inflammatoires (majeures parties des cytokines pro inf ont un poids moléculaire< point de coupure)

Littérature hémofiltration

A) Hémofiltration conventionnelle

2011 Update to The Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists Blood Conservation Clinical Practice Guidelines[*]*

Conventional ultrafiltration is a method of ultrafiltration used during CPB. One meta-analysis [347], four randomized trials [348, 349, 350, 351], and two cohort studies [352, 353] report the use of conventional ultrafiltration in patients undergoing cardiac procedures using CPB. Subgroup analysis of five studies included in the meta-analysis by Boodhwani [347] demonstrated no advantage in terms of red cell usage or blood loss with conventional ultrafiltration alone [349, 350, 351, 352, 353].

- Pas d'avantage en terme de transfusion

A) Hémofiltration conventionnelle

Ann Card Anaesth. 2016 Jan-Mar;19(1):45-51. doi: 10.4103/0971-9784.173019.

Conventional hemofiltration during cardiopulmonary bypass increases the serum lactate level in adult cardiac surgery.

Soliman R[1], Fouad E, Belghith M, Abdelmageed T.

-Etude observationnelle, CEC prog, hypothermie modérée
-138 patient avec HF VS 145 sans (pts similaires)
-HF après départ en CEC pour obj Ht entre 25 et 30%
-instabilité hémodynamique et hyperlactatémie en per et au sevrage de la CEC dans le groupe HF…

In the present study, the hemofiltration during CPB lead to hemoconcentration, increased HCT, decreased blood transfusion and resulted in hypotension due to hypovolemia during CPB, impaired tissue perfusion, decreased oxygen supply and the result was an elevation of serum lactate level. On the other side, Group C patients without hemofiltration during CPB, there was hemodilution that improved tissue perfusion, oxygenation and decreased level of serum lactate. The central VO_2 and urine output decreased greatly in patients with hemofiltration. The type of prime solutions was the same in both groups and was mainly Ringer's lactate. There was one study showed that infusion of Ringer's lactate does not affect the accuracy of lactate measurement,[19] and other study showed the occurrence of metabolic alkalosis due to metabolism of lactate to bicarbonate and the lactate act as a base and cannot cause acidosis.[20,21]

In the present study, there was hypotension during hemofiltration and the perfusionist had to give phenylephrine to maintain the mean arterial blood pressure in Group H as a result of hypovolemia during hemofiltration and these findings were documented by other studies.

Table 1: Preoperative data of patients

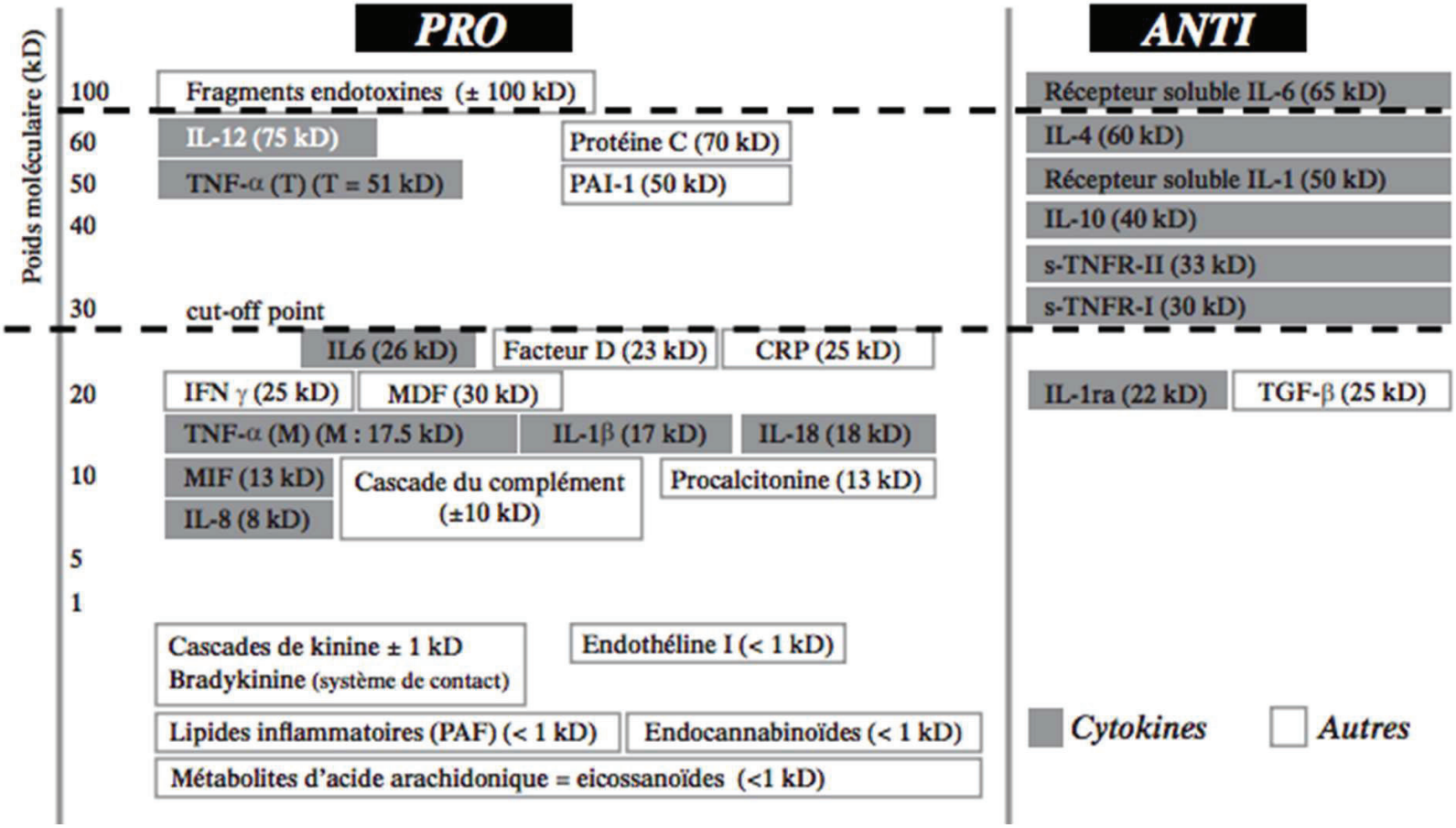
A') Hémofiltration « balance zero »

2011 Update to The Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists Blood Conservation Clinical Practice Guidelines[*]*

With ZBUF, the ultrafiltrate fluid is replaced with an equal volume of balanced electrolyte solution during CPB. Patients may benefit from ZBUF through the removal of mediators and products of systemic inflammatory response syndrome, rather than as a result of fluid removal [356]. Randomized controlled trials investigating ZBUF in adult cardiac procedures did not demonstrate a reduction in blood loss or transfusion with the application of ZBUF [357, 358].

- Pas d'avantage en terme de transfusion

A') Hémofiltration « balance zero »



Silvester W. Mediator removal with CRRT (continuous renal replacement therapy): complement and cytokines. Am J Kid- ney Dis 1997;30(Suppl 4):S38-43.

A') Hémofil

Am J Respir Crit Care Med. 2015 Nov 15;192(10

**Early High-Volume Hemofil
HEROICS Study.**

Combes A[1], Bréchot N[1], Amour J[2], Cozic N
A[12], Trouillet JL[1], Mallet A[3], Chastre J[1], Lep

-HVHF (80 ml/kg/h maximum of 8 L/h) VS Standard
-224 patients

Time since ICU admission, h	12.9 (11.7)	12.7 (11.8)
Patients on ECMO	47 (42%)	52 (46%)
Patients on IABP	19 (17%)	15 (13%)
Patients on IABP or ECMO	58 (52%)	60 (54%)
SAPS II	54.0 (12.3)	55.1 (12.3)
SOFA score	11.5 (2.8)	12.0 (2.9)
Glasgow coma score	13.5 (3.0)	13.2 (3.4)
Systolic blood pressure, mm Hg	113 (24)	109 (25)
Diastolic blood pressure, mm Hg	63 (14)	62 (14)
Mean blood pressure, mm Hg	79 (14)	77 (14)
Heart rate, beats/min	94 (18)	94 (16)
Epinephrine dose, μg/kg/min	0.23 (0.39)	0.27 (0.46)
Norepinephrine dose, μg/kg/min	0.23 (0.45)	0.32 (0.70)
Inotropic score‡	45.6 (53.9)	59.1 (80.7)
Creatinine, μmol/L	148 (81)	162 (77)
Blood urea nitrogen, mmol/L	11.1 (6.7)	12.0 (5.6)
Urine output, ml		
<500	36 (31)	46 (41)
500–999	35 (32)	26 (23)
>1,000	41 (37)	40 (36)
Lactate, mmol/L	5.0 (3.9)	4.8 (3.8)
Bicarbonate, mmol/L	19.5 (4.9)	19.1 (3.8)

A') Hé

Am J Respir Crit Care Med. 2

Early High-Volun HEROICS Study.

Combes A[1], Bréchot N[1], Ar A[12], Trouillet JL[1], Mallet A[3]

Variable	Early HVHF (*n* = 112)	Standard Care (*n* = 112)	Odds Ratio (95% CI)	*P* Value
Mortality				
Day 30	40 (36%)	40 (36%)	1.00 (0.58–1.73)	1.00
Day 60	48 (43%)	42 (38%)	1.25 (0.73–2.05)	0.82
Day 90	51 (46%)	43 (38%)	1.34 (0.79–2.28)	0.28
ICU	49 (44%)	44 (39%)	1.20 (0.71–2.05)	0.50
In-hospital	50 (45%)	44 (39%)	1.25 (0.73–2.12)	0.42
ICU length of stay, d				
For ICU survivors	13 [7–25]	13 [8–29]	—	0.78
For patients who died in the ICU	11 [2–21]	6 [2–14]	—	0.15
Hospital length of stay, d				
For survivors	37 [22–54]	29 [20–49]	—	0.31
For patients who died in-hospital	11 [2–22]	6 [2–14]	—	0.12
Day 1–60 ICU-free days	21 [0–48]	22 [0–48]	—	0.66
Day 1–60 hospital-free days	0 [0–24]	0 [0–31]	—	0.75
Days with catecholamines	5 [3–9]	5 [3–9]	—	0.50
Day 1–30 catecholamine-free	3 [0–10]	3 [0–8]	—	0.64

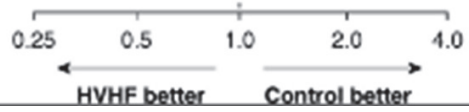
A') Hémo

Am J Respir Crit Care Med. 2015 Nov

Early High-Volume He
HEROICS Study.

Combes A[1], Bréchot N[1], Amour J[2], A[12], Trouillet JL[1], Mallet A[3], Chastre

Prespecified subgroup	Early HVHF (*n* = 112)	Standard Care (*n* = 112)	Odds Ratio (95% CI)
	No of deaths/no of patients (%)		
Sex			
Male	30/88 (34.1)	28/89 (31.5)	1.13 (0.60–2.11)
Female	10/24 (41.6)	12/23 (52.2)	0.65 (0.21–2.07)
NYHA class = 4			
Yes	20/59 (33.9)	20/54 (37.0)	0.87 (0.40–1.89)
No	19/53 (35.8)	20/58 (34.5)	1.09 (0.50–2.39)
Euroscore >10			
Yes	24/56 (42.9)	25/54 (46.3)	1.15 (0.50–2.62)
No	16/56 (28.6)	15/58 (25.9)	0.87 (0.41–1.85)
Heart transplant			
Yes	4/23 (17.4)	4/28 (14.3)	1.26 (0.29–5.72)
No	36/89 (40.5)	36/84 (42.9)	0.91 (0.50–1.66)
CPB duration >120 min			
Yes	21/28 (43.8)	22/55 (40.0)	1.17 (0.53–2.56)
No	19/64 (29.7)	18/57 (31.6)	0.91 (0.42–1.98)
SOFA >12			
Yes	17/37 (45.9)	22/49 (44.9)	1.04 (0.44–2.46)
No	23/75 (30.7)	18/63 (28.6)	1.11 (0.53–2.31)
Serum lactate >4 mmol/l			
Yes	21/38 (55.3)	18/41 (43.9)	1.58 (0.65–3.84)
No	19/74 (25.7)	22/71 (31.0)	0.77 (0.37–1.59)
Inotropic score >40			
Yes	17/43 (39.5)	20/48 (41.7)	0.92 (0.40–2.12)
No	23/69 (33.3)	20/64 (31.3)	1.10 (0.53–2.78)
Postoperative ECMO			
Yes	19/47 (40.4)	18/52 (34.6)	1.28 (0.57–2.90)
No	21/65 (32.3)	22/60 (36.7)	0.82 (0.39–1.73)
All-cause death at Day 30	40/112 (36.0)	40/112 (36.0)	1.00 (0.58–1.73)



B) Hémofiltration modifiée (MUF)

2011 Update to The Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists Blood Conservation Clinical Practice Guidelines*,*

2017 EACTS/EACTA Guidelines on patient blood management for adult cardiac surgery FREE

Domenico Pagano ✉, Milan Milojevic, Michael I Meesters, Umberto Benedetto, Daniel Bolliger, Christian von Heymann, Anders Jeppsson, Andreas Koster, Ruben L Osnabrugge, Marco Ranucci ... Show more
Author Notes

European Journal of Cardio-Thoracic Surgery, Volume 53, Issue 1, January 2018, Pages

Eur J Cardiothorac Surg. 2006 Dec;30(6):892-7. Epub 2006 Oct 13.

Ultrafiltration reduces blood transfusions following cardiac surgery: A meta-analysis.

Boodhwani M[1], Williams K, Babaev A, Gill G, Saleem N, Rubens FD.

- Méta analyse sur HF:
- Diminution transfusion en terme de CGR, PFC et plaquettes dans les études MUF
- Etudes « Anciennes » fin 90 début 2000,hypothermie, cardioplégie importante en Volume, méthodo imparfaite

Modified Ultrafilt

Indications hémofiltration per CEC

- Probablement pas d'intérêt en systématique
- en fonction du patient:

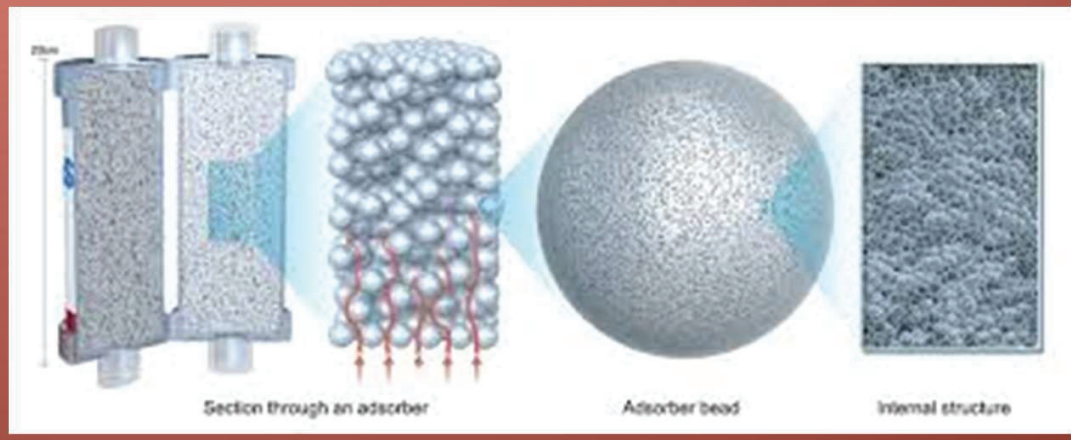
-Surcharge volémique avec hémodilution et œdème interstitiel (souffrance multi organe)

-Elimination d'un médicament épurable (ex: Dabigatran) ou d'un « déchet métabolique »

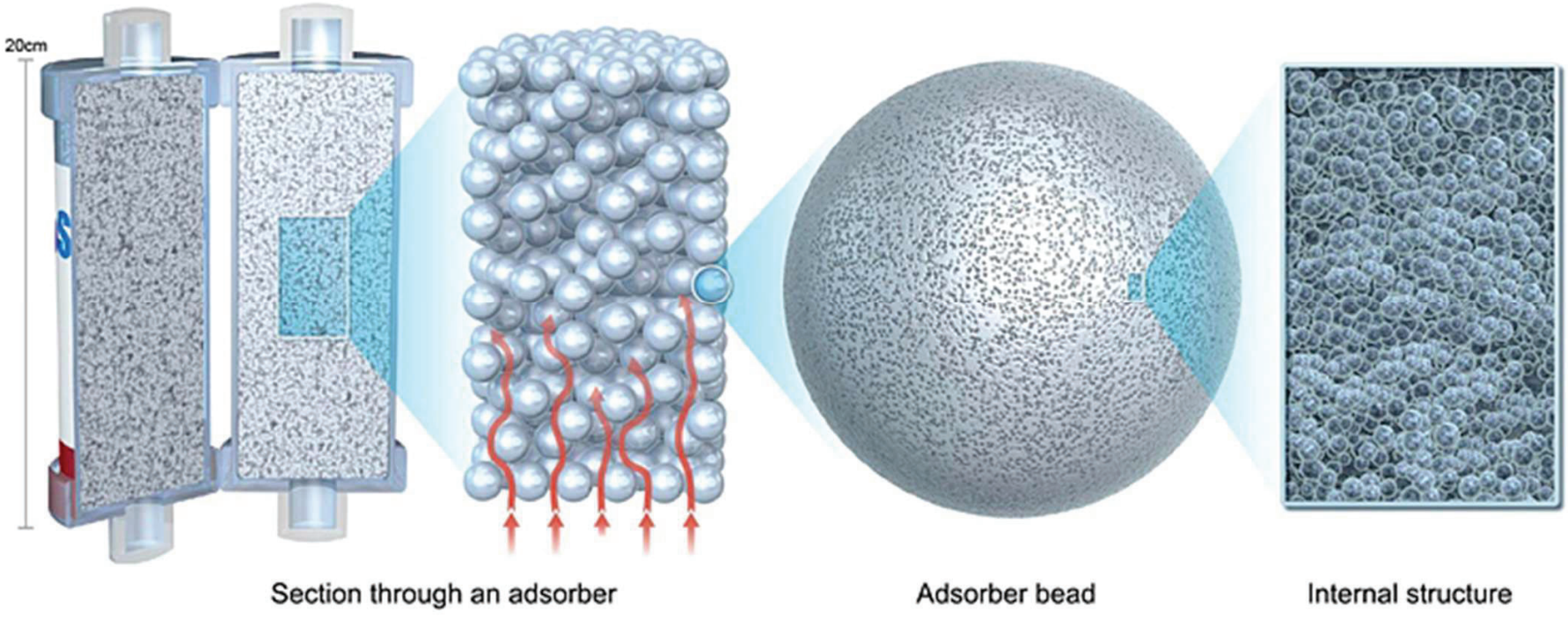
-Gestion du volume dans le reservoir de cardiotomie: un diurétique peut aussi faire l'affaire…

- Non prouvée: Bénéfice à l' élimination de molécules pro inflammatoires ….. Et anti inflammatoires

Hémoadsorption/Purification

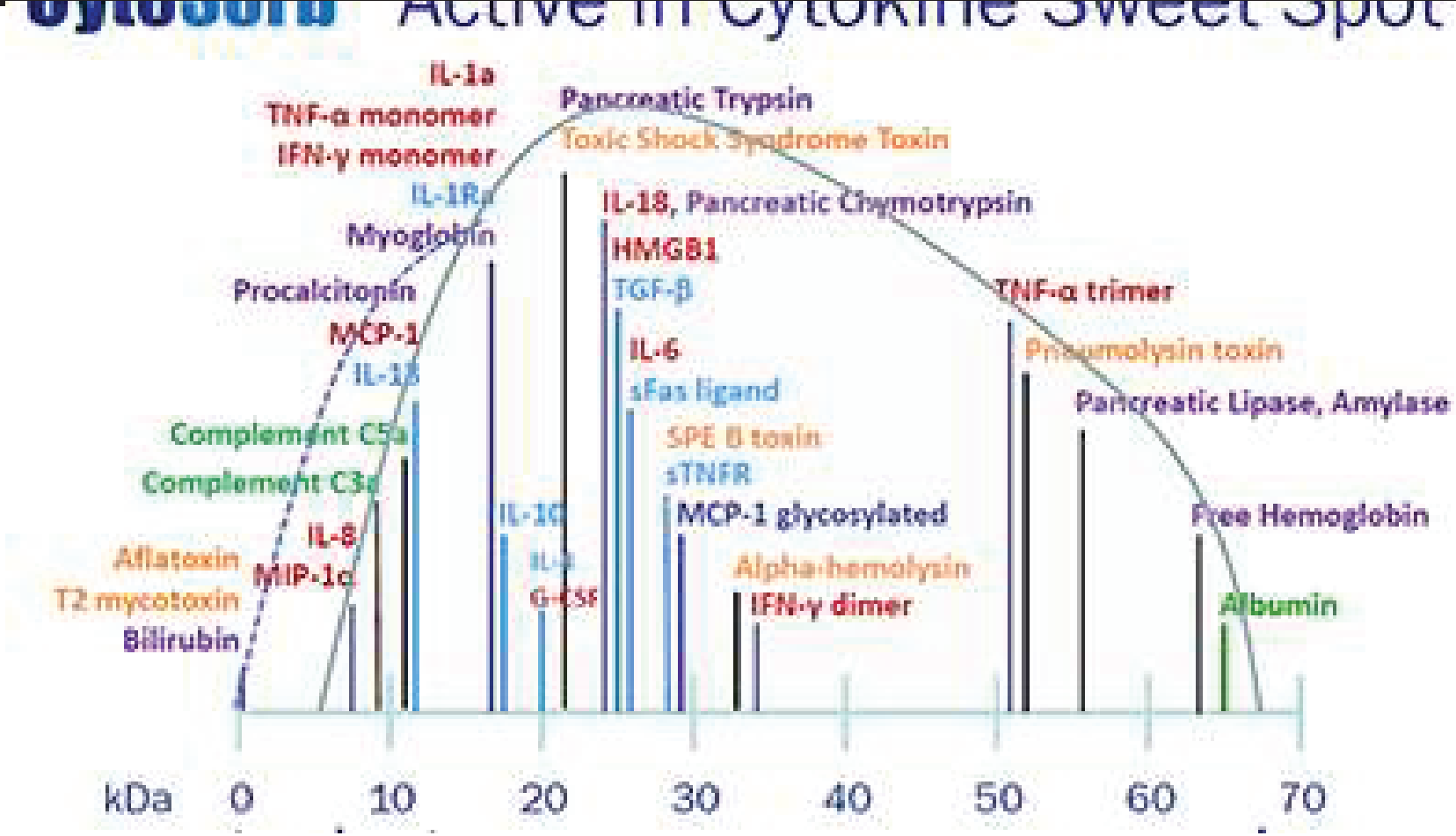


Hémoadsorption non selective: Cytosorb /Jafron



-Cartouche remplie de billes de polymère poreuses
-Adsorption de surface des molécules entre 5 et 60 kDA
-Sur un principe non “specifique”
-Adsorption concentration dépendante
-surface d’échange de 4 terrains de foot
-Saturation possible

Principe Hémoadsorption non selective



Principe Hémoadsorption “selective”

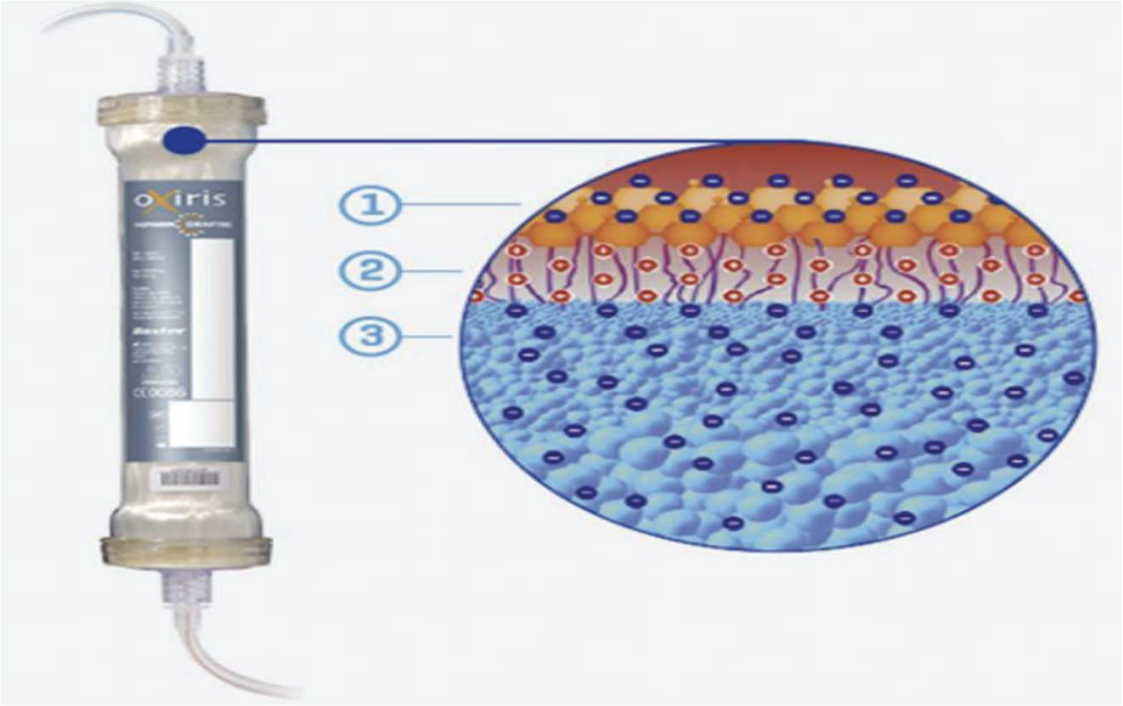
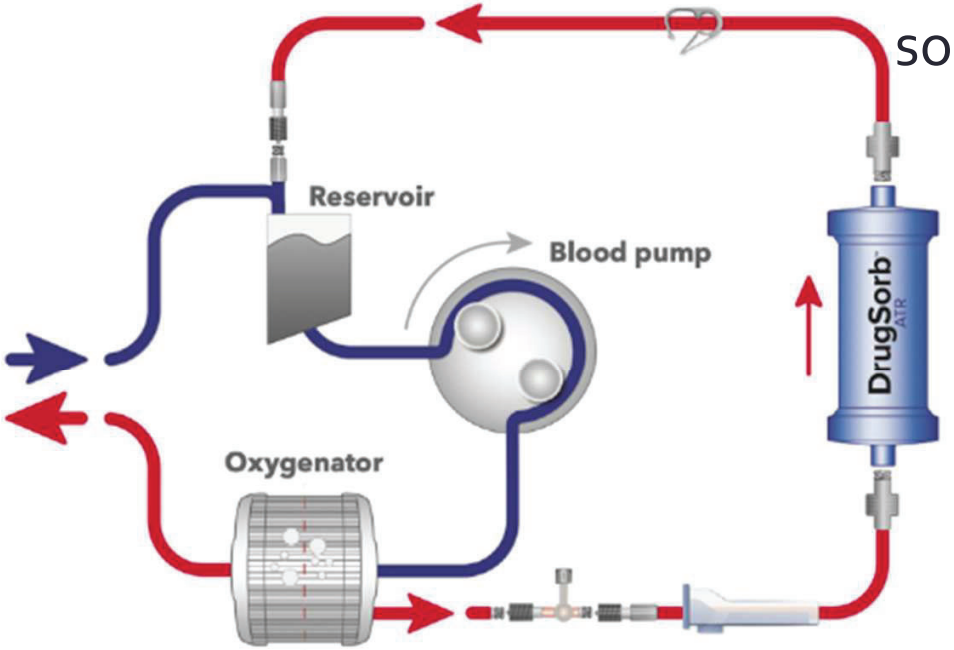


Figure 5 Schéma représentatif de la membrane oXiris® à 3 couches. (1) L’héparine greffée sur la membrane réduit sa thrombogénicité. (2) Le traitement de surface par la PEI (polyéthylèneimine) permet l'adsorption des endotoxines. (3) La membrane AN69 améliorée permet l’adsorption des cytokines.

Azrat Ibrahima. Effets de l’hémoadsorption par la membrane oXiris® après chirurgie cardiaque sous circulation extracorporelle. Médecine humaine et pathologie. 2023. dumas-04269557

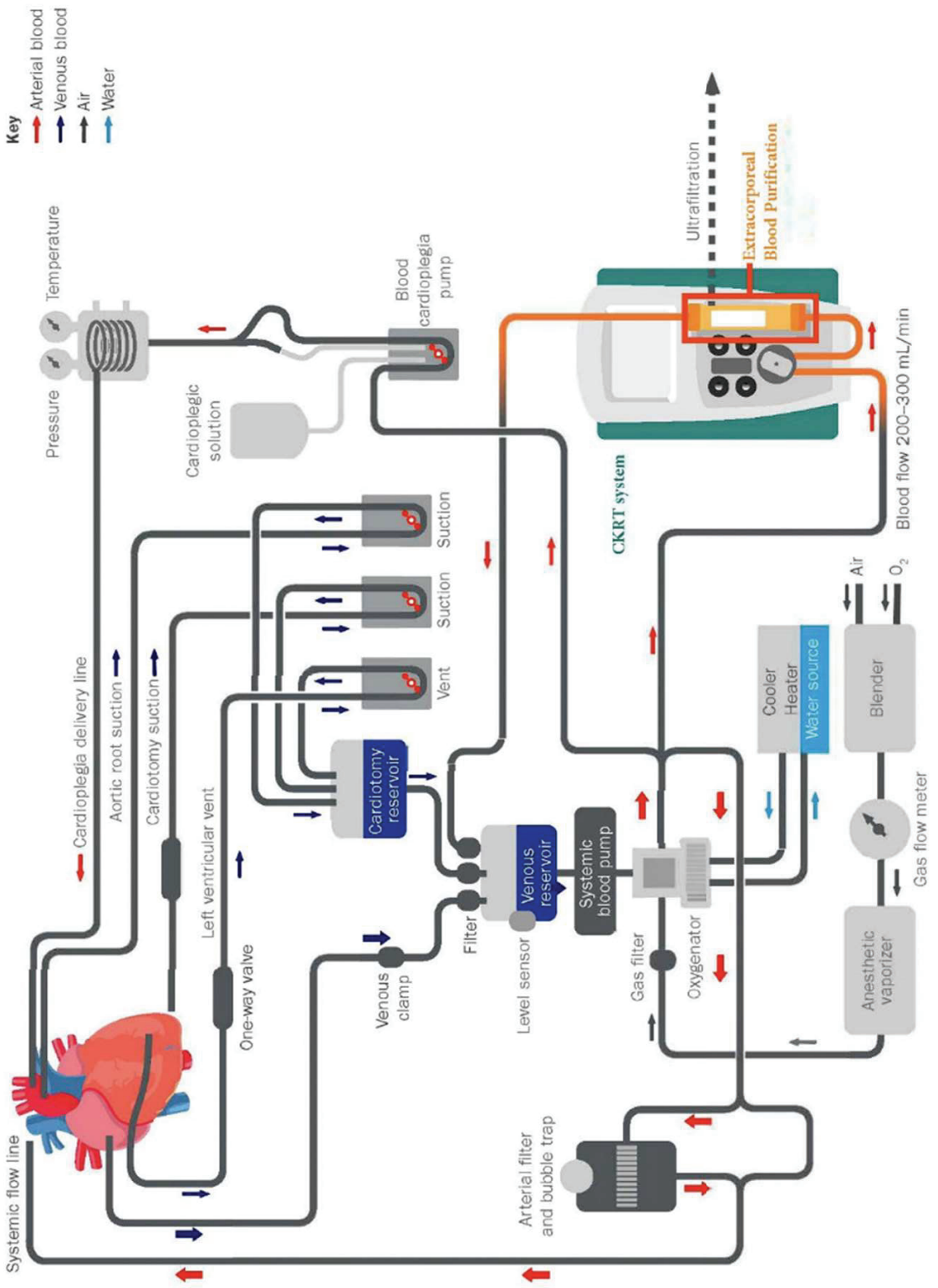
Intégration circuit

-Faible résistance d'écoulement
-Débit sanguin recommandé 150-500 ml/min
-Préchargé/primé avec une solution saline isotonique



C. Michael Gibson et al

Standard integration of DrugSorb-ATR within a CPB circuit: DrugSorb is integrated as a parallel shunt circuit to the main CPB circuit. Blood flow intake to the parallel circuit is after the pump in the main CPB circuit, and blood flow return from the parallel circuit is to the blood reservoir in the main CPB circuit.



Blood purification device connected to the CPB circuit CPB, cardiopulmonary bypass. CKRT, continuous kidney replacement therapy. Some elements of the figure have been adapted from Cohn LH and Adams DH, Cardiac Surgery in the Adult 5th edition, McGraw-Hill).

Littérature

Cytokines

Crit Care. 2019 Apr 3;23(1):108. doi: 10.1186/s13054-019-2399-4.

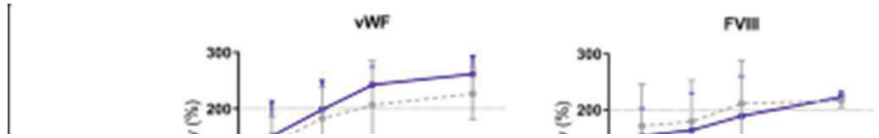
Cytokine clearance with CytoSorb® during cardiac surgery: a pilot randomized controlled trial.

Poli EC[1], Alberio L[2,3], Bauer-Doerries A[4], Marcucci C[4,3], Roumy A[5], Kirsch M[5,3], De Stefano E[5], Liaudet L[1,3], Schneider AG[6,7].

15 patients cytosorb 15 controles, chirurgie réglée
Pas d'effet secondaire délétère
Pas de variation des taux de cytokines ni facteurs coag

Cardio-pulmonary bypass characteristics		
Median bypass duration—(IQR) min	138 (87–207)	145 (130–183)
Median cross-clamp duration (IQR) min	115 (68–159)	122 (97–146)
Centrifugal pump—no. (%)	5 (33.3)	4 (26.7)

CONCLUSIONS: CytoSorb® HA during CPB was not associated with a decrease in pro- or anti-inflammatory cytokines nor with an improvement in relevant clinical outcomes. The procedure was feasible and safe. Further studies should evaluate the efficacy of CytoSorb® HA in other clinical contexts.



Cytokines

The effect of perioperative hemadsorption in patients operated for acute infective endocarditis—A randomized controlled study

Silke Asch, Tobias Peter Kaufmann, Michaela Walter, Marcus Leistner, Bernd C. Danner, Thorsten Perl, Ingo Kutschka, Heidi Niehaus

First published: 21 June 2021 | https://doi.org/10.1111/aor.14019

Cytokines

The effect of perioperative hemadsorption in patients operated for acute infective endocarditis—A randomized controlled study

Silke Asch, Tobias Peter Kaufmann, Michaela Walter, Marcus Leistner, Bernd C. Danner, Thorsten Perl, Ingo Kutschka, Heidi Niehaus

First published: 21 June 2021 | https://doi.org/10.1111/aor.14019

Patients with confirmed IE of any type (native or prosthetic valve) and localization (affected valve) undergoing cardiac surgery were included in this study and randomly assigned to either the HA group or the control group. Exclusion criteria were a lack of informed consent,

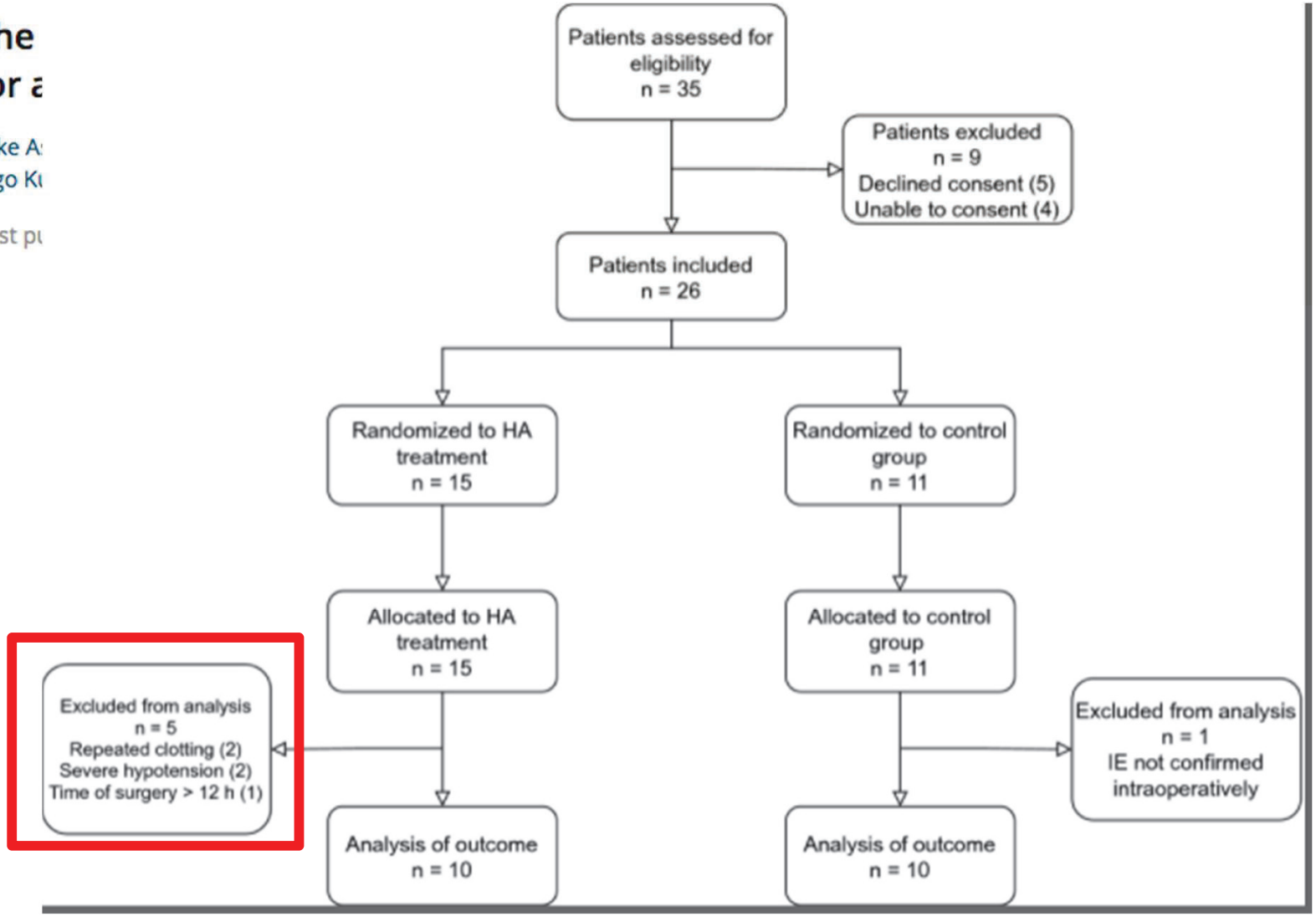
The primary endpoint of the study was the postoperative course of cytokine levels (IL-6, TNF-a, IL-1b) and infection parameters (CRP, PCT, leucocytes). Secondary endpoints were the development of the severity-of-the disease (estimated by the SOFA, SAPS II and APACHE II score), postoperative catecholamine and fluid requirement, the incidence of adverse events as well as in-hospital mortality.

Cytokines

The
for a

Silke A
Ingo K

First pu



[redacted]

The effi
for acu

Silke Asch
Ingo Kutsch

First publis

[redacted]

	HA group	Control group	
	n = 10	n = 10	*P* value
Baseline parameters			
Age [years]	65 (53-70)	69 (56-81)	.315
Female gender [n]	3	1	.582
Body mass index [kg/m^2]	26.0 (21.5-30.6)	25.0 (20.7-31.8)	.853
LVEF [%]	50 (50-56)	60 (54-62)	.105
EuroSCORE II [%]	8.5 (2.7-16.4)	3.6 (2.6-11.8)	.393
Re-operation [n]	3	2	1.000
Emergency surgery [n]	2	1	1.000
Endocarditis-related parameters			
Single valve IE [n]	7	9	1.000
Multiple valves IE [n]	3	1	1.000
Septic embolism [n]	4	4	1.000
Cardiogenic shock [n]	1	0	1.000
Co-morbidities			
Arterial hypertension [n]	4	7	.370
Insulin-dependent diabetes [n]	1	3	.582
Peripheral artery disease [n]	2	0	.474
Renal replacement therapy [n]	1	1	1.000
COPD [n]	2	0	.474
Cardiac surgery			
AV surgery [n]	5	2	.350
MV surgery [n]	2	4	.628
AV and MV surgery [n]	2	3	1.000
MV and TV surgery [n]	1	1	1.000
Cross clamp time (minutes)	90 (65-150)	118 (60-148)	.888
CPB time (minutes)	126 (94-276)	180 (93-219)	.963

Cytokines

The effect of perioperative hemadsorption in patients operated for acute infective endocarditis—A randomized controlled study

Silke Asch, Tobias Peter Kaufmann, Michaela Walter, Marcus Leistner, Bernd C. Danner, Thorsten Perl, Ingo Kutschka, Heidi Niehaus

First published: 21 June 2021 | https://doi.org/10.1111/aor.14019

(n = 7). All patients survived to discharge. No significant differences concerning median cytokine levels (IL-6 and TNF-α) were observed between both groups. CRP and PCT baseline levels were significantly higher in the HA group (59.5 vs. 26.3 mg/dL, *P* = .029 and 0.17 vs. 0.05 μg/L, *P* = .015) equalizing after surgery. Patients in the HA group required significantly higher doses of vasopressors (0.093 vs. 0.025 μg/kg/min norepinephrine, *P* = .029) at 12 hours postoperatively as well as significantly more overall volume replacement (7217 vs. 4185 mL at 12 hours, *P* = .015; 12 021 vs. 4850 mL at 48 hours, *P* = .015). HA therapy did neither result in a reduction of inflammatory parameters nor result in an improvement of hemodynamic parameters in patients operated for IE. For a more targeted use of HA therapy, appropriate selection criteria are required.

Cytokines

Lancet Respir Med. 2021 Jul; 9(7): 755–762.
Published online 2021 May 14. doi: 10.1016/S2213-2600(21)00177-6
PMCID: PMC8121541
PMID: 34000236

Cytokine adsorption in patients with severe COVID-19 pneumonia requiring extracorporeal membrane oxygenation (CYCOV): a single centre, open-label, randomised, controlled trial

Alexander Supady, MD,[a,d,f,*] Enya Weber, PhD,[a,c] Marina Rieder, MD,[a,d] Achim Lother, MD,[a,d] Tim Niklaus, BA,[a,d]

The CYCOV trial was a single-centre, randomised, controlled, parallel group, open-label, superiority trial. All adult patients (≥18 years of age) admitted to the participating intensive care units (ICUs) of the Freiburg University Medical Center with reverse transcriptase (rt) PCR-confirmed SARS-CoV-2 infection who were selected to receive venovenous ECMO were eligible. Exclusion criteria were a known patient

In the intervention group, a CytoSorb adsorber was incorporated into the ECMO system and replaced every 24 h for a total treatment duration of 72 h. Routinely, the adsorber was installed in the ECMO as part of the system setup before connecting it to the patient circuit, but at the latest within 4 h after initiation of the

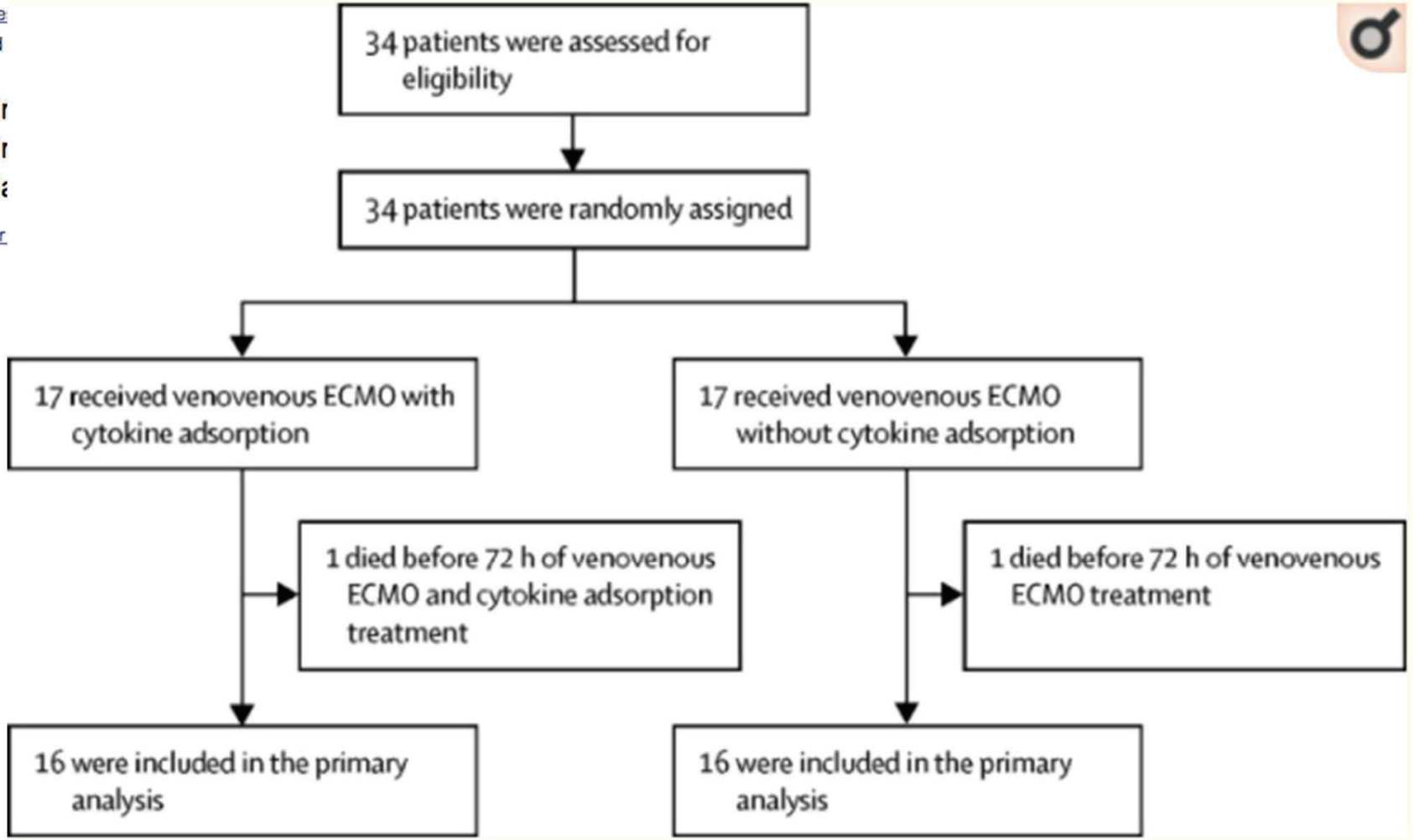
The primary endpoint was serum IL-6 after 72 h of ECMO with or without cytokine adsorption. Secondary endpoints were ICU survival and 30-day survival, days on ECMO, days on mechanical ventilation, serum lactate, Willebrand factor, D-dimers, vasopressor dosage, amount of fluid substitution, fluid balance after 72 h, and Sequential Organ Failure Assessment score after 24, 48, and 72 h.21

Cytokines

Lancet Re
Published

Cytoki
requiri
open-l

Alexander



	Cytokine adsorption group (n=17)	Control group (n=17)
Age, years	62·0 (54·0–71·5)	59·0 (43·5–66·5)
Sex		
Female	5 (29%)	4 (24%)
Male	12 (71%)	13 (76%)
Body-mass index, kg/m²	29·41 (24·69–33·20)	29·68 (26·41–36·48)
Laboratory values		
Interleukin-6, pg/mL	357·0 (177·4–1186·0)	289·0 (84·7–787·0)
C-reactive protein, mg/L	254·9 (148·0–374·4)	169·3 (128·6–342·2)
Procalcitonin, ng/mL	0·73 (0·50–1·84)	1·34 (0·37–5·98)
Ferritin, ng/mL	2172·0 (883·5–3706·0)*	1489·0 (938·5–2543·0)
Leukocytes, $\times10^3$/µL	10·03 (8·22–19·92)	14·43 (8·40–16·48)
Neutrophils, $\times10^3$/µL	9·12 (6·59–14·84)*	11·86 (7·18–13·92)
Lymphocytes, $\times10^3$/µL	0·67 (0·44–1·15)*	0·59 (0·39–0·88)
Monocytes, $\times10^3$/µL	0·51 (0·20–0·98)*	0·46 (0·22–0·90)
Willebrand factor antigen, %	603·5 (458·5–642·5)†	399·0 (362·0–542·5)*
D-dimers, mg/L FEU	9·1 (4·5–21·0)*	4·7 (3·4–13·5)
Scores		
SOFA	9·0 (8·0–10·0)	9·0 (7·0–10·5)
RESP	1·0 (0·5–2·0)	1·0 (0–3·5)
PRESERVE	4·0 (3·0–5·0)	4·0 (2·0–6·0)
Comorbidities		
Hypertension	9 (53%)	7 (41%)
Diabetes	5 (29%)	3 (18%)
Coronary heart disease	3 (18%)	1 (6%)
Chronic lung disease	1 (6%)	3 (18%)
Liver cirrhosis	0	0
Haematological malignancy	1 (6%)	1 (6%)
Solid malignant tumour	0	0
Immunosuppressive therapy	1 (6%)	0
Active smoker	2 (12%)	1 (6%)
Any comorbidity	12 (71%)	10 (59%)
Pre-ECMO treatment		
Time from hospital admission to ECMO, days	6·0 (4·0–13·5)	8·0 (4·5–14·0)
Time from intensive care unit admission to ECMO, days	5·0 (2·5–11·5)	6·0 (4·0–14·0)
Duration of mechanical ventilation (including non-invasive and invasive	6·0 (3·5–12·0)	5·0 (2·0–14·0)

	Cytokine adsorption group (n=17)	Control group (n=17)
(Continued from previous page)		
Ventilation parameters		
FiO_2, %	100·0 (95·0–100·0)	100·0 (85·0–100·0)
Positive end-expiratory pressure, mbar	15·0 (14·0–17·0)	15·0 (12·5–18·0)
Peak pressure, mbar	34·0 (29·5–36·0)	32·0 (31·0–35·0)
Dynamic driving pressure, mbar	18·0 (15·0–20·0)	20·0 (14·0–20·0)
Tidal volume, mL	460·0 (354·0–576·5)	417·0 (334·3–479·5)*
Tidal volume, mL/kg	5·30 (3·90–6·25)	3·85 (2·95–4·83)*
Breathing rate, 1/min	25·0 (21·5–31·0)	25·0 (21·0–29·0)
Last blood-gas values pre-ECMO		
pH	7·34 (7·17–7·39)	7·28 (7·16–7·41)
PaO_2, mm Hg	57·3 (48·5–70·7)	75·1 (52·1–88·4)
$PaCO_2$, mm Hg	65·5 (42·5–80·1)	61·9 (55·1–73·8)
PaO_2/FiO_2, mm Hg	62·7 (48·5–72·7)	84·2 (59·9–95·6)
Plasma bicarbonate, mmol/L	25·3 (20·9–29·5)¶	24·6 (20·6–31·8)*
Arterial lactate, mmol/L	1·8 (1·2–2·3)	1·4 (0·9–1·8)
Pre-ECMO treatment		
Time from hospital admission to ECMO, days	6·0 (4·0–13·5)	8·0 (4·5–14·0)
Time from intensive care unit admission to ECMO, days	5·0 (2·5–11·5)	6·0 (4·0–14·0)
Duration of mechanical ventilation (including non-invasive and invasive ventilation) before ECMO, days	6·0 (3·5–12·0)	5·0 (2·0–14·0)
Duration of invasive ventilation before ECMO, days	5·0 (0·5–11·0)	4·0 (1·0–8·5)
Prone positioning	11 (65%)‡	12 (71%)
Renal replacement therapy	1 (6%)	0
Hydroxychloroquine	4 (24%)	5 (29%)
Lopinavir-ritonavir	3 (18%)	1 (6%)
Tocilizumab	2 (12%)	0
Remdesivir	5 (29%)	1 (6%)
Methylprednisolone	9 (53%)	10 (60%)§
Norepinephrine support, µg/kg per min	0·15 (0·04–0·22)	0·03 (0·00–0·36)

Cytokines

Lancet Respir Med. 2021 Jul; 9(7): 755–762. PMCID: PMC8121541

Publishe

Cytok
requi
open-

Alexand

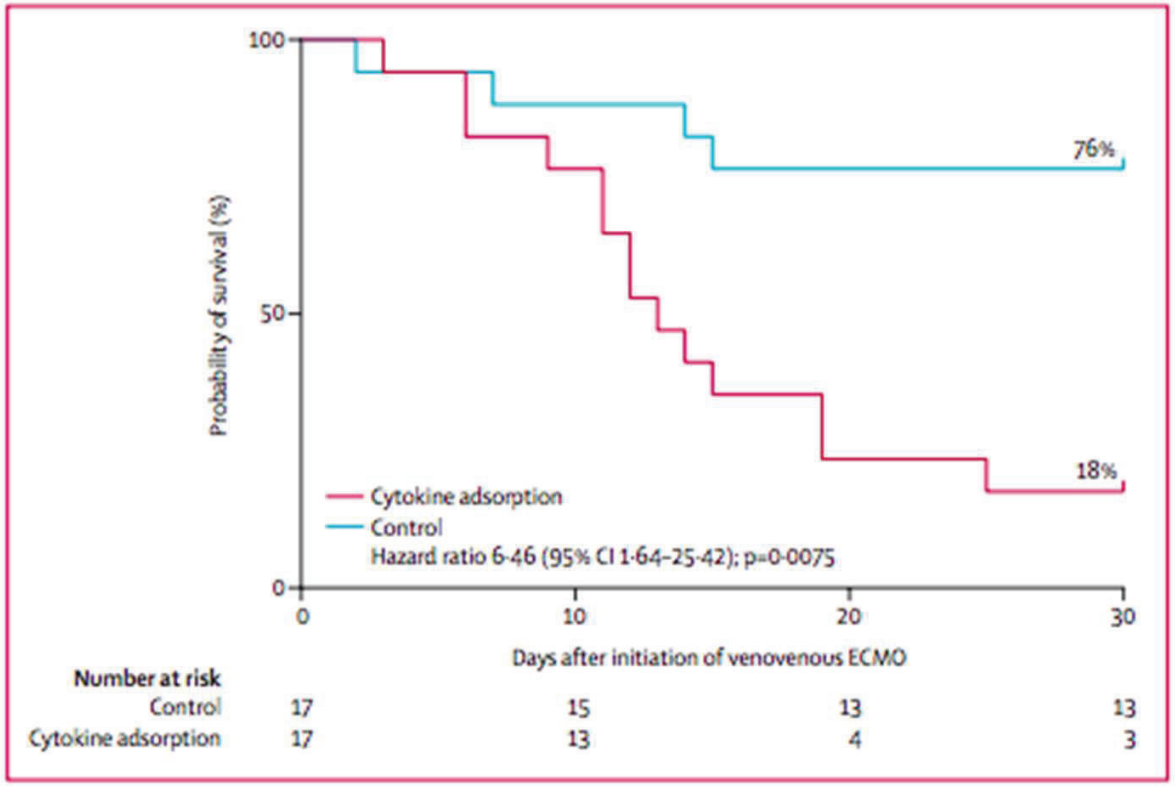
	Cytokine adsorption group (n=17)	Control group (n=17)	p value
Primary endpoint			
Serum interleukin-6 after 72 h	98·6 (71·0 to 192·8)*	112·0 (48·7 to 198·5)*	0·54†
Other endpoints			
30-day survival	3 (18%)	13 (76%)	0·0016‡
Discharged from intensive care unit until day 30	0	3 (18%)	0·23‡
Serum lactate after 72 h, mmol/L	1·35 (1·05–1·58)*	1·25 (0·93–1·85)*	0·80§
Willebrand factor antigen after 72 h, %	426·0 (396·0–501·0)¶	311·5 (287·8 to 405·8)*	0·021§
D-dimers after 72 h, mg/L FEU	8·77 (3·90 to 35·19)*	15·23 (5·79 to 34·23)*	0·48§
SOFA score after 24 h	7·0 (6·0 to 9·5)	8·0 (6·0 to 10·0)	0·59§
SOFA score after 48 h	8·0 (6·5 to 9·5)	8·0 (6·0 to 10·5)	0·95§
SOFA score after 72 h	7·5 (6·0 to 10·8)*	8·5 (6·0 to 10·0)*	0·81§
Norepinephrine support at 72 h, μg/kg per min‖	0·07 (0·03 to 0·13)*	0·00 (0·00 to 0·10)*	0·04§
Cumulative fluid balance for 72 h after initiation of ECMO, mL	2665·0 (663·5 to 5152·0)	2145·0 (−92·5 to 3002·0)	0·29§
Fluid substitution during the first 72 h after implementation of venovenous ECMO, mL	11 773 (8959 to 13 468)	8344 (7304 to 10 866)	0·0068§

Cytokines

Lancet Respir Med. 2021 Jul; 9(7): 755–762.
Published online 2021 May 14. doi: 10.1016/S2213-2600(21)00177-6
PMCID: PMC8121541
PMID: 34000236

Cytokine adsorption in patients with severe COVID-19 pneumonia requiring extracorporeal membrane oxygenation (CYCOV): a single centre, open-label, randomised, controlled trial

Alexander Supady, MD,[a,d,f,*]



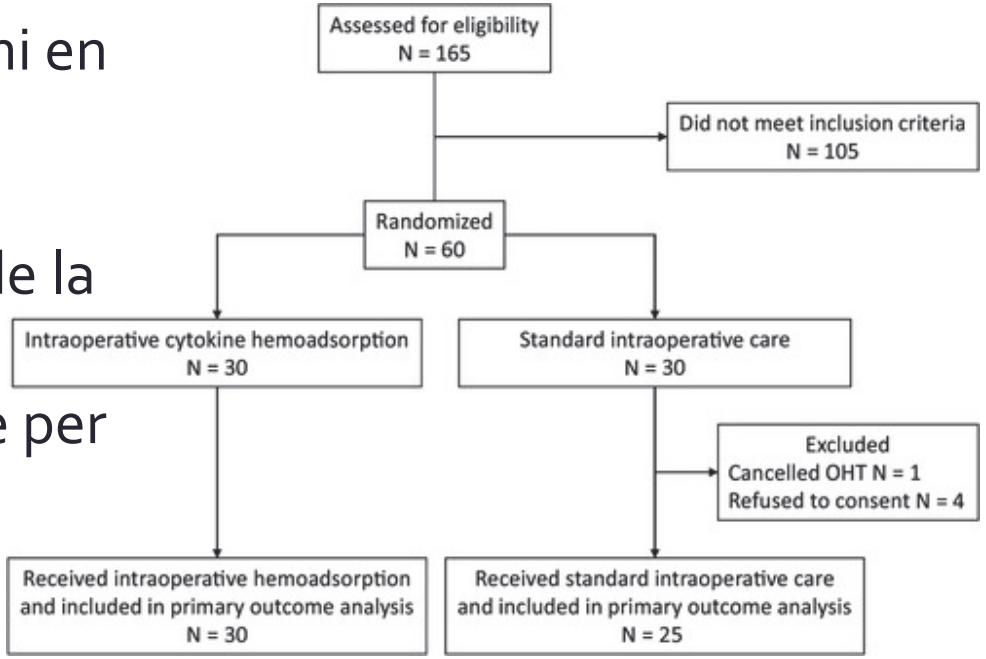
Cytokines

ESC Heart Fail. 2023 Dec 19. doi: 10.1002/ehf2.14632. Online ahead of print.

Use of intraoperative haemoadsorption in patients undergoing heart transplantation: a proof-of-concept randomized trial

Endre Nemeth [1,2], Adam Soltesz [1,2], Eniko Kovacs [1,2], Zsofia Szakal-Toth [1], Eszter Tamaska [1,2], Hajna Katona [1,2], Kristof Racz [1,2], Gergely Csikos [1,2], Viktor Berzsenyi [1,2], Szabolcs Fabry [1,2], Zsuzsanna Ulakcsai [1,2], Csilla Tamas [1], Beata Nagy [3], Marina Varga [4], Bela Merkely [1]

-Greffe « simple » (ni en choc ni en aigue ni redux)
-Cyrosorb VS standard, uniquement durant le temps de la CEC au bloc
-majoration anibioprophylaxie per op



Cytokines

ESC Heart Fail. 2023 Dec 19. doi: 10.1002/ehf2.14632. Online ahead of print.

Use of intraoperative haemoadsorption in patients undergoing heart transplantation: a proof-of-concept randomized trial

Endre Nemeth [1 2], Adam Soltesz [1 2], Eniko Kovacs [1 2], Zsofia Szakal-Toth [1], Eszter Tamaska [1 2], Hajna Katona [1 2], Kristof Racz [1 2], Gergely Csikos [1 2], Viktor Berzsenyi [1 2], Szabolcs Fabry [1 2], Zsuzsanna Ulakcsai [1 2], Csilla Tamas [1], Beata Nagy [3], Marina Varga [4], Bela Merkely [1]

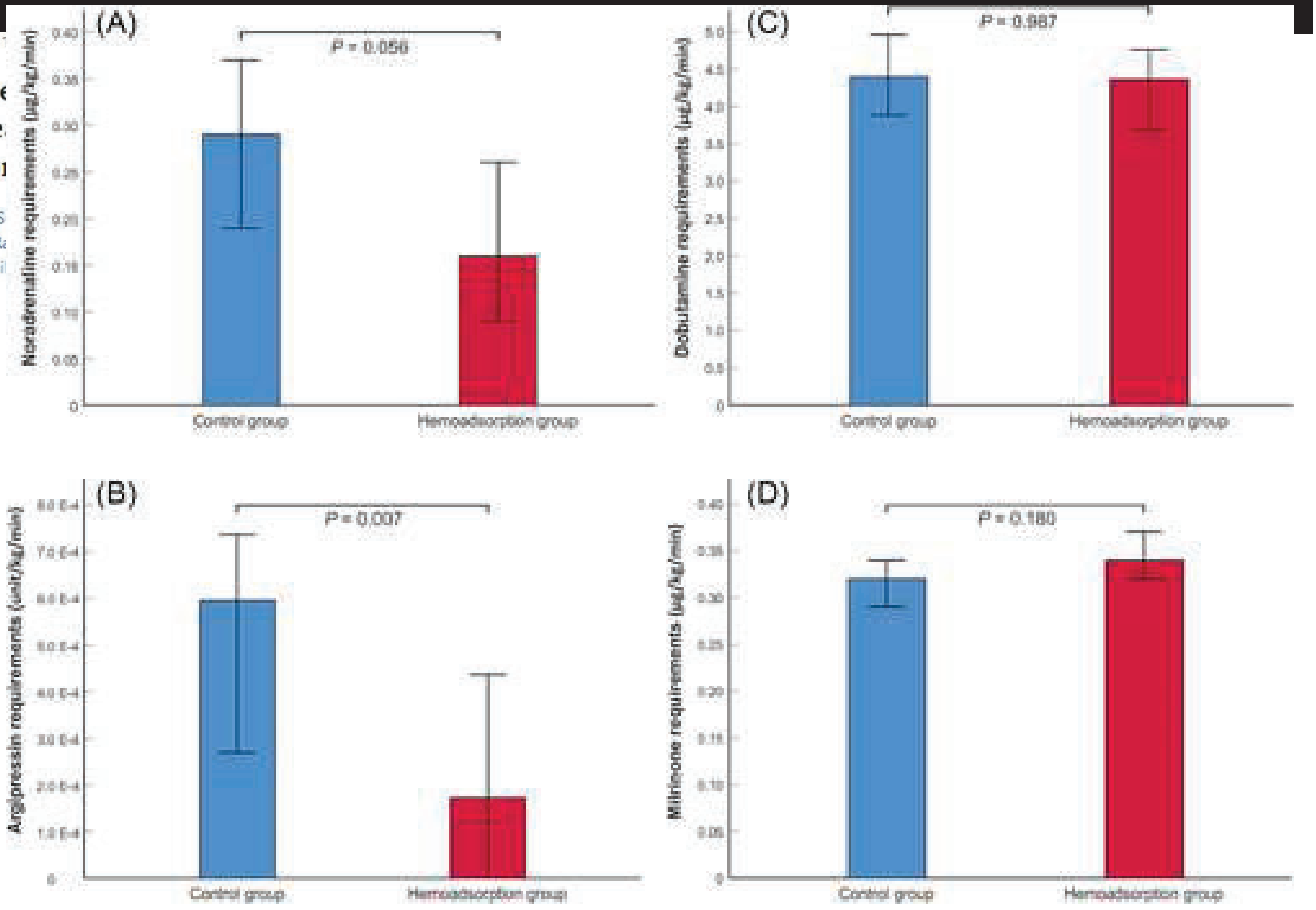
- Critère de jugement principal: vasoactive-inotropic score (VIS)
- Patients in the haemoadsorption group had significantly lower VIS than patients in the control group during the first post-operative 24 h (median VIS: 27.2 [14.6–47.7] vs. 41.9 [22.4–63.2], *P* = 0.046, respectively)

Cytokines

› ESC Heart Fail. 2023 Dec

**Use of intraope
undergoing he
concept rando**

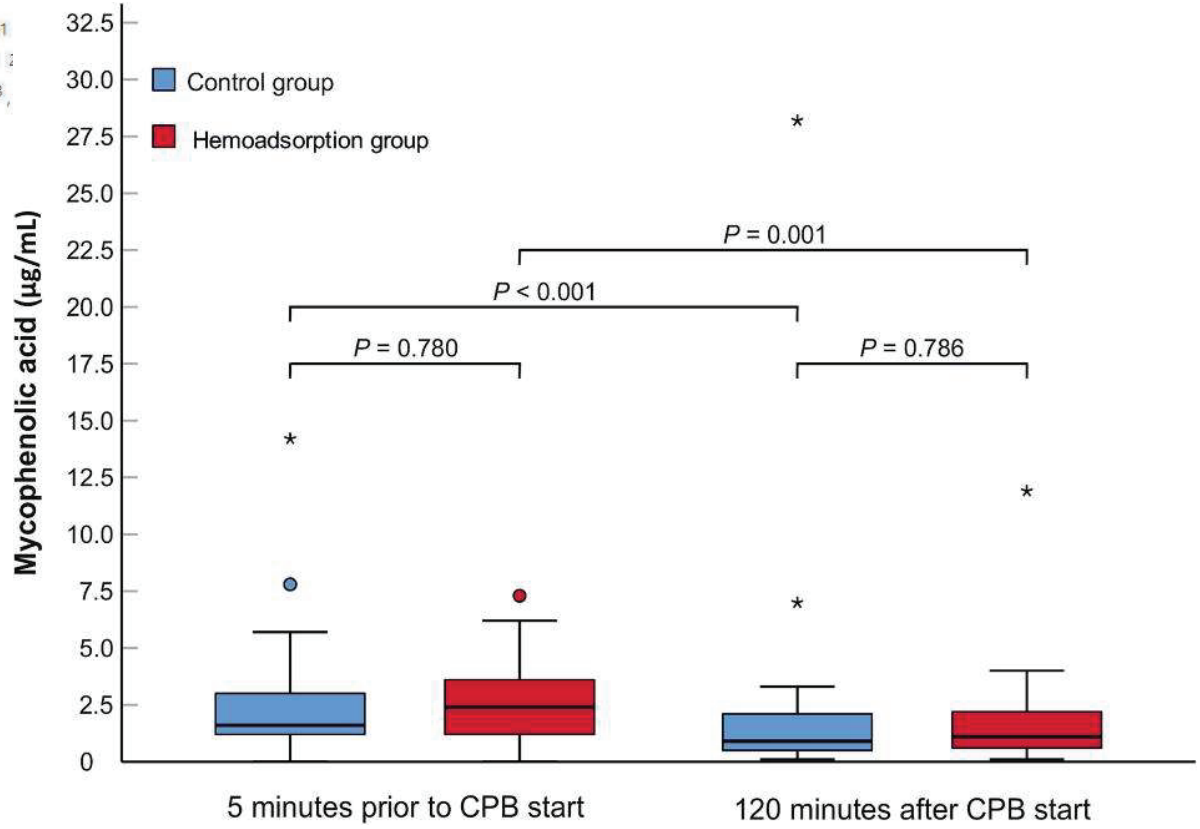
Endre Nemeth [1 2], Adam S
Hajna Katona [1 2], Kristof Ra
Zsuzsanna Ulakcsai [1 2], Csi



ESC Heart Fail. 2023 Dec 19. doi: 10.1002/ehf2.14632. Online ahead of print.

Use of intraoperative haemoadsorption in patients undergoing heart transplantation: a proof-of-concept randomized trial

Endre Nemeth [1 2], Adam Soltesz [1 2], Eniko Kovacs [1]
Hajna Katona [1 2], Kristof Racz [1 2], Gergely Csikos [1]
Zsuzsanna Ulakcsai [1 2], Csilla Tamas [1], Beata Nagy [3],



able 3 Comparative analysis of secondary outcome parameters

arameters	Control group (N = 25)	Haemoadsorption group (N = 30)	P-valu
ost-cardiotomy ECMO, *n*	3 (12.0%)	0 (0%)	0.088
ost-operative bleeding, mL	570 [385–1305]	565 [350–1130]	0.543
eoperation for bleeding, *n*	2 (8.0%)	0 (0%)	0.202
RC/post-CPB 24 h, unit	4.0 [0–5.5]	2.0 [0–4.0]	0.243
FP/post-CPB 24 h, unit	2.0 [0–3.0]	2.0 [0–3.0]	0.571
LT/post-CPB 24 h, unit	12.0 [0–16.0]	12.0 [8.0–16.0]	0.597
ost-operative MV, h	65 [23–287]	25 [19–68.8]	0.025
cute kidney injury stage 1, n^a	15 (60.0%)	9 (30.0%)	0.025
cute kidney injury stage 2, n^a	0 (0%)	1 (3.3%)	1.00
cute kidney injury stage 3, n^a	4 (16.0%)	1 (3.3%)	0.104
cute kidney injury$_{total}$, *n*	19 (76.0%)	11 (36.7%)	0.004
ost-operative RRT, *n*	4 (16.0%)	0 (0%)	0.037
er cent change in bilirubin, %	72.1 [11.2–191.4]	2.5 [−24.6–71.1]	0.009
arly sepsis, n^b	1 (4.0%)	0 (0%)	0.455
ength of ICU stay, day	12 [8.5–18.0]	8.5 [8.0–10.3]	0.022
ength of hospital stay, day	28 [24–38.5]	25 [22–34.3]	0.232
0-day mortality, *n*	2 (8.0%)	0 (0%)	0.202
MB cellular rejection			
Post-transplant day 7, *n*	0 (0%)	0 (0%)	
Post-transplant day 14, *n*	5 (20.0%)	5 (16.7%)	1.00
Post-transplant day 21, *n*	5 (20.0%)	5 (16.7%)	1.00
Post-transplant day 28, *n*	6 (24.0%)	10 (33.3%)	0.448
MB antibody-mediated rejection			
Post-transplant day 7, *n*	1 (4.0%)	0 (0%)	0.455
Post-transplant day 14, *n*	1 (4.0%)	2 (6.7%)	1.00
Post-transplant day 21, *n*	1 (4.0%)	3 (10.0%)	0.617
Post-transplant day 28, *n*	2 (8.0%)	1 (3.3%)	0.585

ata are presented as number of patients (frequency) and median [interquartile range]. N = 55. Of 36 registered cellular rejections, 3
7.2%) were confirmed as grade 1R and 1 (2.8%) was confirmed as grade 2R (ISHLT 2005). The registered antibody mediated rejection
ere confirmed as pAMR 1I (ISHLT 2013).

CMO, extracorporeal membrane oxygenation; EMB, endomyocardial biopsy; FFP, fresh frozen plasma; ICU, intensive care unit; MV, me
anical ventilation; pAMR, pathologic antibody-mediated rejection; PLT, platelet transfusion; PRC, packed red cell; RRT, renal replace
ent therapy.

Acute kidney injury was classified according to Kidney Disease Improving Global Outcomes creatinine-based definition criteria over th
irst 5 post-operative days.

Cytokines/Rein

JAMA

QUESTION Does use of a nonselective extracorporeal blood purification (EBP) device reduce the incidence of cardiac surgery associated-acute kidney injury (CSA-AKI) in high-risk patients undergoing cardiopulmonary bypass (CPB)?

CONCLUSION In high-risk patients undergoing cardiac surgery, the use of an EBP device was associated with a significant reduction in the incidence of CSA-AKI in the first 7 days after the surgical procedure.

POPULATION

224 Men
119 Women

Patients 18 years or older undergoing nonemergent cardiac surgery at high risk for CSA-AKI

Mean age: 69 years

LOCATIONS

2 Tertiary hospitals in Spain

INTERVENTION

343 Patients randomized

169
EBP
Use of a nonselective EBP device connected to the CPB circuit

174
Standard care
Standard care during CPB

PRIMARY OUTCOME

The incidence of CSA-AKI after 7 days

FINDINGS

CSA-AKI after 7 days

EBP	Standard care
48 of 169 patients	69 of 174 patients
28.4%	39.7%
(95% CI, 21.7% to 35.8%)	(95% CI, 32.3% to 47.3%)

The difference was statistically significant:

Adjusted between-group difference using a log-binomial model,

10.4% (95% CI, 2.3% to 18.5%); $P = .01$

Pérez-Fernández X, Ulsamer A, Cámara-Rosell M, et al; SIRAKI02 Study Group. Extracorporeal blood purification and acute kidney injury in cardiac surgery: the SIRAKI02 randomized clinical trial. *JAMA*. Published online October 9, 2024. doi:10.1001/jama.2024.20630

	Extracorporeal blood purification	Standard care	p.overall
Aortic valve, N (%)	127 (75.1%)	124 (71.3%)	0.490
Mitral valve, N (%)	96 (56.8%)	88 (50.6%)	0.294
Ascending aorta, N (%)	39 (23.1%)	49 (28.2%)	0.340
CABG, N (%)	68 (40.2%)	61 (35.1%)	0.380
Tricuspid valve, N (%)	35 (20.7%)	29 (16.7%)	0.411
Type of surgery (categories)			
Ascending aorta plus valve replacement	33 (19.5%)	42 (24.1%)	0.119
CABG plus valve replacement (single, double, triple) and/or aorta	68 (40.2%)	61 (35.1%)	
Double valve replacement	45 (26.6%)	55 (31.6%)	
Single valve replacement	10 (5.92%)	12 (6.90%)	
Triple valve replacement	13 (7.69%)	4 (2.30%)	
CPB flow rate (mL/min), Mean (SD)	4333 (534)	4340 (405)	0.92
CPB time (minutes), Mean (SD)	132 (46.7)	127 (39.2)	0.32
Median [Q1;Q3]	123 [102;154]	124 [99.0;145]	
Clamp time, Mean (SD)	98.7 (32.6)	97.4 (31.5)	0.72
Median [Q1;Q3]	90.0 [75.0;116]	93.0 [75.0;114]	
Ultrafiltration, N (%)	41 (24)	21 (12)	0.01
Ultrafiltration volume, (mL)	480 [320-750]	700 [500-1200]	0.01
Extracorporeal blood purification device flow rate, (mL/min)	276 (35)	-	
Manitol 20%, N (%)	104 (61.5%)	111 (63.8%)	0.75
Manitol 20% (ml), Mean (SD)	99.4 (47.3)	96.9 (44.8)	
Median [Q1;Q3]	100 [50.0;125]	100 [50.0;120]	
Furosemide, N (%)	28 (17)	31 (18)	0.91
Furosemide (mg), Mean (SD)	56.0 (45.6)	112 (224)	0.182
Median [Q1;Q3]	50.0 [20.0;72.5]	40.0 [20.0;80.0]	0.789

Surgical characteristics of the patients included in the primary analysis (N=343). CABG: Cor
Crafting, CPB: Cardiopulmonary bypass

Table 2. Primary Outcome of Cardiac Surgery–Associated Acute Kidney Injury (CSA-AKI)

Outcome	Mean (SD)		Unadjusted		Adjusted	
	Extracorporeal blood purification (n = 169)	Standard care (n = 174)	Difference (95% CI)[a,b]	*P* value[c]	Difference (95% CI)[a,b]	*P* value[c]
Primary outcome						
Occurrence of CSA-AKI by day 7, No./total No. of patients (%)	48/169 (28.4)	69/174 (39.7)	11.25 (1.30 to 21.21)	.03	10.42 (2.34 to 18.49)	.01
Elements of primary outcome						
Peak serum creatinine, mg/dL[d]	1.26 (0.61)	1.39 (0.89)	0.13 (−0.03 to 0.30)	.11		
Oliguria >6 h[e]	22 (13)	35 (20)	7.14 (−0.83 to 15.10)	.08		
CSA-AKI						
I	26 (15)	35 (20)	4.73 (−3.34 to 12.80)			
II	17 (10)	24 (14)	3.73 (−3.11 to 10.58)			
III	5 (3)	1 (6)	2.79 (−1.51 to 7.09)			
II/III	22 (13)	34 (20)	6.52 (−1.25 to 14.30)	.08		
Post hoc exploratory analysis related to primary outcome						
Kidney replacement therapy, No./total No. of patients (%)	3/169 (1.8)	6/174 (3.5)	1.67 (−1.69 to 5.04)	.50		
Early CSA-AKI (first 48 h)	39 (23)	57 (33)	9.68 (0.25 to 19.11)	.05		
AKI						
Transitory (resolved <48 h)	23 (59)	35 (61)	2.43 (−7.93 to 12.79)	.98		
Persistent (>48 h)	16 (41)	22 (39)				

SI conversion: To convert creatinine to µmol/L, multiply by 88.4.

[a] Mean difference for continuous variables and percentage difference for categorical variables.

[b] Unadjusted results: *t* test for continuous variables and Wilson method with continuity correction for categorical variables. Adjusted results: log-binomial model.

[c] Unadjusted results: *t* test for continuous variables and χ^2 or Fisher exact test for categorical variables. Adjusted results: log-binomial model.

[d] Serum creatinine concentration during the first 7 days after cardiac surgery. Higher value during the first 7 days was used to classify CSA-AKI category.

[e] CSA-AKI categories represent the severity of acute kidney injury based on serum creatinine increase and/or urine output decrease and are determined by the worst AKI stage according to KDIGO (Kidney Disease Improving Global Outcome), identified within the first 7 days after cardiac surgery. Oliguria >6 hours defined as urine output <0.5 mL/kg/h for >6 hours.

Table 3. Secondary and Post Hoc Exploratory Outcomes

	Median (IQR)		
	Extracorporeal blood purification (n = 169)	Standard care (n = 174)	Unadjusted difference (95% CI)[a,b]
Prespecified secondary outcomes[c]			
ICU length of stay, d[d]	3 (2 to 6)	3 (2 to 5)	0 (−1 to 1)
Hospital length of stay, d	13 (10 to 20)	13 (10 to 19)	0 (−3 to 0)
Survival at day 7, No. (%)	167 (99)	172 (99)	0.03 (−2.27 to 2.34)
Survival at day 28, No. (%)	163 (96)	169 (97)	0.68 (−3.64 to 4.99)
Survival at day 90, No. (%)	160 (95)	167 (96)	1.30 (−3.75 to 6.36)
Cytokine variation during surgery [(T1 − T0)/T0][e]			
IFN-γ	−31.3 (−51.0 to −12.1) [n = 106]	−24.2 (−45.3 to −5.7) [n = 99]	7.2 (−5.0 to 19.2)
IL-2	−29.6 (−52.1 to −9.3) [n = 106]	−21.6 (−42.3 to −4.4) [n = 99]	8.1 (−5.5 to 18.6)
IL-6	642 (208 to 1655) [n = 106]	514 (154 to 1982) [n = 99]	−128.4 (−506.8 to 172.9)
IL-8	135 (64.7 to 350) [n = 106]	241 (133 to 639) [n = 99]	106.2 (−3.8 to 213.1)
IL-10	4486 (1391 to 12 376) [n = 106]	4100 (976 to 12 920) [n = 99]	−386.8 (−3305.6 to 2864.6)
TNF	−2.5 (−21.3 to 42.3) [n = 106]	25.3 (0 to 91.8) [n = 99]	27.7 (9.0 to 47.4)
Post hoc exploratory outcomes			
Cardiopulmonary bypass duration, mean (SD), min	132 (46.7)	127 (39.2)	1 (−8 to 9)
SOFA ICU[f]	6 (5 to 7) [n = 161]	6 (5 to 7) [n = 172]	0 (−1 to 0)
APACHE II ICU[g]	13 (11 to 16) [n = 132]	14 (11 to 16) [n = 150]	1 (−1 to 2)
Days free from vasopressor/inotrope support[h]	11 (8 to 17)	11 (8 to 16)	0 (−2 to 1)
Use of vasopressor/inotrope support, No. (%)[h]	143 (85)	145 (83)	−1.28 (9.04 to 6.48)
Days free from IMV[h]	13 (9 to 19)	13 (9 to 17)	0 (−2 to 0)
Days free from KRT[h]	13 (10 to 20)	13 (10 to 19)	0 (−3 to 0)
Laboratory values			
Serum creatinine at 7 d, mg/dL	0.85 (0.69 to 1.06) [n = 159]	0.86 (0.72 to 1.05) [n = 165]	0.01 (−0.08 to 0.09)
Serum creatinine at 28 d, mg/dL	0.93 (0.77 to 1.13) [n = 124]	0.93 (0.76 to 1.13) [n = 123]	−0.01 (−0.12 to 0.04)
Serum creatinine at 90 d, mg/dL	0.89 (0.79 to 1.16) [n = 127]	0.97 (0.76 to 1.18) [n = 125]	0.08 (−0.03 to 0.14)
Lactate at ICU admission, mmol/L	1.40 (1.10 to 1.90) [n = 167]	1.40 (1.00 to 1.90) [n = 170]	0 (−0.2 to 0.1)
Lactate 8 h after admission, mmol/L	1.80 (1.27 to 2.40) [n = 155]	1.85 (1.30 to 2.60) [n = 158]	0.05 (−0.2 to 0.3)
C-reactive protein (day 3), mg/L[i]	215 (156 to 287) [n = 81]	237 (172 to 302) [n = 85]	22 (3.2 to 45)
GPT (day 1), U/L	19 (15 to 30) [n = 148]	19 (13 to 28) [n = 145]	−0.1 (−3.6 to 3)
Troponin T (8 h), ng/L[j]	884 (522 to 1586) [n = 99]	944 (586 to 1648) [n = 110]	60.5 (226.16 to 385.7)
Troponin I (24 h), ng/L[k]	662 (387 to 1148) [n = 106]	636 (412 to 1125) [n = 111]	−26 (−214.63 to 136.5)

Abbreviations: APACHE, Acute Physiology and Chronic Health

[f] SOFA evaluates 6 organ functions ranging from 0 (normal function) to 4

Adsorption médicament

Ann Thorac Surg. 2019 Jul;108(1):45-51. doi: 10.1016/j.athoracsur.2018.12.032. Epub 2019 Jan 23.

Cytosorb Adsorption During Emergency Cardiac Operations in Patients at High Risk of Bleeding.

Hassan K[1], Kannmacher J[2], Wohlmuth P[3], Budde U[4], Schmoeckel M[5], Geidel S[5].

55 patients avec CEC urgente traités par Ticagrelor ou Rivaroxaban
39 patients prospectifs traités par cytosorb VS 16 contrôles rétrospectifs

	CA Group		WA Group		
Variables	Ticagrelor (n = 32)	Rivaroxaban (n = 7)	Ticagrelor (n = 11)	Rivaroxaban (n = 5)	*p* Value
Desmopressin treated	21 (65.6)	4 (57.1)	11 (100)	5 (100)	0.4780
Rethoracotomy rate	0 (0)	0 (0)	4 (36.4)	2 (40)	0.0003
Drainage volume in 24 hours	350 (300–450)	390 (310–430)	890 (630–1,025)	600 (590–1,000)	0.0037
ntensive care, days	2 (1–3)	2 (2–3)	3 (2–4)	6 (5–6)	0.0141
Total length of stay, days	11 (9–12)	11 (10–13)	14 (10–16)	18 (18–20)	0.0244

Saignement, transfusion et reprises plus importantes dans groupe controle

Adsorption médicament

> Am Heart J. 2021 Nov 1;245:19-28. doi: 10.1016/j.ahj.2021.10.188. Online ahead of print.

Rationale and design of the safe and timely antithrombotic removal – ticagrelor (STAR-T) trial: A prospective, multi-center, double-blind, randomized controlled trial evaluating reductions in postoperative bleeding with intraoperative removal of ticagrelor by the drugsorb™-ATR device in patients undergoing cardiothoracic surgery within 48 hours from last ticagrelor dose

C Michael Gibson [1], Michael J Mack [2], Victoria T Lee [3], David J Schneider [4], Frank W Sellke [5], E Magnus Ohman [6], Vinod H Thourani [7], Gheorghe Doros [8], Hans Kroger [3], Donald E Cutlip [9], Efthymios N Deliargyris [3]

Adsorption antibiotiques

Ann Intensive Care. 2022; 12: 44.
Published online 2022 May 23. doi: 10.1186/s13613-022-01017-5
PMCID: PMC9124739
PMID: 35599248

Does the cytokine adsorber CytoSorb® reduce vancomycin exposure in critically ill patients with sepsis or septic shock? a prospective observational study

Christina Scharf,[1] Ferdinand Weinelt,[2,3] Ines Schroeder,[1] Michael Paal,[4] Michael Weigand,[4] Michael Zoller,[1] Michael Irlbeck,[1] Charlotte Kloft,[2] Josef Briegel,[1] and Uwe Liebchen[✉1,2]

Conclusion

Go to:

The use of CytoSorb® leads to a clinically significant adsorption of vancomycin (max. 572 mg) in critically ill patients with sepsis or septic shock. We recommend the administration of an additional dose of 500 mg vancomycin over 2 h to avoid subtherapeutic vancomycin exposure.

Conclusion hémoadsorption

- Technique récente
- Littérature foisonnante faible niveau de preuve du bénéfice lié à l'imunomodulation, en chirurgie cardiaque et chez patients « médicaux », études randomisées discordantes
- Intéressant sur adsorption ticagrelor et rivaroxaban (apixaban?)
- Adsorption de médicaments utiles?

Ventilation per CEC

Cours à venir

Insufflation de CO_2

Rationnel

-Remplacer l'air ambiant dans la cavité thoracique par du CO_2, +lourd + soluble dans le sang et + rapidement absorbé par les tissus.

-Vise à minimiser la présence de bulles d'air dans le sang susceptibles de provoquer des complications de type embolie gazeuse

Rationnel

J Thorac Cardiovasc Surg. 2006 Nov;132(5):1119-25.

Short-term changes in cerebral activity in on-pump and off-pump cardiac surgery defined by functional magnetic resonance imaging and their relationship to microembolization.

Abu-Omar Y[1], Cader S, Guerrieri Wolf L, Pigott D, Matthews PM, Taggart DP.

- 25 patient avec PAC CEC et 25 cœurs battant
- Association entre quantité d'emboles gazeux (doppler TC) et activation préfrontale à l'IRM fonctionnel à 1 mois

Rationnel

Circulation. 2004 Mar 9;109(9):1127-32. Epub 2004 Feb 23.

Effect of CO2 insufflation on the number and randomized clinical trial.

Svenarud P[1], Persson M, van der Linden J.

10 patients CO_2 VS 10 contrôles, detection micrembols par ETO au déclampage (lues en aveugle)

TABLE 2. No. of Microemboli According to Transesophageal Echocardiographic Evaluation of the Left Atrium and Ventricle and the Proximal Part of the Ascending Aorta

	No. of Microemboli		
Study Period/Area of Interest	Group Control (n=10)	Group CO_2 (n=10)	*P*
From release of cross-clamp until 20 minutes after end of CPB			
LA	340 (300/393)	69 (39/129)	<0.001
LV	254 (173/334)	68 (59/112)	<0.001
Ao	184 (155/244)	56 (19/78)	<0.001
LA+LV+Ao	723 (634/895)	161 (149/310)	<0.001
First 15 minutes after release of cross-clamp			
LA	224 (108/336)	36 (16/69)	<0.01
LV	131 (77/170)	43 (24/61)	<0.001
Ao	81 (71/111)	25 (11/33)	<0.001
LA+LV+Ao	414 (316/597)	101 (67/143)	<0.001
Last 10 minutes of CPB			
LA	72 (27/193)	17 (9/41)	<0.01
LV	50 (36/82)	21 (9/30)	<0.001
Ao	47 (30/87)	16 (5/26)	<0.01
LA+LV+Ao	179 (92/327)	66 (22/88)	<0.001
First 20 minutes after end of CPB			
LA	94 (40/141)	8 (4/32)	<0.01
LV	73 (14/175)	12 (2/33)	0.01
Ao	56 (16/105)	13 (1/19)	<0.01
LA+LV+Ao	221 (67/418)	32 (8/77)	<0.01

Values are given as median (25th/75th percentile). LA indicates left atrium; LV, left ventricle; and Ao, aorta.

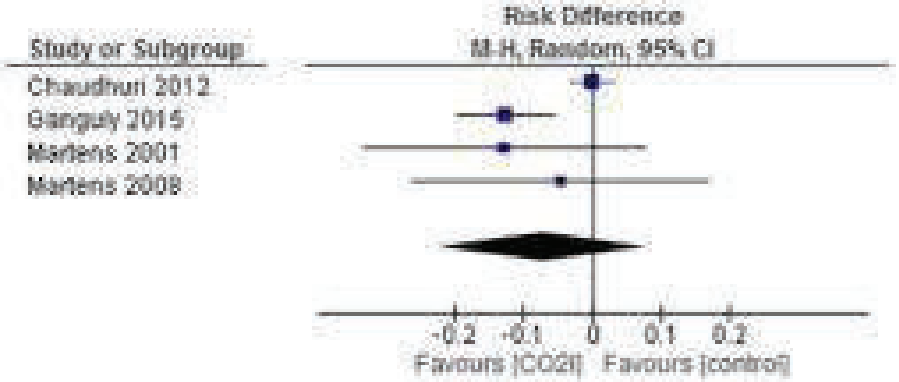
Littérature

Semin Thorac Cardiovasc Surg. 2017 Autumn;29(3):301-310. doi: 10.1053/j.semtcvs.2017.05.002. Epub 2017 May 23.

Carbon Dioxide Insufflation During Cardiac Surgery: A Meta-analysis of Randomized Controlled Trials.

Benedetto U[1], Caputo M[2], Guida G[2], Bucciarelli-Ducci C[2], Thai J[2], Bryan A[2], Angelini GD[2].

- 8 études à la méthodologie différentes+++
- Pas de différence sur le déclin cognitif



Direct visualization of carbon dioxide field flooding: Optical and concentration level comparison of diffusor effectiveness

Stijn Vandenberghe, PhD, David Iseli, BSc, and Stefanos Demertzis, MD

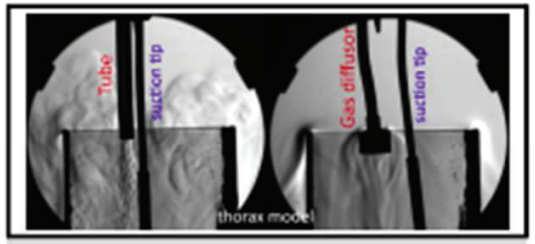
ABSTRACT

Objective: Carbon dioxide field flooding during open-heart surgery is intended to avoid blood-air contact, bubble formation, and embolism, and therefore potential neurologic and other ischemic complications. The inert gas is invisible, and thus its use and effectiveness are heavily debated. We intended to provide better insight in the behavior of the gas via direct concentration measurements and visualization of the gas cloud.

Methods: A transparent rectangular model of the open thorax was created, foreseen with carbon dioxide concentration sensors in 2 locations (atrial and aortic incisions), and placed in an optical test bench that amplifies the diffraction gradients. Six different commonly used carbon dioxide diffusors (3 commercial, 3 improvised) were tested with different flow rates of gas delivery (1, 4, 7, 10 standard liter per minute [SLPM]) and combined with the application of suction.

Results: The imaging reveals that commercially available diffusors generally create less turbulent flow than improvised diffusors, which is supported by the concentration measurements where improvised diffusors cannot generate a 100% carbon dioxide atmosphere at the aorta incision location. The atrial incision is easier to protect: 0% air with all commercial devices for all flow rates greater than 1 SLPM. A flow rate of 1 SLPM does not create an inert atmosphere with any device.

Conclusions: The optically observed carbon dioxide atmosphere is unstable and influenced by many factors. The device used for diffusion and the flow rate are important determinants of the maximum gas concentration that can be achieved, as is the location where this is measured. (J Thorac Cardiovasc Surg 2020;159:958-68)



CO_2 flow at 10 SLPM from an improvised delivery tube (L) versus a commercial diffusor (R).

Central Message

CO_2 field flooding is not well understood. We provided insight in diffusor effectiveness via visualization and concentration measurements and demonstrated an unstable CO_2 atmosphere.

Perspective

Many misunderstandings exist about CO_2 field flooding, mainly because the gas cannot be observed. This engineering study literally reveals the gas behavior, and the observations are corroborated by instantaneous concentration measurements. The reported findings should be mostly of interest to cardiac surgeons, who can easily improve cerebral protection of their next patient.

See Commentaries on pages 969 and 970.

Littérature

Randomized Controlled Trial > J Cardiovasc Surg (Torino). 2022 Jun;63(3):369-375.
doi: 10.23736/S0021-9509.22.12004-5. Epub 2022 Mar 28.

Warm humidified CO2 insufflation improves pericardial integrity for cardiac surgery: a randomized control study

Reny Segal [1 2], Paul M Mezzavia [1], Roni B Krieser [1], Shienny Sampurno [3], Michael Taylor [3], Robert Ramsay [2 3], Michael Kluger [1], Keat Lee [1 2], Francis L Loh [1], James Tatoulis [1 2], Michael O'Keefe [1 2], Yinwei Chen [1], Teresa Sindoni [1], Irene Ng [4 2]

Conclusions: Humidified warm CO<inf>2</inf> insufflation significantly reduced pericardial epithelial damage when compared to dry cold CO<inf>2</inf> insufflation in open-chamber cardiac surgery. Further studies are warranted to investigate its potential clinical benefits.

Littérature

BMJ Open. 2023; 13(5): e074221.
Published online 2023 May 17. doi: 10.1136/bmjopen-2023-074221
PMCID: PMC10193051
PMID: 37197819
Protocol

Efficacy and safety of carbon dioxide insufflation for brain protection for patients undergoing planned left-sided open heart valve surgery: protocol for a multicentre, placebo-controlled, blinded, randomised controlled trial (the CO2 Study)

Rachel Todd,[✉1] Chris A Rogers,[2] Maria Pufulete,[2] Lucy Culliford,[2] Pieter Pretorius,[3] Natalie Voets,[3] Enoch Akowuah,[4] Rana Sayeed,[5] Michelle Lazaroo,[2] Surinder Kaur,[1] Gianni D Angelini,[6,7] and Ben Gibbison[6,7]

Conclusion insufflation CO_2

-couramment utilisée pour réduire le risque d'embolie gazeuse

-n'a pas démontré d'effet significatif sur la réduction des complications neurologiques majeures dans les méta-analyses et essais randomisés contrôlés disponibles.
-necessite une adaptation du balayage (pendant et apres)
-perturbe l'utilisation du CO_2 gap per CEC

Merci !