

# RÉCUPÉRATION SANGUINE PEROPÉRATOIRE

*Spécificités en chirurgie cardio-vasculaire*

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**CHU  
BDX**

**ANESTHÉSIE-RÉANIMATION  
CARDIOVASCULAIRE**

**Extract from the 2022 ESC Guidelines  
on cardiovascular assessment and  
management of patients undergoing  
non-cardiac surgery - Patient Blood  
Management**

<b>Recommendations</b>	<b>Class<sup>a</sup></b>	<b>Level<sup>b</sup></b>
In patients undergoing surgery with expected blood loss of $\geq 500$ mL, use of washed cell salvage is recommended.	<b>I</b>	<b>A</b>
It is recommended to use point-of-care diagnostics for guidance of blood component therapy, when available.	<b>I</b>	<b>A</b>

Guidelines

Guidelines on enhanced recovery after cardiac surgery under cardiopulmonary bypass or off-pump<sup>☆,☆☆</sup>



**R5.2 — It is probably recommended to use an intraoperative cell saver to limit red blood cell transfusion in cardiac surgery.  
GRADE 2+ (STRONG AGREEMENT)**

# PRINCIPES (TRAITEMENT SÉQUENTIEL)

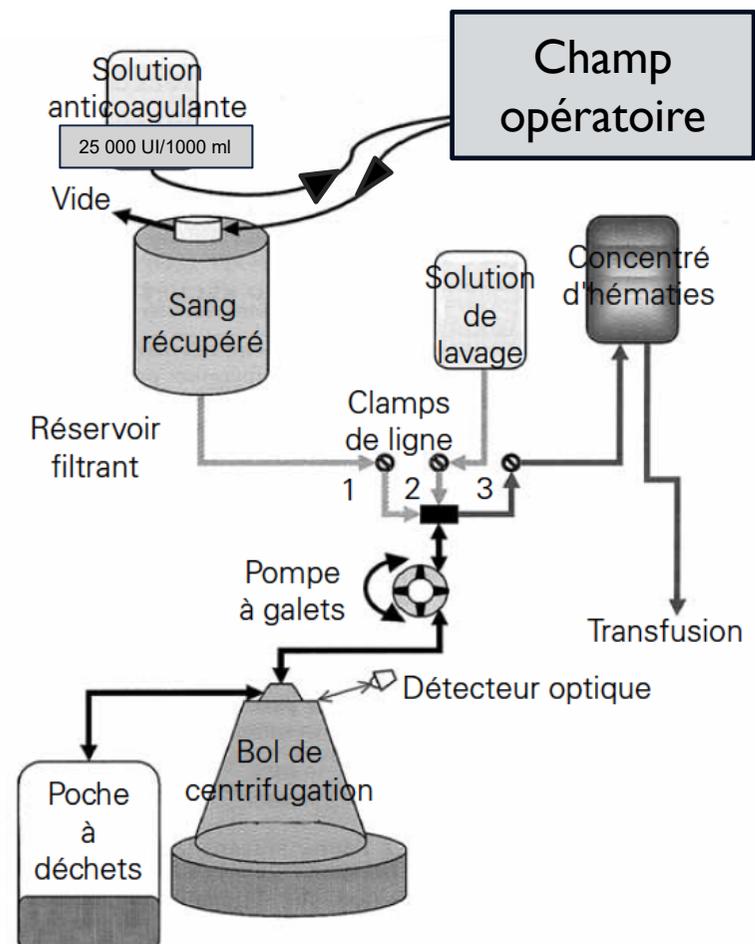
Système aspiratif (vide autonome ou mural) – **150-200 mmHg** permettant d'aspirer sang épanché (cristalloïdes) dans collecteur rigide ouvert (2500-3600 ml) avec filtration (**40-200 µm**)

Dilution continue du sang recueilli par cristalloïdes à une débit de **100 à 150 ml/min** (cristalloïdes hépariné)

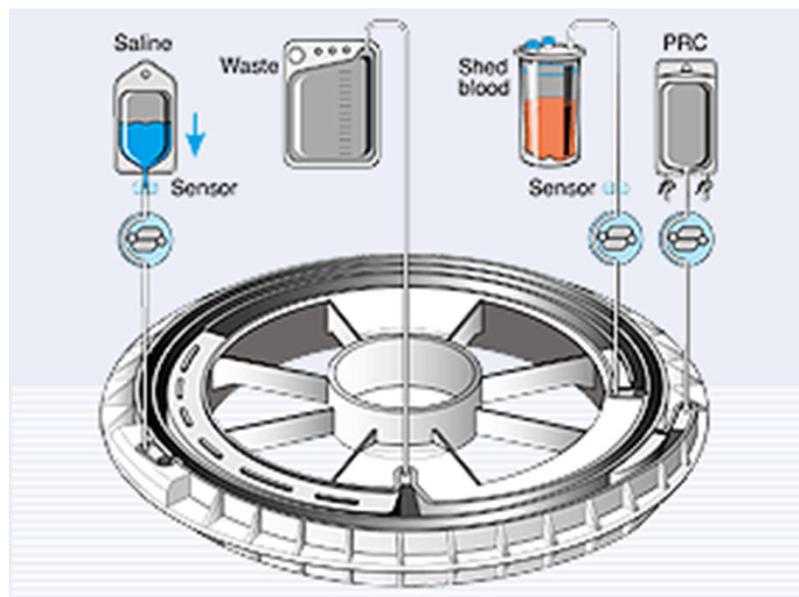
Concentration par centrifugation (**2500-5600 trm**) des éléments figurés dans bol (**70-225 ml**)

Lavage **500-800 ml/min** (cristalloïdes 1000 ml)

Restitution d'un concentré érythrocytes (**Hte 50-60%**)  
Transfusion au travers filtre anti-leucocytaire **200 µm**



## PRINCIPES (TRAITEMENT CONTINU)



Concentration et lavage continu ( $\geq 50$  ml et restitution à partir de 175 ml)



Autolog Medtronic

C.A.T.S Fresenius



Xtra Sorin



Haemonetics Elite



## PERFORMANCES COMPARÉE DES SYSTÈMES

Parameter	Sequestra* (Medtronic)	BRAT 2* (Cobe)	CATS* (Fresenius)	Cell Saver* (Haemonetics)	AUTOLOG* (Medtronic)	OrthoPAT* (Haemonetics)	Colloid ** sedimentation
RBC recovery; %	65 - 76	71 - 93	51 - 87	64 - 94	79	80	90
WBC removal; %	31 - 78	30	45 - 80	22 - 55	78	72	60
PLT removal; %	87 - 93	68	92 - 96	86 - 87	99	88	48
PFHB removal; %	89	63	65 - 95	85 - 93	92	96	53
TP or ALB removal; %	97 - 98	91 - 93	93 - 99	NA	NA	97	76
K <sup>+</sup> removal; %	92	90	90 - 98	91	89	97	NA
Cytokine removal; %	95	95	95	91 - 95	NA	90	70 - 77

Values are minimum – maximum interval. CATS: continuous autotransfusion system; RBC: red blood cells; WBC: leucocytes; PLT: platelets; PFHB: plasma free haemoglobin; TP: total protein; ALB: albumin. NA: not assessed. References: \* (68-77), \*\* (51).

## PERFORMANCES COMPARÉE DES SYSTÈMES

Parameter	Sequestra* (Medtronic)	BRAT 2* (Cobe)	CATS* (Fresenius)	Cell Saver* (Haemonetics)	AUTOLOG* (Medtronic)	OrthoPAT* (Haemonetics)	Colloid ** sedimentation
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TP or ALB removal; %	97 - 98	91 - 93	93 - 99	NA	NA	97	76
K <sup>+</sup> removal; %	92	90	90 - 98	91	89	97	NA
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Values are minimum – maximum interval. CATS: continuous autotransfusion system; RBC: red blood cells; WBC: leucocytes; PLT: platelets; PFHB: plasma free haemoglobin; TP: total protein; ALB: albumin. NA: not assessed. References: \* (68-77), \*\* (51).

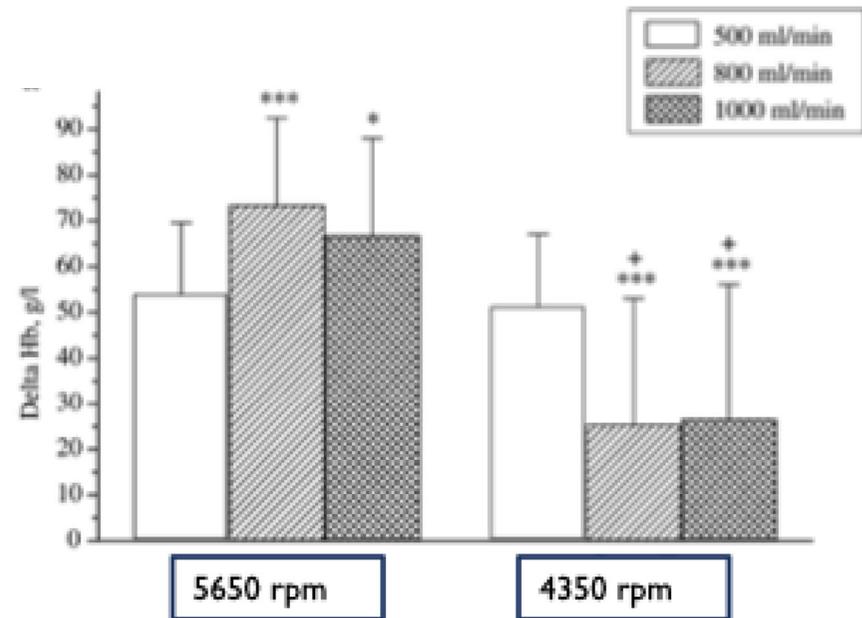
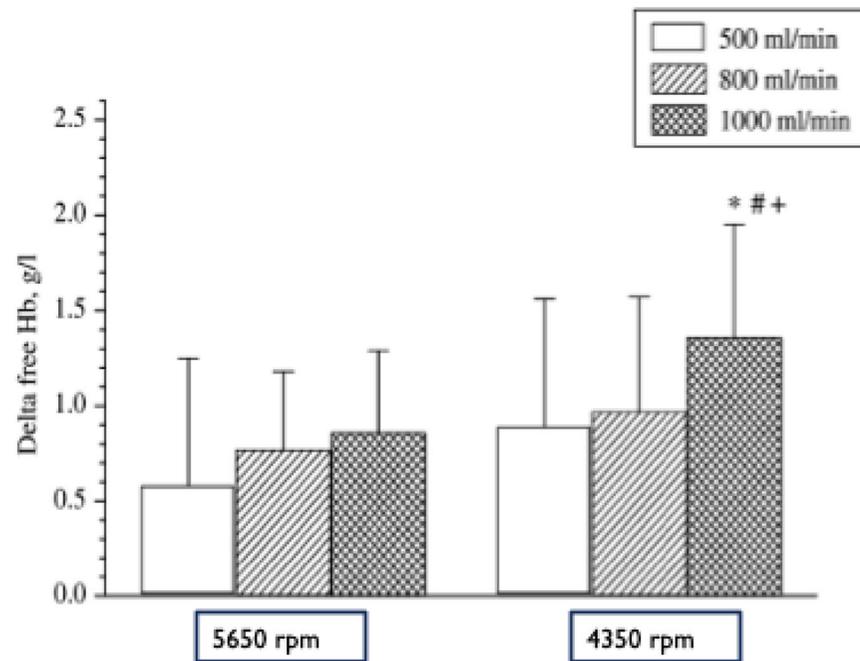
## HÉMOLYSE INDUITE....

Tests	Increase in plasma-free hemoglobin from baseline (mg/dL)	Relative hemolysis (%)
Surgical surface at 100 mm Hg† (n = 10)	135.5 ± 35.9	1.02 ± 0.27
Surgical surface at 300 mm Hg* (n = 10)	304.3 ± 60.6	2.29 ± 0.46
Surgical surface at 300 mm Hg + dilution (n = 10)	119.3 ± 15.0	0.90 ± 0.11
Beaker at 100 mm Hg (n = 10)	36.0 ± 12.8	0.27 ± 0.10
Beaker at 300 mm Hg (n = 10)	63.9 ± 15.2	0.48 ± 0.11
Beaker at 300 mm Hg + dilution (n = 10)	27.7 ± 8.6	0.21 ± 0.06

Data presented as Mean ± SEM.

- Eviter aspiration -150 à -200 mmHg
- Limiter aspiration simultanée d'air
- Maintenir dilution > 100 ml/h (1 goutte/2 sec minimal)

## Vitesse de centrifugation et débit de lavage

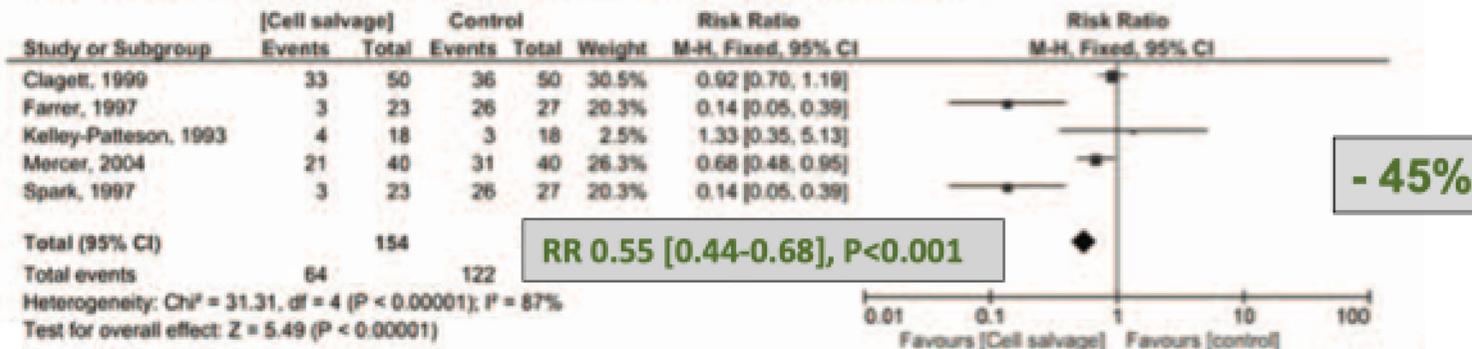


# Washed cell salvage in surgical patients

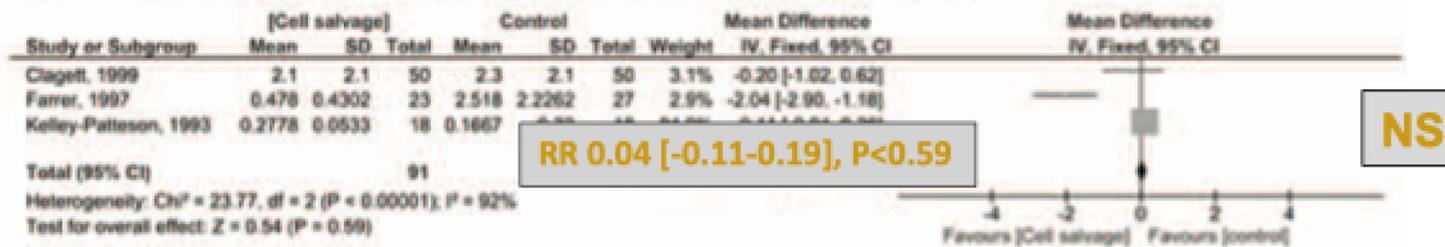
A review and meta-analysis of prospective randomized trials under PRISMA

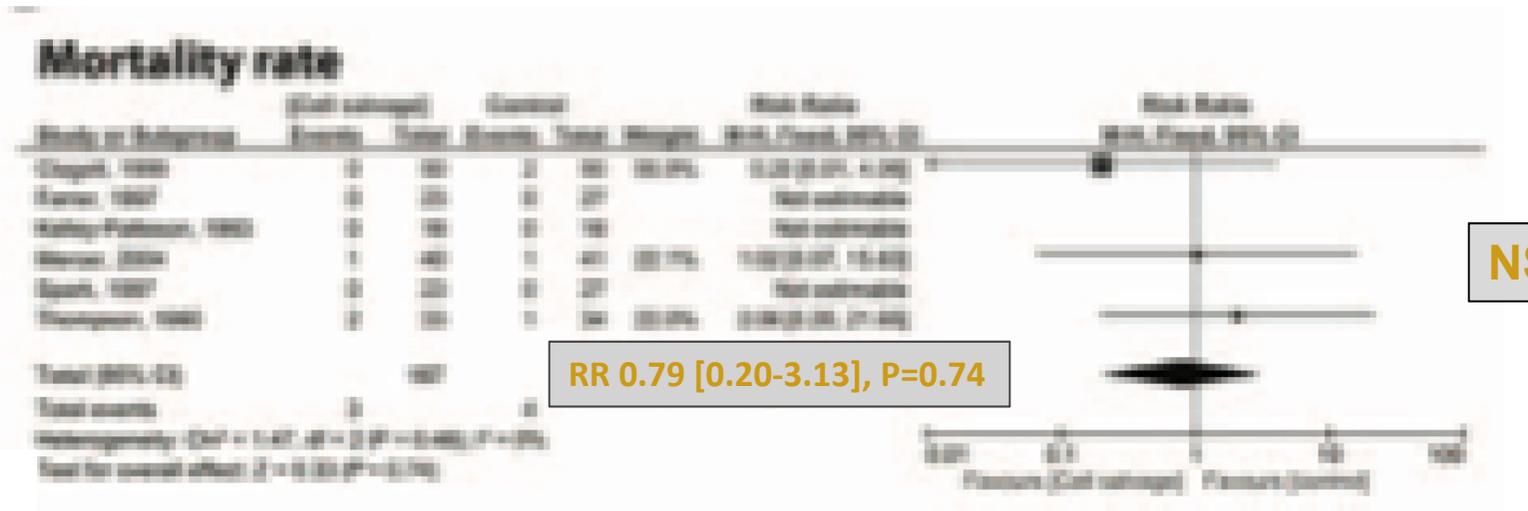
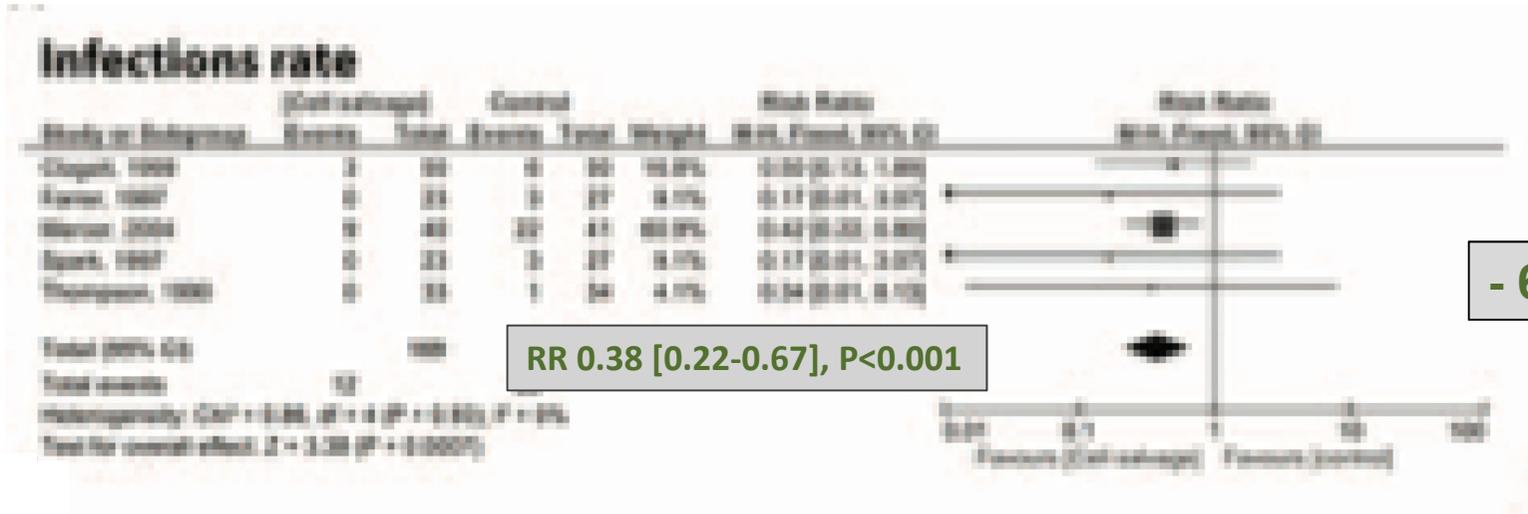
## Vascular surgery

### Number of patients exposed to allogeneic RBC



### Number of units of allogeneic RBC per patient





REVIEW ARTICLE

**Impact of cell saver during cardiac surgery on blood transfusion requirements: a systematic review and meta-analysis**

Méta-analyse sur études randomisées (>2010)

Chirurgie cardiaque (PAC isolé et chirurgie valvulaire)

Exclusion chirurgie aorte ascendante et redo (faible risque hémorragique)

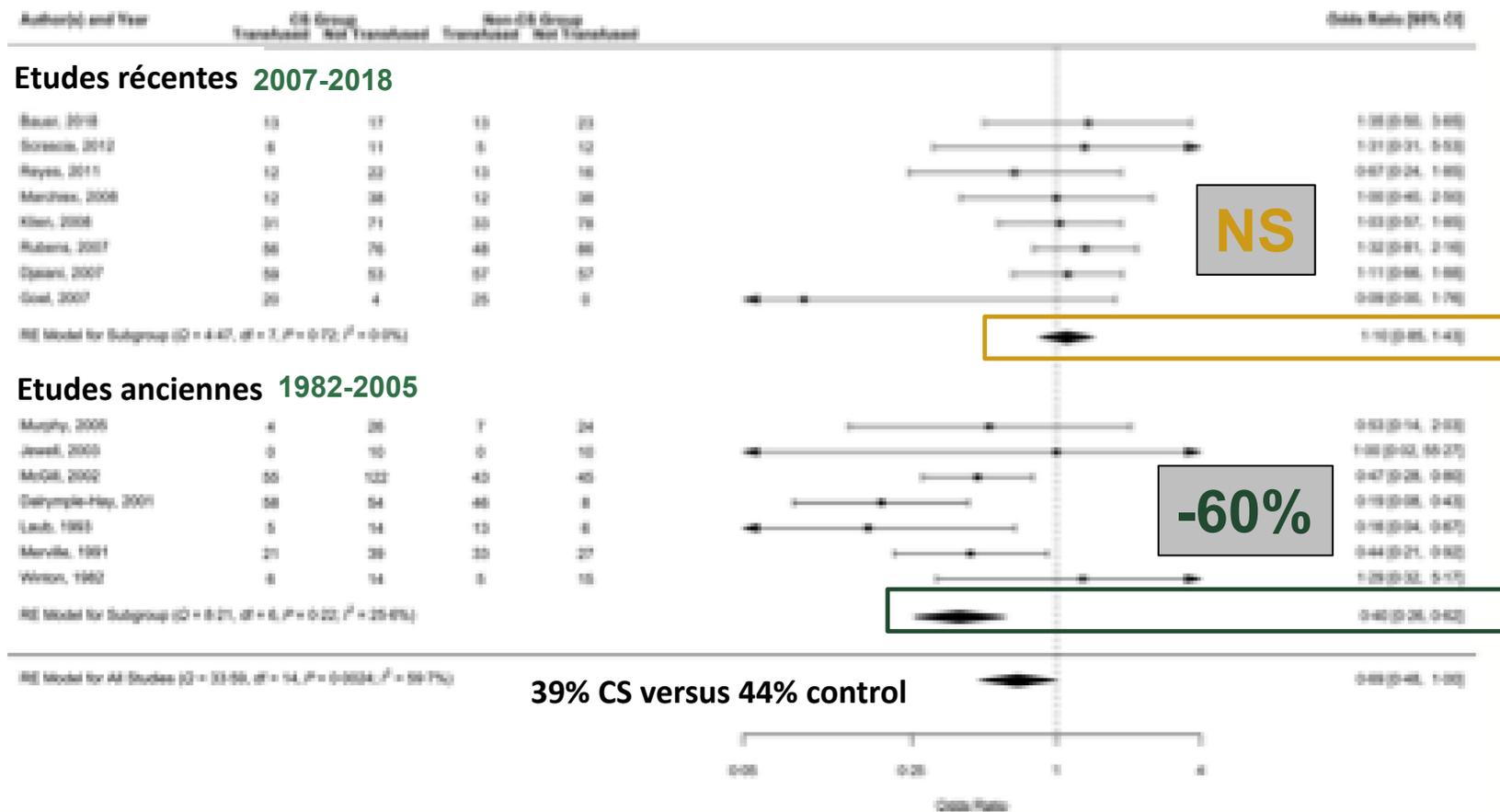
Recours périopératoires aux produits sanguins labiles (pas de notion d'unités ni volume)

15 études dans l'analyse finale (n=1727)

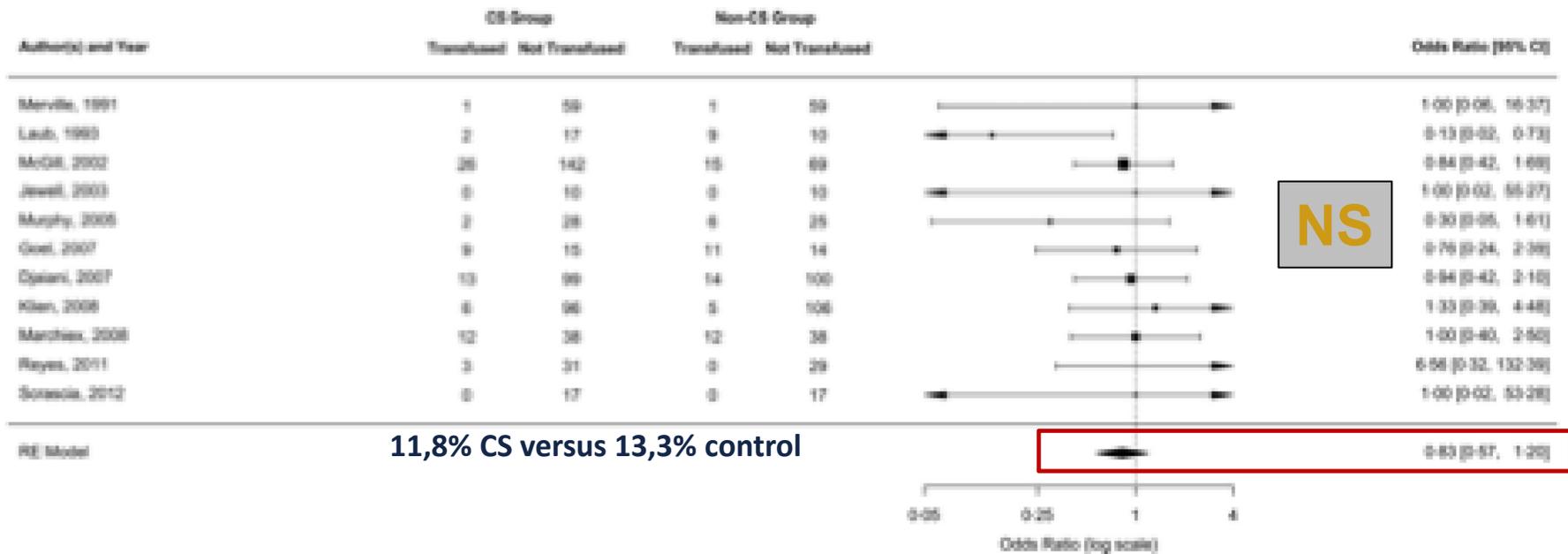
Traitement **sang épanché** + **volume résiduel CEC** (6 études).

Volume retransfusé **105-715 ml**

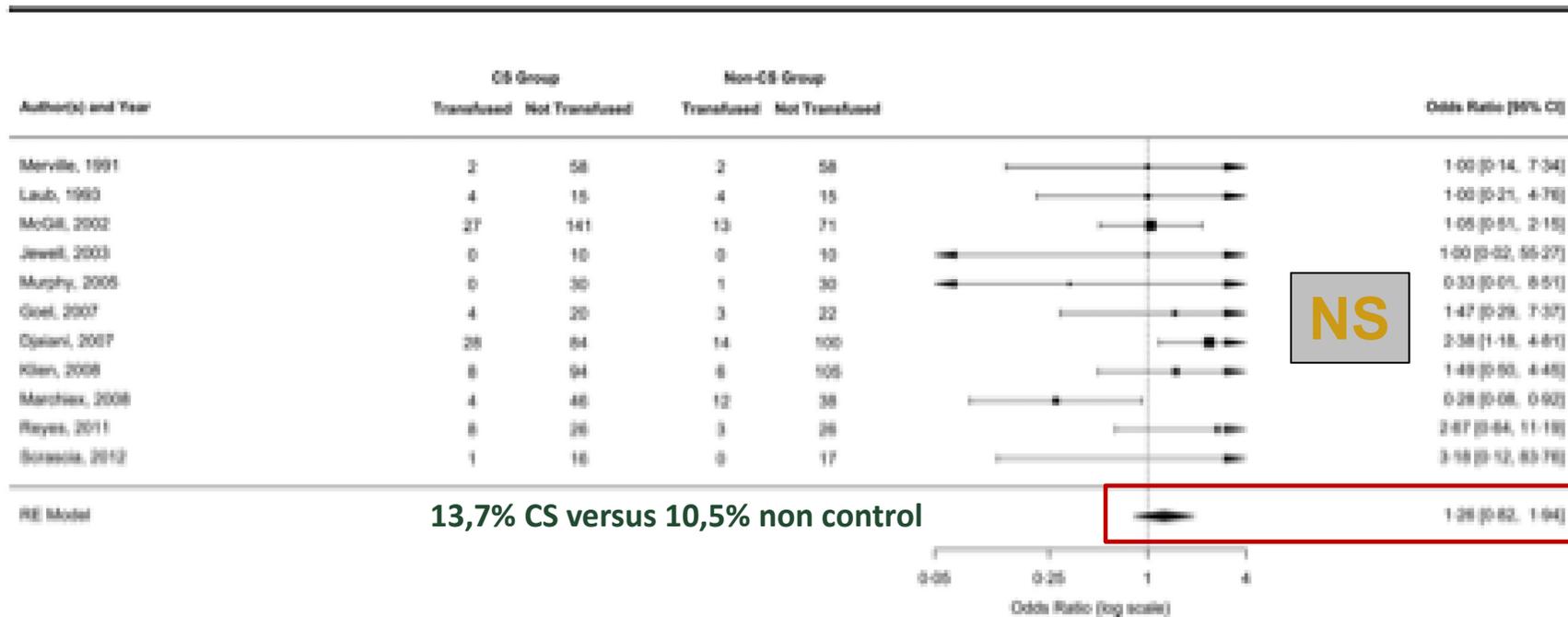
# Transfusion périopératoire de concentré globules rouges



Transfusion périopératoire plaquettes (11 études)



# Transfusion périopératoire plasma frais congelé (11 études)



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



The Task Force on Patient Blood Management for Adult Cardiac Surgery of the European Association for Cardio-Thoracic Surgery (EACTS) and the European Association of Cardiothoracic Anaesthesiology (EACTA)

*Background.* Cell salvage of operative blood loss and residual blood from the circuit after CPB may contribute to a reduction in the use of allogeneic blood products, especially PRBCs. A specific rationale for cell salvage is its use during CPB instead of cardiotomy suction, since the retransfusion of whole blood using cardiotomy suction through the ECC may contribute to systemic inflammation and bleeding.

## VOLUME À RÉCUPERER CONSÉQUENT

- Sang épanché du site chirurgical (médiastin, plèvre, rétropéritoine...)
- Volume résiduel de la CEC (500-600 ml)
- Volume du saignement postopératoire (?)



# SOUPE INFLAMMATOIRE PÉRICARDIQUE

Interface air/sang

Activation coagulation (surexpression FT)

Activité fibrinolytique excessive (t-PA)

Produits de dégradation de la fibrine

Hémolyse (hémoglobine libre)

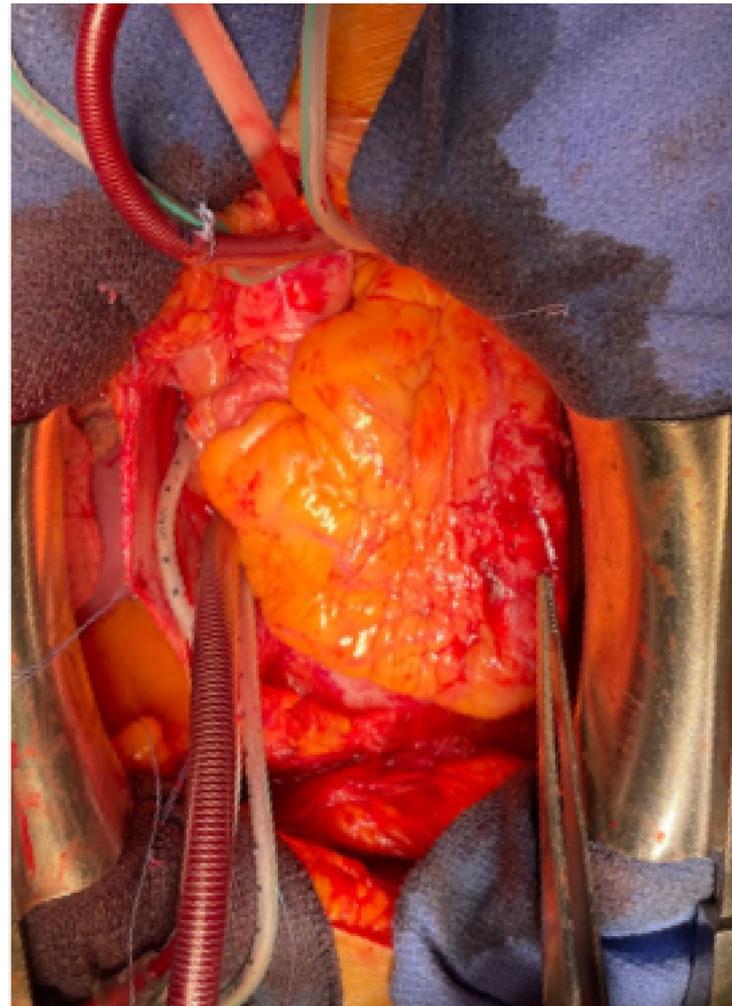
Microparticules graisseuses (dissection sous-cutanée, sternotomie, péricardotomie, prélèvement mammaire....)

Débris osseux

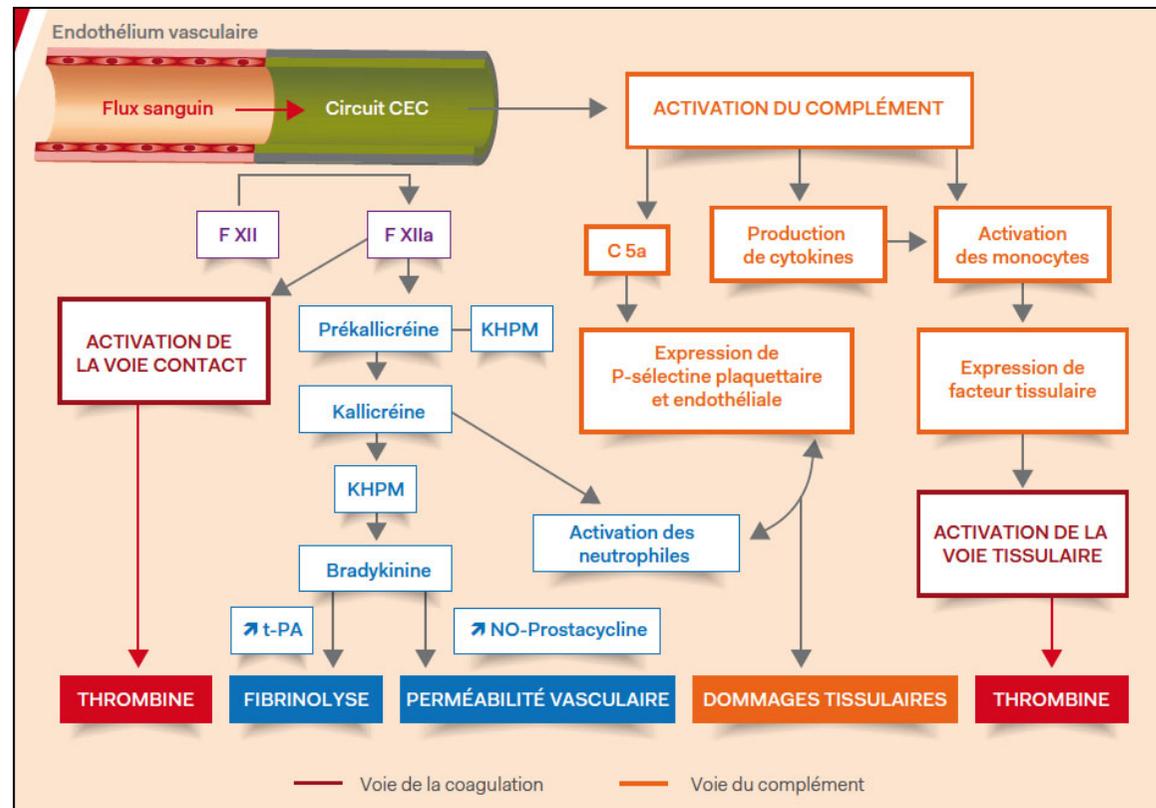
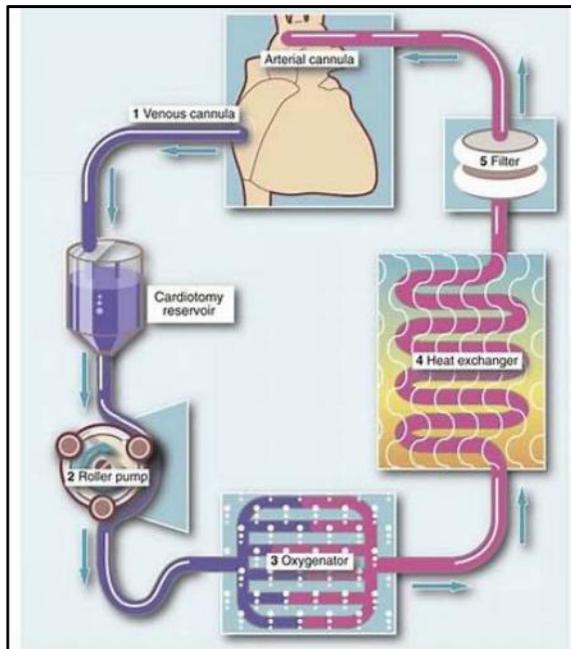
Héparine

Cytokines pro et anti-inflammatoires

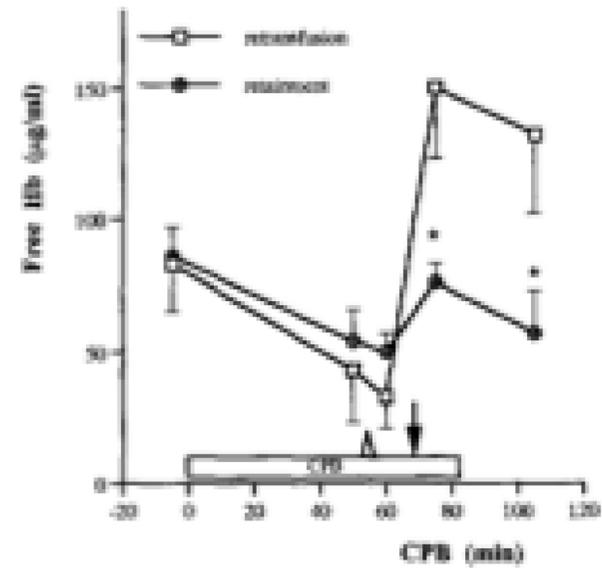
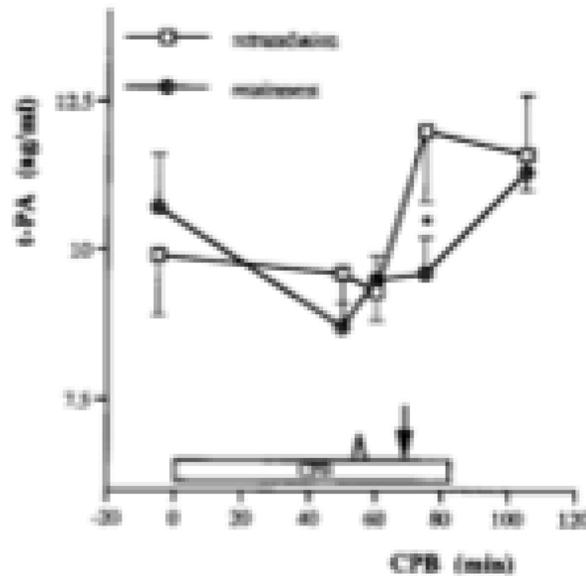
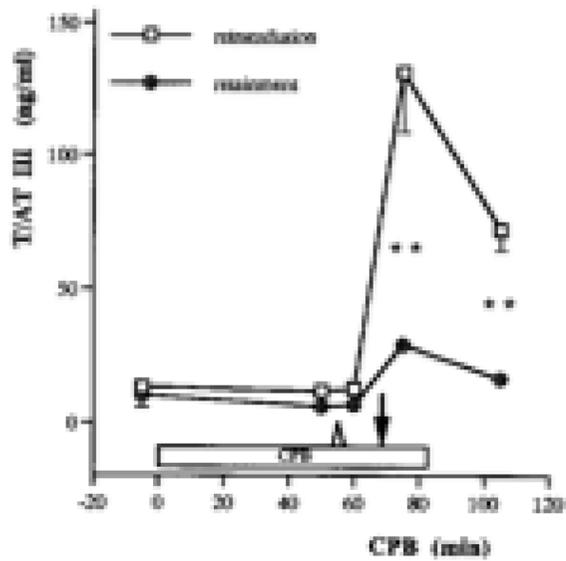
Protéines...



# CIRCULATION EXTRA-CORPORELLE



## SEQUESTRATION DES ASPIRATIONS MÉDIASTINALES?



**Table 2: Cytokines in cardiotomy suction blood and in the systemic circulation at the same time point (n = 25)**

	Cardiotomy suction blood	Systemic circulation	P-value
IL-1Ra (pg/ml)	312 (88-1534)	82 (32-309)	<0.001
IL-4 (pg/ml)	<2 (<2-7.2)	<2 (<2)	0.43
IL-10 (pg/ml)	19.7 (<2-113)	31 (<2-122)	0.21
IL-6 (pg/ml)	210 (13-2678)	45 (3-1119)	<0.001
TNF- $\alpha$ (pg/ml)	4.3 (<2-40)	2.5 (<2-62)	0.033
IL-6-to-IL-10 ratio	10.2 (1.1-75)	1.7 (0.2-24)	<0.001

**Table 3: Cytokines in cardiotomy suction blood before and after cell-saver processing (n = 13)**

	Before cell salvage	After cell salvage	P-value
IL-1Ra (pg/ml)	260 (88-526)	73 (28-359)	0.002
IL-4 (pg/ml)	<2 (<2)	<2 (<2-3.0)	0.18
IL-10 (pg/ml)	17 (8.4-62)	7 (<2-27)	0.011
IL-6 (pg/ml)	140 (13-2678)	57 (<1-760)	0.10
TNF- $\alpha$ (pg/ml)	4.3 (<2-39)	<2 (<2-15)	0.008

The values represent the median and range.

IL: interleukin; TNF: tumour necrosis factor.

## Cell Saver for On-pump Coronary Operations Reduces Systemic Inflammatory Markers: A Randomized Trial

Sune Damgaard, MD, PhD, Claus H. Nielsen, MD, PhD, Lars W. Andersen, MD, DMSc,  
Klaus Bendtzen, MD, DMSc, Michael Tvede, MD, and Daniel A. Steinbrüchel, MD, DMSc

Departments of Cardiothoracic Surgery, Anesthesiology, Clinical Microbiology and the Institute for Inflammation Research,  
Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark

Table 2. Concentrations of Inflammatory Markers

Marker	Group	Induction	Cross-clamp		After Cardiopulmonary Bypass				Interactive
			Before	After	5 Minutes	6 Hours <sup>a</sup>	24 Hours	72 Hours	
Median (IQR) pg/mL									
IL-6	Cell saver	0 (0-5)	0 (0-6)	13 (4-31)	38 (13-67)	112 (66-168)	89 (45-153)	38 (17-84)	0.021
	Control	0 (0-0)	3 (0-8)	17 (7-59)	51 (29-116)	228 (142-331)	90 (44-190)	44 (29-64)	
IL-8	Cell saver	6 (5-8)	6 (4-11)	15 (7-34)	17 (10-40)	23 (17-36)	17 (11-31)	11 (7-42)	0.058
	Control	7 (3-9)	8 (6-11)	23 (15-38)	28 (24-46)	42 (25-68)	18 (13-31)	18 (10-26)	
IL-10	Cell saver	0 (0-1)	0 (0-2)	6 (0-9)	9 (4-19)	2 (0-2)	0 (0-3)	0 (0-3)	0.530
	Control	0 (0-2)	1 (0-3)	7 (4-12)	10 (8-22)	3 (2-8)	3 (1-5)	2 (1-3)	
Median (IQR) ng/mL									
sTNF-RI	Cell saver	0.9 (0.8-1.8)	0.7 (0.5-1.1)	1.8 (1.5-2.4)	2.1 (1.5-2.8)	1.9 (1.1-2.7)	1.7 (1.2-2.7)	1.8 (1.5-4.4)	0.158
	Control	1.0 (0.8-1.6)	0.9 (0.5-1.2)	1.9 (1.7-2.5)	2.4 (1.8-2.9)	2.6 (1.2-3.8)	2.0 (1.1-2.9)	2.4 (1.8-4.1)	
sTNF-RII	Cell saver	2.5 (1.5-2.9)	1.6 (1.0-2.0)	3.0 (1.6-3.4)	3.0 (2.1-3.8)	3.4 (2.6-4.7)	2.8 (1.6-3.9)	3.1 (2.7-5.8)	0.40
	Control	2.4 (1.6-2.9)	1.5 (1.1-1.9)	2.8 (2.3-3.4)	3.5 (2.7-3.9)	4.4 (2.8-4.9)	3.3 (2.0-4.6)	3.6 (2.7-5.0)	
PCT	Cell saver	0.1 (0.1-0.2)	0.1 (0.1-0.1)	0.1 (0.1-0.1)	0.1 (0.1-0.2)	0.2 (0.2-0.6)	0.4 (0.3-1.1)	0.4 (0.2-2.3)	0.472
	Control	0.1 (0.1-0.1)	0.1 (0.1-0.1)	0.1 (0.1-0.1)	0.1 (0.1-0.2)	0.5 (0.3-1.0)	0.7 (0.3-1.4)	0.4 (0.3-0.8)	

## IL-6/IL-10

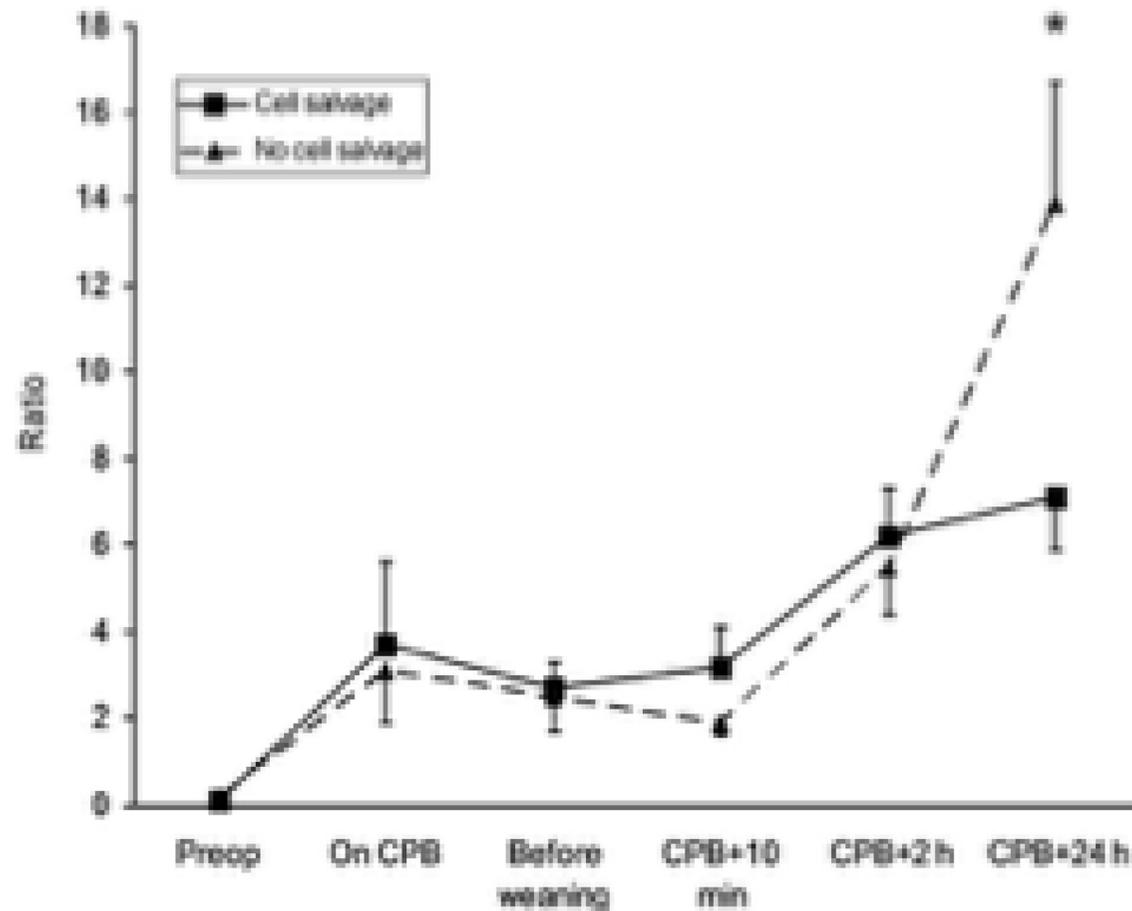
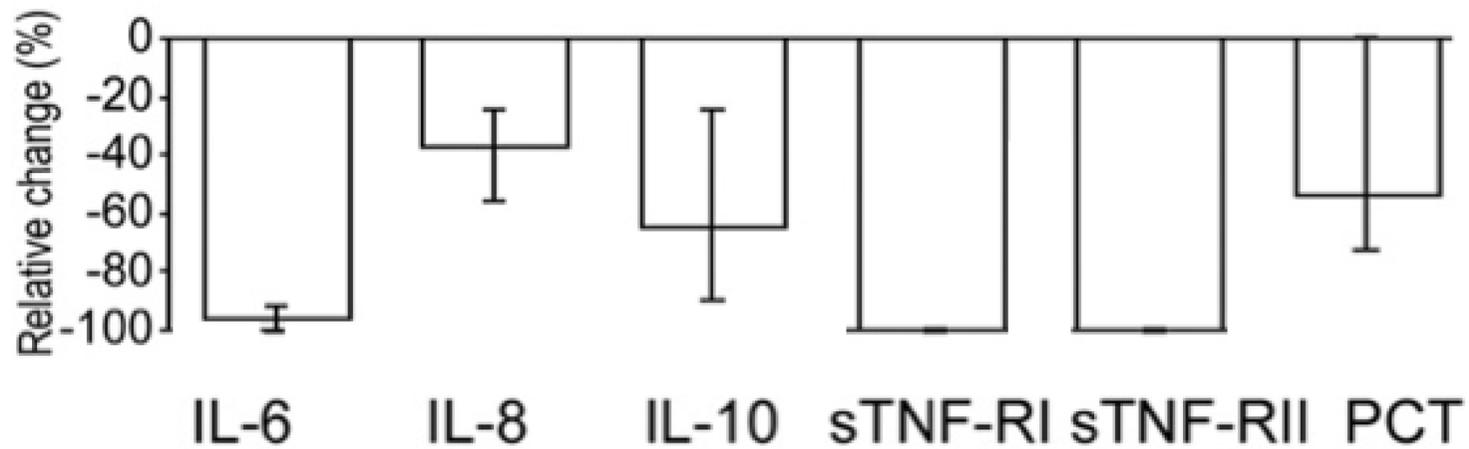


Figure 1: The mean IL-6-to-IL-10 ratio in patients where cardiomy suction blood was either cell salvaged or not before retransfusion. \* $P < 0.05$ . The vertical lines represent the standard deviations.

## RELATIVE CHANGES OF INFLAMMATORY MARKERS (BEFORE AND AFTER CELL SAVING)



## PERFORMANCES COMPARÉE DES SYSTÈMES

Parameter	Sequestra* (Medtronic)	BRAT 2* (Cobe)	CATS* (Fresenius)	Cell Saver* (Haemonetics)	AUTOLOG* (Medtronic)	OrthoPAT* (Haemonetics)	Colloid ** sedimentation
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Values are minimum – maximum interval. CATS: continuous autotransfusion system; RBC: red blood cells; WBC: leucocytes; PLT: platelets; PFHB: plasma free haemoglobin; TP: total protein; ALB: albumin. NA: not assessed. References: \* (68-77), \*\* (51).



# Postoperative Atrial Fibrillation Reduced by Intraoperative and Postoperative Cell Saver System in Coronary Artery Bypass Graft Surgery

Muharrem Koçyiğit<sup>1</sup>, Özgen Ilgaz Koçyiğit<sup>1</sup>, Ahmet Ümit Güllü<sup>2</sup>, Şahin Şenay<sup>2</sup>, Cem Alhan<sup>1</sup>

<sup>1</sup>Department of Anaesthesiology, Açıbadem Mehmet Ali Aydınlar University Vocational School of Health Services, Istanbul, Turkey

<sup>2</sup>Department of Cardiovascular Surgery, Açıbadem Mehmet Ali Aydınlar University Faculty of Medicine, Istanbul, Turkey

**Table 2. Logistic Regression Analysis of AF**

	Adjusted Odds Ratio	95% CI	P
Age >70 (years)	1.229	0.645-2.345	.534
Non-elective surgery	1.017	0.516-2.008	.960
EF <30%	1.391	0.288-6.712	.671
Euroscore $\geq$ 5	2.092	1.018-4.298	.045
Without cell-saver system	3.516	1.690-7.316	<.001

EF, ejection fraction.

# Processing Scavenged Blood With a Cell Saver Reduces Cerebral Lipid Microembolization

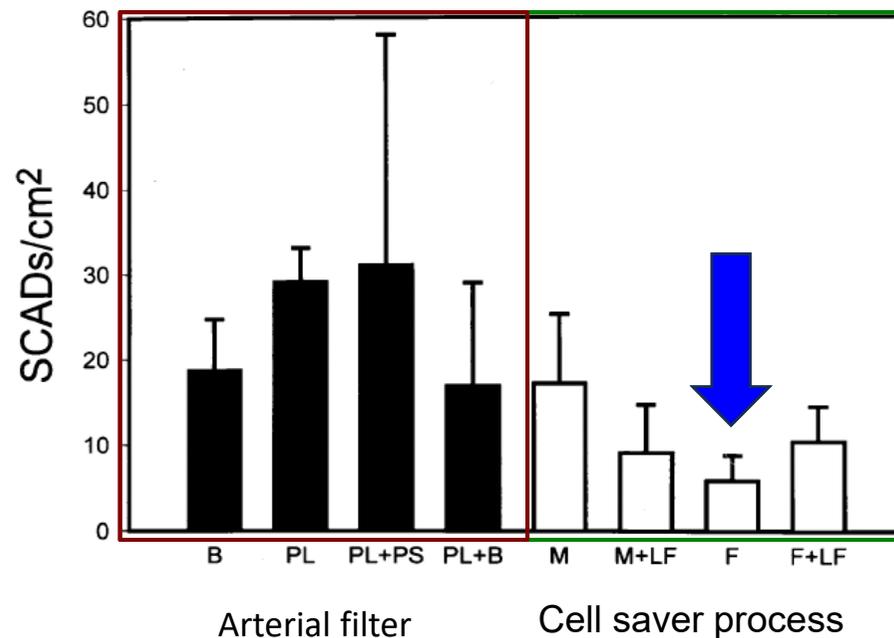
Rôle micro-emboli lipidiques

Morbidité neurologique (ischémie ou dysfonction cognitive) après chirurgie cardiaque sous CEC

Dilatation capillaire ou artériolaire (small capillary and arteriolar dilation SCADs)

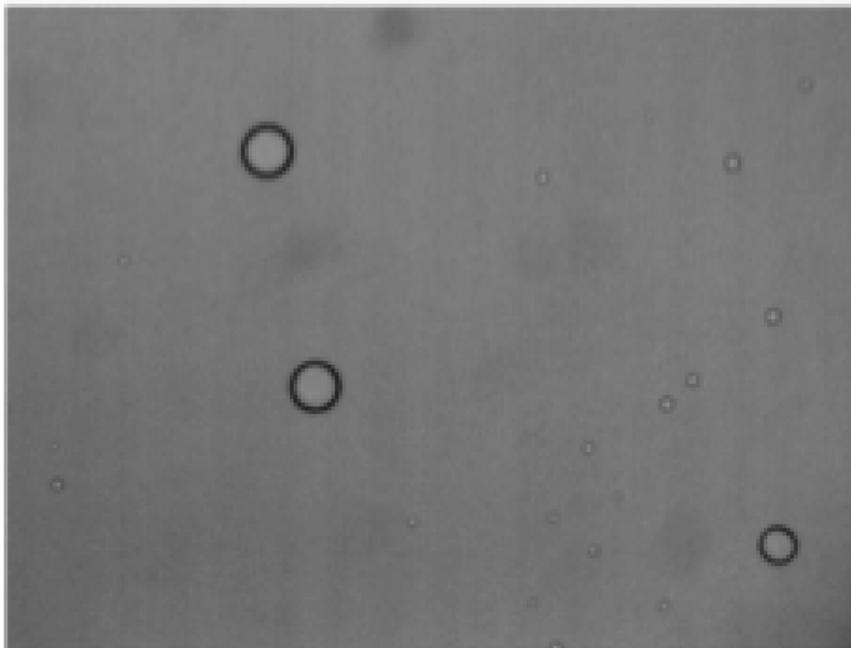
Etude expérimentale (comparative moyens de diminuer micro-emboli graisseux)

Filtre artériel versus cell saver



# Elimination of Fat Microemboli During Cardiopulmonary Bypass

Aditya K. Kaza, MD, Jeffrey T. Cope, MD, Steven M. Fiser, MD, Stewart M. Long, MD, John A. Kern, MD, Irving L. Kron, MD, and Curtis G. Tribble, MD



Fat microemboli after oil red O staining

## Fat micro emboli in processed blood

### Small (10-50 $\mu\text{m}$ in diameter)

- Pericardial blood 4.00 (saturation)
- **Cardiotomy group  $3.43 \pm 0.20$**
- **Cell saver group  $3.33 \pm 0.33$**
- **Dual filtration  $0.67 \pm 0.21$**
- Arterial blood  $1.86 \pm 0.14$  only for cardiotomy group

### Large ( $> 50 \mu\text{m}$ in diameter)

- Pericardial blood 4.00 (saturation)
- Cardiotomy group  $2.57 \pm 0.30$
- **Cell saver group  $1.50 \pm 0.22$**
- **Dual filtration  $0 \pm 0$**
- Arterial blood  $1.00 \pm 0.38$  only for cardiotomy group

## A Randomized Controlled Trial of Cell Salvage in Routine Cardiac Surgery

Etude randomisée (n=213)

Chirurgie cardiaque non urgente (PAC, valve, combinée)

Cell saver pour sang épanché et CEC (+ postopératoire) vs contrôle

Volume ré-infusé **342 ± 194 ml**

	Control (n = 111)	Cell salvage (n = 102)	P
Number of patients (%) requiring any RBC or FFP or PLT*	36/111 (32%)	33/102 (32%)	0.89
	Relative risk 1.00 (95% CI 0.63–1.60)		<b>NS</b>
<b>RBC</b>			
Patients requiring RBC	33 (30%)	31 (30%)	0.96
Total units in operating room	25	24	0.88
Total units in first 6 h	21	20	0.91
Total units >6 h	54	35	0.11
Total	100	79	0.32
	Relative risk 0.86 (95% CI 0.64–1.15)		
<b>FFP</b>			
Patients requiring FFP	6 (5%)	8 (8%)	0.66
Total units transfused	28	31	0.48
	Relative risk 1.20 (95% CI 0.72–2.00)		
<b>PLT</b>			
Patients requiring PLT	5 (5%)	6 (6%)	0.89
Total	14	7	0.19

CARDIOVASCULAR

2024 EACTS/EACTAIC/EBCP Guidelines on cardiopulmonary bypass in adult cardiac surgery

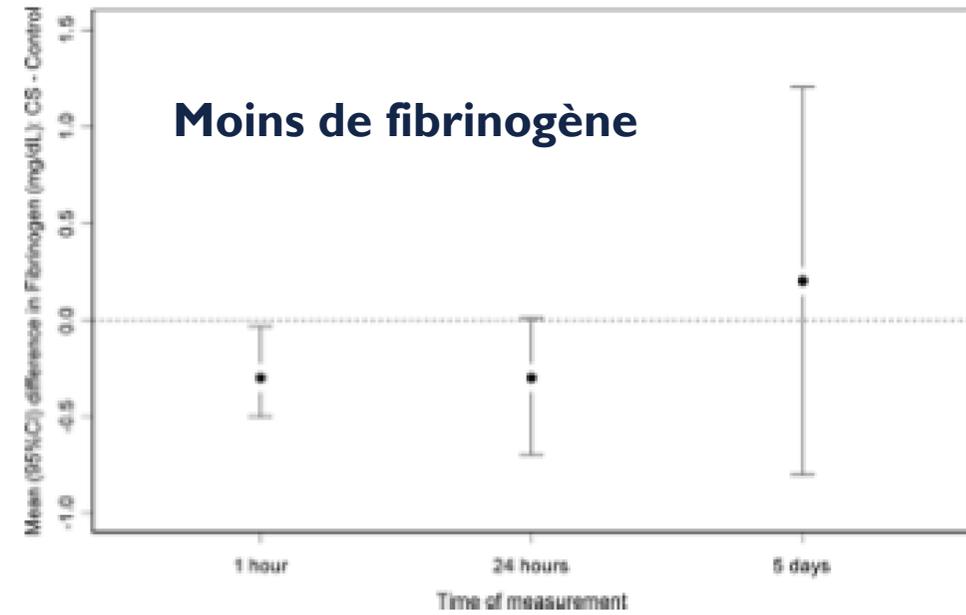
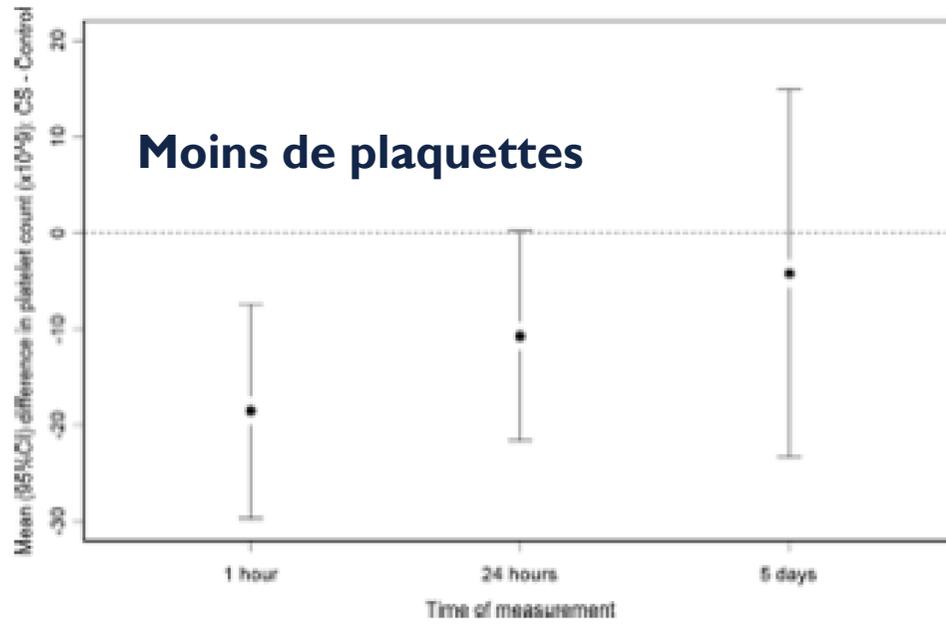


Recommendation Table 49 Recommendations for shed mediastinal blood management

Recommendations	Class <sup>a</sup>	Level <sup>b</sup>	Ref <sup>c</sup>
Discarding shed mediastinal blood should be considered.	IIa	B	711–713
Processing and secondary filtration of red blood cells, for example by use of red blood cell salvage, should be considered to decrease the deleterious effects of reinfused shed blood.	IIa	B	712,713

Recommendation Table 56 Recommendations for residual blood management

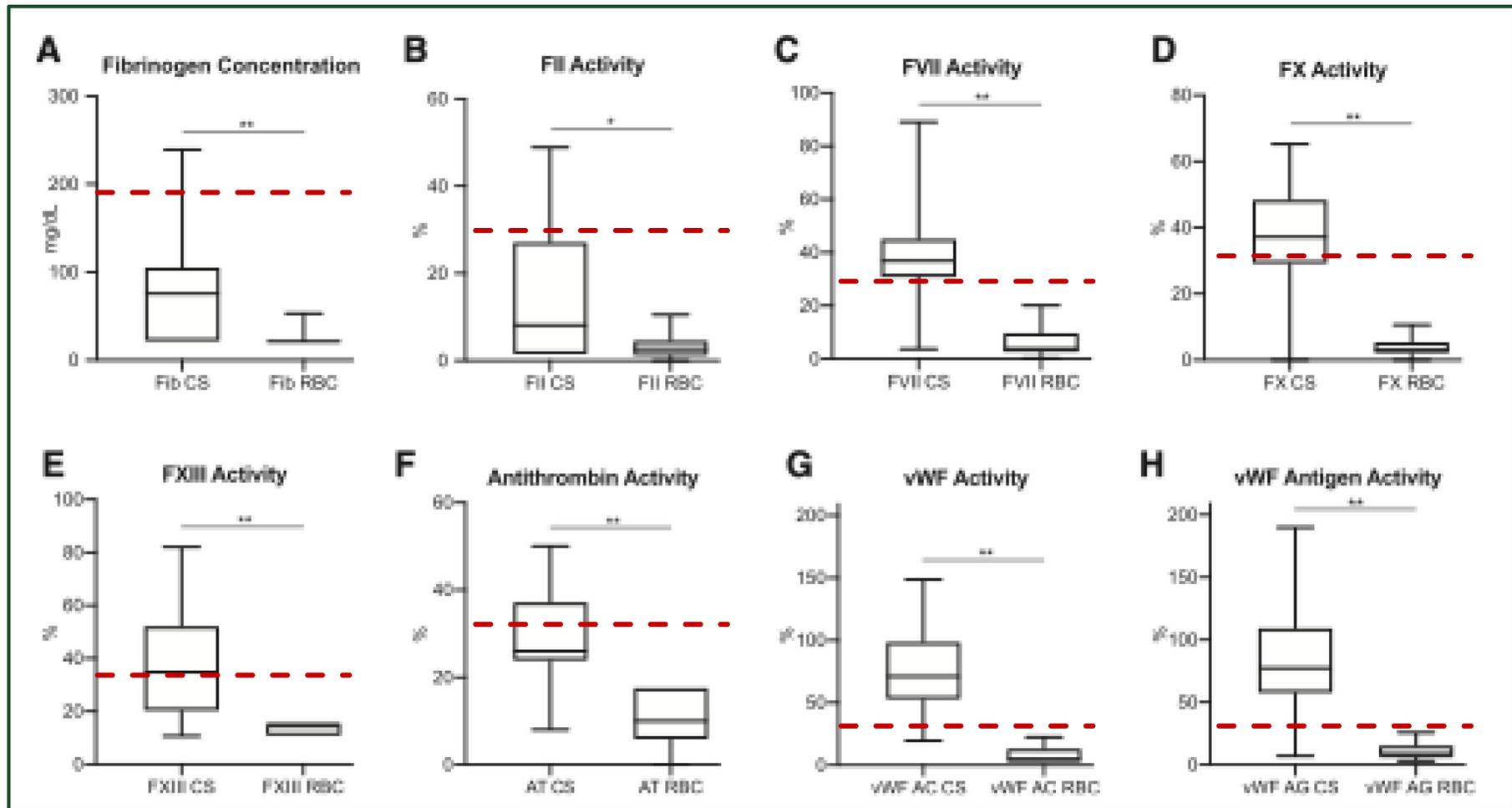
Recommendations	Class <sup>a</sup>	Level <sup>b</sup>	Ref <sup>c</sup>
Retransfusion of the residual volume of the CPB circuit at the end of the procedure is recommended as a part of a blood management programme to minimize allogeneic blood transfusions.	I	C	-
Retransfusion of the processed residual volume of the CPB circuit at the end of the procedure should be considered to minimize the risks of allogeneic blood transfusions.	IIa	B	823,827,829



## PERFORMANCES COMPARÉE DES SYSTÈMES

Parameter	Sequestra* (Medtronic)	BRAT 2* (Cobe)	CATS* (Fresenius)	Cell Saver* (Haemonetics)	AUTOLOG* (Medtronic)	OrthoPAT* (Haemonetics)	Colloid ** sedimentation
RBC recovery; %	65 - 76	71 - 93	51 - 87	64 - 94	79	80	90
WBC removal; %	31 - 78	30	45 - 80	22 - 55	78	72	60
PLT removal; %	87 - 93	68	92 - 96	86 - 87	99	88	48
PFHB removal; %	89	63	65 - 95	85 - 93	92	96	53
TP or ALB removal; %	97 - 98	91 - 93	93 - 99	NA	NA	97	76
K <sup>+</sup> removal; %	92	90	90 - 98	91	89	97	NA
Cytokine removal; %	95	95	95	91 - 95	NA	90	70 - 77

Values are minimum – maximum interval. CATS: continuous autotransfusion system; RBC: red blood cells; WBC: leucocytes; PLT: platelets; PFHB: plasma free haemoglobin; TP: total protein; ALB: albumin. NA: not assessed. References: \* (68-77), \*\* (51).



--- Coagulation factor activity 10 à 30% for pseudnormal coagulation  
 Palla R et al. , Peyvandi F, Shapiro AD. Rare bleeding disorders: diagnosis and treatment. *Blood* 2015;125:2052–61

Etude prospective randomisée (n=150)  
 Chirurgie cardiaque sous CEC à risque hémorragique  
 (aorte, combinée, redo,...)

Cell-saver pour sang épanché et volume résiduel CEC

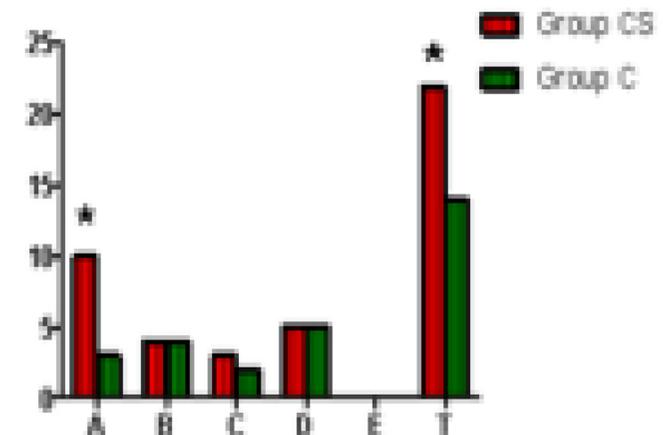
Critères de jugement: transfusion, coagulation  
 conventionnelle et thrombo-élastographie

Variable	Group CS (n=72)	Group C (n=69)	P value
RBC			
proportion	27(37.5)	52(75.4)	0.0002
quantity (U)	2.01(2.75)	5.39(3.28)	<0.0001
FFP			
quantity (ml)	113.9(202.7)	133.3(220.6)	0.725
proportion	14(19.4.)	14(20.3)	0.909
PLT			
quantity (U)	1.97(3.57)	1.91(3.42)	0.879
proportion	16(22.2)	13(18.8)	0.627

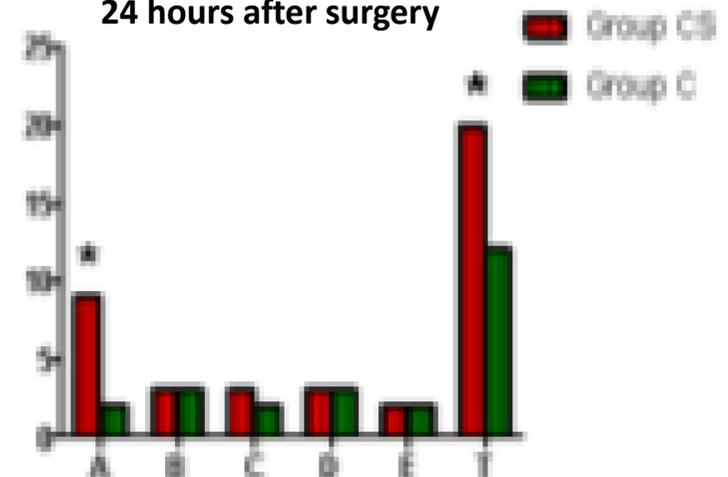
Data are presented as mean (SD) or number (percentage).

Incidence du saignement excessif (définition?) était  
 significativement plus élevée dans le groupe CS  
 (p=0,034)

End of surgery



24 hours after surgery



A=residual heparin, B=hypocoagulability for low platelet, C=  
 hypocoagulability for low fibrinogen, D= hypocoagulopathy for  
 low clotting factors, E= hyperfibrinolysis, T= any reasons

## Héparinisation résiduelle?



# Anaesthesia

Journal of the Association of Anaesthetists of Great Britain and Ireland

## A quality assurance programme for cell salvage in cardiac surgery

A. Kelleher,<sup>1</sup> S. Davidson,<sup>2</sup> M. Gohil,<sup>3</sup> M. Machin,<sup>3</sup> P. Kimberley,<sup>4</sup> J. Hall<sup>5</sup> and W. Banya<sup>6</sup>

	2001	2002	2003	2004	2005	2006	2006	2007
	BRAT	BRAT	BRAT	BRAT	BRAT	BRAT	HCS5	HCS5
Pre-wash heparin concentration; IU.ml <sup>-1</sup>	4.1 (2.5–8.2 [0–11.6])	5.1 (3.5–8.6 [2.0–20.2])	8.8 (4.5–12.7 [2.8–20.2])	4.0 (0.8–13.7 [0–17.6])	5.2 (3.7–9.1 [0.4–16.4])	6.6 (4.2–8.4 [2.9–14.1])	5.7 (4.6–9.1 [4.0–12.0])	5.3 (1.3–9.0 [0.6–13.6])
Post-wash heparin concentration; IU.ml <sup>-1</sup>	0.2 (0.0–0.4 [0–1.9])	0.2 (0.1–0.5 [0–1.7])	0.4 (0.2–2.3 [0–1.7])	0.3 (0.2–0.5 [0–0.8])	0.2 (0–0.4 [0–1.7])	0.3 (0–0.5 [0–0.6])	0.4 (0.2–0.7 [0–2.5])	0 (0.0–0.2 [0–0.4])
Pre-wash free Hb; g.l <sup>-1</sup>	0.6 (0.4–1.1 [0.2–4.0])	0.7 (0.4–1.0 [0.1–10.1])	1.3 (0.4–0.3 [0.2–9.4])	1.0 (0.4–1.7 [0.4–2.9])	0.9 (0.4–1.3 [0.3–8.4])	0.6 (0.4–1.0 [0.3–2.9])	0.5 (0.3–0.6 [0.3–0.7])	0.3 (0.3–1.2 [0.3–1.7])
Post-wash free Hb; g.l <sup>-1</sup>	0.5 (0.3–0.8 [0.1–2.6])	0.5 (0.3–1.0 [0.1–6.5])	0.4 (0.2–0.7 [0.1–2.3])	0.7 (0.5–1.1 [0.2–2.5])	0.8 (0.6–1.3 [0.3–5.2])*	0.8 (0.3–1.4 [0.3–1.8])*	0.3 (0.3–0.4 [0.3–2.7])‡	0.3 (0.3–0.3 [0.3–0.5])‡
Pre-wash Hb; g.dl <sup>-1</sup>	7.3 (5.4–8.5 [2.6–14.7])	8.0 (5.5–8.9 [1.5–11.3])	4.4 (1.9–9.2 [2.3–11.1])	9.0 (6.8–11.7 [2.4–25.6])	6.1 (4.5–8.0 [2.9–13.0])	8.1 (4.0–9.6 [2.5–10.0])	6.8 (5.5–8.5 [1.9–9.6])	5.2 (3.1–8.1 [1.4–9.9])
Post-wash Hb; g.dl <sup>-1</sup>	19.6 (16.7–22.2 [12.9–25.5])‡	19.0 (16.3–20.8 [5.6–24.4])	17.5 (13.6–20.8 [12.6–23.7])†	18.5 (15.0–21.6 [8.5–26.4])	20.3 (17.1–22.5 [10.3–26])	18.4 (18.1–20.8 [16.4–21.5])	18.3 (16.9–19.5 [11.5–24.5])	17.3 (16.4–18.0 [15.1–19.5])

# Safety of Salvaged Blood and Risk of Coagulopathy in Cardiac Surgery

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Semin Thromb Hemost

## Abstract

Cardiac surgery patients are prone to anemia from several mechanisms: intraoperative blood loss, preexisting anemia, and hemodilution. Patients are very frequently transfused with allogeneic red blood cells (RBC), which in itself is associated with harm. The use of RBC salvage technology has been advocated to salvage blood lost in the operative field and to reduce the need of homologous blood transfusion. Direct cardiotomy suction from the surgical field and unprocessed blood retransfusion is a common practice during cardiopulmonary bypass, but which is associated with a powerful activation of the coagulation and inflammatory systems: thrombin generation, excessive fibrinolysis, and release of proinflammatory cytokines. Compared with direct cardiotomy suction, the use of RBC salvage technology is able to reduce the amount of microparticles and activated proteins of autologous blood before retransfusion. However, when compared with no retransfusion of blood from the operative field, processed blood also triggers coagulopathy and inflammation. Clinical studies are discordant regarding the benefit of RBC salvage use during and after cardiac operations. Meta-analysis suggests reduced need of homologous blood transfusion, but no effects on mortality and morbidity.

## Keywords

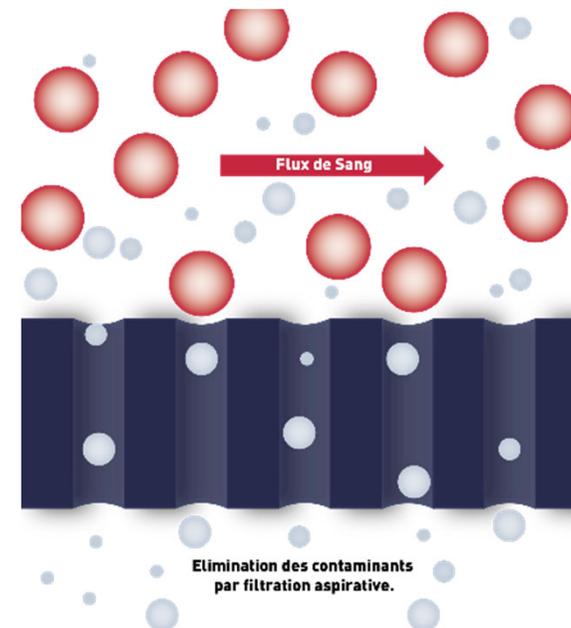
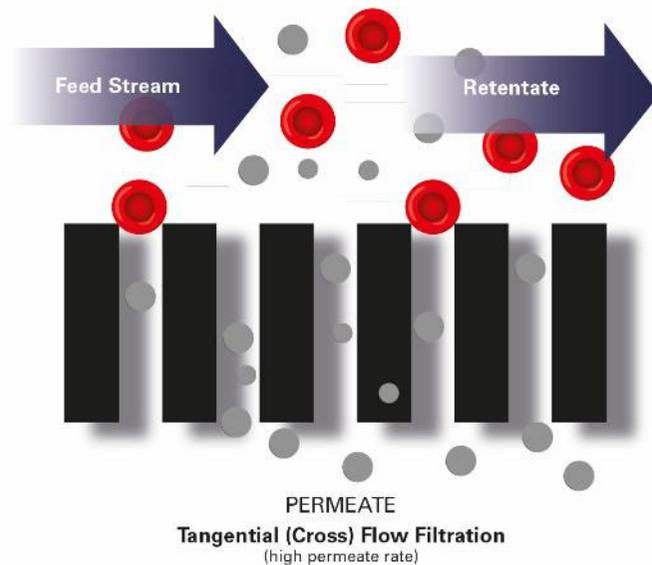
- ▶ cardiac surgery
- ▶ coagulation
- ▶ inflammation
- ▶ cardiotomy suction
- ▶ red blood cells salvage

# Same™: Récupération sanguine par filtration tangentielle

Nouveau dispositif d'autotransfusion innovant par **filtration tangentielle (iSEP France)**

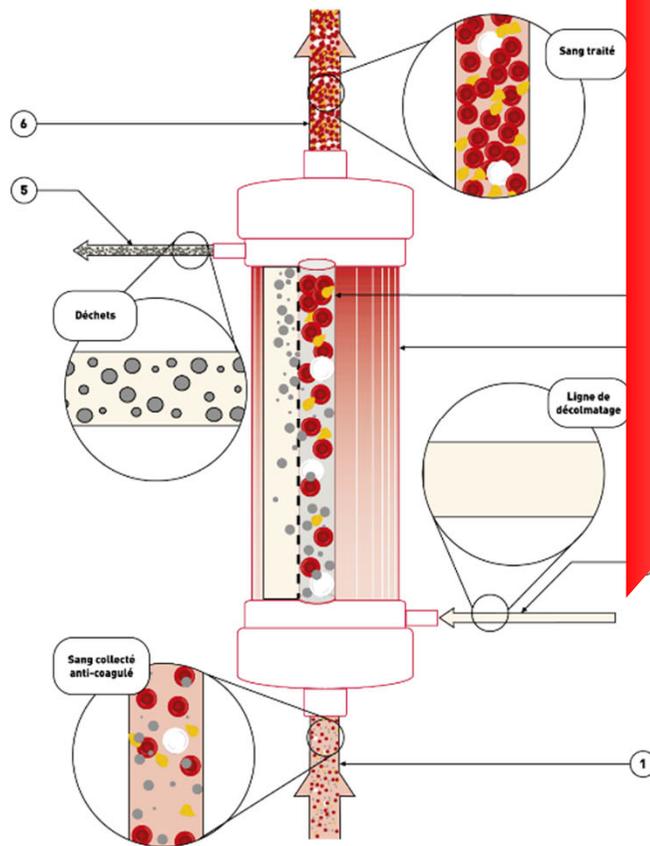
Récupération érythrocytes, les leucocytes mais aussi **les plaquettes**.

Limiter anomalies de l'hémostase périopératoire (voire une amélioration?)

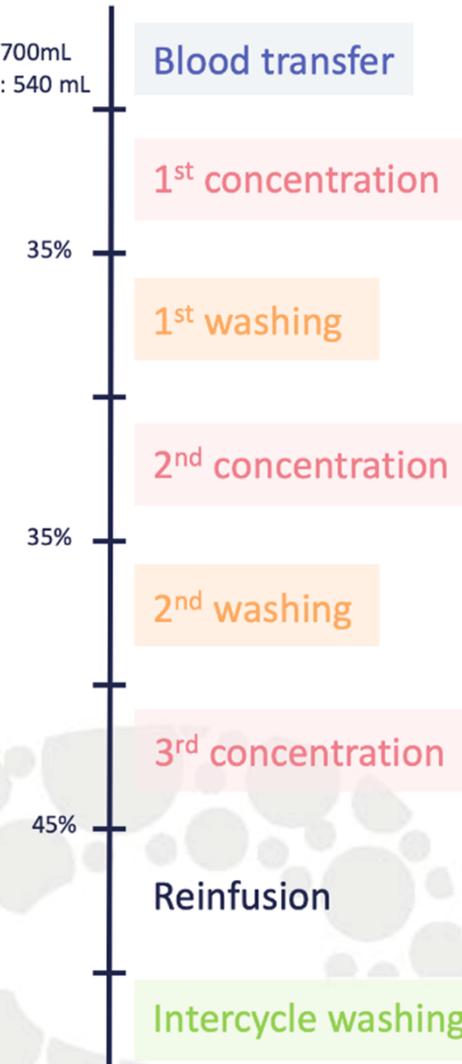


# SAME™ (I-SEP, FRANCE)

-  Globules rouges
-  Globules blancs
-  Plaquettes
-  Déchets / Petites molécules (Protéines, Héparine, Hg libre)
-  Solution de lavage / Sérum physiologique
- ① Ligne entrée fibre
- ② Ligne de décolmatage
- ③ Cartouche de filtration à fibres creuses
- ④ Fibre creuse à porosité contrôlée
- ⑤ Ligne de déchets
- ⑥ Ligne sortie fibre

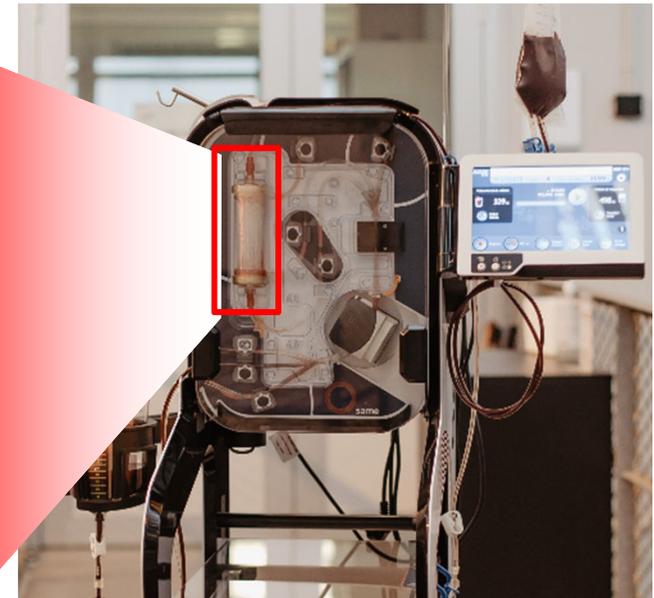
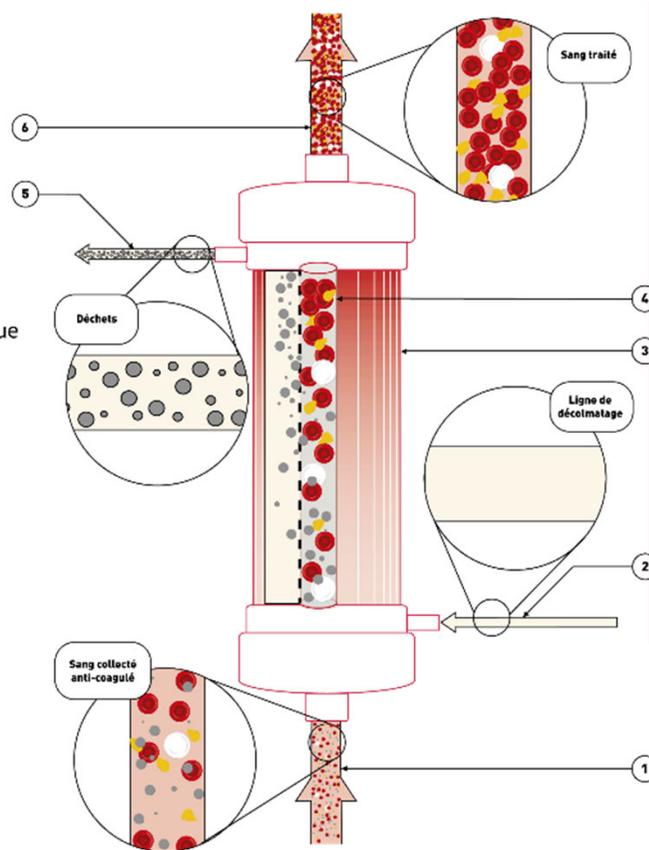


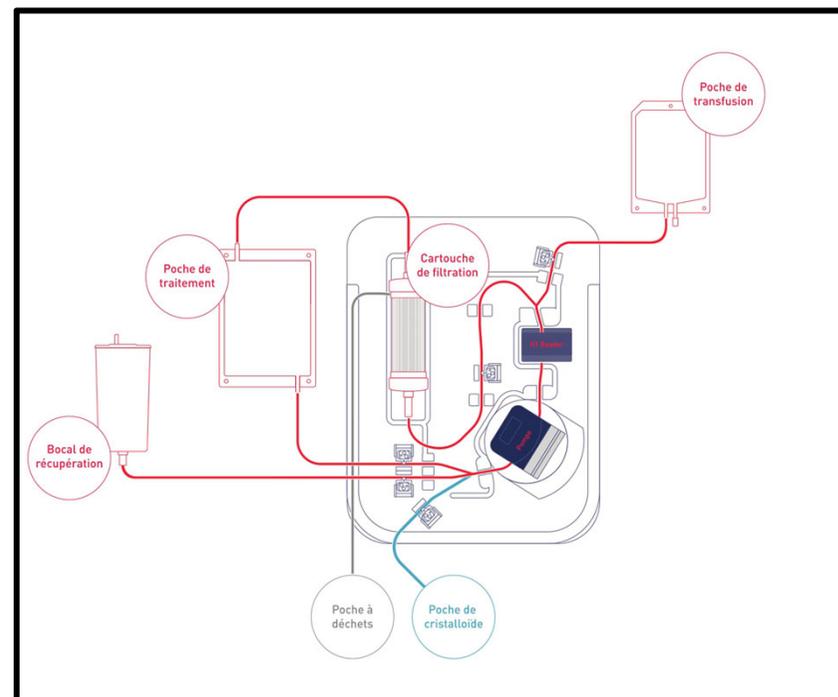
Cycle 1: 700mL  
Cycle ≥2: 540 mL

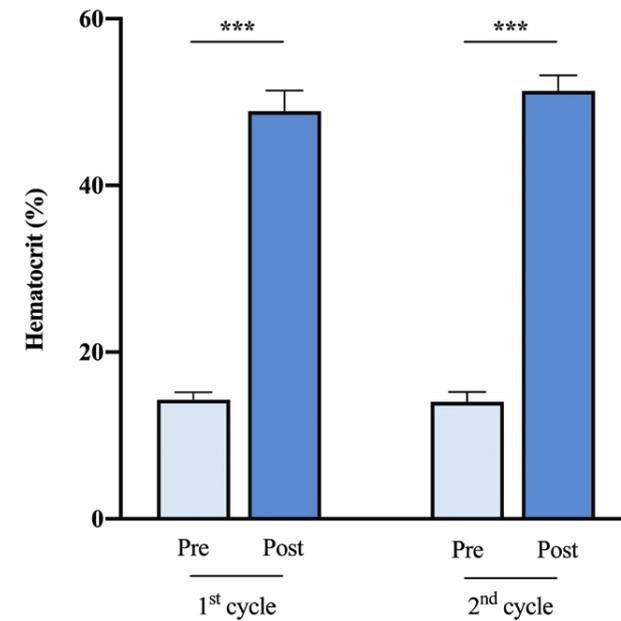
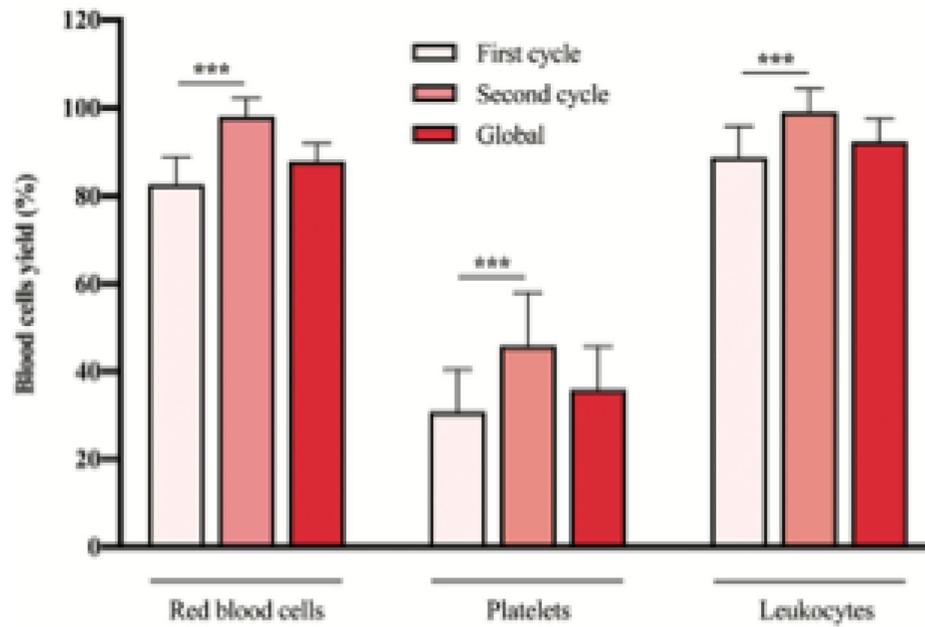
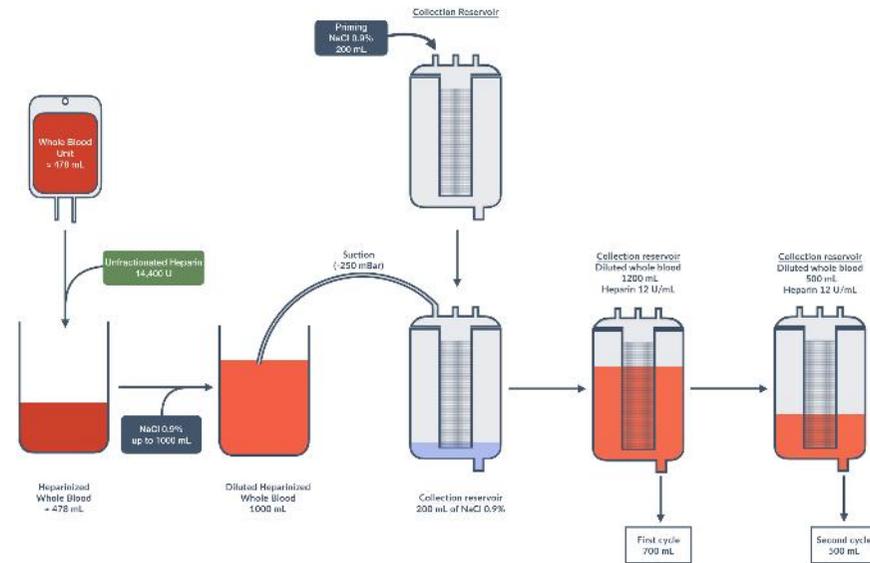


# Same™: Récupération sanguine par filtration tangentielle

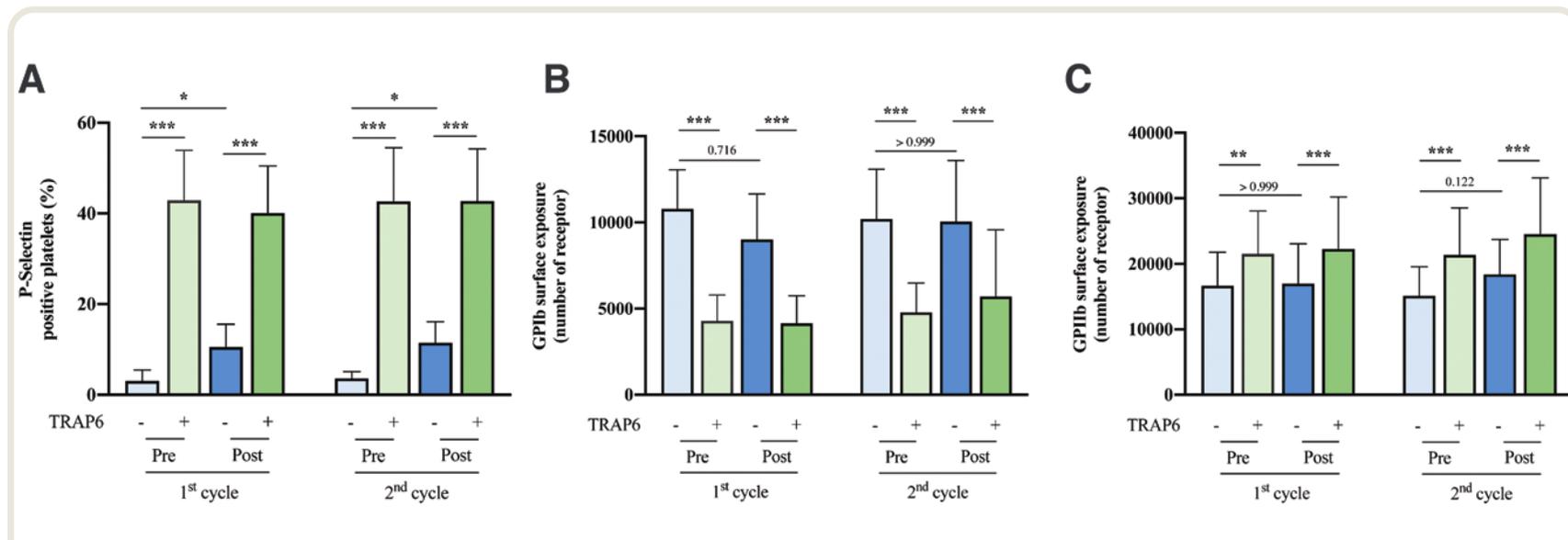
-  Globules rouges
-  Globules blancs
-  Plaquettes
-  Déchets / Petites molécules (Protéines, Héparine, Hg libre)
-  Solution de lavage / Sérum physiologique
- ① Ligne entrée fibre
- ② Ligne de décolmatage
- ③ Cartouche de filtration à fibres creuses
- ④ Fibre creuse à porosité contrôlée
- ⑤ Ligne de déchets
- ⑥ Ligne sortie fibre







# RÉACTIVITÉ PLAQUETTAIRE PRÉSERVÉE



# FIRST IN MAN STUDY (TRANSEP)

## MULTICENTRE (NANTES, RENNES, BDX, HEGP)

Table 3. Cell Recovery Performance

Characteristics	All Patients (n = 50)
<b>Red blood cells</b>	
Pretreatment concentration, 10 <sup>12</sup> /l	1.84 (1.53–2.04)
Posttreatment concentration, 10 <sup>12</sup> /l	4.70 (4.43–4.99)
Recovery, %	86.1 (80.8–91.6)
<b>Platelets</b>	
Pretreatment concentration, 10 <sup>9</sup> /l	82 (67–96)
Posttreatment concentration, 10 <sup>9</sup> /l	116 (93–146)
Recovery, %	52.4 (44.2–60.1)
<b>Leukocytes</b>	
Pretreatment concentration, 10 <sup>9</sup> /l	3.5 (2.3–5.1)
Posttreatment concentration, 10 <sup>9</sup> /l	10.2 (7.4–14.0)
Recovery, %	90.0 (83.4–97.4)

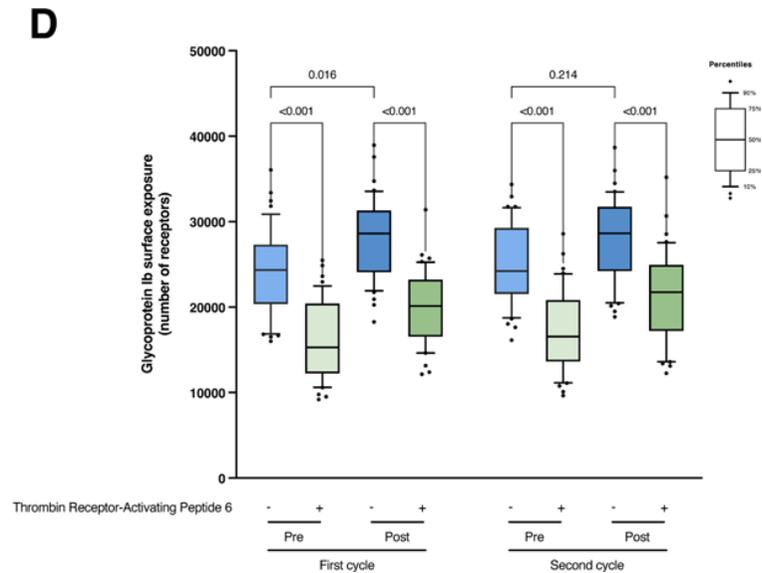
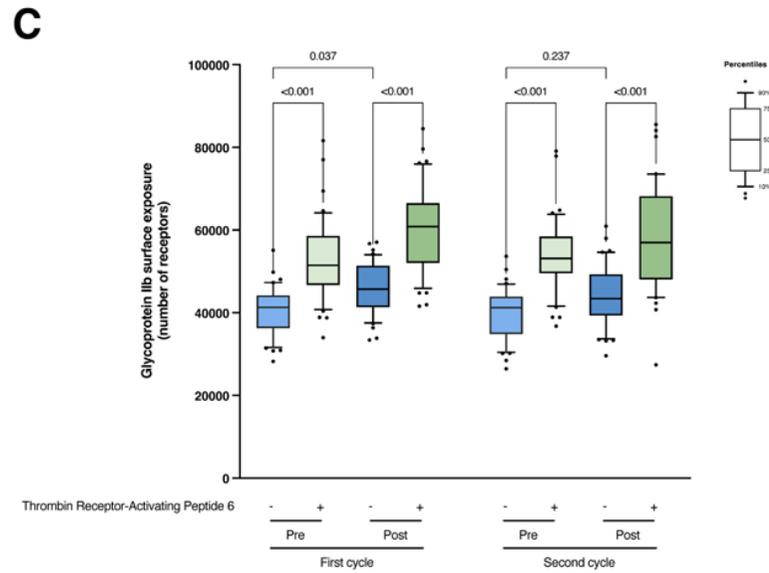
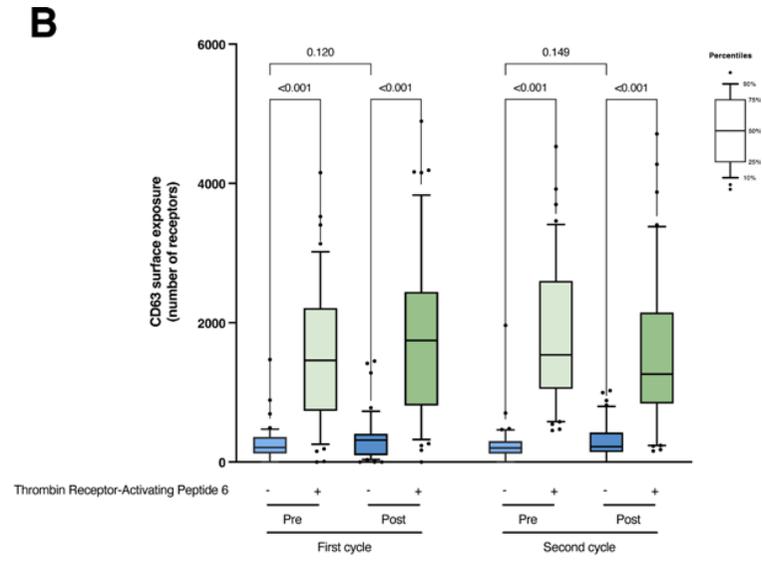
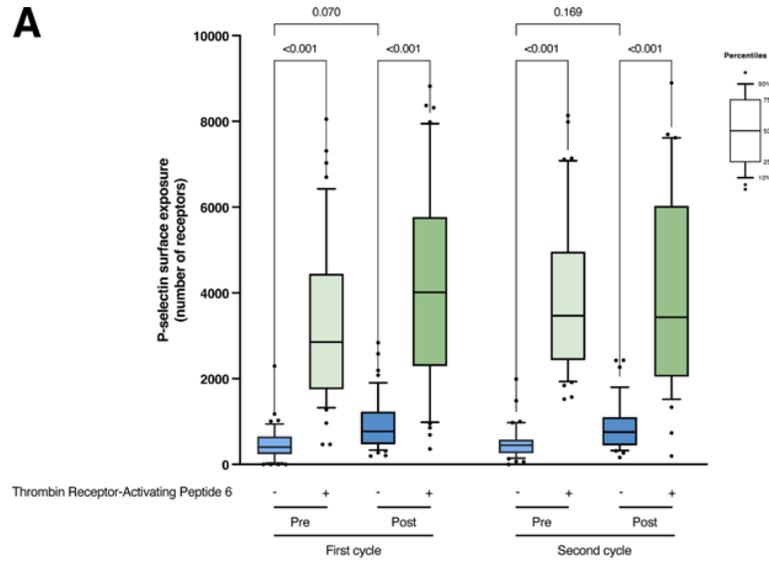
Results are presented as median (25th to 75th percentile interquartile range). Cell recovery performance was assessed for each treatment cycle by sampling pretreatment blood in the collection reservoir and posttreatment blood in the reinfusion bag.

Table 4. Washing Performance

Plasma Components	All Patients (n = 50)
<b>Heparin</b>	
Pretreatment concentration, U/ml	5.9 (4.4–7.7)
Posttreatment concentration, U/ml	0.3 (0.1–0.5)*
Posttreatment quantity, U	80 (19–213)
Removal ratio, %	98.9 (98.2–99.7)
<b>Free hemoglobin</b>	
Pretreatment concentration, mg/dl	171 (112–228)
Posttreatment concentration, mg/dl	284 (222–376)
Removal ratio, %	94.6 (92.7–96.6)
Pretreatment hemolysis index, %	2.7 (1.6–3.8)
Posttreatment hemolysis index, %	1.2 (0.9–1.6)
<b>Total proteins</b>	
Pretreatment, g/l	22.3 (19.0–26.7)
Posttreatment, g/l	5.7 (4.9–6.8)
Removal ratio, %	94.5 (92.2–95.3)
<b>Potassium</b>	
Pretreatment, mmol/l	4.9 (4.2–6.5)
Posttreatment, mmol/l	2.3 (2.0–2.8)
Removal ratio, %	89.1 (87.7–91.7)
<b>Triglycerides</b>	
Pretreatment, mmol/l	0.59 (0.49–0.68)
Posttreatment, mmol/l	0.17 (0.13–0.21)†
Removal ratio, %	94.0 (90.8–95.9)

Results are presented as median (25th to 75th percentile interquartile range). Washing performance was assessed for each treatment cycle by sampling pretreatment blood in the collection reservoir and posttreatment blood in the reinfusion bag.

\*A total of 80 cycles had values inferior to limit of quantification (0.1 U/ml) and were substituted with 0.05 U/ml. †A total of 17 cycles had values inferior to limit of quantification (0.1 mmol/l) and were substituted with 0.05 mmol/l.



# ETUDE COMPARATIVE : COMBINED PLATELET AND ERYTHROCYTE AUTOTRANSFUSION DURING CARDIAC SURGERY (COLTRANE) TRIAL

Etude prospective randomisée multicentrique française

Comparaison de récupération sanguine peropératoire  
centrifugation versus filtration tangentielle

Compétence hémostatique périopératoire (Universal  
Definition of Perioperative Bleeding)

Début juillet 2024 (405 patients inclus)

Ouverture des centres en cours (7/10 centres ouverts)

Fin inclusions décembre 2025



## CONCLUSIONS

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- Récupération sanguine peropératoire par centrifugation permet une épargne de CGR
- Epargne d'autant plus conséquente que volume traité est important (>1000 ml)
- Intérêt limité chez le patient à faible risque hémorragique (collecteur seul mis en place?)
- Traitement du saignement épanché et de la circulation extra-corporelle permet de limiter la réponse inflammatoire et pourrait améliorer le pronostic de nos patients
- En diminuant la charge en micro-embols graisseux, le cell-saver pourrait avoir un impact sur les complications neurologiques post CEC
- Récupération sanguine étant exclusivement limité aux GR, le traitement d'important volume sanguin peut s'associer à des anomalies de l'hémostase qu'il faut savoir déceler et traiter (idéalement préventivement)
- Mécanismes multiples (pertes de facteurs, thrombopénie, héparinisation résiduelle...)
- En récupérant les plaquettes la technologie de récupération sanguine par filtration tangentielle pourrait limiter ces anomalies de l'hémostase et ainsi améliorer la compétence hémostatique périopératoire du patient à risque (Etude COLTRANE...)

