

Bleeding Management in Post Surgical Complications and Cases Discussion

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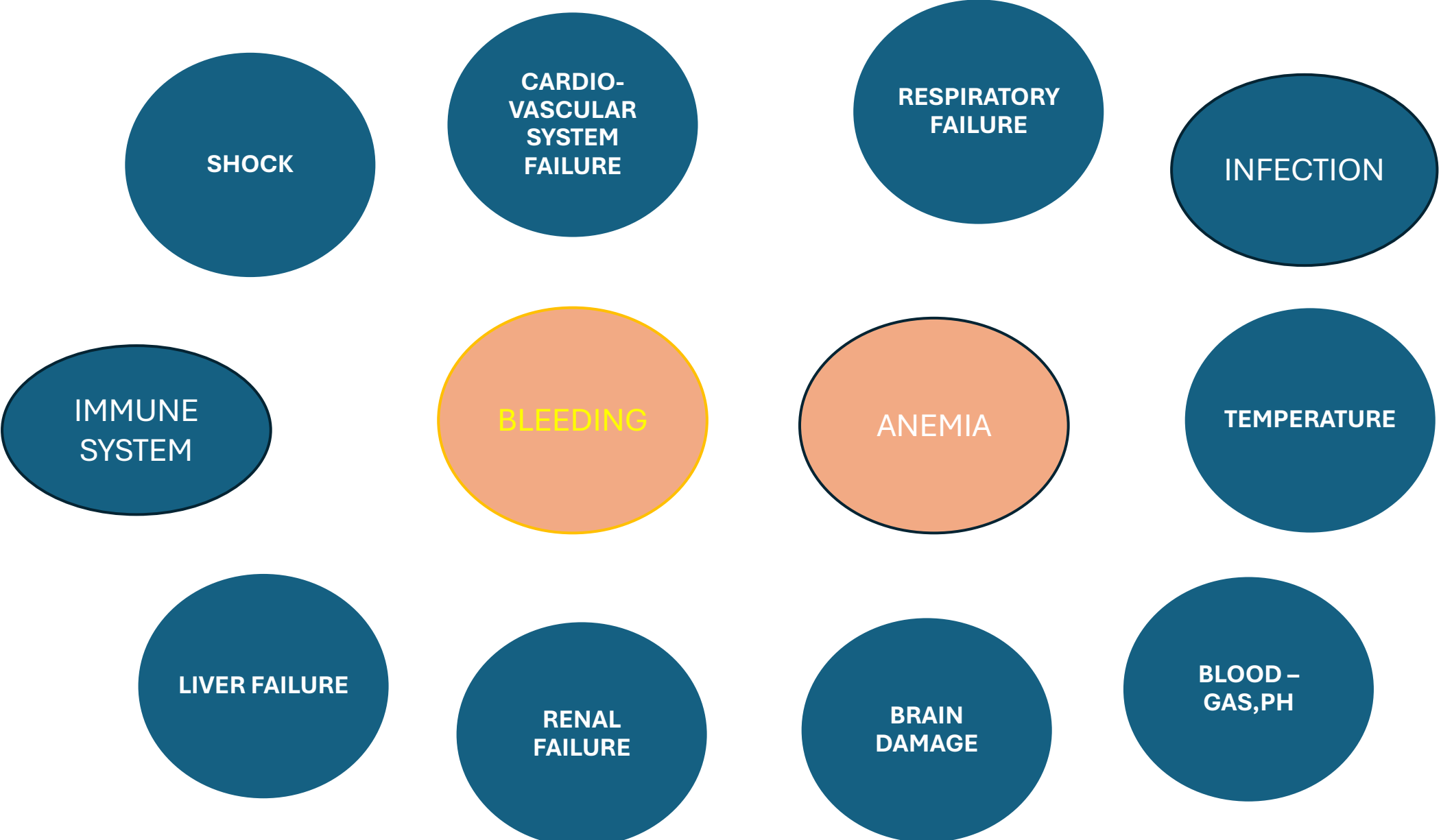
NO CONFLICT OF INTERESTS





SURGERY,
TRAUMA

ICU
ADMISSION



A diagram consisting of twelve circles arranged in a 3x4 grid. The circles are colored either dark blue or light orange. The text inside the circles is as follows:

Row	Column 1	Column 2	Column 3	Column 4
1	SHOCK	CARDIO-VASCULAR SYSTEM FAILURE	RESPIRATORY FAILURE	INFECTION
2	IMMUNE SYSTEM	BLEEDING	ANEMIA	TEMPERATURE
3	LIVER FAILURE	RENAL FAILURE	BRAIN DAMAGE	BLOOD – GAS,PH

SHOCK

**CARDIO-
VASCULAR
SYSTEM
FAILURE**

**RESPIRATORY
FAILURE**

INFECTION

**IMMUNE
SYSTEM**

BLEEDING

ANEMIA

TEMPERATURE

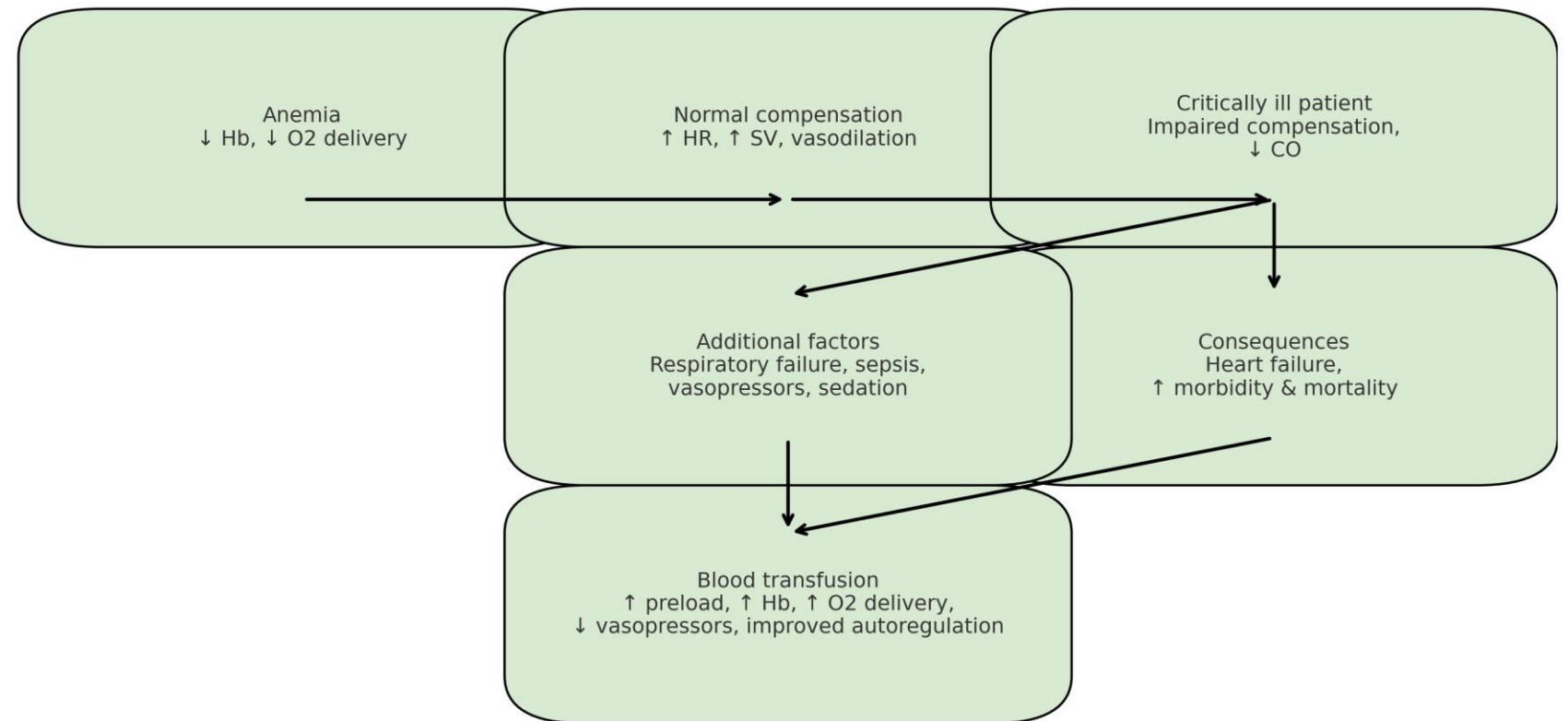
LIVER FAILURE

**RENAL
FAILURE**

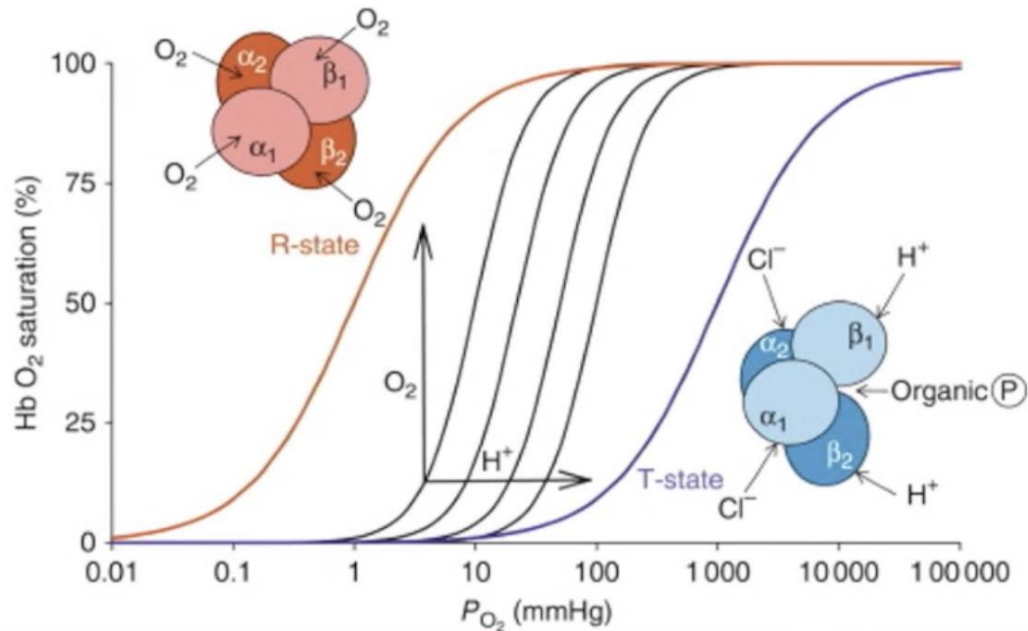
**BRAIN
DAMAGE**

**BLOOD –
GAS,PH**

Blood management in ICU

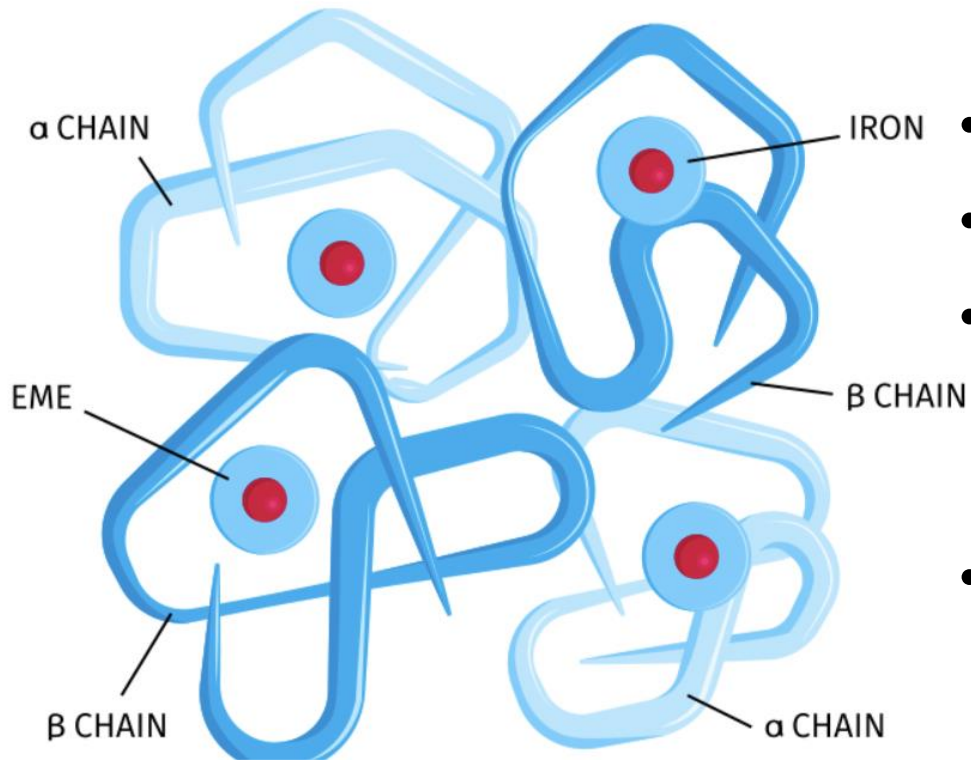


Red blood cell physiology



- 5 milion erythrocytes per uL-
25% of total cells in the body
- Small cells: 7-8micrometers –no nucleus and no mitochondria
- 2 milion per sec
- **Lifespan =120 days**

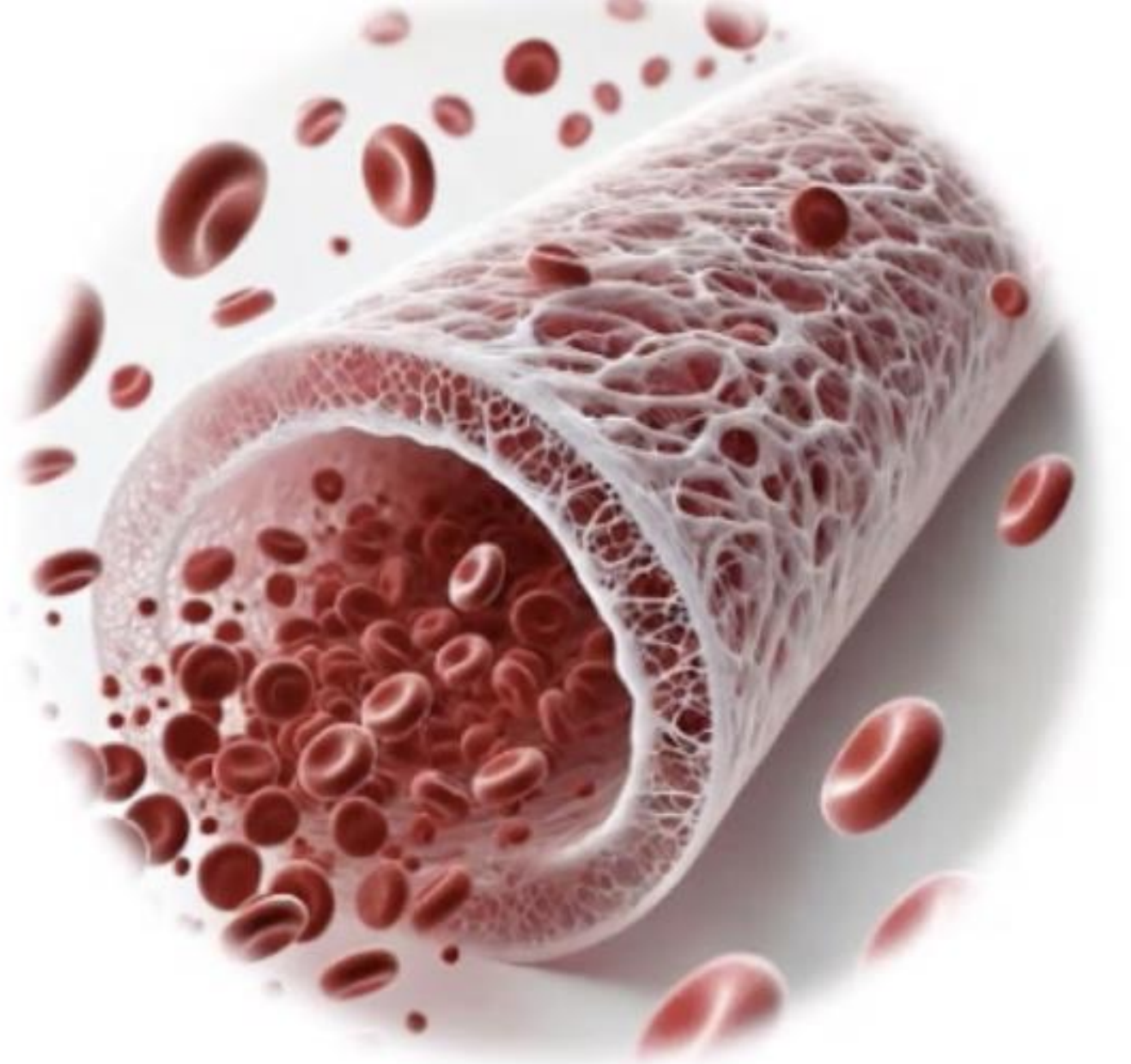
Red blood cell physiology



- Almost all vertebrates contain hemoglobin
- Made of **proteins and iron**
- Contains four globin proteins each of which is bound to one of the iron containing pigment heme
- **A single erythrocyte can contain 300 milion Hb molecules and thus more than 1 bilion oxygen molecules**
- **Transport oxygen , CO₂ (may scavenge NO)**

Anemia in ICU

- Anemia is common in ICU patients (25-30%) and appears early in the ICU course (sepsis>others)
- 50% on admission below „normal range”
- Different definition than in healthy populations



Blood transfusion in ICU

- 3908 (3643) patients,
- 233 centers,
- 30 countries/6 continents

Table 1. Demographics, Stratified by RBC Transfusion Status

Variable	Transfusion (n = 894) ^a	No transfusion (n = 2749) ^a
Age, y	61 (17)	61 (16)
Sex		
Female	351 (39.3)	1025 (37.3)
Male	543 (61.7)	1724 (62.7)
Medical history (multiple options possible)		
Solid tumor	128 (14.3)	357 (13.0)
Chronic kidney failure	107 (12.0)	222 (8.1)
Acute coronary syndrome	106 (11.9)	275 (10.0)
Heart failure	104 (11.6)	323 (11.7)
Chronic obstructive pulmonary disease	73 (8)	339 (12.3)
Liver failure	49 (6)	61 (2)
Hematologic malignancy	32 (4)	63 (2)
Organ transplant	21 (2)	33 (1)
Benign hematologic disease	10 (1)	25 (1)
Bone marrow transplant	3 (<1)	6 (<1)
Other ^b	231 (25.8)	728 (26.5)
Code status		
Do not resuscitate	40 (5)	135 (4.9)
Do not intubate	28 (3)	108 (3.9)
Do not transfuse	7 (<1.0)	6 (<1.0)
APACHE IV score ^c	57 (33-80)	44 (27-66)
EuroSCORE II ^d	2.58 (1.26-5.14)	1.62 (0.88-3.56)
Elective admission	316 (35.3)	955 (34.7)
Referred from		
Operation theater/OR	441 (49.4)	1072 (39.0)
General ward	179 (20.0)	444 (16.2)
Emergency department	155 (17.3)	950 (34.6)
Other hospital	73 (8)	240 (8.7)
Other (ie, home, other ICU)	5 (<1)	42 (2)
Referring specialty		
Cardiothoracic surgery	208 (23.3)	330 (12.0)
Internal medicine	158 (17.7)	534 (19.4)
Surgery	114 (12.8)	326 (11.9)
Gastrointestinal surgery	92 (10)	223 (8.1)
Trauma surgery	57 (6)	94 (3)
Pulmonology	48 (5)	353 (12.8)
Orthopedic surgery	47 (5)	61 (2)
Neurosurgery	43 (5)	248 (9.0)
Cardiology	37 (4)	258 (9.4)
Gynecology	30 (3)	50 (2)
Urology	24 (3)	70 (3)
Neurology	21 (2)	128 (4.7)
Other (ie, emergency, ENT)	15 (2)	74 (3)
Surgery <24 h before ICU admission	491 (54.9)	1111 (40.4)
Reason for ICU admission		
Postoperative monitoring	345 (38.7)	960 (35.0)
Shock	170 (19.1)	262 (9.6)
Respiratory failure	134 (15.0)	657 (24.0)
Other	70 (8)	238 (8.7)
Trauma	63 (7)	106 (3.9)
Metabolic disturbances	49 (6)	219 (8.0)
Acute brain injury	32 (4)	197 (7.2)
In- or out-of-hospital cardiac arrest	29 (3)	104 (3.8)
Shock present	325 (36.4)	527 (19.2)
Supportive therapies at admission (multiple options possible)		
Invasive mechanical ventilation	500 (55.9)	1119 (40.7)
Kidney replacement therapy	54 (6)	77 (3)
Other support ^e	49 (6)	92 (3)
Other mechanical cardiac support	18 (2)	18 (<1)
ECMO	11 (1)	4 (<1)

Blood transfusion in ICU



Table 2. Characteristics During Intensive Care Unit Stay

Variable	Transfusion (n = 894) ^a	No transfusion (n = 2749) ^a
Daily forms	4 (3-9)	3 (2-5)
Mean daily blood loss, mL	82 (0-275)	0 (0-46)
Median SOFA score during ICU stay ^b	5 (2.5-7.85)	3 (1.40-5.33)
Invasive mechanical ventilation during ICU stay	537 (60.1)	980 (35.6)
Kidney replacement therapy during ICU stay	142 (15.9)	149 (5.4)
Newly developed complications during ICU stay		
Acute kidney injury	260 (29.1)	351 (12.8)
Sepsis	257 (28.7)	495 (18.0)
ARDS	141 (15.8)	370 (13.5)
Gastrointestinal bleed	114 (12.8)	45 (2)
Failure to wean	104 (11.6)	117 (4.3)
Acute coronary syndrome	95 (10.6)	223 (8.1)
Liver failure	86 (10)	80 (2.9)
Cerebrovascular event	62 (7)	222 (8.1)
Bone marrow failure	27 (3)	13 (<1)
Retinal hemorrhage	6 (<1)	4 (<1)
Admission laboratory values		
Hb level, g/dL	10.0 (2.7)	12.5 (2.3)
Anemia ^c		
Male	385/543 (70.9)	708/1724 (41.1)
Female	238/351 (67.8)	415/1025 (40.5)
Platelet count, ×10 ⁹ /L	205 (133-283)	227 (170-291)
Laboratory values during ICU stay		
Mean Hb level during ICU stay	8.7 (1.4)	11.4 (2.0)
Nadir Hb	7.6 (1.6)	10.8 (2.1)
Anemia during ICU stay ^c	882/891 (99.0)	2162/2697 (80.2)
Received RBC	894 (100)	0
No. of RBC units transfused, total during ICU stay	2 (1-4)	
No. of RBC units transfused per transfused day ^d	1 (1-1.5)	
No. of RBC units per ICU day ^e	0.5 (0.25-1)	
No. of RBC transfusion events	2 (1-4)	
Received platelet transfusion	163 (18.2)	45 (2)
Received plasma transfusion	254 (28.4)	83 (3)
Received massive transfusion protocol	34 (4)	0 (0)
Received coagulation product	147 (16.4)	61 (2)
Use of VHA, No. of patients	91 (10)	53 (2)
EPO administered	35 (4)	43 (2)

Blood transfusion in ICU

Reason for RBC transfusion (multiple options possible) ^h	
Low Hb value	1412 (81.8)
Active bleeding	479 (27.7)
Hemodynamic instability	406 (23.5)
Improving general state	142 (8.2)
Improving peripheral oxygen	115 (6.7)
(New) coronary ischemia	69 (4)
Presurgery	67 (4)
Age of patient	60 (4)
Other	47 (3)
Improving weaning	43 (3)
Part of clinical trial	6 (<1)
Exchange transfusion	2 (<1)
No. of reasons	1 (1-2)
Trigger for RBC transfusion (multiple options possible) ^h	
Hypotension	728 (42.2)
No physiological trigger affected the decision to transfuse	682 (39.5)
Tachycardia	474 (27.4)
Increased lactate levels (>2 mmol/L)	308 (17.8)
Acidosis	204 (11.8)
Arrhythmia	70 (4)
Other	66 (4)
Venous oxygen saturation <65%	36 (2)
Central venous oxygen saturation <65%	30 (2)
ECG changes	23 (1)
No. of triggers	1 (1-2)



Blood transfusion in ICU

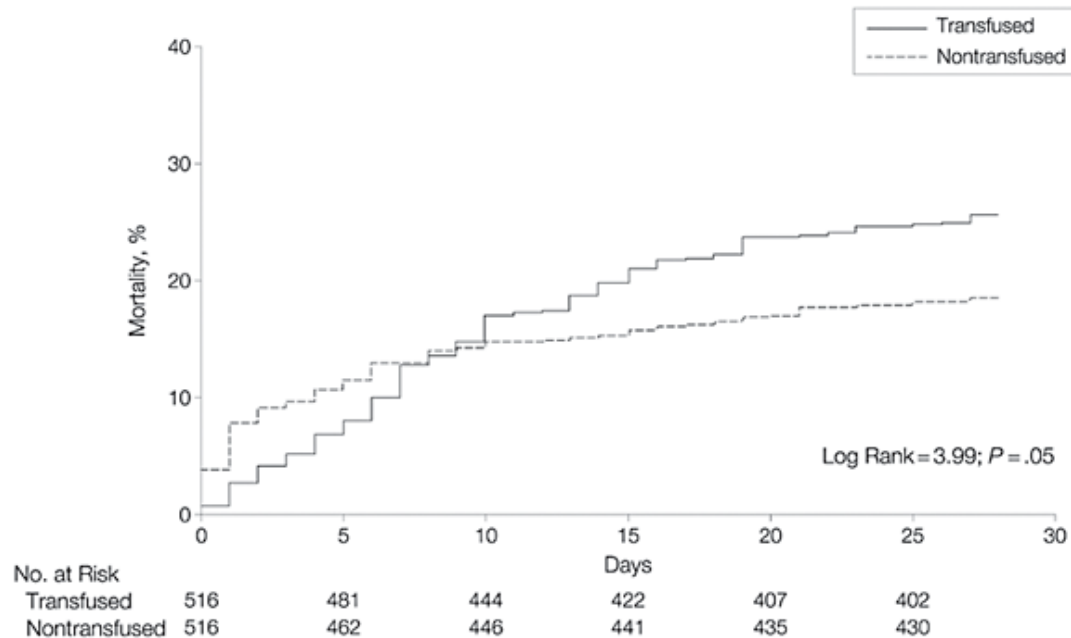


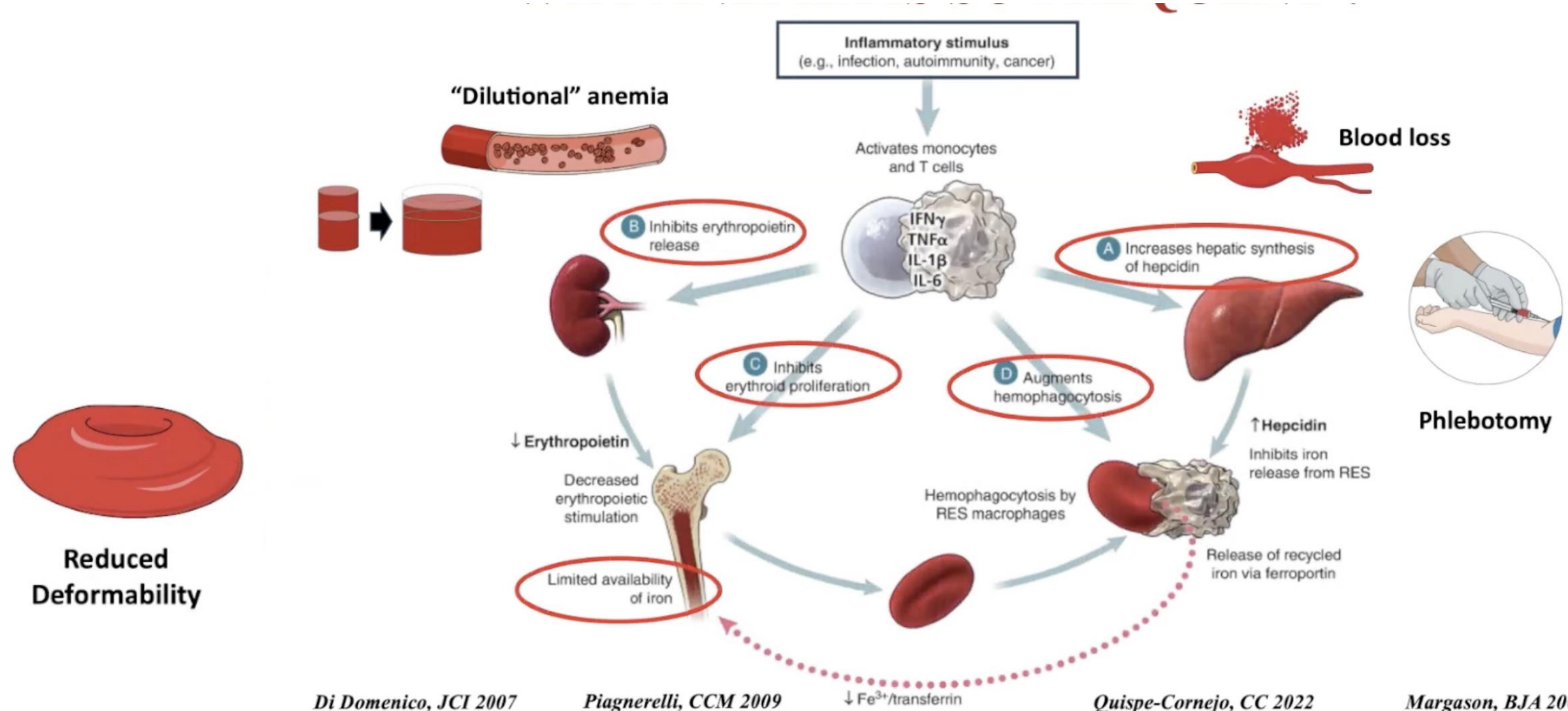
Table 6. Difference in Mortality by Number of Units Transfused

Units Transfused	No.	Mortality, %		P Value*
		Survived (n = 2422)	Died (n = 614)	
0	1896	85.1	14.9	<.01
1	157	84.1	15.9	
2	377	79.6	20.4	
3	157	70.7	29.3	
4	130	69.2	30.8	
>4	319	55.2	44.8	

*Numbers do not total 3534 because of missing data (some forms incomplete). $\chi^2 = 171.46$.

3. Corwin HL, Surgenor SD, Gettinger A. Transfusion practice in the critically ill. Crit Care Med. 2003;31(12 Suppl):S668–71.

Why anemia is so frequent?



Di Domenico, JCI 2007

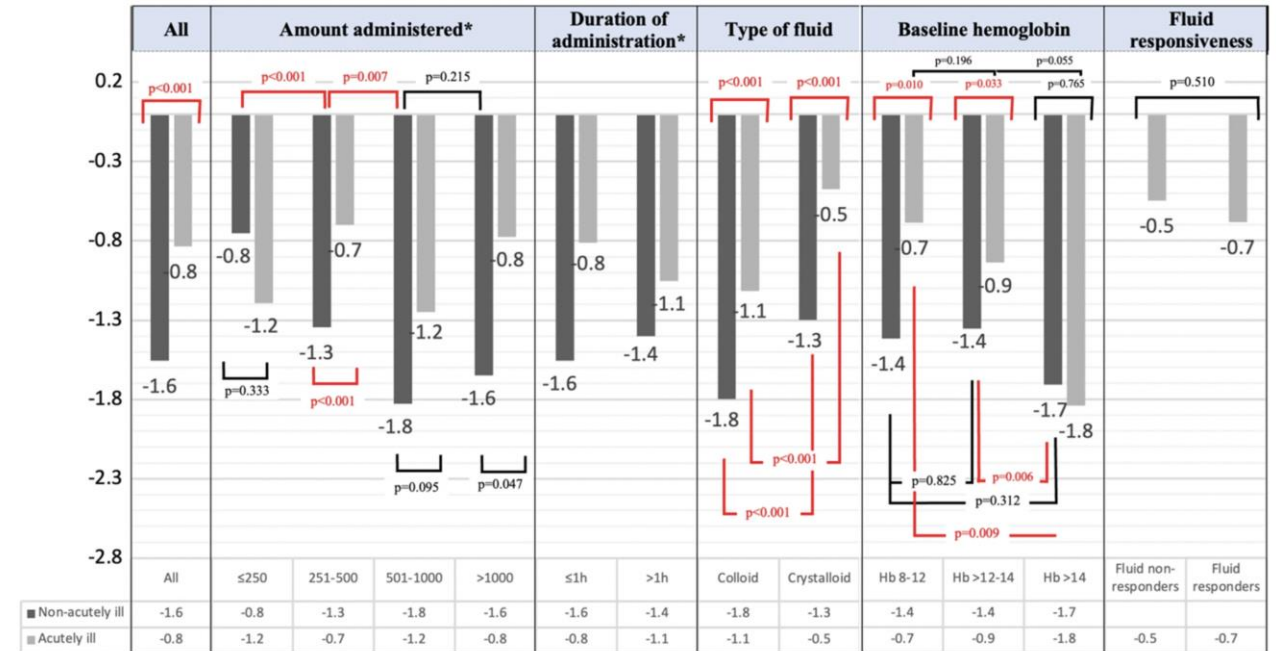
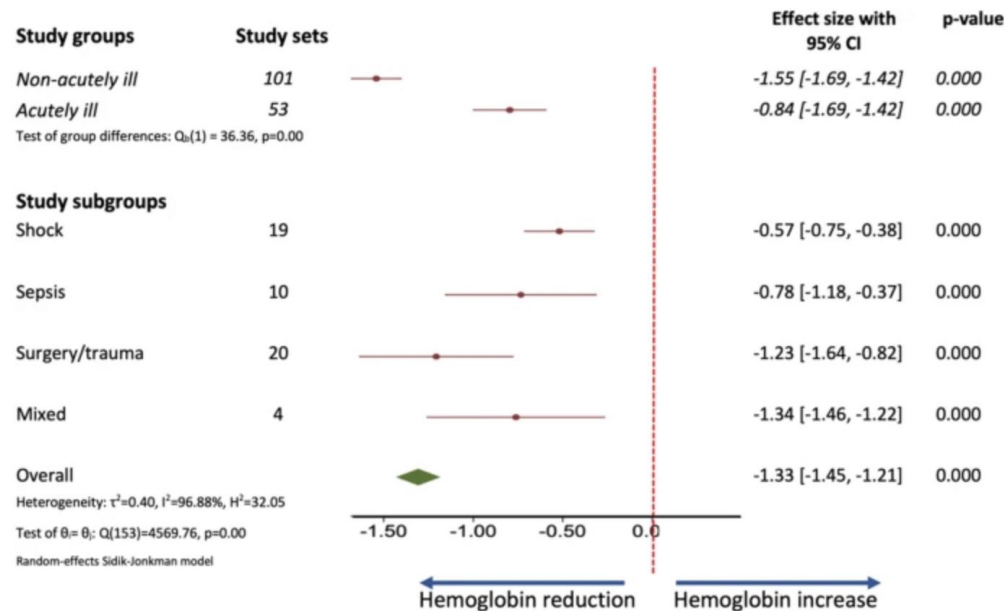
Piagnerelli, CCM 2009

$\downarrow \text{Fe}^{3+}$ /transferrin

Quispe-Cornejo, CC 2022

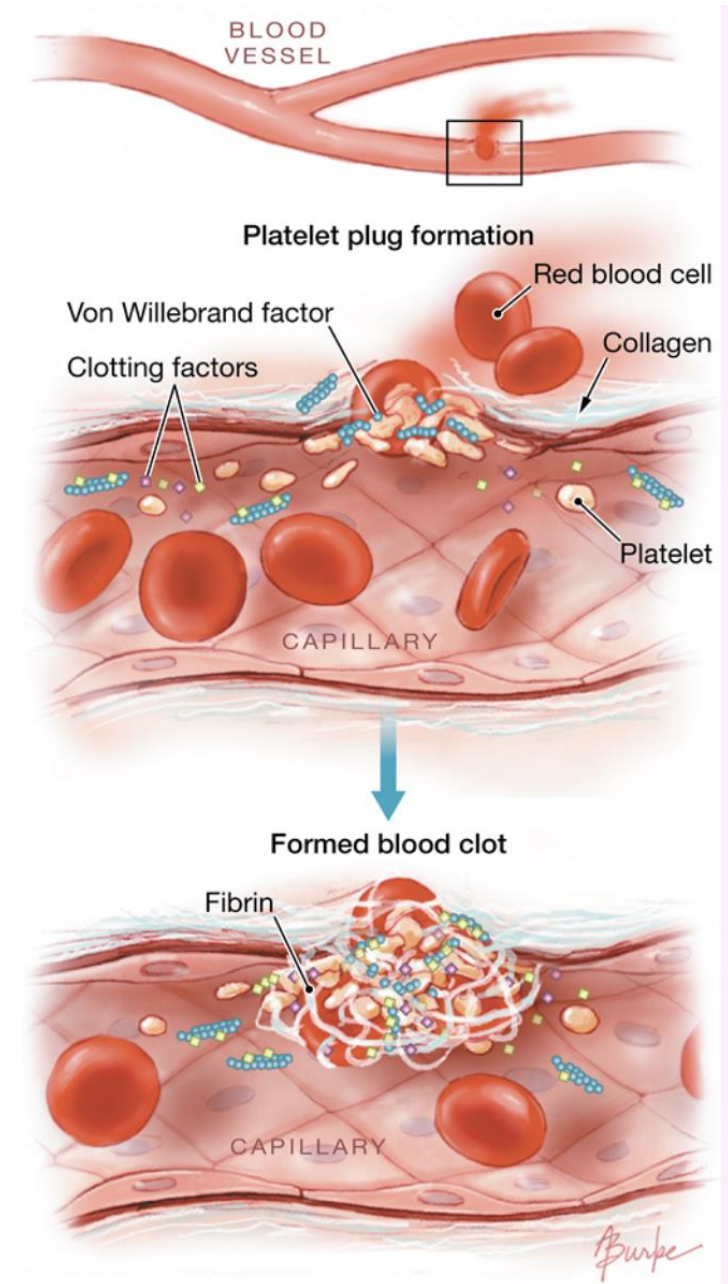
Margason, BJA 2004

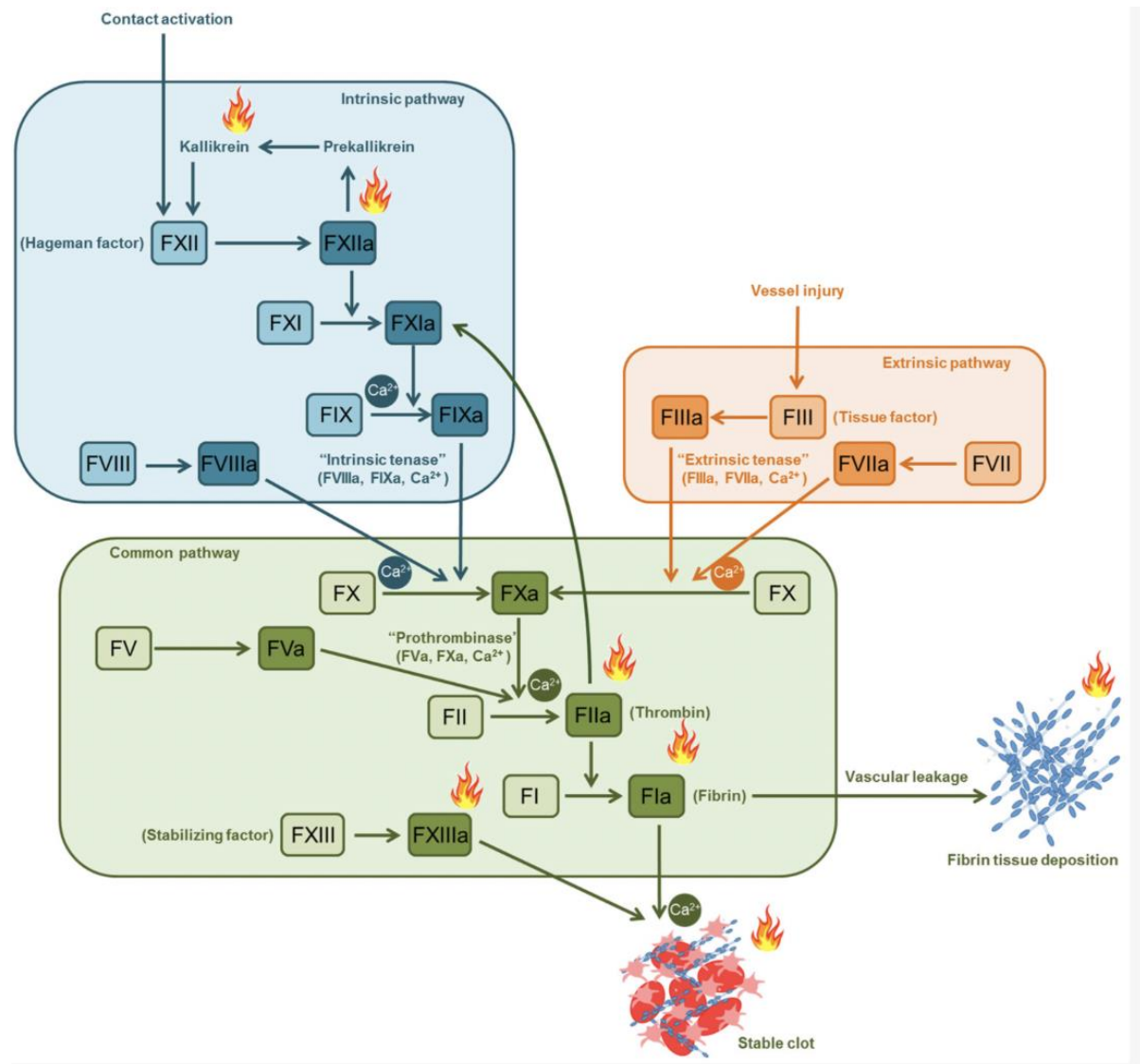
Decrease in hemoglobin concentration (Hb) in non-acutely ill and acutely ill patients



Quispe-Cornejo, A.A., Alves da Cunha, A.L., Njimi, H. et al. Effects of rapid fluid infusion on hemoglobin concentration: a systematic review and meta-analysis. *Crit Care* **26**, 324 (2022). <https://doi.org/10.1186/s13054-022-04191-x>

Coagulation abnormalities (factors and platelets)





Anemia in ICU

- Anemia may lead to **SEVERAL CONSEQUENCES** as prolonged weaning, AKI, myocardial ischemia (MORTALITY)
- Anemia management should instead be focused on causal anemia treatment and minimization of patient blood loss



Blood transfusion

Red blood cell transfusion (RBCT) is one of the most frequently performed hospital procedures

Transfusion decision making represents a common challenge to critical care physicians

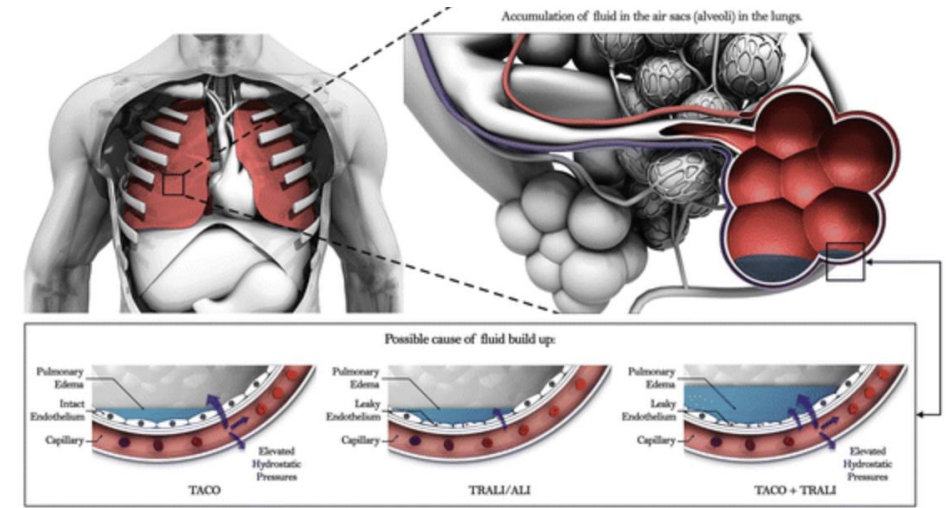
Use of RBCT is more frequent in NON-BLEEDING patients-less availability

Around 30-40% of ICU patients receive RBCT during their ICU stay

Transfusion complications

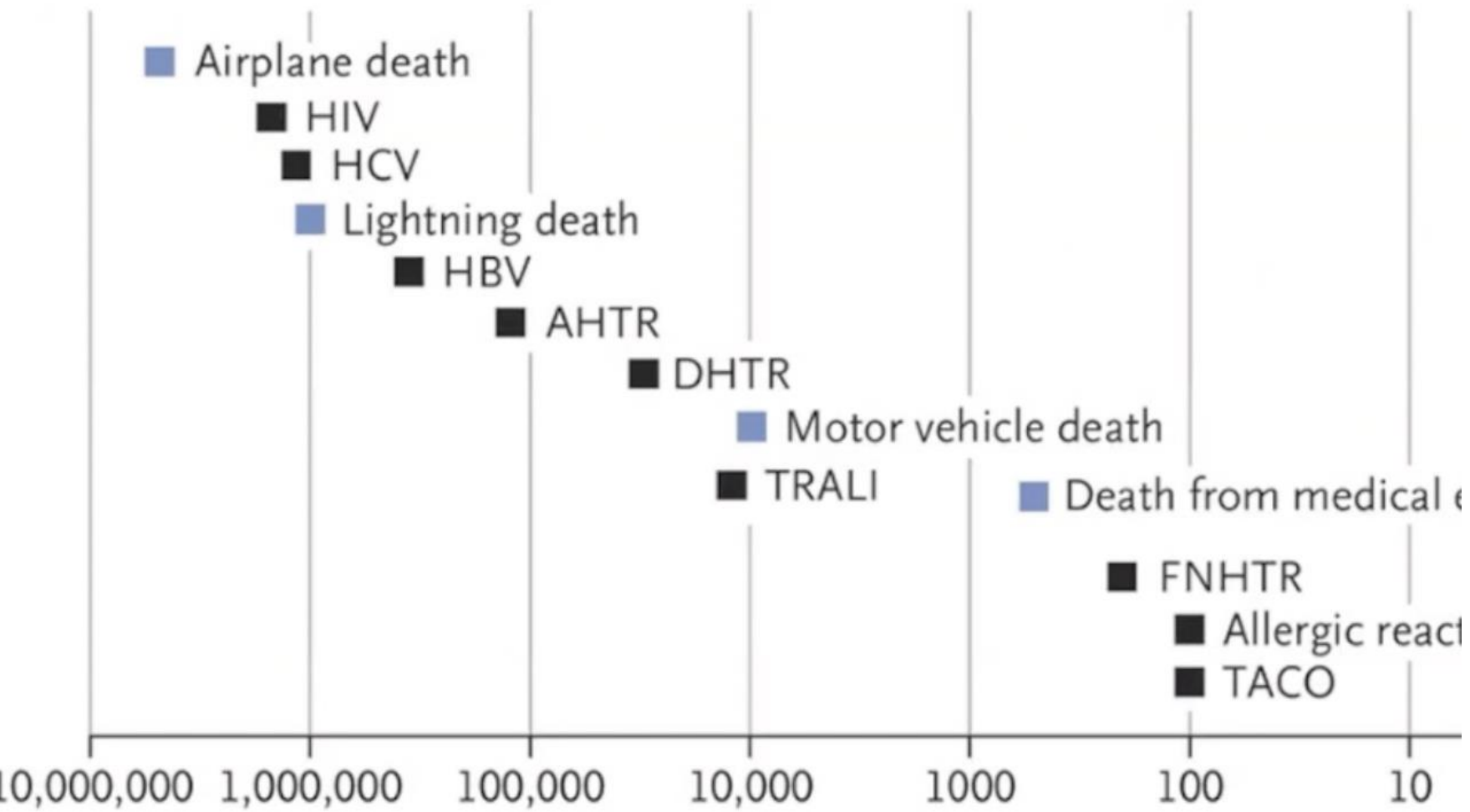
Early

- Haemolytic reactions (immediate, delayed)
- Non-haemolytic febrile reactions
- Allergic reactions (proteins, IgA)
- **TRALI (Transfusion-related acute lung injury)**
- **Bacterial contamination/sepsis**
- **Circulatory overload (TACO)**
- Air embolism
- Thrombophlebitis
- **Hyperkalaemia**
- Citrate toxicity
- Hypothermia
- **Clotting abnormalities (massive transfusion)**



Late

- Transmission of infection:
 - Viral: hepatitis A, B, C; HIV; CMV
 - Bacterial: Treponema pallidum, Salmonella
 - Parasitic: malaria, toxoplasma
- Graft-versus-host disease
- Iron overload (chronic transfusions)
- Immune sensitization (e.g., Rhesus D antigen)



Adverse events

Carson, N Engl J Med. 2017

LEUKOREDUCTION



Tolerance of anemia - DO_2/VO_2

Volume status

Dynamics of anemia

Redistribution of flow

Physiological reserve

Increased EO_2R

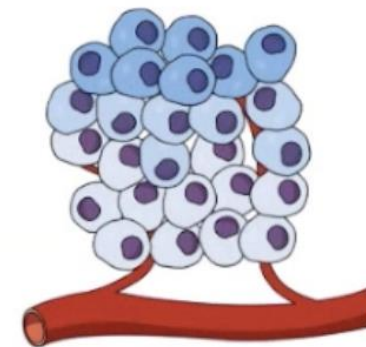
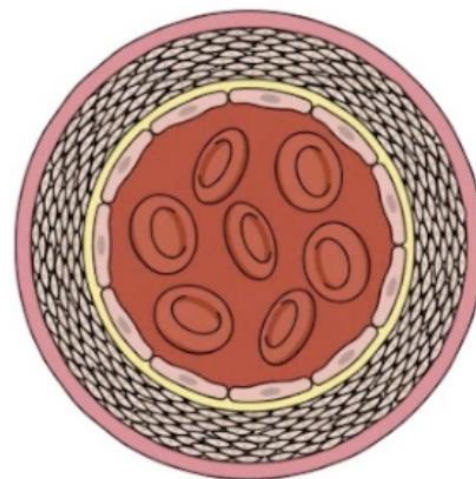
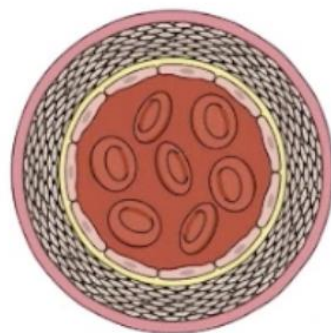
CaO₂



Q_{max}

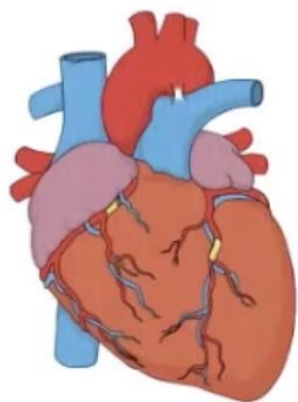
Hb 4-5 g/dL

**Physiological
Reserve**

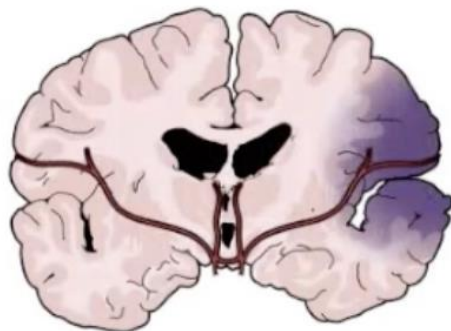


**Tissue
Hypoxia**

DO₂



Heart Disease



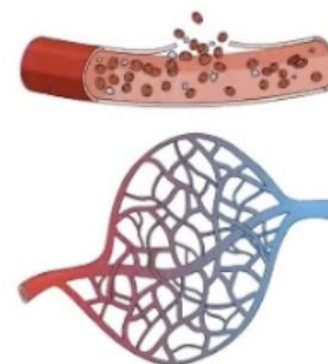
Brain Injury



Elderly

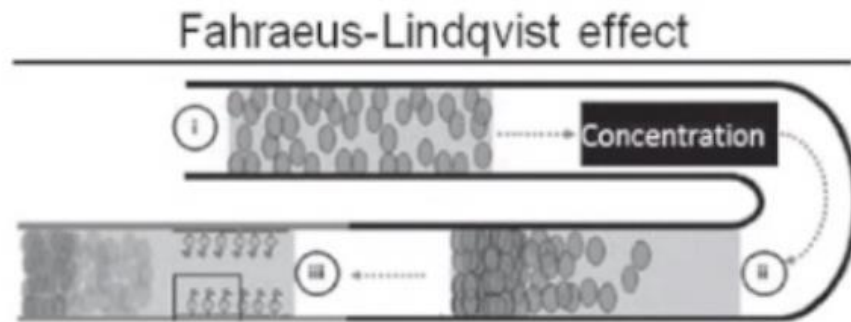


Chronic Hypoxemia

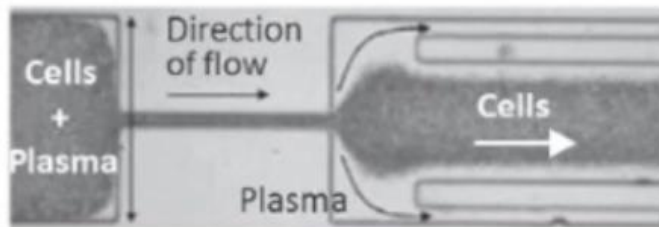


Impaired MC

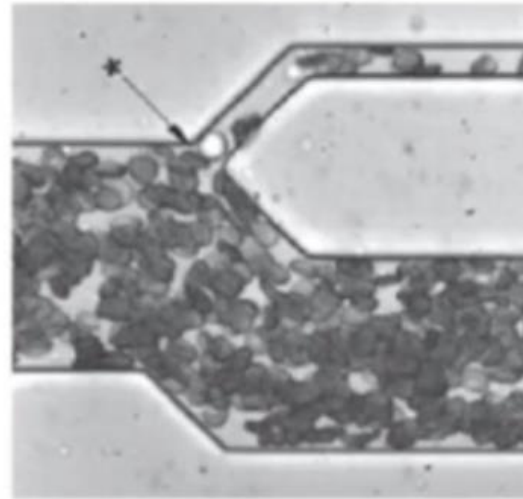
Indications based on Hb concentration



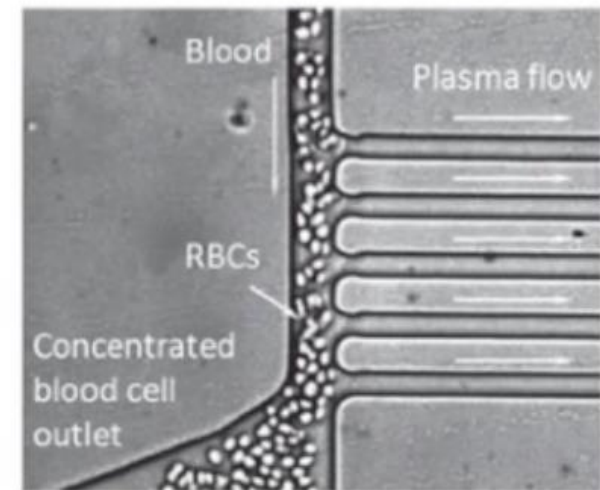
Cell-free & plasma skimming effects

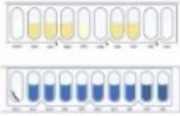


Cell-free effect

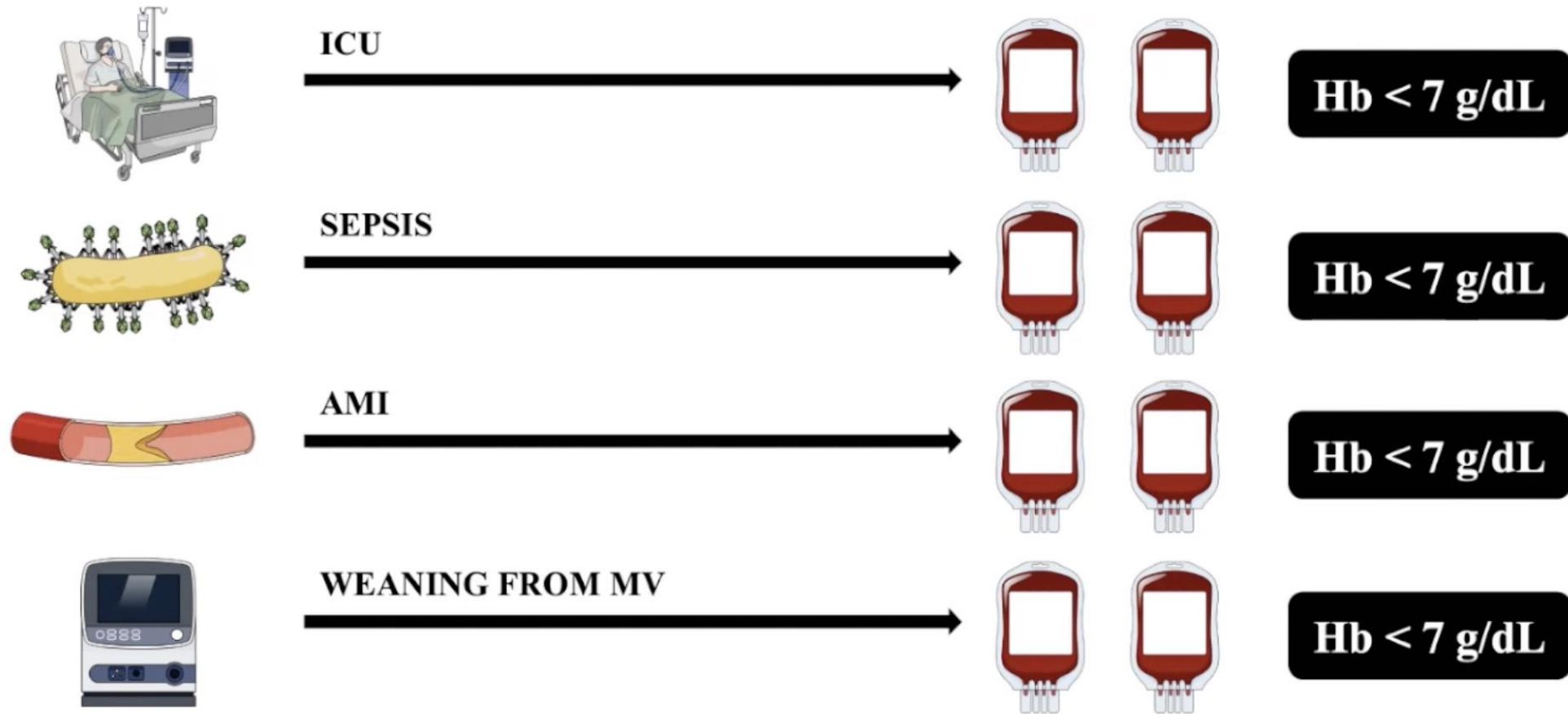


Zweifach-Fung effect



 R L	TRICC (1999)	Lacroix (2007)	Villaneuva (2013)	Carlson (2013)	TRISS (2014)	REALITY (2021)	MINT (2023)	HEMOTION (2024)	TRAIN (2024)
	838	637	921	110	1005	668	3504	742	850
	7 g/dL	7 g/dL	7 g/dL	8 g/dL	7 g/dL	8 g/dL	7-8 g/dL	7 g/dL	7 g/dL
	10 g/dL	9.5 g/dL	9 g/dL	10 g/dL	9 g/dL	10 g/dL	10 g/dL	10 g/dL	9 g/dL
	Critically ill Euvoemia Hb < 9 g/dL 	Critically ill children Hb < 9 g/dL 	Severe acute GI bleeding 	ACS / Stable angina Hb < 10 g/dL 	Septic Shock 	Myocardial Infarction Hb 7-10 g/dL 	Myocardial Infarction Hb <10 g/dL 	TBI Hb < 10 g/dL 	Acute Brain Injury Hb < 9 g/dL 
	30-day mortality	New or progressive MODS	6-wk survival	30-day composite (death, MI, PCI)	90-d mortality	30-day MACE (death, stroke, MI, PCI)	30-day MI or death	6-m GOSE	6-m GOSE
	R 19% L 23% P=0.11	R 12% L 12% ARR=0.4% (NS)	R 95% L 91% P=0.02	R 26% L 11% P=0.054	R 42% L 45%	R 11% L 14% RR 0.79 (NS)	R 17% L 15% P=0.07	R 74% L 68% RR 0.93 (NS)	R 72% L 62% RR 0.86 (S)*
	Young Patients APACHE </> 20 Coronary Disease 	-	Cirrhosis	-	-	-	NSTEMI AKI CHF	-	-
	Pulmonary Edema ARDS 	-	Bleeding	-	-	-	Cardiac Death	-	Cerebral Ischemia

Transfusion strategies in non bleeding critically ill adults: a clinical practice guideline from ESICM

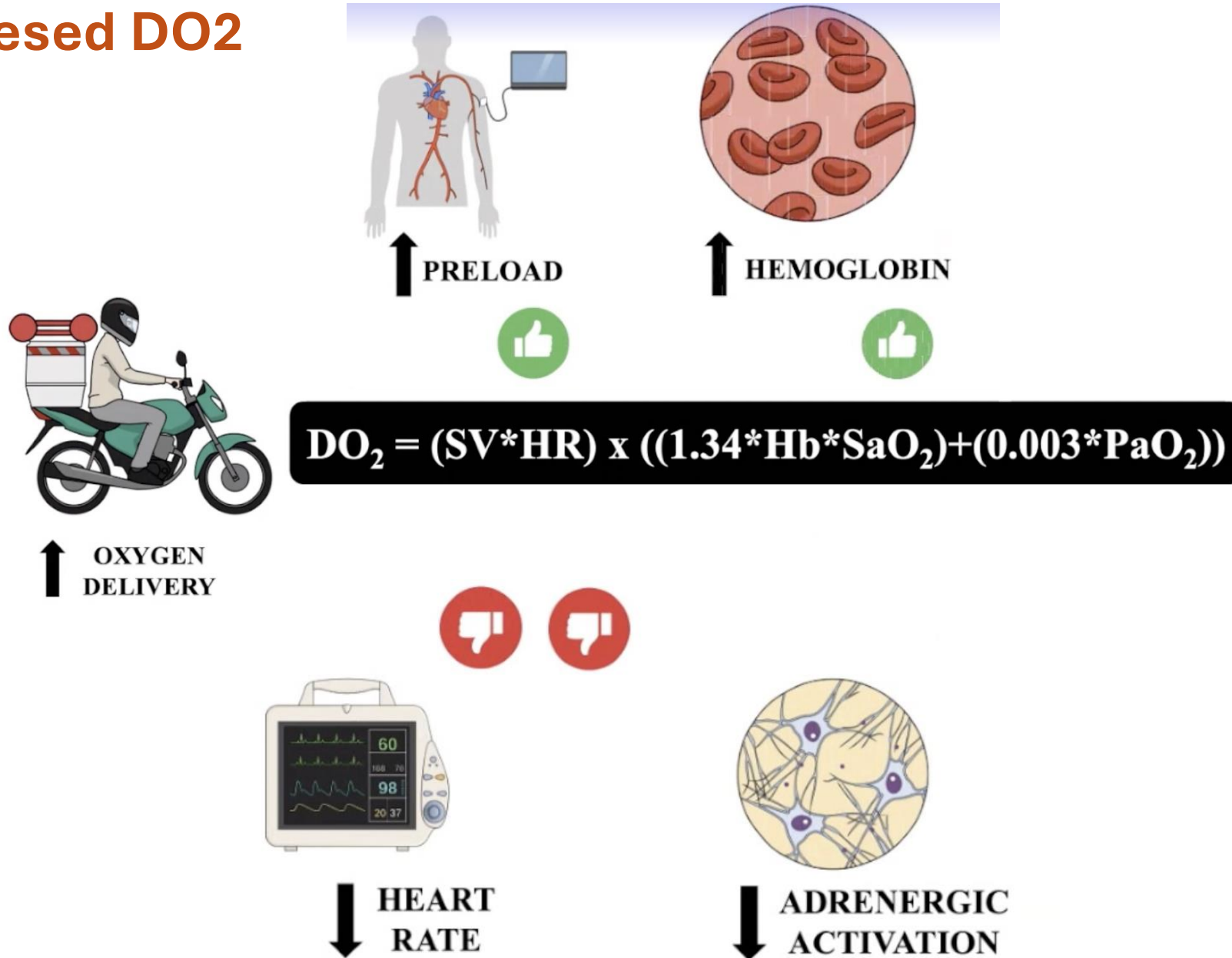


“... This is everything but personalized medicine!

Data from large databases have indicated that liberal blood transfusion strategies in critically ill patients may be associated with improved outcomes.

The RCT gurus will say that even the best propensity analysis cannot take all factors into account, but I will counter that RCTs based on Hb concentrations cannot take into account all the factors that can and should influence the medical decision to transfuse.”

Increased DO₂



Post-transfusion increase of hematocrit *per se* does not improve circulatory oxygen delivery due to increased blood viscosity

Robert Zimmerman¹, Amy G Tsai^{2,4,*}, Beatriz Y Salazar Vázquez^{2,3}, Pedro Cabrales², Axel Hofmann^{4,5}, Jens Meier⁶, Aryeh Shander⁷, Donat R Spahn⁵, Joel M Friedman⁸, Daniel M Tartakovsky^{1,4}, Marcos Intaglietta^{2,4}

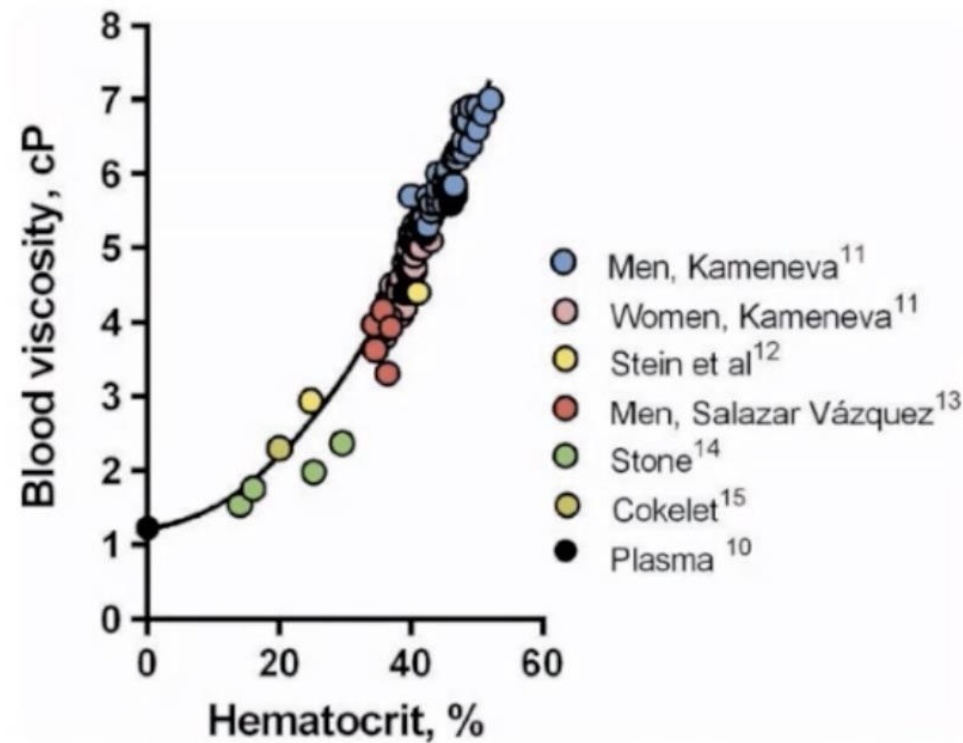
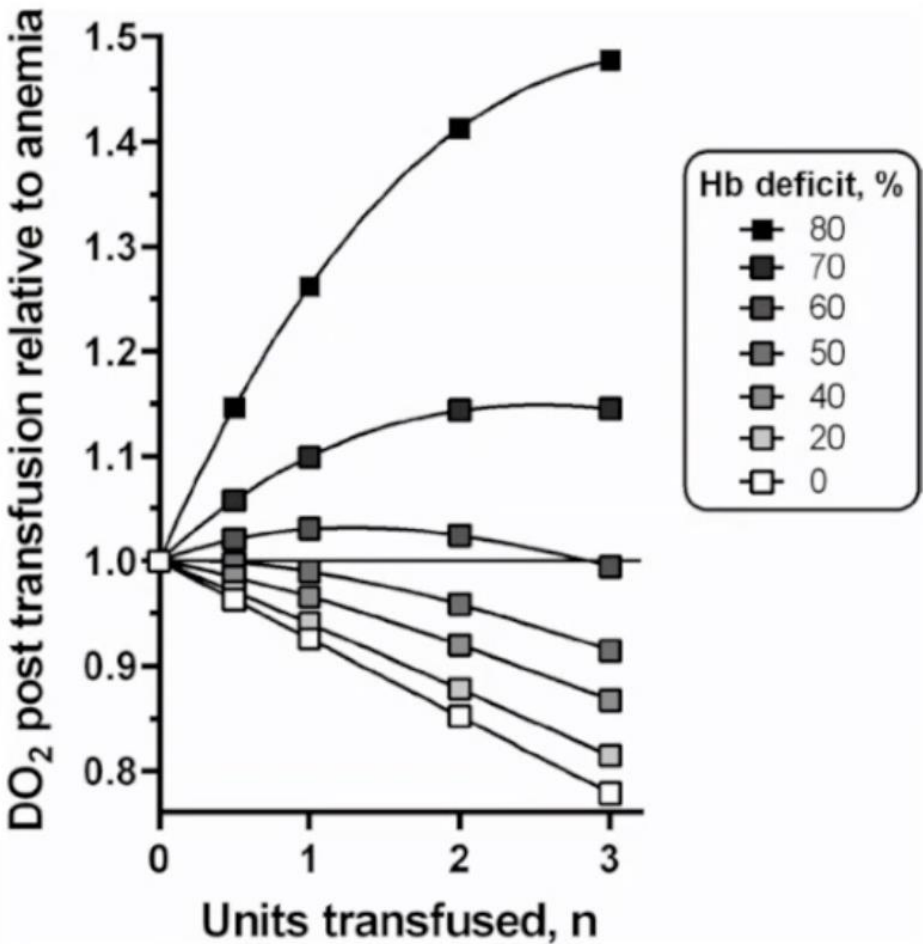
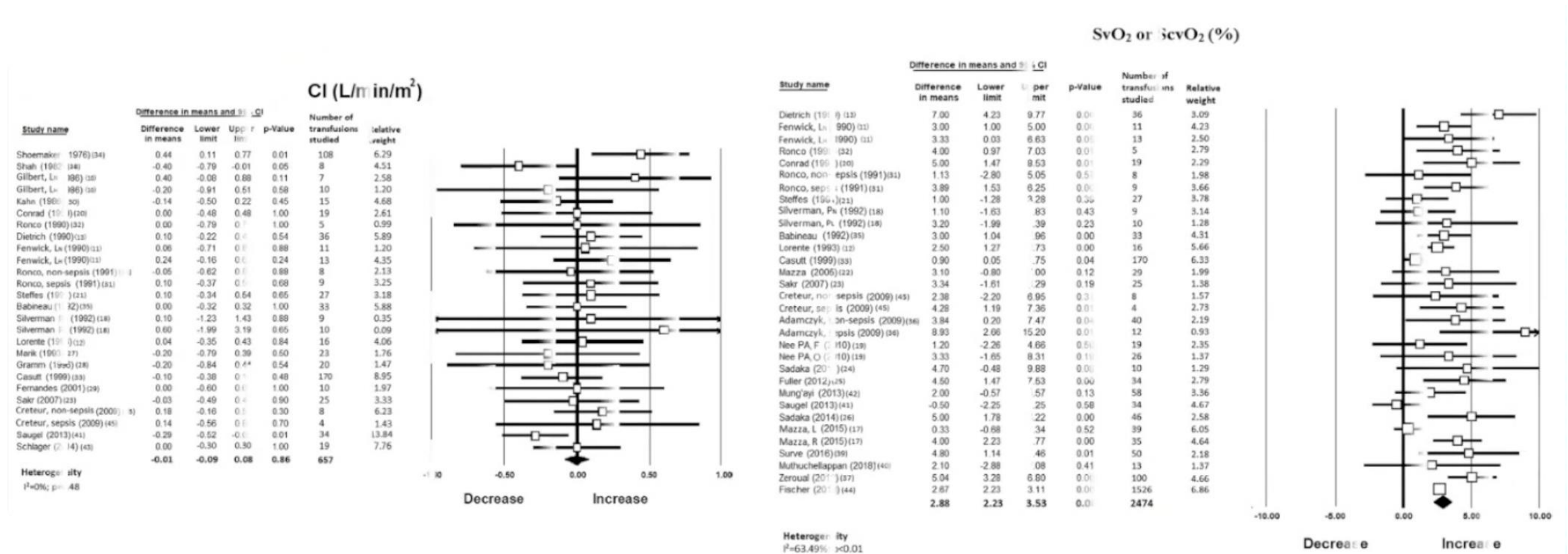


Figure 1. Blood viscosity as a function of hematocrit of normal and anemic individuals. Plasma viscosity 1.22 cP is the average of the available data in the literature.



Systematic review and Meta Analysis of effects of transfusion on hemodynamic and oxygenation variables



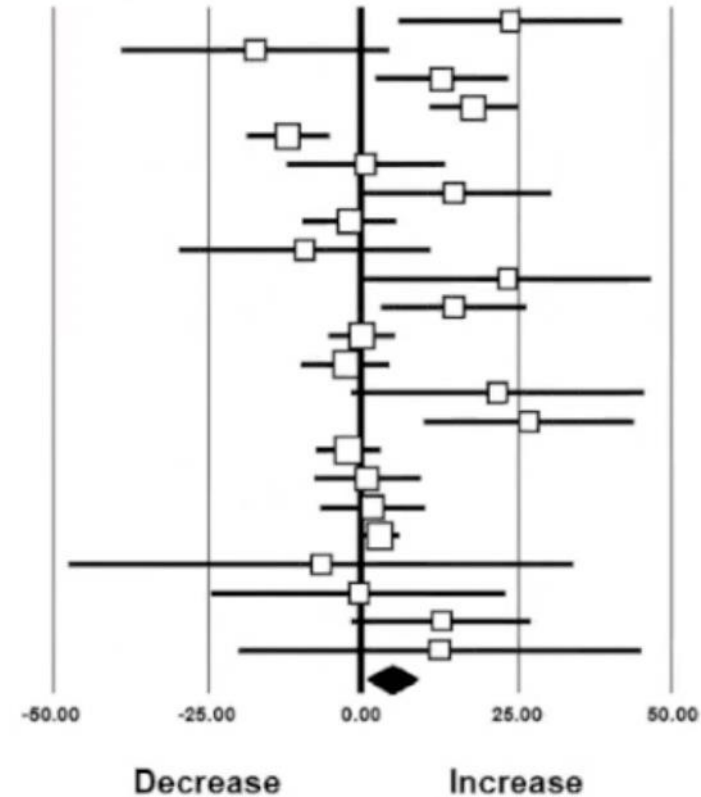
Systematic Review and Meta-Analysis of Effects of Transfusion on Hemodynamic and Oxygenation Variables.

par Cavalcante Dos Santos, Elaine & Orbegozo, Diego & Mongkolpun, Wasineenart & Galfo, Valentina & Nan, Wang & Couvêa Bogossian, Elisa & Taccone, Fabio Silvio & Vallet, Benoît & Creteur, Jacques & Vincent, Jean Louis & Référence Critical care medicine, 48, 2, page (241-248)
Publication Publié, 2020-02-01

VO₂I (ml/min/m²)

Study name	Difference in means and 95% CI			p-Value	Number of transfusions studied	Relative weight
	Difference in means	Lower limit	Upper limit			
Shoemaker (1976)(34)	24.00	6.04	41.96	0.01	108	3.06
Shah (1982)(38)	-17.00	-38.56	4.56	0.12	8	2.42
Gilbert, L _H (1986)(10)	13.00	2.42	23.58	0.02	7	5.08
Gilbert, L _H (1986)(10)	18.00	11.06	24.94	0.00	10	6.34
Kahn (1988)(30)	-11.75	-18.25	-5.25	0.00	15	6.48
Conrad (1990)(20)	0.80	-11.83	13.43	0.90	19	4.42
Ronco (1990)(32)	15.00	-0.60	30.60	0.06	5	3.60
Dietrich (1990)(13)	-1.80	-9.29	5.69	0.64	36	6.14
Fenwick, L _H (1990)(11)	-9.00	-29.19	11.19	0.38	11	2.64
Fenwick, L _H (1990)(11)	23.67	0.64	46.70	0.04	13	2.20
Steffes (1991)(21)	15.00	3.46	26.54	0.01	27	4.76
Ronco, non-sepsis (1991)(31)	0.18	-5.10	5.46	0.95	8	6.88
Ronco, sepsis (1991)(31)	-2.46	-9.45	4.54	0.49	9	6.32
Silverman, P _H (1992)(18)	22.00	-1.46	45.46	0.07	9	2.15
Silverman, P _L (1992)(18)	27.00	10.27	43.73	0.00	10	3.33
Babineau (1992)(35)	-2.00	-7.16	3.16	0.45	33	6.92
Lorente (1993)(12)	1.00	-7.53	9.53	0.82	16	5.78
Marik (1993)(27)	1.90	-6.51	10.31	0.66	23	5.82
Casutt (1999)(33)	3.00	-0.18	6.18	0.06	170	7.43
Fernandes (2001)(29)	-6.40	-47.01	34.21	0.76	10	0.88
Sakr (2007)(23)	-0.34	-23.94	23.26	0.98	25	2.13
Creteur, non-sepsis (2009)(45)	12.95	-1.46	27.36	0.08	8	3.91
Creteur, sepsis (2009)(45)	12.65	-19.62	44.92	0.44	4	1.30
	4.92	0.88	8.95	0.02	575	

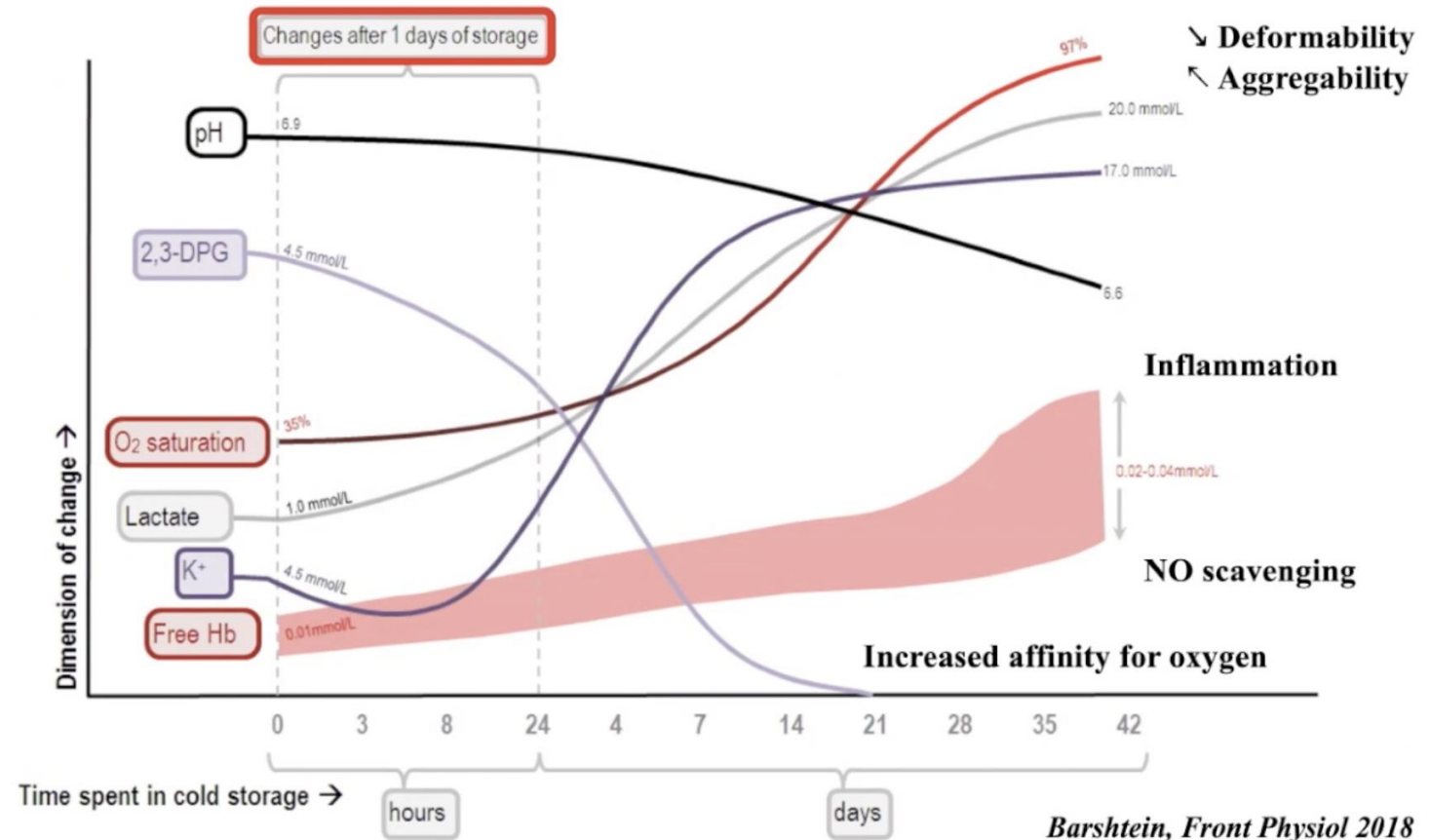
Heterogeneity
I²73.25%; p<0.01



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par Cavalcante Dos Santos, Elaine ;Orbegozo, Diego;Mongkolpun, Wasineenart ;Galfo, Valentina;Nan, Wang;Gouvêa Bogossian, Elisa ;Taccone, Fabio Silvio ;Vallet, Benoît;Creteur, Jacques ;Vincent, Jean Louis
Référence Critical care medicine, 48, 2, page (241-248)
Publication Publié, 2020-02-01

Storage damage



"TIME IS LIFE IN SEVERE BLEEDING!"



First Author	Year	ICU / Post-Surgery	Key Findings
Lyu et al.	2024	✅ ICU patients (not all surgical)	Incidence: 1.4–10.9% had major bleeding. Causes: Coagulopathy, anticoagulants, organ failure. Impact: Mortality 39.4% (with bleeding) vs 14.3% (without).
Halme et al.	2024	⚠️ Post-surgical cohort, not ICU-specific	Incidence: 11.6% had major bleeding in 30 days. Timing: 42.7% in first 24h; 77.7% in 7 days. Impact: Higher mortality, transfusions, reoperations.
Salenger et al.	2025	✅ Cardiac surgery (typically ICU patients)	Focus: Transfusions, quality metrics in cardiac surgery. Impact: Increased mortality, LOS, transfusions. Causes: Surgical and hemostatic factors.
Besnier et al.	2024	✅ Cardiac ICU population	Tool: Developed POBS-Card risk score. Impact: Severe bleeding = worse outcomes. Risk Factors: Age, surgery type, clinical profile.
Plötzl et al.	2025	⚠️ General surgery, not ICU-specific	Incidence: 1.6% of 43,360 surgeries. Causes: Male sex, age, surgery characteristics. Focus: Risk mitigation strategies.
Vigneron et al.	2024	✅ ICU patients with hematologic malignancies	Incidence: 10.8% had ICU-acquired bleeding. Causes: Renal disease, PT, SOFA. Impact: ↑ ICU stay and mortality.
Pang et al.	2023	⚠️ Postoperative patients, not ICU-specific	Focus: Secondary hemorrhage post-abdominal surgery. Risks: OR time >5h, delay to re-op. Impact: Hemorrhagic + septic shock, MODS.
Pinchuk et al.	2024	⚠️ Neurosurgical patients, not ICU-specific	Focus: ASA and bleeding post-glioma surgery. Incidence: 2.7% (ASA group) vs 1.3%. Impact: Lower GCS/KPS.

Bleeding Parameters, Transfusion Forms, Protocols, and Clinical Outcomes in Post-Surgical ICU Patients

Author	Year	Study Context	Bleeding Assessment Parameters	Transfusion Forms	Protocols / PBM	Clinical Outcomes
<u>Sheikhalishi et al.</u>	2024	<u>Postoperative ICU patients (multicenter)</u>	32 clinical variables (labs, vitals, bleeding prediction parameters)	RBC	Predictive model; no formal transfusion protocol	Prolonged ICU stay in transfused patients; mortality data not reported
Flint et al.	2025	ICU, Australia/NZ (mixed population)	<u>Hb, clinical signs of bleeding, VHA (ROTEM/TEG) in some patients</u>	RBC, Platelets, FFP, Cryoprecipitate	<u>National guidelines; low MTP use</u>	<u>ICU mortality 15.3%; longer ICU stay in transfused patients</u>
<u>Salenger et al.</u>	2025	<u>Cardiac surgery (routine ICU admission)</u>	Drainage volume, blood loss, TXA use, surgical risk factors	<u>RBC, Platelets, Plasma, TXA</u>	Routine TXA; PBM focus; institutional variation	<u>More complications, deaths, and longer LOS with higher blood loss</u>

Yadav et al.	2024	ICU review (includes surgical patients)	Hb, INR, PLT, <u>fibrinogen, point-of-care testing</u>	RBC, Platelets, Plasma, TXA	Restrictive strategy (Hb ~7–8 g/dL)	Review: ↑ infections, complications, LOS with liberal transfusion
Lyu et al.	2024	ICU (various bleeding sources)	<u>Clinical documentation of ICU-acquired bleeding</u>	RBC	Observational; no protocol	ICU mortality: 39.4% (with bleeding) vs 14.3% (without)
Halme et al.	2024	<u>Postoperative population (not ICU-specific)</u>	Reoperation, intervention, transfusion events	RBC (unspecified quantity)	No transfusion protocol reported	↑ 30-day mortality, especially after non-cardiac surgery
Besnier et al.	2024	Cardiac surgery – ICU bleeding risk stratification	POBS-Card score: PT, PLT, fibrinogen, BMI, redo surgery	RBC, <u>Platelets, Plasma (assumed)</u>	Predictive scoring tool; no transfusion protocol	High <u>scores = ↑ transfusion, longer ICU stay, more complications</u>
Plötzl et al.	2025	General surgery (large cohort, non-ICU specific)	Bleeding identified via ICD codes and surgical reintervention	Transfusions (not specified)	No <u>protocol reported</u>	↑ Reoperation risk and in-hospital mortality
Vigneron et al.	2024	ICU, patients with hematologic malignancies	PT, PLT, SOFA as bleeding risk predictors	Transfusions (not detailed)	No <u>protocol reported</u>	↑ ICU mortality and LOS; 22% of deaths bleeding-related
Pang et al.	2023	<u>Abdominal surgery (not ICU-specific)</u>	Secondary hemorrhage; delayed reoperation as key metric	RBC	No <u>protocol; recommends prompt reoperation</u>	Delay = ↑ mortality (shock + MODS)
Pinchuk et al.	2024	Neurosurgery (gliomas, ASA users)	Hemorrhage via imaging; GCS and KPS assessment	RBC	<u>ASA-related risk assessment; no PBM strategy</u>	<u>Worse neurological status in patients with postoperative bleeding</u>

Blood Transfusion Practices in Intensive Care

Blood Transfusion Practices in Intensive Care: A Prospective Observational Binational Study

[Andrew W J Flint](#)^{1,2,3,✉}, [Alexis Poole](#)^{2,4}, [Senta Jorinde Raasveld](#)^{5,6}, [Michael Bailey](#)², [Karina Brady](#)¹, [Pin-Yen Chen](#)¹, [Yan Chen](#)⁷, [D Jamie Cooper](#)², [Craig French](#)^{2,8}, [Alisa Higgins](#)², [Adam H Irving](#)^{1,9}, [Richard E McAllister](#)¹⁰, [Ary Serpa Neto](#)², [Tony Trapani](#)², [Neil Waters](#)¹, [James Winearls](#)¹¹, [Michael C Reade](#)^{2,12,13,14}, [Erica M Wood](#)^{1,15}, [Alexander P J Vlaar](#)⁵, [Zoe K McQuilten](#)^{1,15,✉}

Use of MTPs in practice

MTPs were implemented *nine times* among six patients (0.7% of studied patients)

Thresholds / Pre-transfusion triggers

They measured the pre-transfusion **hemoglobin** for RBCs, **platelet count** for platelets, **INR** for FFP, **fibrinogen** level for cryoprecipitate.

Viscoelastic hemostatic

VHA - available in many ICUs but used as guidance: only in ~9.3% of non-RBC transfusions.

Consistency with national guidelines

LACK OF STANDARDIZED PRACTICE RATHER THAN DEFINING A PROTOCOL.

Comparison of Guidelines (STS, ESAIC, EACTS/EACTAIC) on Post-Surgical ICU Bleeding Management



Guideline	Hemoglobin Thresholds	Use of Antifibrinolytics	MTP Triggers	Viscoelastic Assays
STS 2021	- Restrictive	Routine use of TXA in cardiac surgery recommended -	Advocates for structured protocols but does not define universal MTP triggers	- transfusion decisions when available
ESAIC 2022	Restrictive	Strong recommendation for TXA in all major surgery	Emphasizes structured MTPs	-Strongly recommended - Prefer viscoelastic testing over conventional labs for dynamic bleeding monitoring
EACTS / EACTAIC 2024	Restrictive	- Recommends routine TXA use in cardiac surgery	Recommends having formal MTP in place	- recommended

Outcomes in Patients Receiving Ultra-Massive Transfusion (UMT)

A Retrospective Study of Ultramassive Transfusion in Trauma Patients: Is There a Value After Which Additional Transfusions Are Futile?

Major, Frank R. BS¹; Pickering, Trevor A. PhD²; Stefanescu, Kristen BS³; Singh, Mandeep MD⁴; Clark, Damon H. MD⁵; Inaba, Kenji MD⁶; Nahmias, Jeffrey T. MD, MHP⁷; Tay-Lasso, Erika L. MD⁸; Alvarez, Claudia MD⁹; Chen, Joy L. MD, FASA¹⁰; Ahmed, Farzin BDS, MPH¹¹; Kaslow, Olga Y. MD, PhD¹²; Tong, Jeffrey L. MD¹³; Xiao, Jianzhou MD¹⁴; Hall, Elizabeth MD¹⁵; Elkhatib, Rania MD, MS-CTSP¹⁶; Bahgat, Youssef BS¹⁷; Tatum, Danielle PhD¹⁸; Simpson, John T. MD¹⁹; Singh, Siddharth DO²⁰; Klein, Norma J. MD²¹; Applegate, Richard L. II MD²²; Kuza, Catherine M. MD, FASA²³

Author Information[Ⓔ]

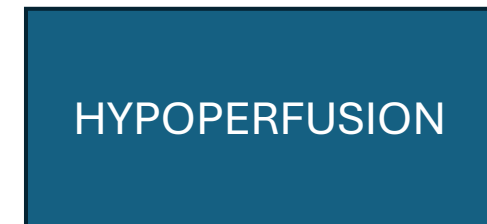
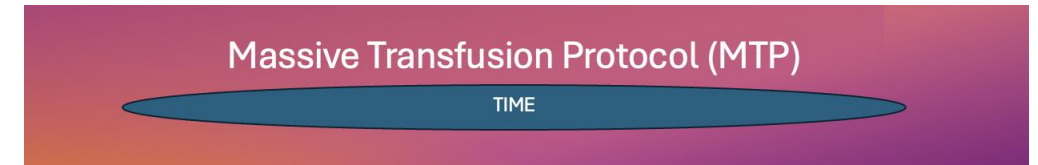
Anesthesia & Analgesia [J:10.1213/ANE.00000000000007569, May 30, 2025. | DOI: 10.1213/ANE.00000000000007569

Outcome / Comparison	Risk Ratio (RR)	95% CI	P value	Conclusion
24-hour mortality (UMT)	6.00	4.79–7.52	< .001	Increased risk
Index hospitalization mortality (UMT)	3.99	3.34–4.75	< .001	Increased risk
Complications (UMT)	1.67	1.44–1.94	< .001	More frequent complications
Multiple organ failure (UMT)	2.78	2.20–3.52	< .001	Increased risk
30–44 RBC units vs 20–29 units	1.32	0.93–1.87	.12	No significant difference
≥45 RBC units vs 20–29 units	1.59	1.12–2.25	.009	Significantly higher risk of death
Beyond 45 RBC units	–	–	–	No survival benefit

Effects on mortality, length of stay (LOS), mechanical ventilation (MV), and complications.

Massive Transfusion Protocol (MTP) Triggers in Guidelines for Postoperative Bleeding

Trigger Category	ESAIC	STS	EACTS/EA CTAIC
>1500 mL rapid blood loss	✓ Yes	⚠ Possible	◆ Situational
>4 units RBCs within hours	✓ Yes	⚠ Not fixed	◆ Situational
Hemodynamic instability (shock)	✓ Yes	✓ Yes	✓ Yes
Coagulopathy (e.g., INR >1.5)	✓ Yes	◆ Implied	✓ VHA-dependent
Institutional discretion	✓ Encouraged	✓ Encouraged	✓ Encouraged



TOOLS

GUIDELINES

Transfusion strategies in bleeding critically ill adults: a clinical practice guideline from the European Society of Intensive Care Medicine



Alexander P. J. Vlaar^{1*} , Joanna C. Dionne^{2,3,4,21}, Sanne de Bruin¹, Marije Wijnberge^{1,5}, S. Jorinde Raasveld¹, Frank E. H. P. van Baarle¹, Massimo Antonelli^{6,7}, Cecile Aubron⁸, Jacques Duranteau⁹, Nicole P. Juffermans^{10,11}, Jens Meier¹², Gavin J. Murphy¹³, Riccardo Abbasciano¹³, Marcella C. A. Müller¹, Marcus Lance¹⁴, Nathan D. Nielsen¹⁵, Herbert Schöchl^{16,17}, Beverley J. Hunt¹⁸, Maurizio Cecconi^{19,20} and Simon Oczkowski^{2,3,4}

GUIDELINES

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1. Massive
bleeding

2. No
massive
bleeding

**MASSIVE
BLEEDING**



Transfusion strategies in bleeding critically ill adults: a clinical practice guideline from the European Society of Intensive Care Medicine

Alexander P. J. Vlaar^{1*}, Joanna C. Dionne^{2,3,4,21}, Sanne de Bruin¹, Marije Wijnberge^{1,5}, S. Jorinde Raasveld¹, Frank E. H. P. van Baarle¹, Massimo Antonelli^{6,7}, Cecile Aubron⁸, Jacques Duranteau⁹, Nicole P. Juffermans^{10,11}, Jens Meier¹², Gavin J. Murphy¹³, Riccardo Abbasciano¹³, Marcella C. A. Müller¹, Marcus Lance¹⁴, Nathan D. Nielsen¹⁵, Herbert Schöchl^{16,17}, Beverley J. Hunt¹⁸, Maurizio Cecconi^{19,20} and Simon Oczkowski^{2,3,4}

-use of high-ratio transfusion strategies (at least one unit plasma per two units of packed red blood cells) vs. low-ratio transfusion strategies in critically ill patients with massive bleeding due to trauma

-no recommendation regarding the use of fixed high-ratio transfusion strategies in critically ill patients with non-traumatic massive bleeding

Nascimento B, Callum J, Tien H, Rubenfeld G, Pinto R, Lin Y, Rizoli S (2013) Effect of a fixed-ratio (1:1:1) transfusion protocol versus laboratory-results-guided transfusion in patients with severe trauma: a randomized feasibility trial. CMAJ 185:E583-589

Holcomb JB, Tilley BC, Baraniuk S, Fox EE, Wade CE, Podbielski JM, del Junco DJ, Brasel KJ, Bulger EM, Callcut RA, Cohen MJ, Cotton BA, Fabian TC, Inaba K, Kerby JD, Muskat P, Keeffe T, Rizoli S, Robinson BR, Scalea TM, Schreiber MA, Stein DM, Weinberg JA, Callum JL, Hess JR, Matijevic N, Miller CN, Pittet JF, Hoyt DB, Pearson GD, Leroux B, van Belle G, Group PS (2015) Transfusion of plasma, platelets, and red blood cells in a 1:1:1 vs a 1:1:2 ratio and mortality in patients with severe trauma: the PROPPR randomized clinical trial. JAMA 313:471–482

High FFP: transfusion and high platelet ratios 1:1:2 compared to 1:1:1

The pooled results did not result in a mortality benefit at 24 h

(RR 0.75, 95% CI 0.52–1.08; RD – 4.2%, 95% CI – 8.1 to 1.4%, moderate certainty) **and 30 days** (RR 0.93, 95% CI 0.72–1.2; RD – 1.7%, 95% CI – 7 to 5)

Higher transfusion ratios may result in better clinical hemostasis, reducing probability of death by exsanguination

(RR 0.7, 95% CI 0.51–0.96, RD – 23.7%, 95% CI – 38.8 to – 3.2, low certainty)

Fibrinogen

Recommendation

We make **no recommendation** regarding the use of early empiric fibrinogen replacement in critically ill patients with massive hemorrhage due to trauma (*No recommendation, low certainty evidence*).

Observational data: hypofibrinogenemia linked to coagulopathy & worse outcomes

- RCTs:
 - Fibrinogen concentrate ↑ fibrinogen levels & FIBTEM
 - Possible ↓ transfusion needs in low fibrinogen patients
- Unclear:
 - Early/empirical vs test-guided strategy
 - Optimal dose & target fibrinogen level

Possible association of **high fibrinogen levels with mortality & thrombosis**

- Greatest benefit likely in patients with **low fibrinogen lab values**
- Threshold may vary across populations
- If early fibrinogen strategy is used → should include **rapid testing** to avoid unnecessary use

NON MASSIVE BLEEDING



Recommendation

In patients with non-massive bleeding after vascular surgery, we **suggest** restrictive (7.5–8 g/ d/L) red blood cell transfusion threshold (*Conditional recommendation, low certainty*).

7,5-8g/dL

Recommendation

In patients with non-massive gastrointestinal bleeding, we **suggest** restrictive (7 g/dL) transfusion vs. liberal (9 g/dL) red blood cell transfusion threshold (*Conditional recommendation, moderate certainty*).

7 g/dL

R
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**No recommendation for restrictive vs
liberal plasma transfusion strategy**

Only **one retrospective cohort study**

Compared:

1. ICH + ↓ platelet activity (aspirin test) + platelets
 2. ICH + platelets
- vs controls (aspirin responders / no platelets)

No effect on hematoma size (RR 0.71) or expansion (RR 1.44)

2 RCTs → no benefit with platelet transfusion

PATCH trial (n=190):

- ICH, GCS > 8, on antiplatelet drugs
- Higher death/dependence at 3 months with platelet transfusion (RR 2.05, p=0.014)
- No significant difference in mortality alone

Recommendation

We make **no recommendation** for the use of a restrictive vs a liberal platelet transfusion threshold in non-massively bleeding patients with thrombocytopenia (*No recommendation, very low certainty evidence*).

PLATELET TRANSFUSION

Recommendation

We **suggest** using a restrictive platelet transfusion strategy (no transfusion) in patients with intracranial hemorrhage (spontaneous or traumatic intracerebral hemorrhage) who are on antiplatelet therapy (*Conditional recommendation, moderate certainty evidence*).

We make **no recommendation** for the use of a restrictive (no transfusion) vs liberal platelet transfusion strategy in critically ill patients with non-massive bleeding who are on antiplatelet therapy (*No recommendation, very low certainty of evidence*).

Platelet transfusion in non bleeding patients

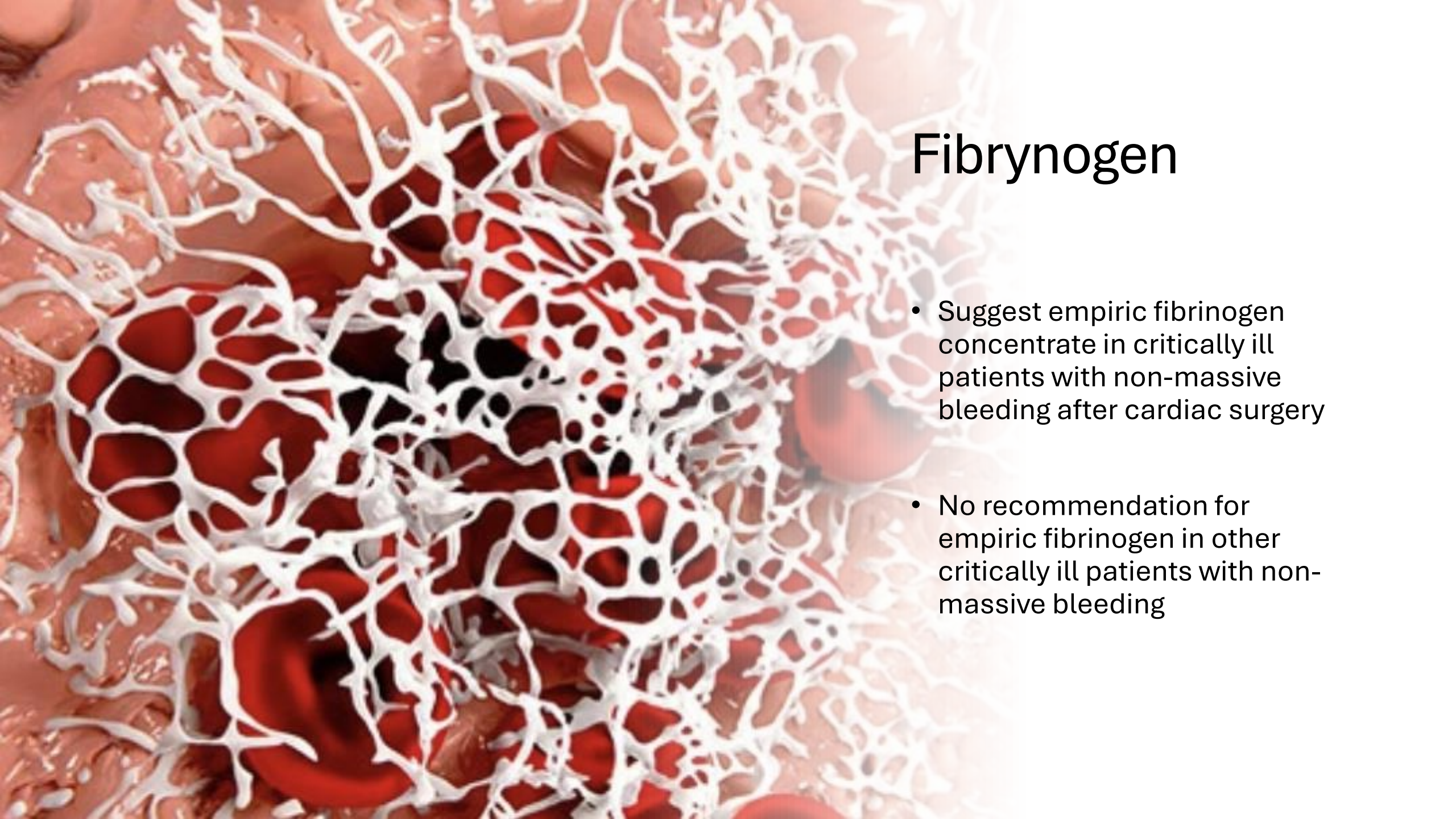
-No recommendation for
restrictive vs liberal platelet
transfusion thresholds

-Define **lower limits** for
prophylactic platelet transfusion,
regardless of bleeding

**Restrictive strategy (no
transfusion)** suggested for:

- Spontaneous or traumatic ICH
- Patients on antiplatelet therapy
- **No recommendation** for restrictive vs liberal transfusion in: Critically ill patients with non-massive bleeding on antiplatelet therapy

INDIVIDUAL PATIENT CHARACTERISTICS



Fibrinogen

- Suggest empiric fibrinogen concentrate in critically ill patients with non-massive bleeding after cardiac surgery
- No recommendation for empiric fibrinogen in other critically ill patients with non-massive bleeding

Viscoelastic testing

We suggest using either viscoelastic testing or conventional coagulation testing to guide transfusion in patients with massive and non-massive bleeding due to cirrhosis, in liver transplant recipients, or in critically ill trauma patients.

Recommendation

We **suggest** for either for viscoelastic or conventional coagulation assays to guide transfusions in massively bleeding trauma critically ill patients (*Conditional recommendation, low quality of evidence*).

Although viscoelastic testing may improve certain outcomes (e.g. TRALI, ARDS), the limited number of studies, heterogeneity, and imprecision → **overall low certainty of evidence**.

Clinical Case 1

Patient: Male, 75 years old

Diagnosis: Severe aortic stenosis

Procedure: Elective aortic valve replacement (AVR)

Duration of surgery: 118 minutes

Aortic cross-clamp time: 35 minutes

Medical history:

Arterial hypertension

Type 2 diabetes mellitus

Severe aortic stenosis

No other significant comorbidities

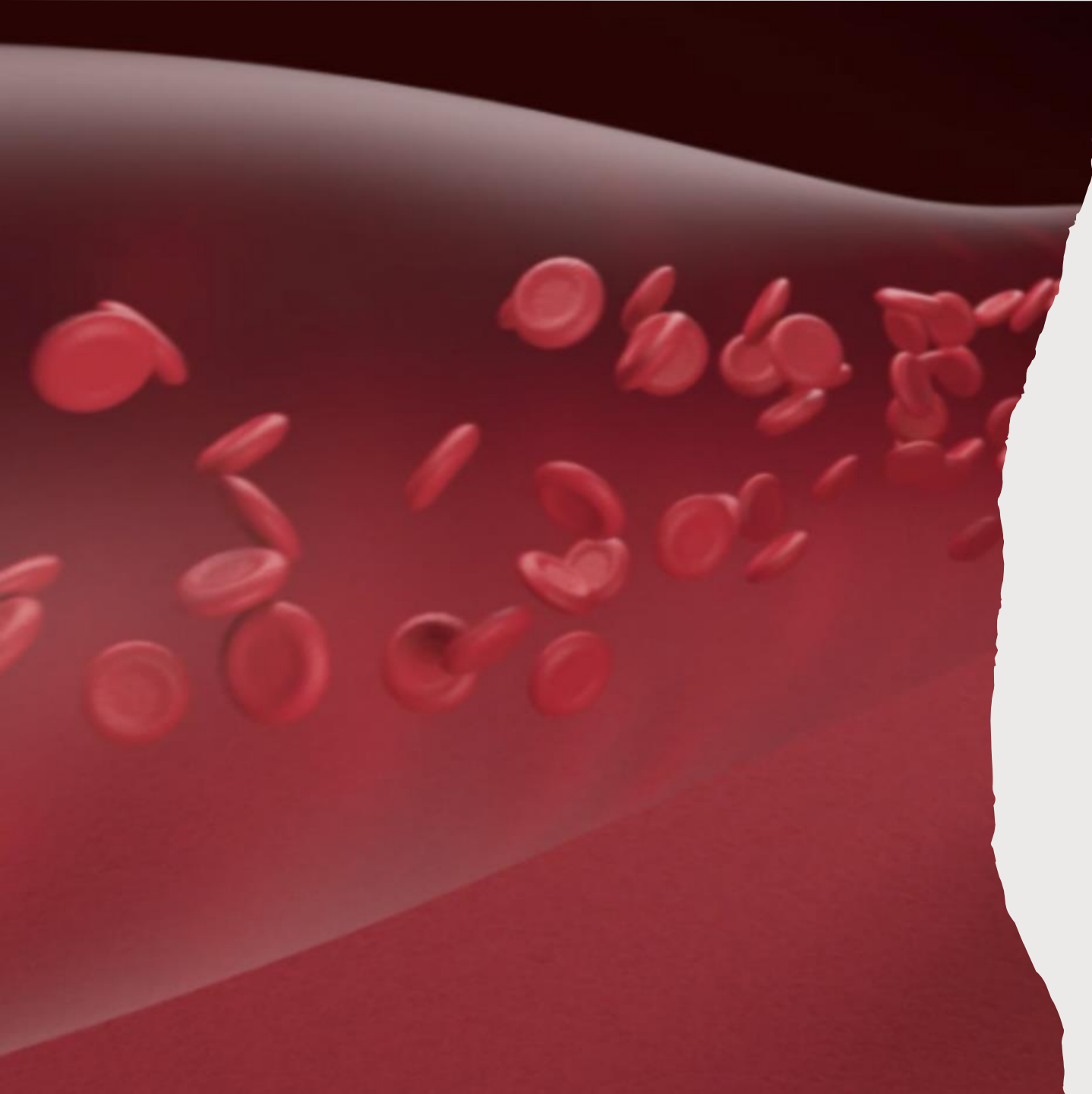
Regular medication: ASA,
antihypertensive

Intraoperative course:

- Procedure completed without technical complications
- No blood or blood product transfusions
- According to the surgeon: “closed dry,”
- Hemodynamics stable during surgery

Postoperative blood gas analysis:

- Hemoglobin: 10.1 g/dl
- Hematocrit: 29%
- **Upon arrival to ICU:**
- Continuous mediastinal drainage output of approximately **100 ml/hour**
- Hemodynamically stable
- No signs of tamponade or acute instability



Clinical Question

Persistent mediastinal
bleeding of ~100 ml/hour
after AVR

**What should be done
next?**

Continuous Noninvasive Hemoglobin Monitoring
(Total Hemoglobin SpHb)

01

HEMODYNAMIC
MONITORING,

02

BLOOD GAS
ANALYSES,

03

MORPHOLOGY
AND STANDARD
LABORATORY
TESTS

Limitations of Conventional Coagulation Tests (CCT)

Tests: PT, INR, PTT, platelet count, fibrinogen

Drawbacks: plasma only, not trauma-specific, incomplete cascade picture

PT/PTT stop when only ~5% of thrombin is generated

Cannot distinguish functional vs nonfunctional fibrinogen

Slow turnaround: median 88 min (up to 235 min)

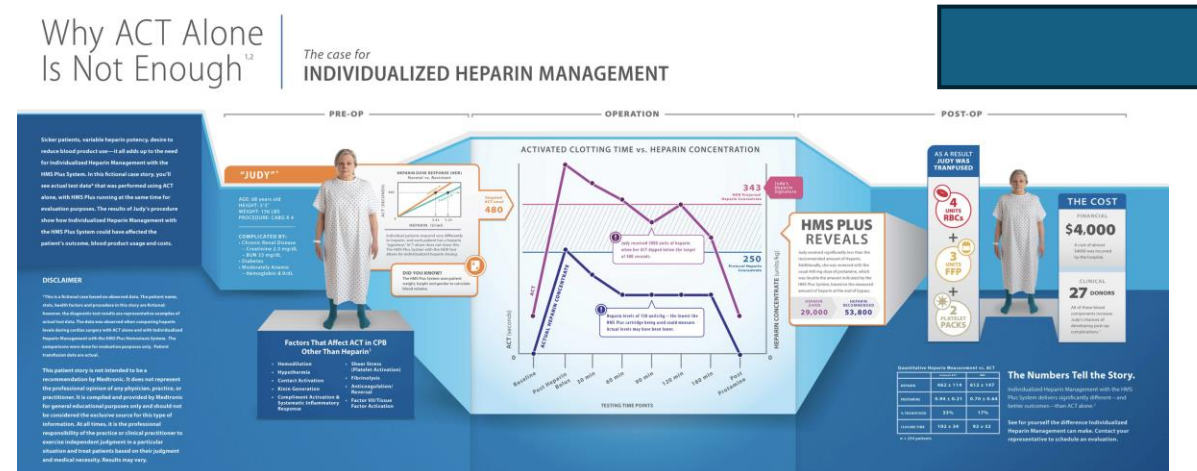
Management of severe peri-operative bleeding: Guidelines from the European Society of Anaesthesiology and Intensive Care

Second update 2022

Kietaibl, Sibylle; Ahmed, Aamer; Afshari, Arash; Albaladejo, Pierre; Aldecoa, Cesar; Barauskas, Giedrius; De Robertis, Edoardo; Faraoni, David; Filipescu, Daniela C.; Fries, Dietmar; Godier, Anne; Haas, Thorsten; Jacob, Matthias; Lancé, Marcus D.; Llau, Juan V.; Meier, Jens; Molnar, Zsolt; Mora, Lidia; Rahe-Meyer, Niels; Samama, Charles M.; Scarlatescu, Ecaterina; Schlimp, Christoph; Wikkelsø, Anne J.; Zacharowski, Kai

„Upon withdrawal from cardiopulmonary bypass, we suggest the use of heparin monitoring to avoid protamine-to-heparin dosing ratios above 1 .

Activated Clotting Time (ACT)



Limitations: nonlinear at high heparin levels; influenced by hypothermia, hemodilution, thrombocytopenia.



Monitoring

- HMS PLUS HEMOSTASIS MANAGEMENT SYSTEM
- **ANTI-XA ASSAYS**
- VISCOELASTIC TESTING WITH **HEPARINASE CHANNELS.**

Anti -Xa assays

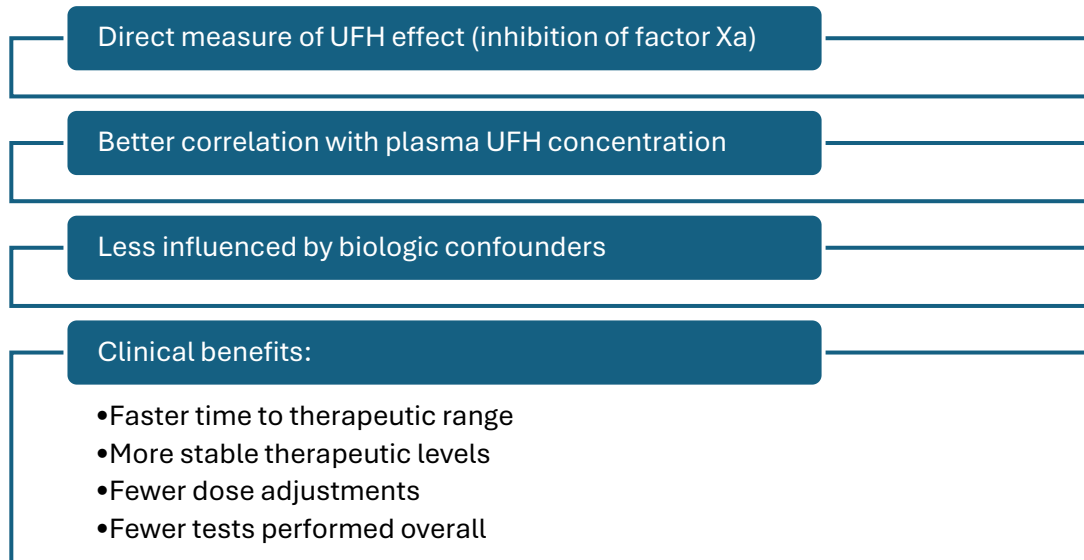
	Population	Key Protocol Details	Target Range
O'Meara et al., 2015	Pediatric ECMO	Protocol titrating UFH infusion directly to anti-Xa	Target: 0.4–0.8 IU/ml ; ATIII supplementation often required
Levy et al.,2022	Adult & pediatric ECMO	Review of anticoagulation strategies	Recommends anti-Xa monitoring with target 0.3–0.7 IU/ml ; advises combining with global hemostasis tests
Helms et al., 2023	Adult ECMO	Expert guidance document	Recommends anti-Xa–based protocols; emphasizes individualized targets (commonly 0.3–0.7 IU/ml)
Rodrigues et al., 2024	Adult VV-ECMO	Review of monitoring strategies	Anti-Xa 0.3–0.7 U/ml suggested; use in combination with ACT/aPTT
Ruggeri et al., 2021	Adult ECMO	Observational data comparing assays	Showed anti-Xa better correlates with UFH than aPTT; suggested 0.3–0.5 IU/ml safe range

Our proposition protocol

Phase	Action	Target Values	Monitoring Frequency
Initiation	UFH bolus at cannulation, start infusion	0.3–0.7 IU/ml	Anti-Xa 1–2 h after bolus/dose change; parallel aPTT/ACT
Maintenance	Adjust UFH infusion based on anti-Xa (+aPTT/ACT)	Maintain anti-Xa in range	Anti-Xa q4–6 h; once stable q12 h
Discordant results	Anti-Xa in range but aPTT low → ↑ UFH - aPTT therapeutic but Anti-Xa > 1 IU/ml → ↓ UFH	Maintain balance between assays	Use UFH sliding scale
Special situations	Bleeding, thrombosis, oxygenator change, heparin resistance, low ATIII	Target anti-Xa per above + check ATIII, consider TEG/ROTEM	More frequent monitoring (q2–4 h)
Escalation	Persistent sub/suprathreshold values	Consider ATIII supplementation, adjust bolus, revise targets	Individualize by patient risk

Anti-Xa: Advantages & Limitations

Advantages



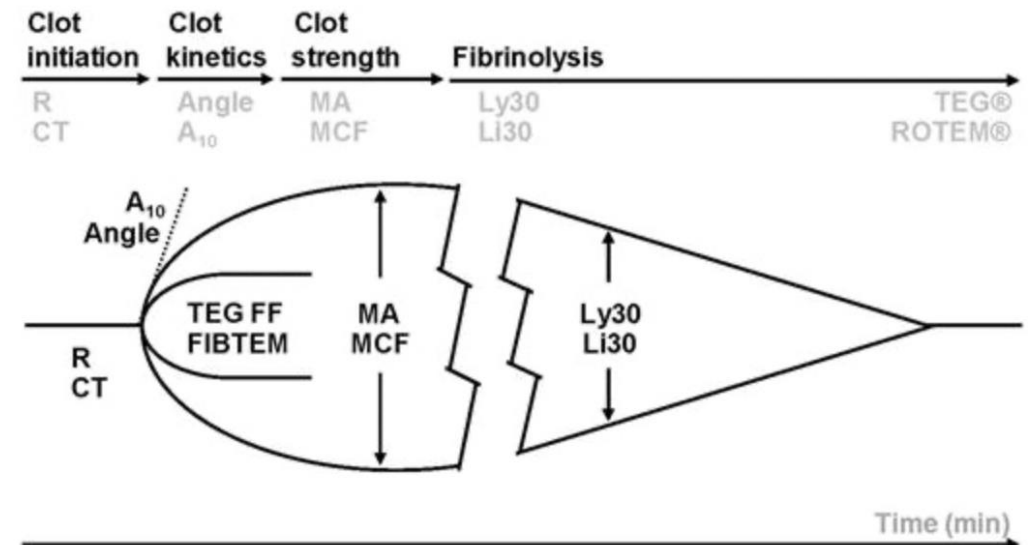
Limitations

- Higher cost, less available in some centers
- Inter-laboratory variability due to different reagents
- Not yet fully standardized globally

Conventional coagulation tests vs viscoelastic testing

Aspect	CCT (PT/INR/PTT)	TEG/ROTEM
Sample type	Plasma only	Whole blood
Result time	88-235 min	<15 min
Scope	Partial cascade	Dynamic clot (initiation, kinetics, strength, lysis)
Sensitivity to TIC	Low	High
Clinical utility	Not trauma-specific	Guides targeted therapy

algorithms **reduce unnecessary plasma/platelet transfusions** compared to conventional coagulation tests.



Clinical case

2

Patient: Male, 26 years old

Mechanism of injury: Fall from height

Time from injury to admission: ~8 hours

Diagnoses:

- Head trauma
- Intracranial hematoma after decompressive craniectomy
- Kidney injury
- Spinal injury (post-surgical)
- Hypothermia on admission

Severely injured
polytrauma patient, post
craniectomy and
abdominal/spinal surgery,
hypothermic, admitted 8
hours after trauma

**What should be done
next in the ICU?**

Principles of Managing Coagulopathy

- Multidimensional assessment: clinical, laboratory, point-of-care
- Essential preconditions of hemostasis:
 - pH > 7.25
 - Ionized calcium > 1 mmol/L
 - Body temperature > 34 °C
- **Minor bleeding: may pause anticoagulant, close monitoring**
- **Major bleeding: urgent damage control surgery → ICU stabilization → definitive surgical repair**

Bleeding

TIME



Post traumatic coagulopathy

Immediate detection and management of traumatic coagulopathy improves outcomes of severely injured patients.

The European guideline on management of major bleeding and coagulopathy following trauma: sixth edition

[Rolf Rossaint](#) , [Arash Afshari](#), [Bertil Bouillon](#), [Vladimir Cerny](#), [Diana Cimpoesu](#), [Nicola Curry](#), [Jacques Duranteau](#), [Daniela Filipescu](#), [Oliver Grottke](#), [Lars Grønlykke](#), [Anatole Harrois](#), [Beverley J. Hunt](#), [Alexander Kaserer](#), [Radko Komadina](#), [Mikkel Herold Madsen](#), [Marc Maegele](#), [Lidia Mora](#), [Louis Riddez](#), [Carolina S. Romero](#), [Charles-Marc Samama](#), [Jean-Louis Vincent](#), [Sebastian Wiberg](#) & [Donat R. Spahn](#)

Critical Care **27**, Article number: 80 (2023) | [Cite this article](#)

Recommendation 11

We recommend the early and repeated monitoring of haemostasis, using either a traditional laboratory determination such as prothrombin time (PT)/international normalised ratio (INR), Clauss fibrinogen level and platelet count and/or point-of-care (POC) PT/INR and/or a viscoelastic method (Grade 1C).

Recommendation 12

We recommend that the routine use of POC platelet function devices for platelet function monitoring in trauma patients on antiplatelet therapy or with suspected platelet dysfunction be avoided (Grade 1C).

Recommendation 13

In the initial phase following trauma, we recommend the use of a restricted volume replacement strategy with a target systolic blood pressure of 80–90 mmHg (mean arterial pressure 50–60 mmHg) until major bleeding has been stopped without clinical evidence of brain injury (Grade 1B).

In patients with severe TBI ($GCS \leq 8$), we recommend that a mean arterial pressure ≥ 80 mmHg be maintained (Grade 1C).

Recommendation 14

If a restricted volume replacement strategy does not achieve the target blood pressure, we recommend the administration of noradrenaline in addition to fluids to maintain target arterial pressure (Grade 1C).

We recommend infusion of dobutamine in the presence of myocardial dysfunction (Grade 1C).

Recommendation 15

We recommend that fluid therapy using a 0.9% sodium chloride or balanced crystalloid solution be initiated in the hypotensive bleeding trauma patient (Grade 1B).

We recommend that hypotonic solutions such as Ringer's lactate be avoided in patients with severe head trauma (Grade 1B).

We recommend that the use of colloids be restricted due to the adverse effects on haemostasis (Grade 1C).

Recommendation 18

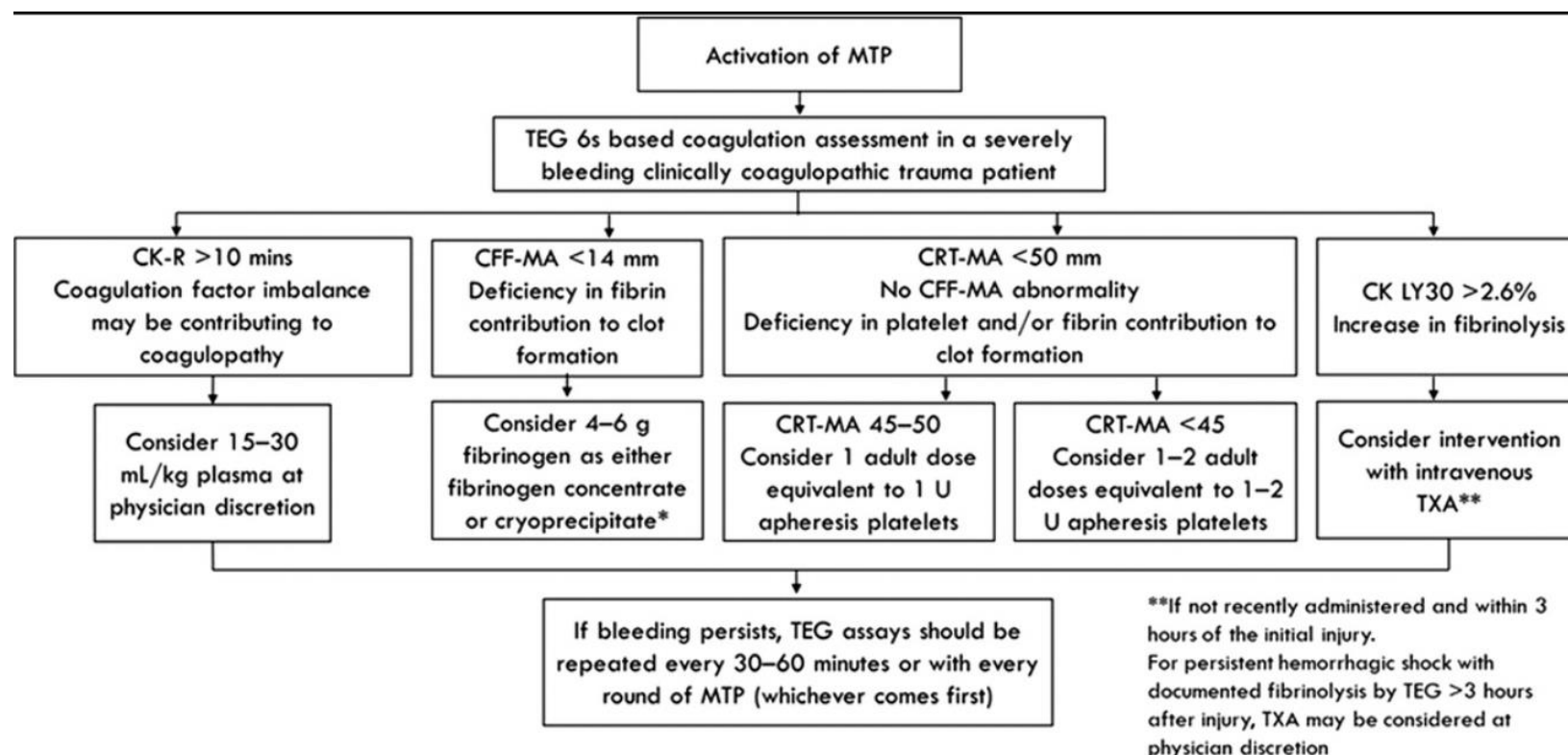
We recommend early application of measures to reduce heat loss and warm the hypothermic patient to achieve and maintain normothermia (Grade 1C).

Goal-directed transfusion algorithm for trauma patients with severe hemorrhage using TEG 6S: Results of a Delphi consensus survey and expert panel recommendations

 Sarani, Babak MD; Callum, Jeannie MD; Neal, Matthew D. MD; Meizoso, Jonathan P. MD, MSPH; Spinella, Philip C. MD; Leeper, Christine MD; Saillant, Noelle MD; Thurston, Brian MD; Moore, Ernest E. MD; Winfield, Robert MD; Brooks, Adam MD; Kornblith, Lucy Z. MD

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Journal of Trauma and Acute Care Surgery 98(6):p 984-991, June 2025. | DOI: 10.1097/TA.0000000000004606 



Case 3

ACT 183

Patient: Male, 67 years old

Procedure: CABG (LIMA-LAD, RCA)

Duration of surgery: 128 minutes

Aortic cross-clamp time: 43 minutes

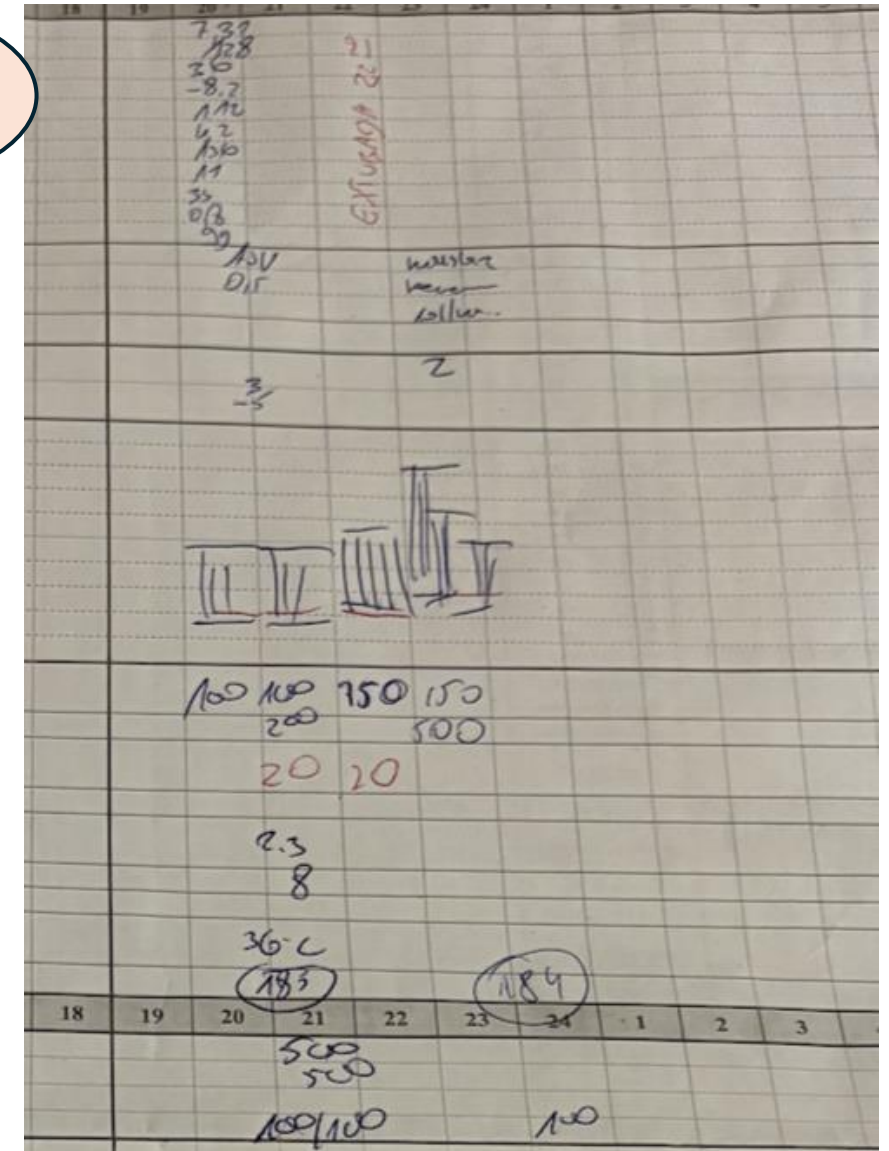
Medical history:

Arterial hypertension

Type 2 diabetes mellitus

Chronic heart disease

Regular medication: ASA, antihypertensive

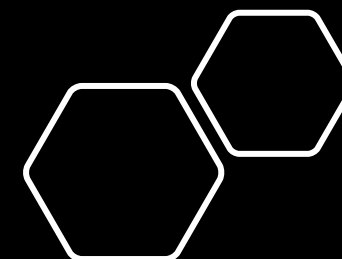


What is the next step??

Wynik pierwszego i ostatniego badania

2025-09-26 22:26 Gazometria POCT (krew tętnicza)

pH	7.36		7.35-7.45	N	
pCO2	36	mm[Hg]	32.0-45.0	N	
pO2	151	mm[Hg]	83.0-108.0		H
Na+	136	mmol/L	136.0-145.0		N
K+	4.4	mmol/L	3.5-5.1	N	
Cl-	109	mmol/L	98.0-107.0		H
Ca++	1.26	mmol/L	1.15-1.33	N	
Glu	118	mg/dL	65.0-95.0	H	
Lac	1.0	mmol/L	0.5-1.6	N	
tHb	12.0	g/dL	11.7-17.4	N	
O2Hb	97.3	%	90.0-95.0	H	
COHb	0.9	%	<3.0	N	
MetHb	0.8	%	0.0-1.5	N	
HHb	1.0	%	1.0-5.0	N	
sO2	99.0	%	94.0-98.0	H	
pH(T)	7.36		7.35-7.45	N	
pCO2(T)	36	mm[Hg]	32.0-45.0	N	
pO2(T)	151	mm[Hg]	83.0-108.0		H
TCO2	21.4	mmol/L	19.0-24.0	N	
BEecf	-5.1	mmol/L	-2.0-3.0	L	
BE(B)	-4.5	mmol/L	-2.0-3.0	L	
HCO3-(c)	20.3	mmol/L	21.0-28.0	L	
HCO3-std	21.4	mmol/L	21.0-28.0	N	
Hct(c)	36	%	37.0-50.0	L	
mOsm	278.5	mmol/L			
Temp	37.0	Cel			
FIO2		%			



Print
shot

Screenshot

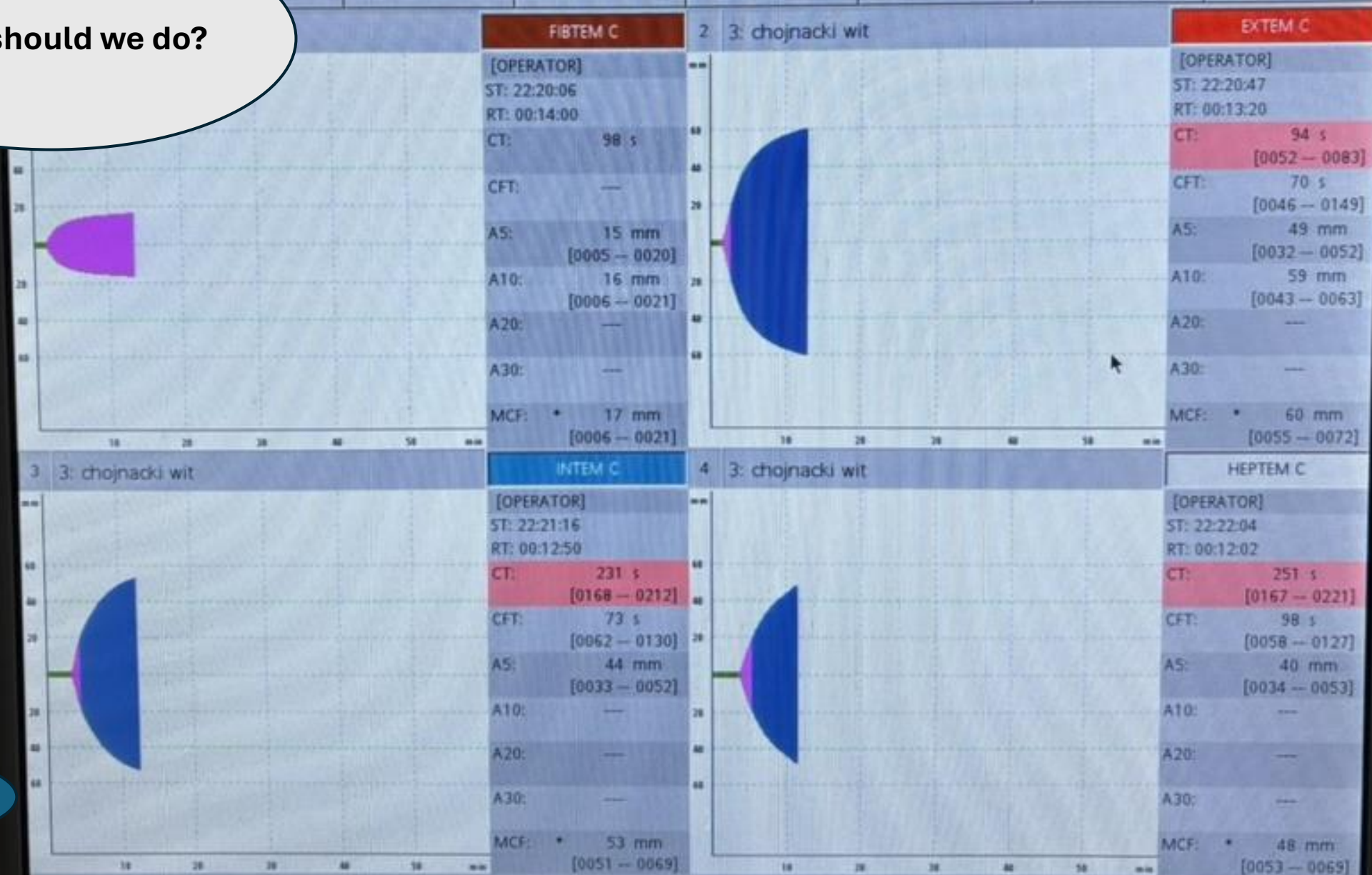
Profile
overlay

Patient
overlay

Help

Quit

What should we do?



2

2025-09-27 Aminotransferaza alaninowa (ALT) (krew żylna,surowica)Aminotransferaza alaninowa (ALT) 23 U/L [<50]**2025-09-27 Aminotransferaza asparaginianowa (AST) (krew żylna,surowica)**Aminotransferaza asparaginianowa (AST) 32 U/L [<50]**2025-09-27 Białko CRP**Białko CRP 26,7 H mg/l [<5]**2025-09-27 Bilirubina całkowita (krew żylna,surowica)**

Bilirubina całkowita w surowicy 1,5 H mg/dl [0,3 - 1,2]

2025-09-26 Czas kaolinowo - kefalinowy (APTT) (krew żylna,osocze cytrynian)

APTT 45,3 H sek [25,4 - 36,9]

Ratio 1,53

2025-09-26 Czas kaolinowo - kefalinowy (APTT) (krew żylna,osocze cytrynian)

APTT 62,3 H sek [25,4 - 36,9]

Ratio 2,10

2025-09-26 Czas protrombinowy (PT) /wskaźnik Quicka, INR/ (krew żylna,osocze cytrynian)

PT 17,3 H sek [9,4 - 12,5]

Wsk. 66 L % [80 - 105]

INR 1,52 H [0,80 - 1,15]

2025-09-27 Kreatynina (krew żylna,surowica)

Kreatynina w surowicy 1,06 mg/dl [0,67 - 1,17]

EGFR 72 ml/min/1,73m²**2025-09-28 Kreatynina (krew żylna,surowica)**

Kreatynina w surowicy 0,84 mg/dl [0,67 - 1,17]

EGFR 91 ml/min/1,73m²**2025-09-26 Fibrynogen (krew żylna,osocze cytrynian)**

Fibrynogen 2,9 g/l [2 - 4]

2025-09-26 Kinaza kreatynowa-izoenzym sercowy (CK-MB) aktywność (krew żylna,surowica)Kinaza kreatynowa-izoenzym sercowy (CK-MB) aktywność 36 H U/L [<24]

Lekka hemoliza surowicy - wskazane ponowne oznaczenie.

2025-09-27 Kinaza kreatynowa-izoenzym sercowy (CK-MB) aktywność (krew żylna,surowica)Kinaza kreatynowa-izoenzym sercowy (CK-MB) aktywność 21 U/L [$<$

1

Take-home messages

- Post-surgical bleeding and anemia remain major ICU challenges.
- Restrictive transfusion strategies are generally safe for non-bleeding patients.
- Goal-directed, viscoelastic-guided transfusion improves outcomes in massive bleeding.
- Transfusion decisions must be individualized, considering patient condition, comorbidities, and institutional protocols.



Thank you for your attention!

