

Prim. Tina Tomić Mahečić MD, PhD

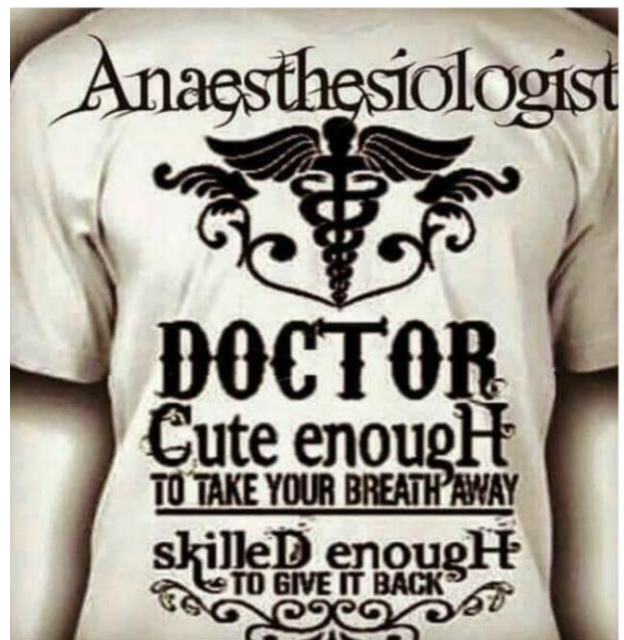
UHC Zagreb

Croatia

IMPLEMENTATION OF PATIENT BLOOD MANAGEMENT IN CLINICAL PRACTICE



COI



- Croatian Association for the Education and Promotion of Management for Perioperative Bleeding and Coagulation Disorders
- Member of the Board of Directors of NATA (the Network for the Advancement of Patient Blood Management, Haemostasis and Thrombosis)
- Co-chair of the ISTH Subcommittee on Perioperative and Critical Care Thrombosis and Hemostasis.
- From 1.1.2026. I am appointed as Chair for Intensive Care within Scientific Forum 4 of ESAIC

Europe – Croatia



CERTIFIKATI CERTIFIKATI CERT

ECMM Excellence



FACT-JACIE



European Reference
Center



6th EEMEA Acute Care
Experts Meeting
October 15-16, 2025 • Vilnius

werfen

PBM – INITIAL PLAN “OPTIMAL BLOOD USE”



Volume 2 December 2005
ISSN 1448-482X

UPDATES IN >

Blood Conservation and Transfusion Alternatives

JOURNAL OF THE AUSTRALASIAN ASSOCIATION FOR BLOOD CONSERVATION

Contents

> WHY SHOULD HEALTH PROFESSIONALS BE CONCERNED ABOUT BLOOD MANAGEMENT AND BLOOD CONSERVATION?

James Isbister

Royal North Shore Hospital of Sydney
Clinical Professor of Medicine, University of Sydney, NSW, Australia

> THE USE OF AUTOLOGOUS BLOOD IN THE SURGICAL SETTING: INTRAOPERATIVE BLOOD SALVAGE SHOULD BE USED WHERE POSSIBLE.

James B Semmens, Michael MD Lawrence-Brown

Centre for Health Services Research, School of Population Health, The University of Western Australia, Nedlands, Western Australia.

> OPTIMISATION OF PERIOPERATIVE AUTOTRANSFUSION

Jonathan H. Waters*, Paul S. Potter

Director, Autotransfusion Services, Department of General Anesthesiology and Clinical Pathology, Cleveland Clinic Foundation, Cleveland, Ohio, USA

Expecting clinicians to be gatekeepers of the blood supply is wrong.
We need better **patient blood management** based on a solid understanding of pathophysiology and better evidence for transfusion efficacy.

Table 2. Current Definitions of Patient Blood Management^{24,96–103}

Organization	Definition	Date first published
SABM (early) ⁹⁶	“Appropriate provision and use of blood, its components and derivatives, and strategies to reduce or avoid the need for a blood transfusion, with the ultimate goal of improved patient outcome”	2007
SABM (current) ⁹⁶	“The timely application of evidence-based medical and surgical concepts designed to maintain Hb concentration, optimize hemostasis, and minimize blood loss in an effort to improve patient outcome”	2012
Western Australia PBM Group ²⁴	“An evidence-based bundle of care that optimizes medical and surgical patient outcomes by clinically managing and preserving a patient’s own blood”	2016
IFPBM ⁹⁷	“An evidence-based bundle of care that optimizes medical and surgical patient outcomes by clinically managing and preserving a patient’s own blood”	2016
WHO ⁹⁸	“A set of evidence-based practices to optimize medical and surgical patient outcomes through preservation of the patient’s own blood	2020
AABB ⁹⁹	“An evidence-based, multidisciplinary approach to optimizing the care of patients who might need transfusion. PBM encompasses all aspects of patient evaluation and clinical management surrounding the transfusion decision-making process, including the application of appropriate indications, as well as minimization of blood loss and optimization of patient red cell mass. PBM can reduce the need for allogeneic blood transfusions and reduce health care costs, while ensuring that blood components are available for the patients who need them”	2021
Joint UK Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee ¹⁰⁰	“A multidisciplinary, evidence-based approach to optimising the care of patients who might need a blood transfusion. PBM puts the patient at the heart of decisions made about blood transfusion to ensure they receive the best treatment and avoidable, inappropriate use of blood and blood components is reduced”	2021
National Blood Authority (Australia) ^{101,102}	“PBM aims to improve clinical outcomes by avoiding unnecessary exposure to blood components. It includes the three pillars: optimisation of blood volume and red cell mass; minimisation of blood loss; and optimisation of the patient’s tolerance of anaemia”	2021
Australia Commission on Safety and Quality in Health Care ¹⁰³	“PBM takes an individualised, multidisciplinary approach to the management of a patient’s blood, through assessment and the development of a management plan to: Optimise a patient’s own blood (identify and address the health conditions that might lead to a blood transfusion such as anaemia or iron deficiency); minimise blood loss (such as surgical techniques that reduce blood loss); and optimise tolerance of anaemia (with appropriate management, the body may tolerate anaemia without resorting to blood transfusion”	2021

Shander A, Hardy JF, Ozawa S, et al. A Global Definition of Patient Blood Management. *Anesth Analg*. 2022;135(3):476-488.

Global Definition:

For Providers: “Patient Blood Management (PBM) is a patient-centered, systematic, evidence-based approach to improve patient outcomes by managing and preserving the patient’s own blood, while promoting patient safety and empowerment.”

Up to now:
Product-centred approach



Shander A, Hardy JF, Ozawa S, et al. A Global Definition of Patient Blood Management. *Anesth Analg*. 2022;135(3):476-488.

Global Definition:

For Providers: “Patient Blood Management (PBM) is a patient-centered, systematic, evidence-based approach to improve patient outcomes by managing and preserving the patient’s own blood, while promoting patient safety and empowerment.”

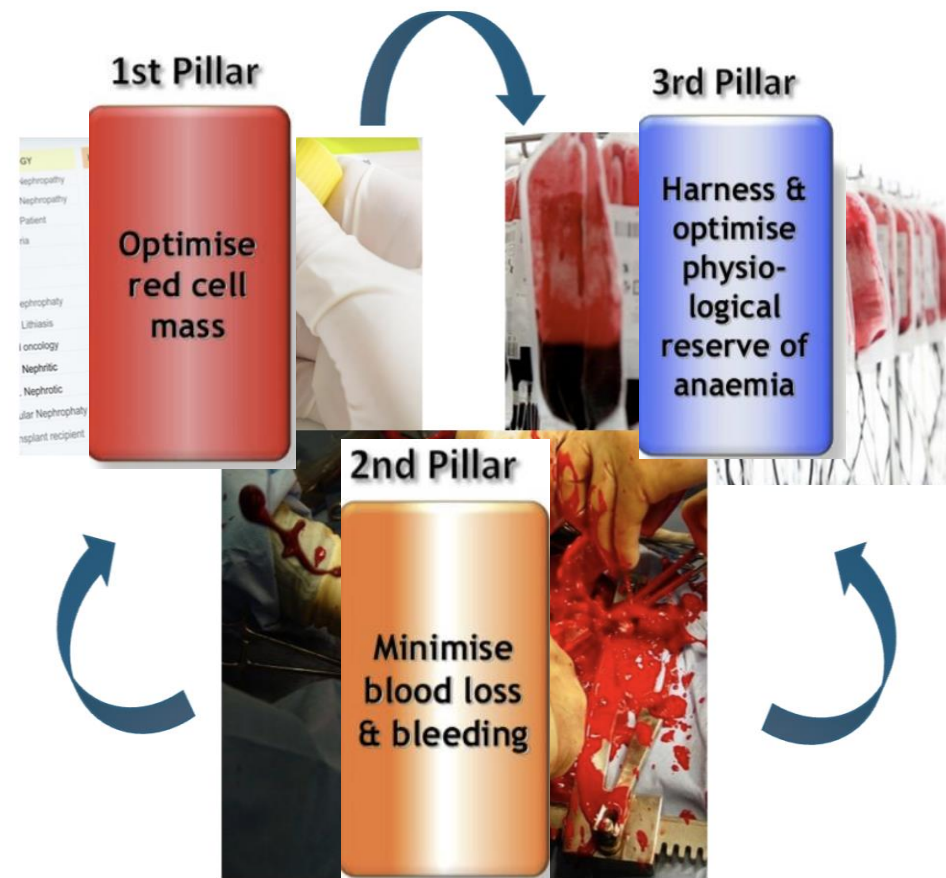
Latest strategy:
Patient-centred approach



Shander A, Hardy JF, Ozawa S, et al. A Global Definition of Patient Blood Management. *Anesth Analg*. 2022;135(3):476-488.

Global Definition:

For Providers: “Patient Blood Management (PBM) is a patient-centered, systematic, evidence-based approach to improve patient outcomes by managing and preserving the patient’s own blood, while promoting patient safety and empowerment.”



Shander A, Hardy JF, Ozawa S, et al. A Global Definition of Patient Blood Management. *Anesth Analg*. 2022;135(3):476-488.

Pillar One

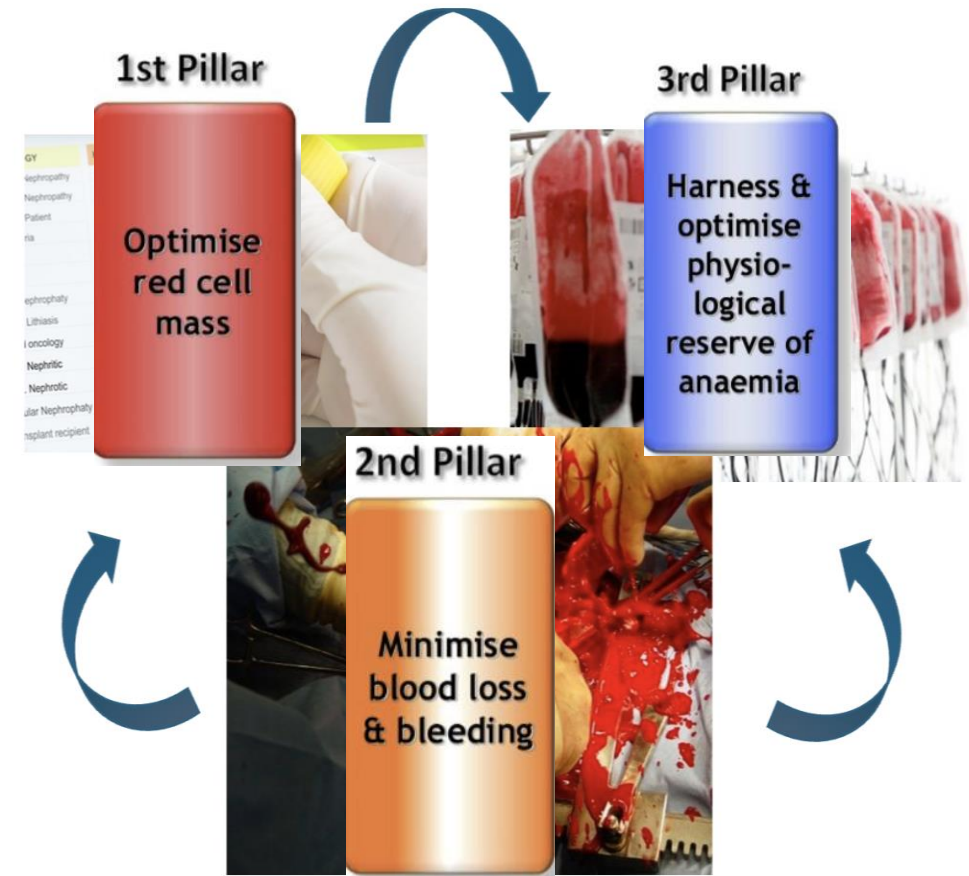
1. Iron, EPO, Iron and EPO
How, when, why?
2. Diagnosis of reasons for anaemia?
3. Alternatives for anaemia treatment?

Pillar Two

4. POC coagulation monitoring?
5. Adequate coagulation therapy?
6. Cell salvage?
7. Antifibrinolytics?

Pillar Three

8. How to measure anaemia tolerance?
9. Optimal transfusion triggers?



Shander A, Hardy JF, Ozawa S, et al. A Global Definition of Patient Blood Management. *Anesth Analg*. 2022;135(3):476-488.

PBM Implementation and Education



PBM Implementation and Education



- personal experience
- professional judgement
- convention
- habit
- personal insight and deduction

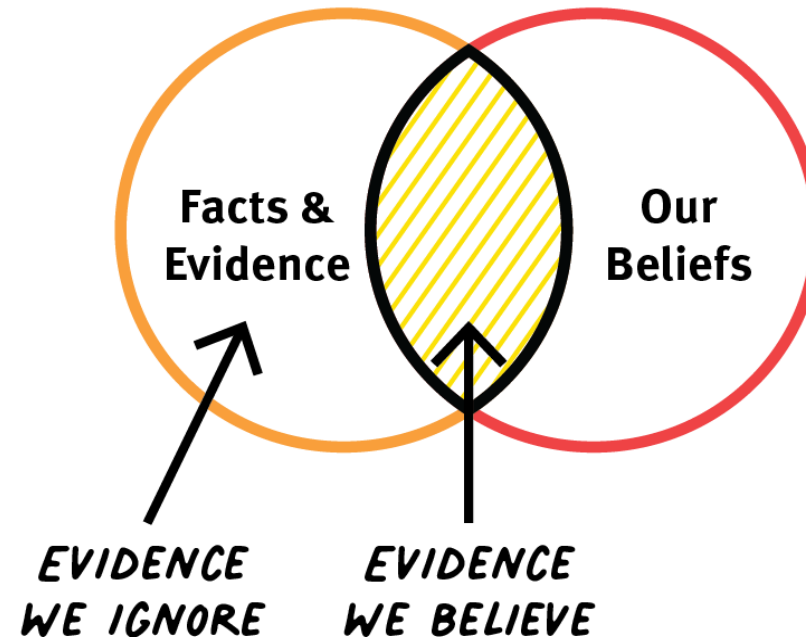


PBM Implementation and Education

Why facts don't change our minds?

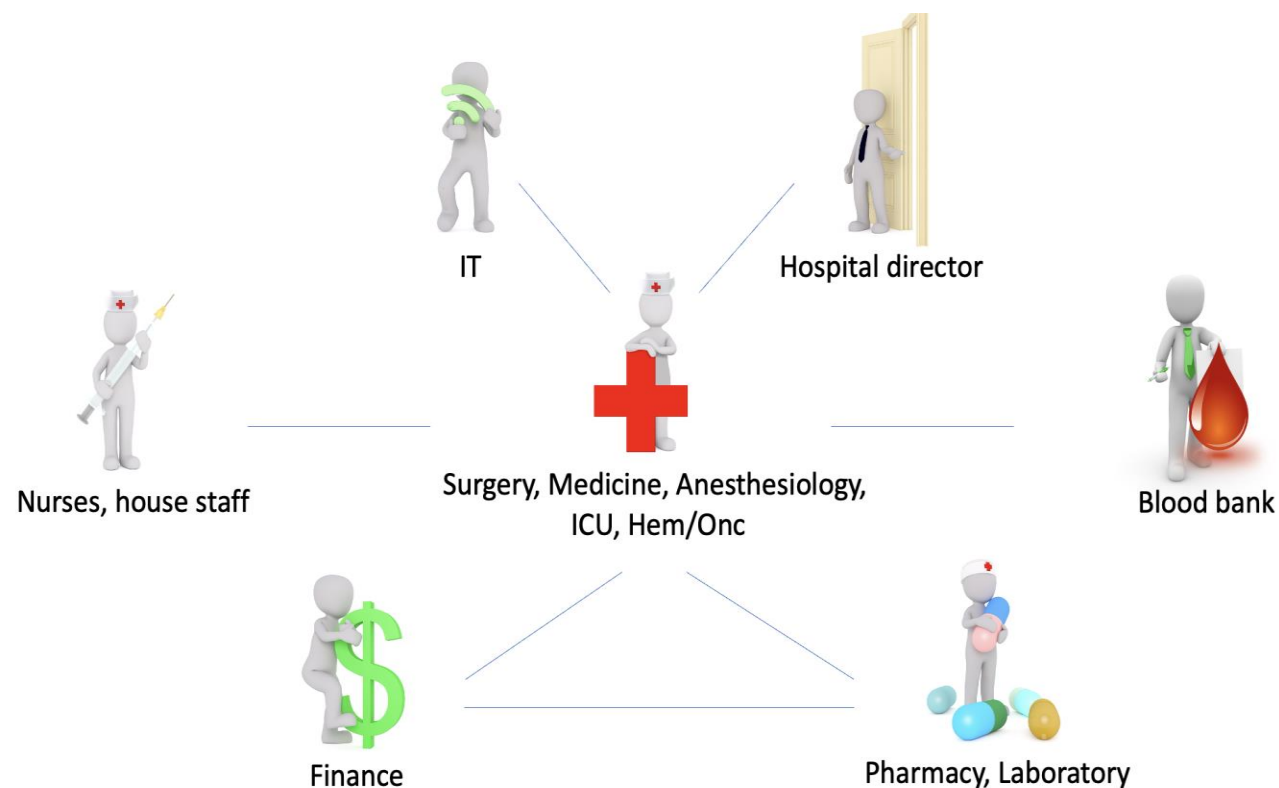


Confirmation Bias



Kolbert, The New Yorker, 2017

TEAMWORK AND LEADERSHIP - PRECONDITIONS FOR SUCCESS



PBM Implementation and Education



PBM IMPLEMENTATION

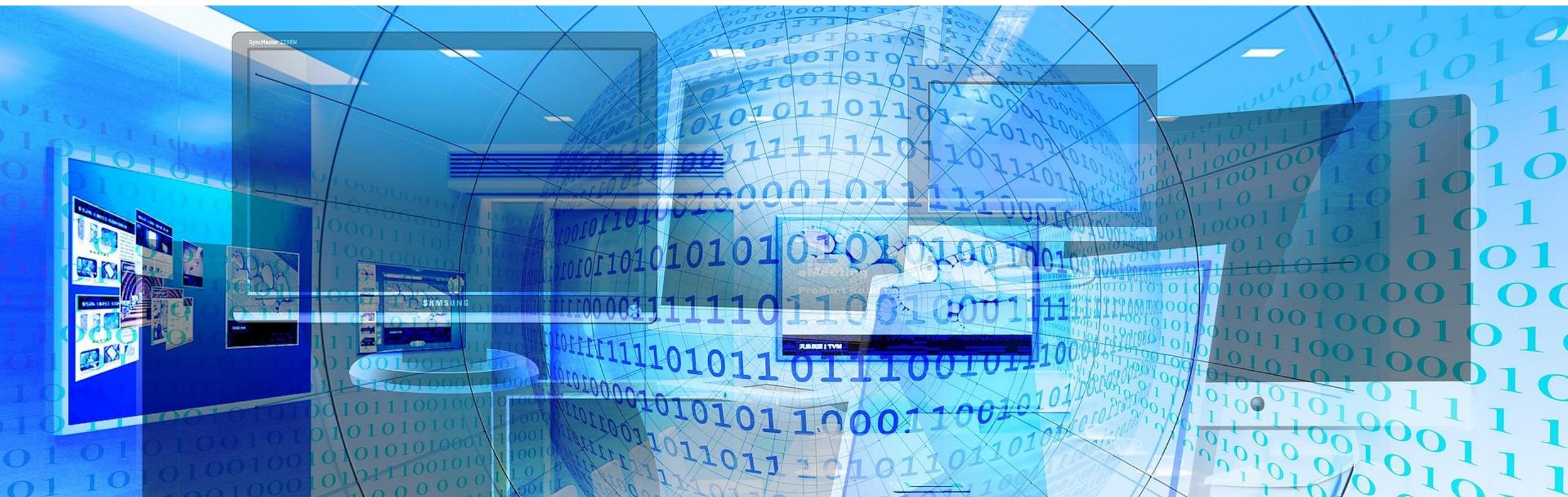


"In God we trust.
All others must bring data."

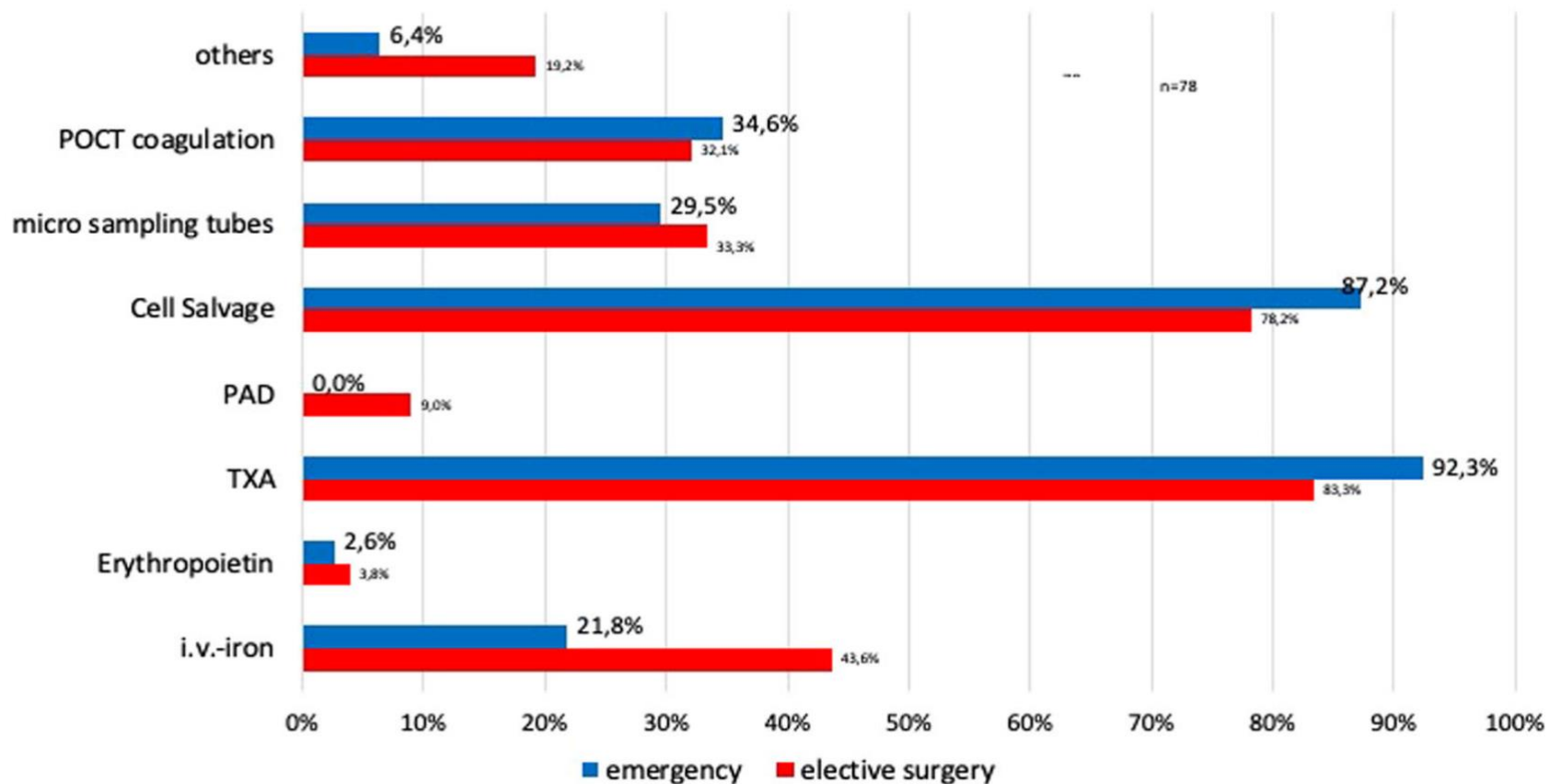
- Dr. W. Edwards Deming



HELP of IT



IMPLEMENTATION

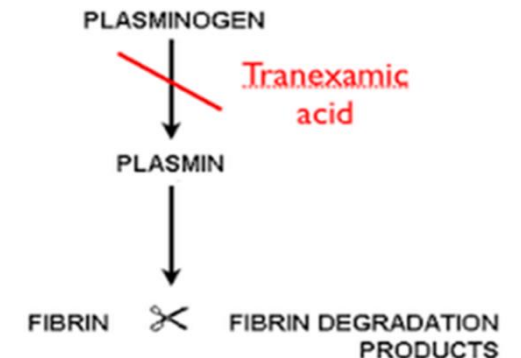
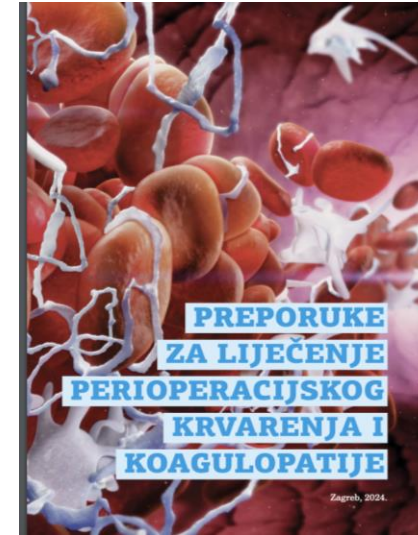


Frietsch T, Wittenberg G, Horn A, Steinbicker AU. Implementation of a "Patient Blood Management" program in medium sized hospitals: Results of a survey among German hemotherapists. Health Sci Rep. 2022 Nov 18;5(6):e924.

SHORT - TERM WINS

INEXPENSIVE
EASY TO UNDERSTAND
VISIBLE

- Improved communications
- Implementing restrictive transfusion criteria
- Massive transfusion protocol
- Reducing TI using a single unit strategy
- 1 g TRANEXAMIC ACID on induction



Maximum Surgical Blood Ordering Schedule (MSBOS)

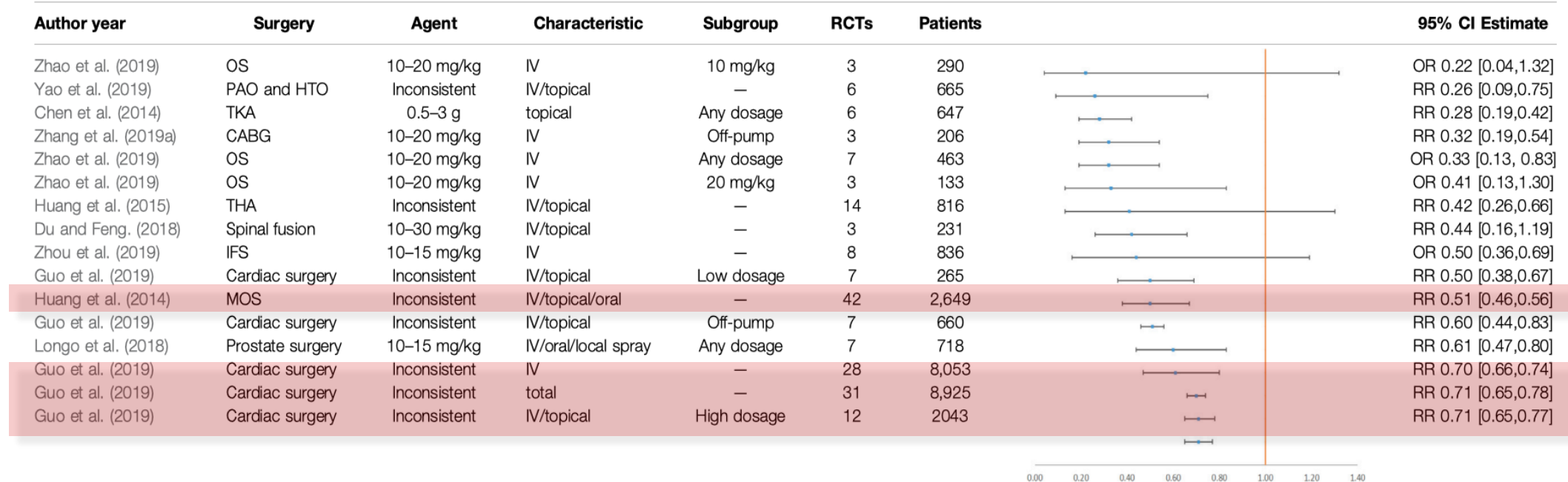


RBC transfusions can be predicted in 94% of elective surgical interventions

- Hgb level
- Possible blood loss
- Transfusion trigger

Gombotz H (2011) Patient blood management is key before elective surgery. Lancet 378(9800):1362–1363

Tranexamic acid – TXA – reducing transfusion rate?

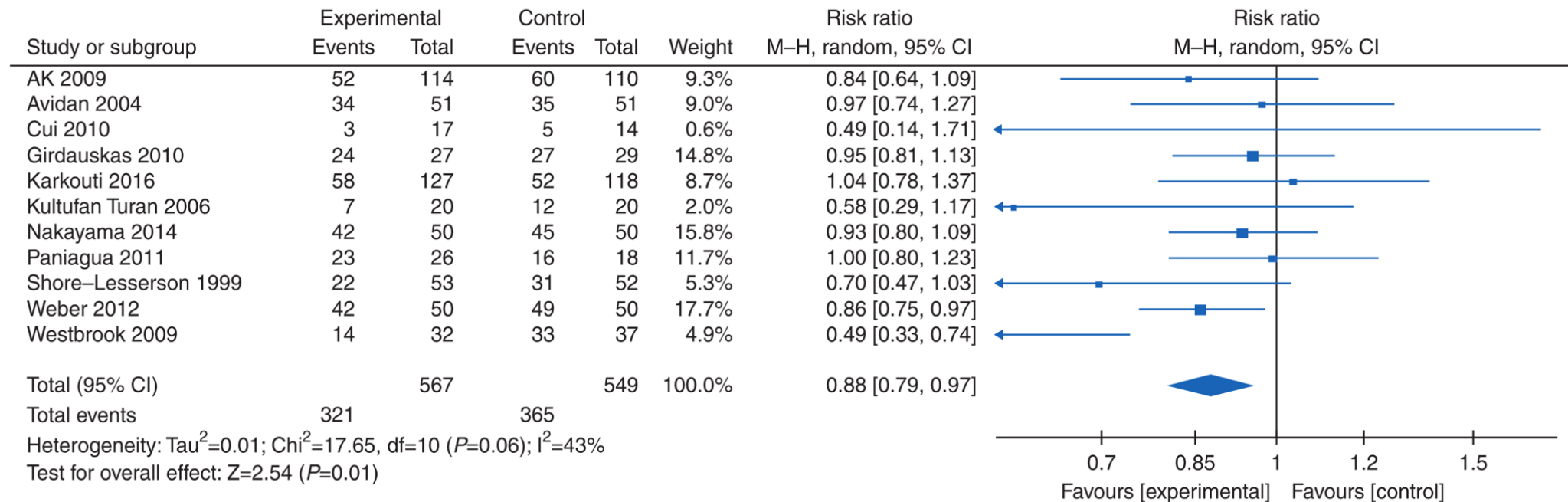


OS, orthognathic surgery; PAO, periacetabular osteotomy; HTO, high tibial osteotomy; CABG, coronary artery bypass grafting; MOS, major orthopedic surgery (TKA, THA, and spine surgery); IFS, intertrochanteric fracture surgery.

Hong P, Liu R, Rai S, Liu J, Ding Y, Li J. Does Tranexamic Acid Reduce the Blood Loss in Various Surgeries? An Umbrella Review of State-of-the-Art Meta-Analysis. Front Pharmacol. 2022 May 19;13:887386.

Routine use of POC coagulation devices will reduce transfusion rate

B Red blood cell transfusion



Serraino GF, Murphy GJ. Routine use of viscoelastic blood tests for diagnosis and treatment of coagulopathic bleeding in cardiac surgery: updated systematic review and meta-analysis. Br J Anaesth. 2017 Jun 1;118(6):823-833.

Heubner L, et al. Point of care coagulation management in anesthesiology and critical care. Minerva Anesthesiol. 2022 Jul-Aug;88(7-8):615-628.

Intraoperative blood salvage (IOS)

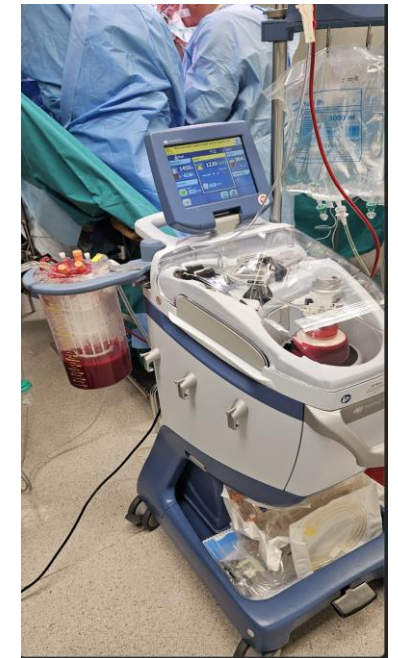
- IOS, also known as cell salvage, is a major form of autologous blood transfusion.
- It involves recovering blood lost during surgery and re-infusing it into the patient.

TAAA Crawford I

Loss of 17,5 L of blood

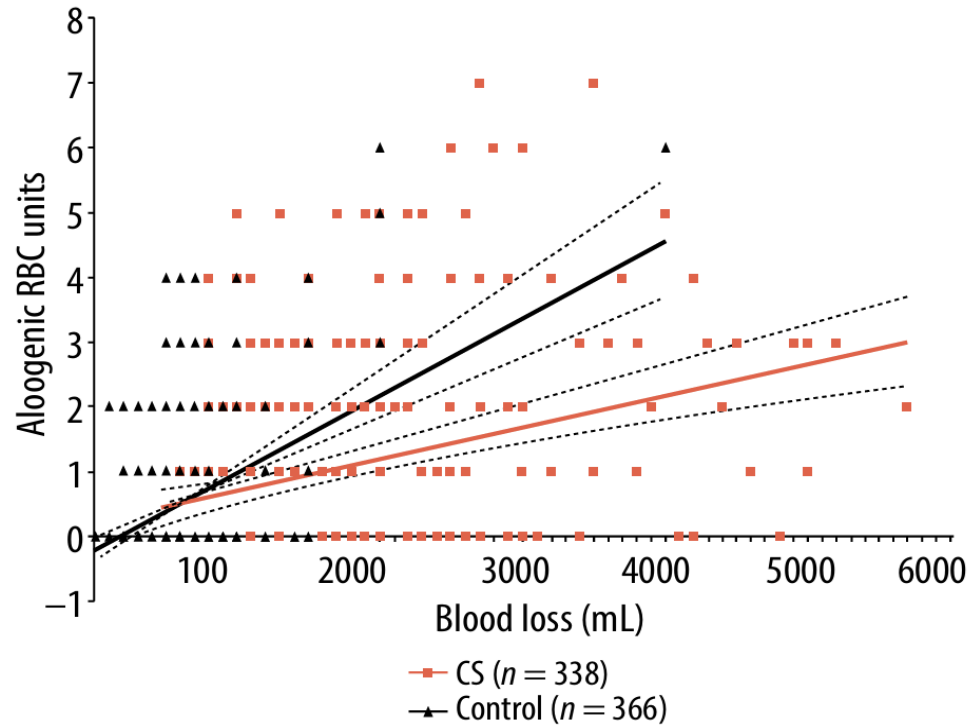
Cell saver 12,5 l (autologous blood 6282 ml)

ALL together: 26 RBC, 7 FFP, 16 Platelets,
19 g Fibrinogen, 4000 ij. PCC, FXIII 3000 ij.

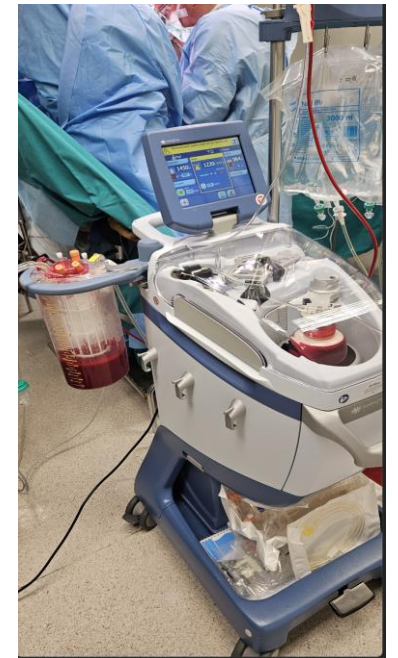




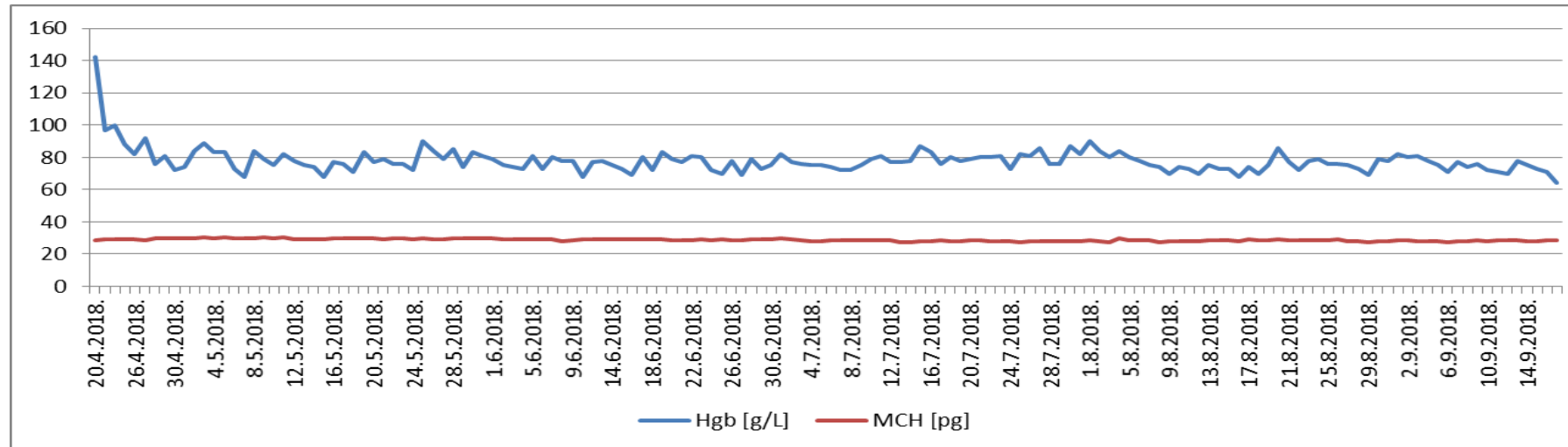
Intraoperative blood salvage (IOS)



Neef V, et al The association between intraoperative cell salvage and red blood cell transfusion in cardiac surgery - an observational study in a patient blood management centre. *Anaesthesiol Intensive Ther.* 2021;53(1):1-9.



Anemia is present in **up to 90%** of patients in the immediate postoperative period after major surgery.

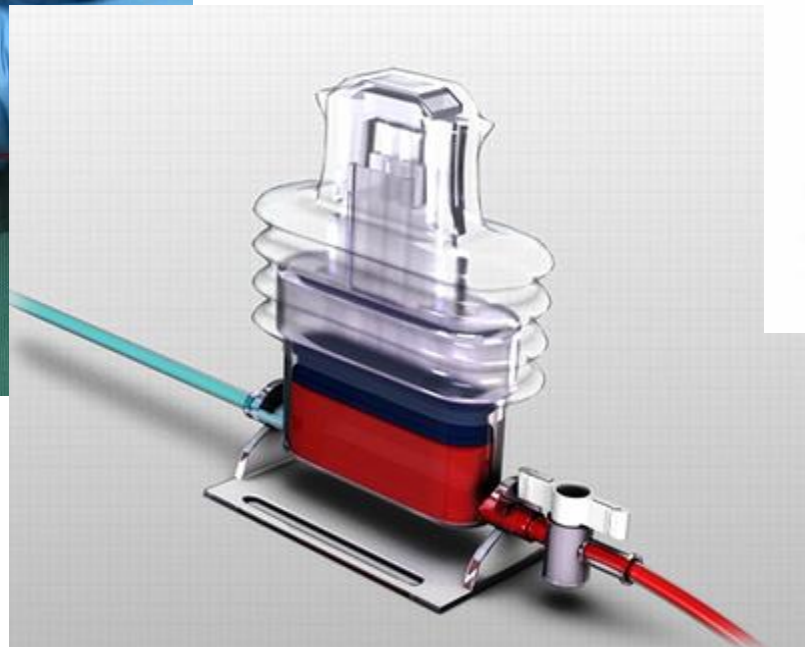


PBM - iatrogenic anaemia

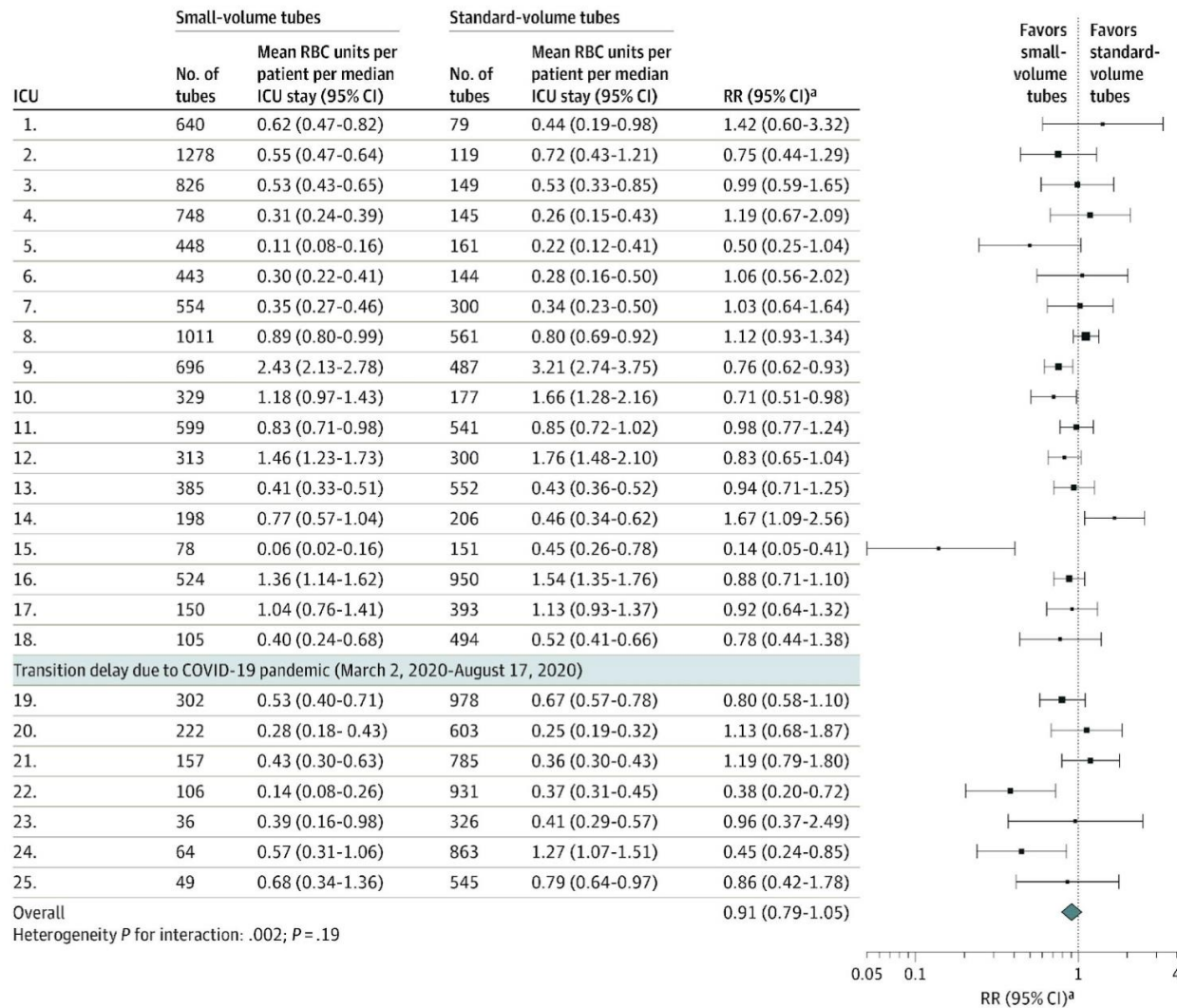


- PREVENTING UNNECESSARY BLOOD DRAWINGS
- REDUCING THE VOLUME OF BLOOD COLLECTION TUBES
- ADJUST FREQUENCY OF DRAWINGS
- REDUCE THE „DISCARD” VOLUME

Which blood sample volume is needed?



Avoidable Blood Loss in Critical Care and Patient Blood Management: Scoping Review of Diagnostic Blood Loss Philipp Helmer, J. Clin. Med. **2022**, 11, 320

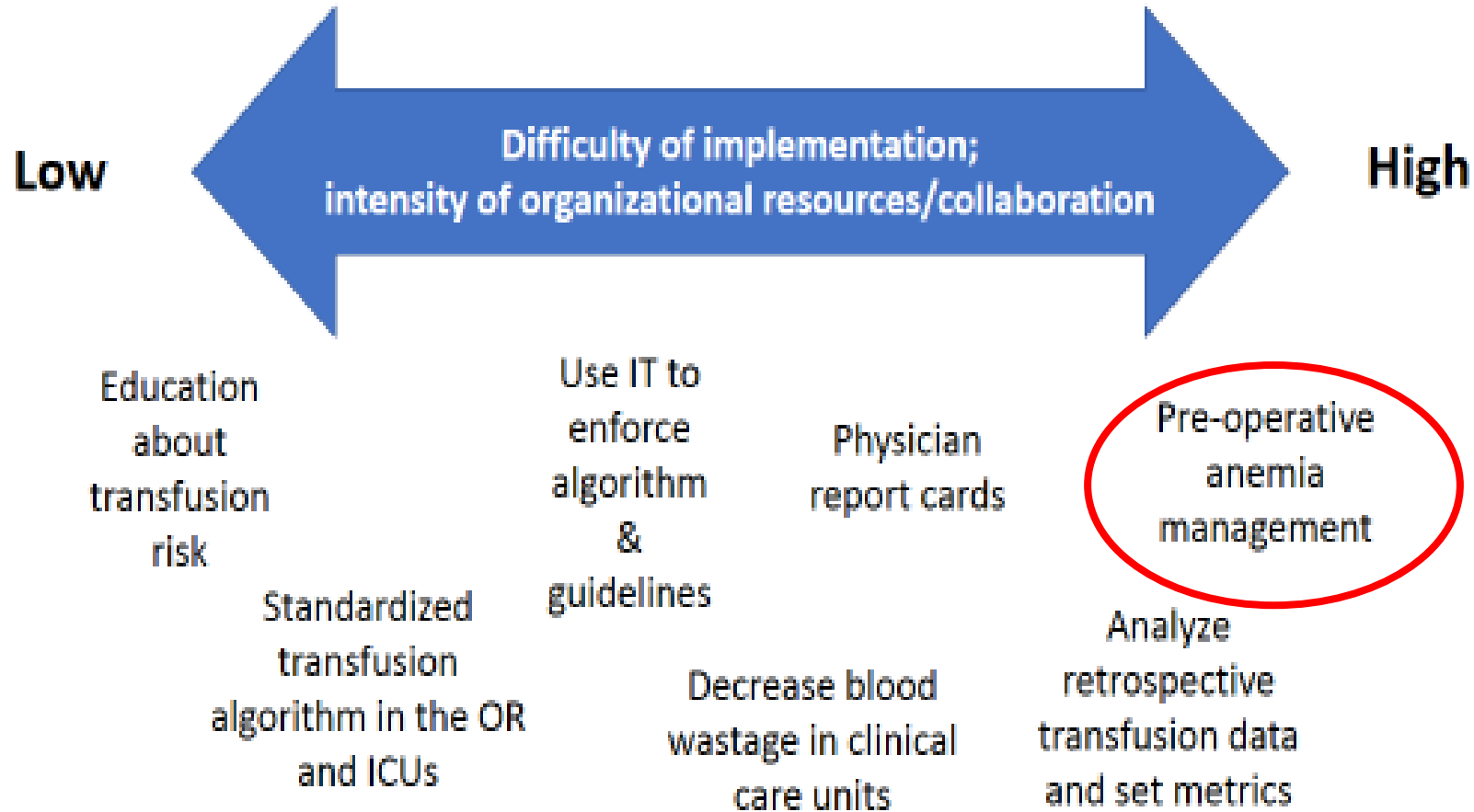


Small-Volume Blood Collection Tubes to Reduce Transfusions in Intensive Care: The STRATUS Randomized Clinical Trial

Conclusions and relevance:
Use of small-volume blood collection tubes in the ICU may decrease RBC transfusions without affecting laboratory analysis.

Siegal DM, et al. Small-Volume Blood Collection Tubes to Reduce Transfusions in Intensive Care: The STRATUS Randomized Clinical Trial. JAMA. 2023 Nov 21;330(19):1872-1881. doi: 10.1001/jama.2023.20820.

SPECTRUM OF PBM ACTIVITIES



1st Pillar Optimize hematopoiesis

Preoperative

- Screen for & manage anemia
- Manage underlying disorder(s)
- Refer for further evaluation if necessary
- Consider anemia as a contraindication for elective surgery

Intraoperative

- Time surgery with hematological optimization

Postoperative

- Screen for & Treat anemia
- Be aware of drug interactions that can cause/worsen anemia

Anaemia and Surgery

J. N. LUNN,* M.D., F.F.A. R.C.S. ; P. C. ELWOOD,† M.D.

British Medical Journal, 1970, 3, 71-73

Summary: In 1,584 patients who had received an anaesthetic the association was examined between circulating haemoglobin level and the postoperative course (length of hospital stay, the occurrence of a complication, and death). In men a significant association ($P < 0.05$) was found for each index, but in women this was present only for death.

It is suggested that the hypothesis which best explains

the associations, and is consistent with further analyses of the data, is that the preoperative haemoglobin level reflects the severity of the underlying condition which has necessitated surgery. A randomized clinical trial would test the alternative hypothesis that anaemia constitutes an additional risk in surgical procedures.

Introduction

Traditionally, anaemia is believed to increase the risk of surgery, and it is common practice for non-urgent surgery to be postponed if a patient is anaemic. The level of circulating

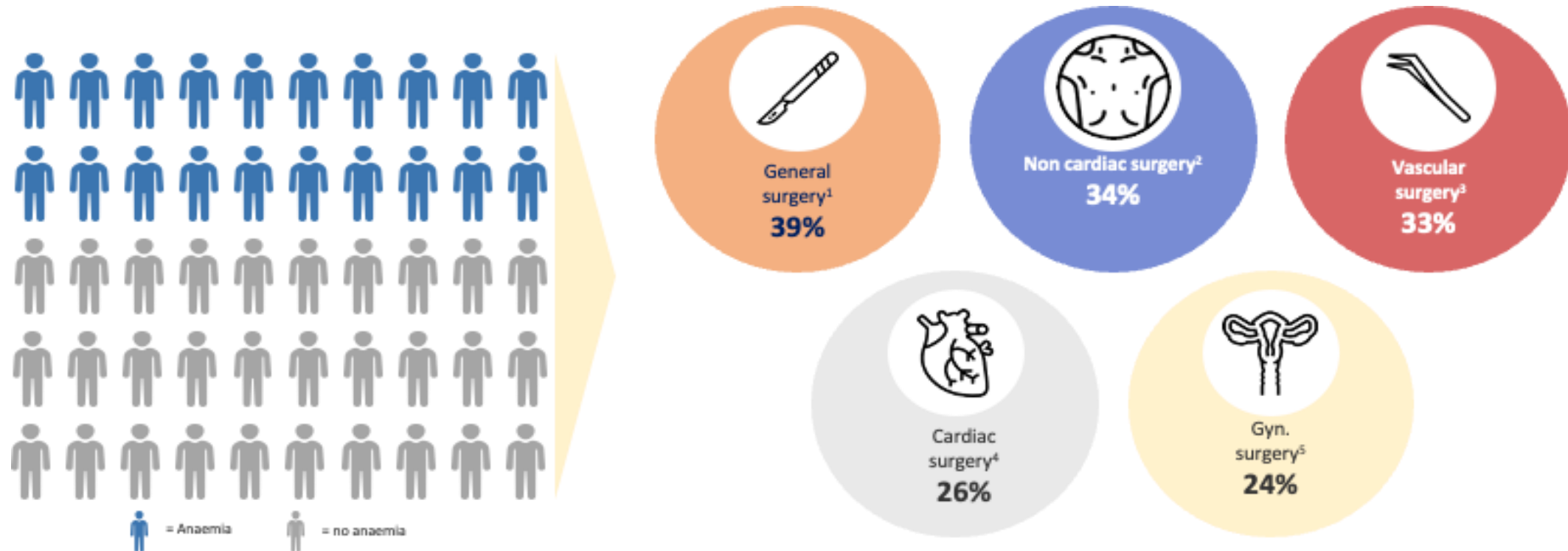
* Senior Lecturer in Anaesthetics, Welsh National School of Medicine, Cardiff.

† Member of M.R.C. Epidemiology Research Unit, Cardiff.

GUIDELINES**Management of severe peri-operative bleeding: Guidelines from the European Society of Anaesthesiology and Intensive Care***Second update 2022*

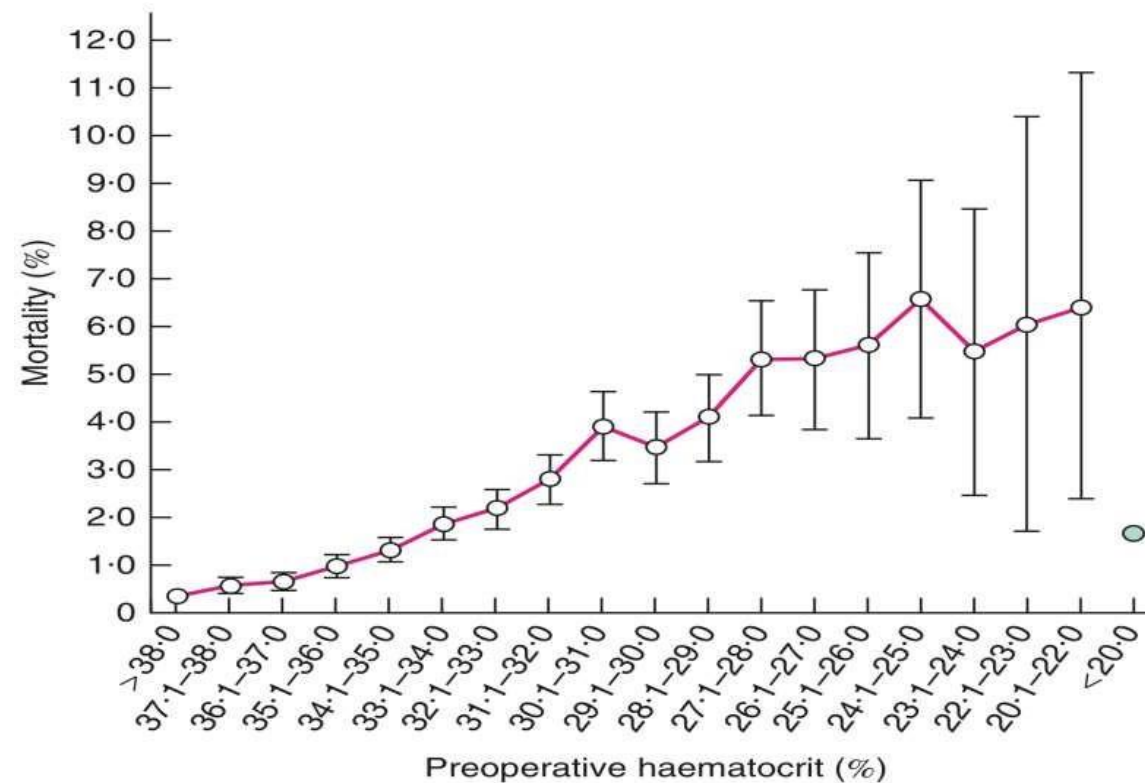
- We recommend that patients **at risk of bleeding are assessed for anaemia well before surgery** in order to permit time for anaemia correction if needed. 1B
- In noncancer patients with pre-operative anaemia scheduled for elective major surgery, we recommend **postponing surgery** until anaemia has been corrected. 1A
- We recommend defining an **internal hospital algorithm** for a comprehensive differential diagnosis of pre-operative anaemia. 1C
- We recommend the use of **intravenous iron in preference to oral iron**. 1C
- We recommend **against pre-operative RBC transfusion** to mask pre-operative mild-to-moderate anaemia. 1C
- We suggest a **time interval of 1 to 2 weeks** following parenteral stimulation of erythropoiesis and uncomplicated cause of anaemia, whereas 3 to 8 weeks may be required for oral correction of IDA and complex cause of anaemia. 2C

PREOPERATIVE ANEMIA



Fowler Br J Surg. 2015; Muñoz Anaesthesia. 2017; Dunkelgrun Am J Cardiol. 2008; Karkouti Circulation. 2008; Richards PLoS One. 2015

ANEMIA IS DANGEROUS AND RISKY



Clevenger, B., Mallett, S. V., Klein, A. A., & Richards, T. (2015). Patient blood management to reduce surgical risk. *British Journal of Surgery*, 102(11), 1325-1337.

TREATMENT OPTIONS



Hey Siri is it okay to do nothing

Tap to Edit >

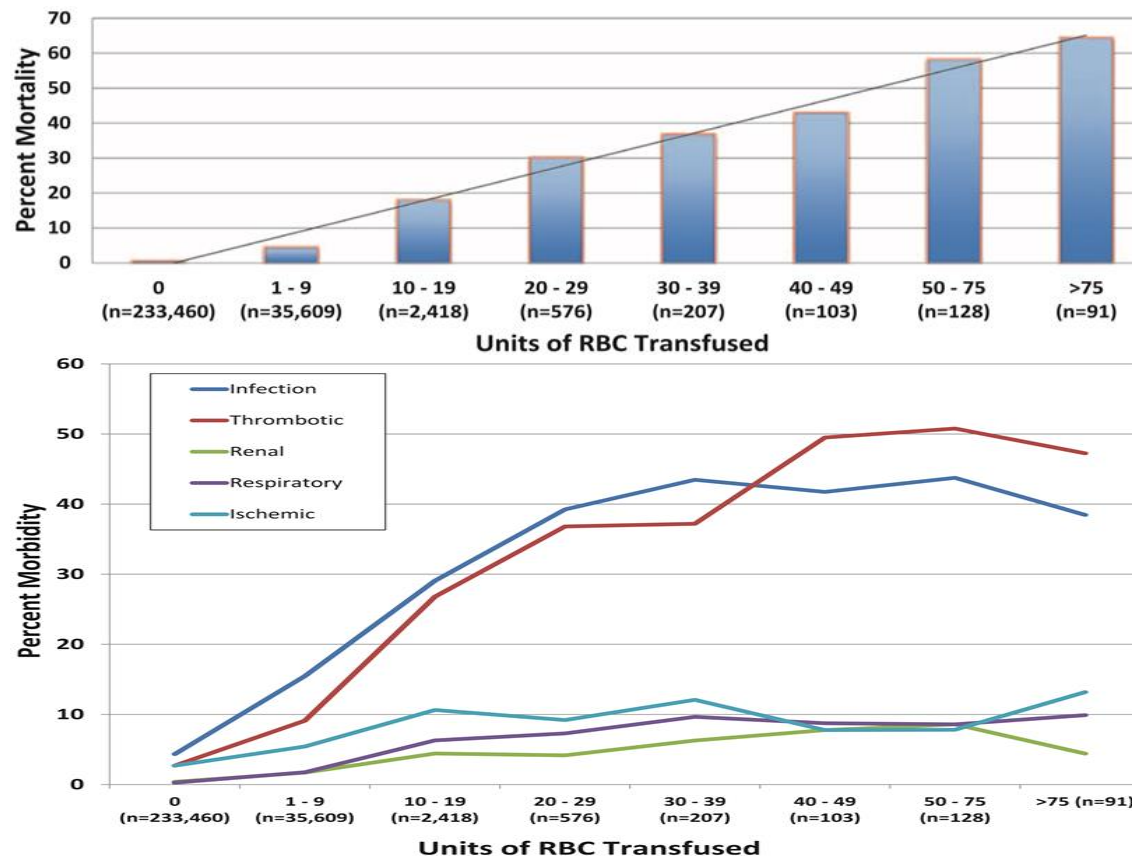
Interesting question, Debbie.

TRANSFUSION is an independent, dose-dependent and additive risk factor for morbidity, average LOS and mortality in most clinical settings.

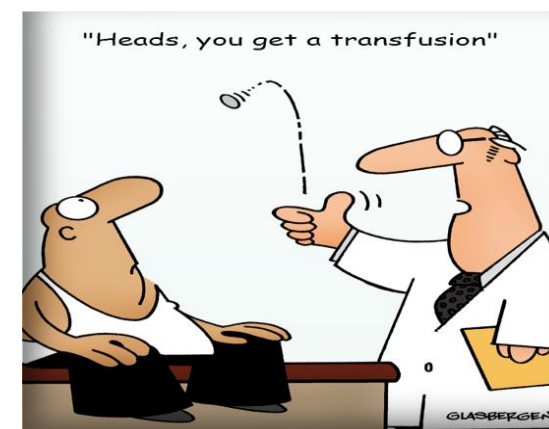
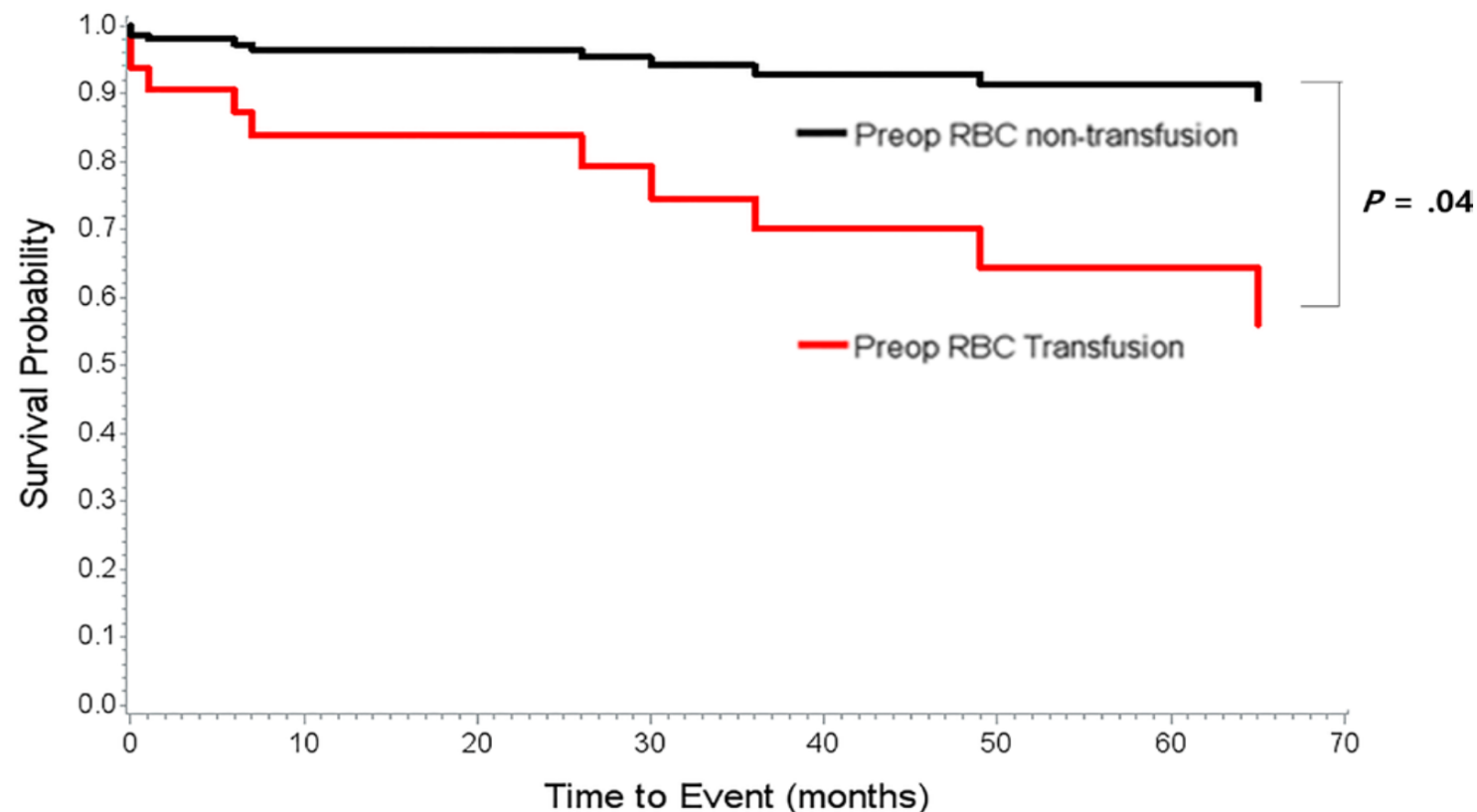
Risks of Blood Transfusion



Daniel J. Johnson, et al; Morbidity and Mortality after High-dose Transfusion.
Anesthesiology 2016; 124:387–395



TRANSFUSION IS NOT A GOOD SOLUTION



Seong H, et al.. Impact of preoperative red blood cell transfusion on long-term mortality of liver transplantation: A retrospective cohort study. *Medicine (Baltimore)*. 2023 Sep 15;102(37):e34914.

TRANSFUSION IS NOT A GOOD SOLUTION

184,444 patients underwent primary tumor resection for **esophageal, gastric, colorectal, and pancreatic** cancer, or primary or metastatic resection of the **liver**

Known preoperative hematocrit and transfusion status

179,290 patients

Preoperative hematocrit between 21% and 27% obtained within 30 days of surgery

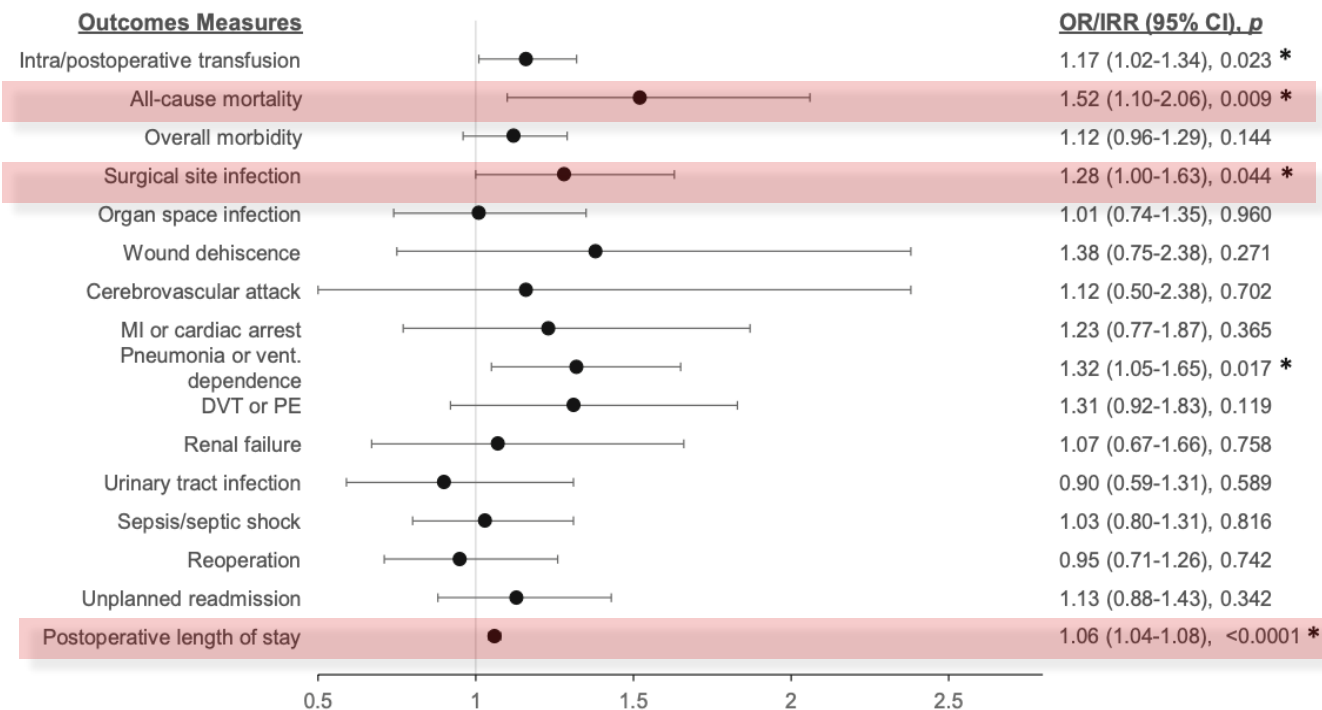
7,143 patients

Final study cohort: 6,222 patients

Preoperative transfusion:
1,000 patients

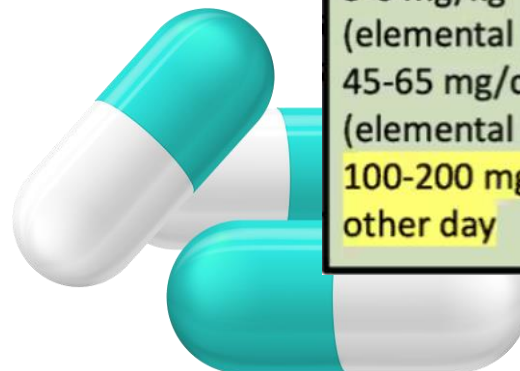
No preoperative transfusion:
5,222 patients

Exclude:
Outpatient surgery (N=25)
Emergent operation (N=668)
History of congestive heart failure (N=201)
Unknown postoperative length of stay (N=27)

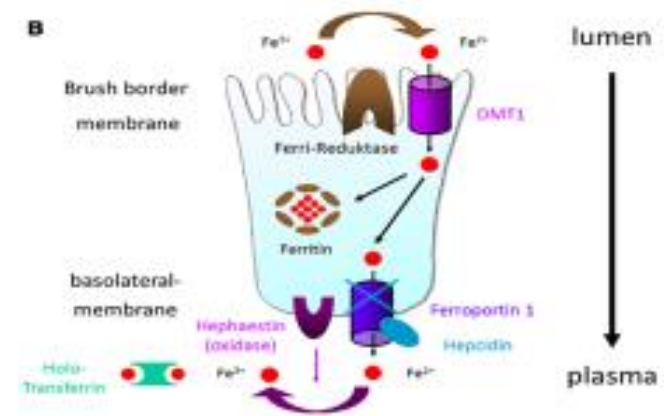
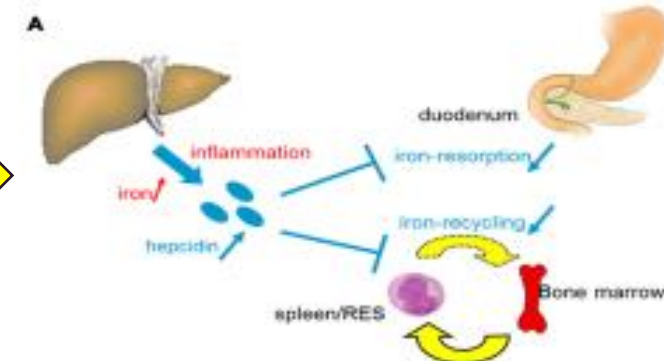
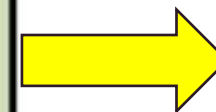


Shannon AB, Song Y, Davis Rivera LB, et al. Preoperative Transfusion for Anemia in Patients Undergoing Abdominal Surgery for Malignancy. *J Gastrointest Surg.* 2021;25(6):1534-1544.

TREATMENT OPTIONS

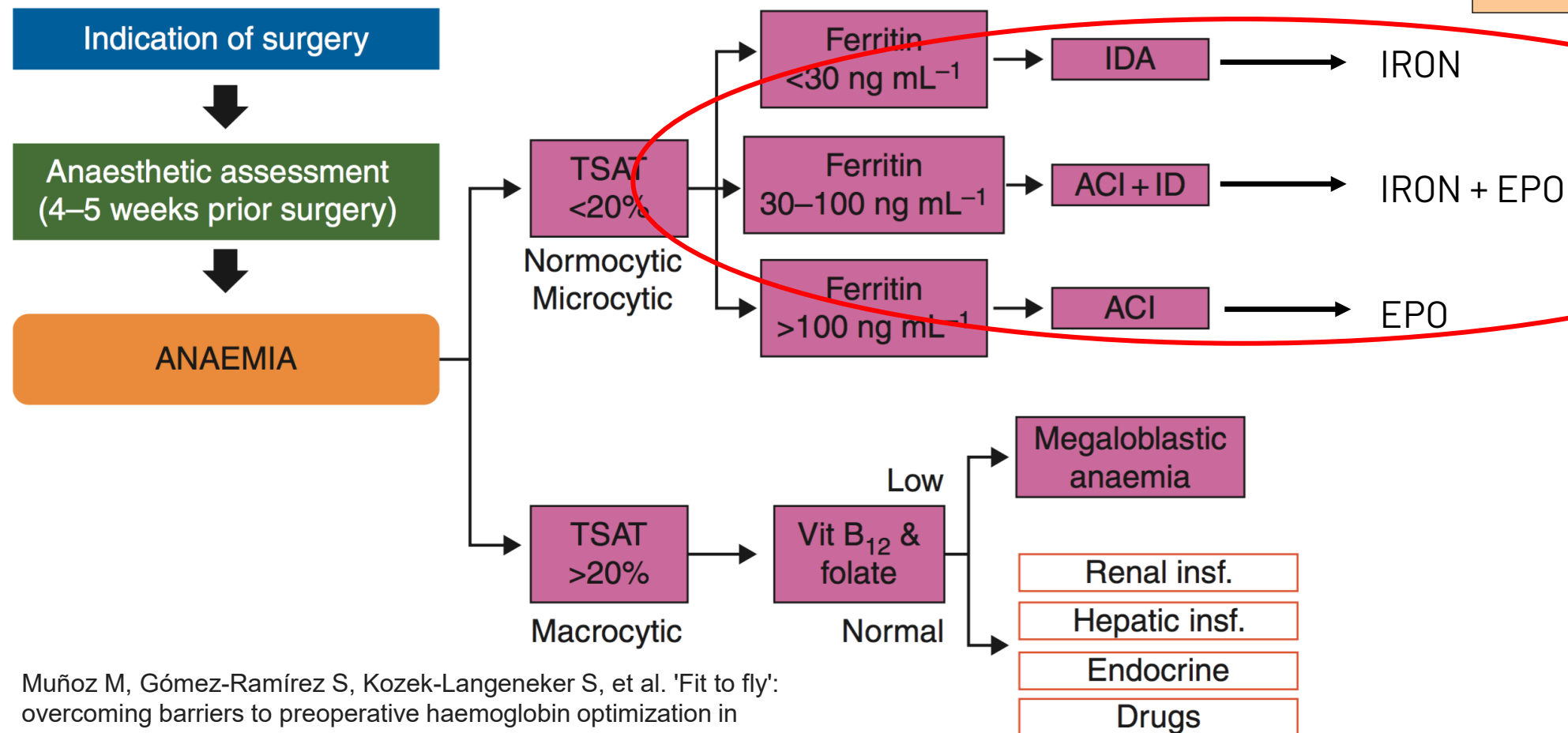


3-6 mg/kg
(elemental iron)
45-65 mg/day
(elemental iron)
100-200 mg/every
other day



THE STANDARD ALGORITHM

80 %

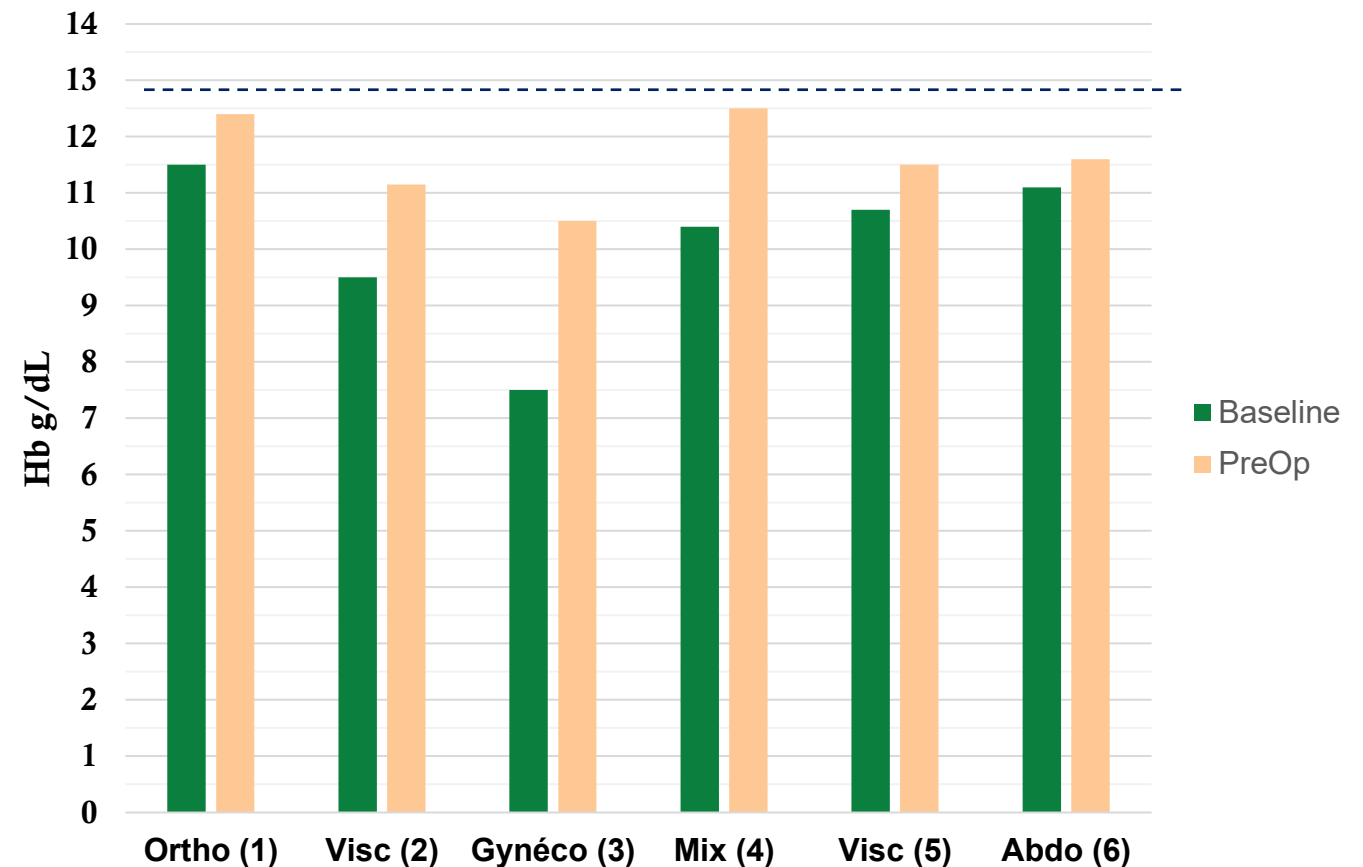


Muñoz M, Gómez-Ramírez S, Kozek-Langeneker S, et al. 'Fit to fly': overcoming barriers to preoperative haemoglobin optimization in surgical patients. *Br J Anaesth.* 2015;115(1):15-24.

TREATING ID ANEMIA WITH IV IRON INCREASES Hb ...NOT ENOUGH?

- Preop IV IRON
- 4 to 21 days before surgery
- Doses ranging from 900 mg to 1,2g

1. Theusinger Anesthesiology 2007
2. Keeler Colorectal Dis 2014
3. Kim Acta Haematol 2009
4. Bisbe BJA 2011
5. Froessler Ann Surg 2016
6. Richards Lancet 2020



STUDY PROTOCOL

Open Access

PREVENTT: preoperative intravenous iron to treat anaemia in major surgery: study protocol for a randomised controlled trial



Toby Richards¹, Ben Clevenger^{1,6*}, Jane Keidan², Tim Collier³, Andrew A. Klein⁴, Stefan D. Anker⁵ and John D. Kelly¹

	Placebo (n=243)	Intravenous iron (n=244)	Iron vs placebo (95% CI, p value)
Blood transfusion or death			
Combined	67/237 (28%)	69/237 (29%)	1.03 (0.78–1.37, p=0.84)
Transfusion	67/237 (28%)	68/237 (29%)	..
Death	2/237 (1%)	2/237 (1%)	..
Transfusion episodes			
0	170/237 (72%)	169/237 (71%)	..
1	37/237 (16%)	49/237 (21%)	..
2	22/237 (9%)	9/237 (4%)	..
3	5/237 (2%)	5/237 (2%)	..
4	1/237 (<1%)	3/237 (1%)	..
5	1/237 (<1%)	1/237 (<1%)	..
6	1/237 (<1%)	1/237 (<1%)	..
Mean	0.47 (0.9)	0.44 (0.9)	0.98 (0.68–1.43, p=0.93)

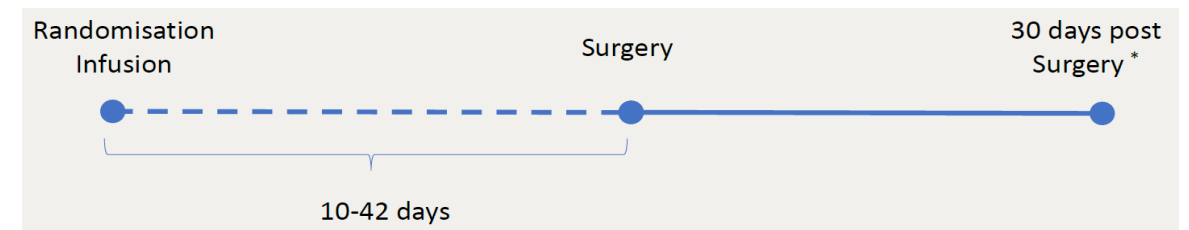


Data are n/N (%), mean (SD), and risk or rate ratio (95% CI, p value). A transfusion episode is defined as receiving any volume of 1 unit (or part thereof) or more of packed red blood cells or any other blood product. Treatment effect is a risk ratio for the first coprimary endpoint (number of blood transfusions or deaths) and a rate ratio for the second coprimary endpoint; for the second coprimary endpoint, number of blood transfusions is the number of separate transfusions administered.

Table 2: PREVENTT coprimary endpoints from randomisation to 30 days after operation

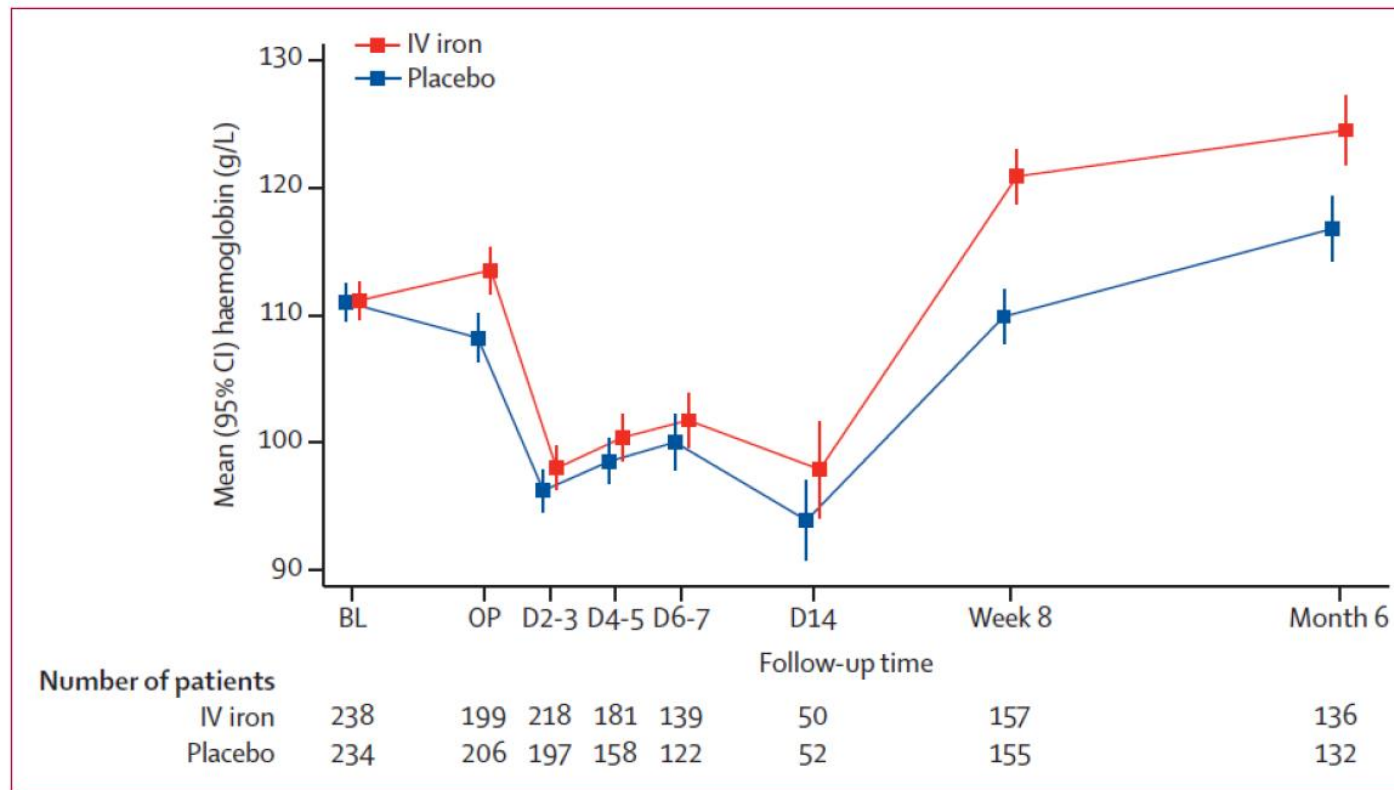
Study design –RCT / 487 pt

- P Anemia (M < 130 g/L; F < 120 g/L)
10 –42 days pre-operatively
Major open abdominal surgery
- I IV iron 1000 mg
- C Placebo (double-blind)
- O Primary
Risk of **any** blood transfusion or death
No. of **any** blood transfusions from randomization to 30 days post-op
Secondary
Hb, Complications, LOS, QoL



TREATING ID ANEMIA WITH IV IRON INCREASES Hb ...NOT ENOUGH?

Pre-op IV IRON improves post-op Hb levels



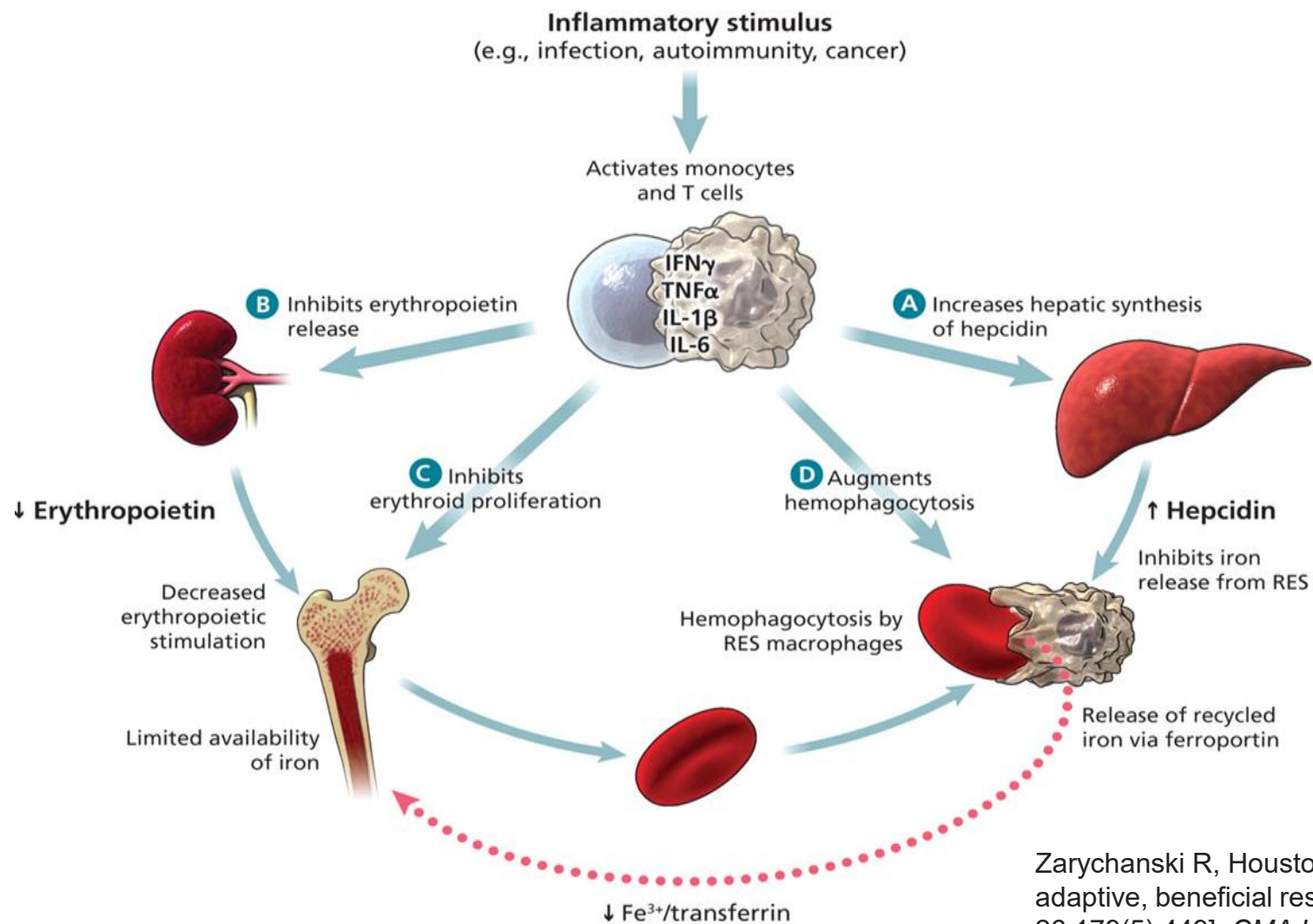


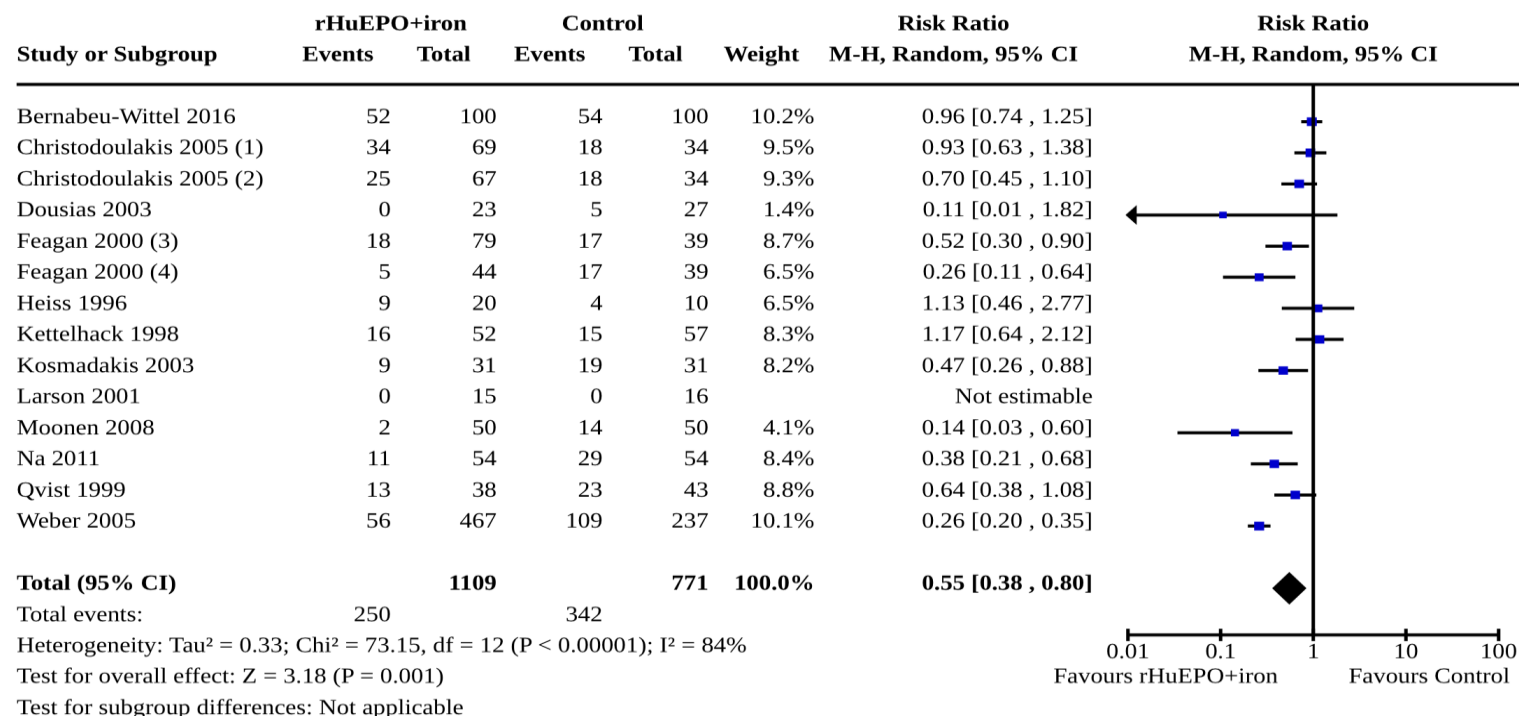
Table 1. Disease groups in which AI is common

Disease group
Cancer and hematological malignancies
Infections
Immune-mediated diseases
Inflammatory diseases
Chronic kidney disease
Congestive heart failure
Chronic pulmonary disease
Obesity
Anemia of the elderly
Anemia of critical illness (accelerated course)

Zarychanski R, Houston DS. Anemia of chronic disease: a harmful disorder or an adaptive, beneficial response? [published correction appears in CMAJ. 2008 Aug 26;179(5):449]. *CMAJ*. 2008;179(4):333-337.

I.V. IRON PLUS EPO IS EFFECTIVE

i.v. iron + EPO vs. **control**



Many dosing regimens:

- 600 IU/kg/week x 3-4
- 200 UI/kg/day x 10 days
- 300 UI/kg/preop + surgical + postop day

Kaufner L, von Heymann C, Henkelmann A, et al. Erythropoietin plus iron versus control treatment including placebo or iron for preoperative anaemic adults undergoing non-cardiac surgery. *Cochrane Database Syst Rev.* 2020;8(8):CD012451. Published 2020 Aug 13.

EPO + IRON VS IRON

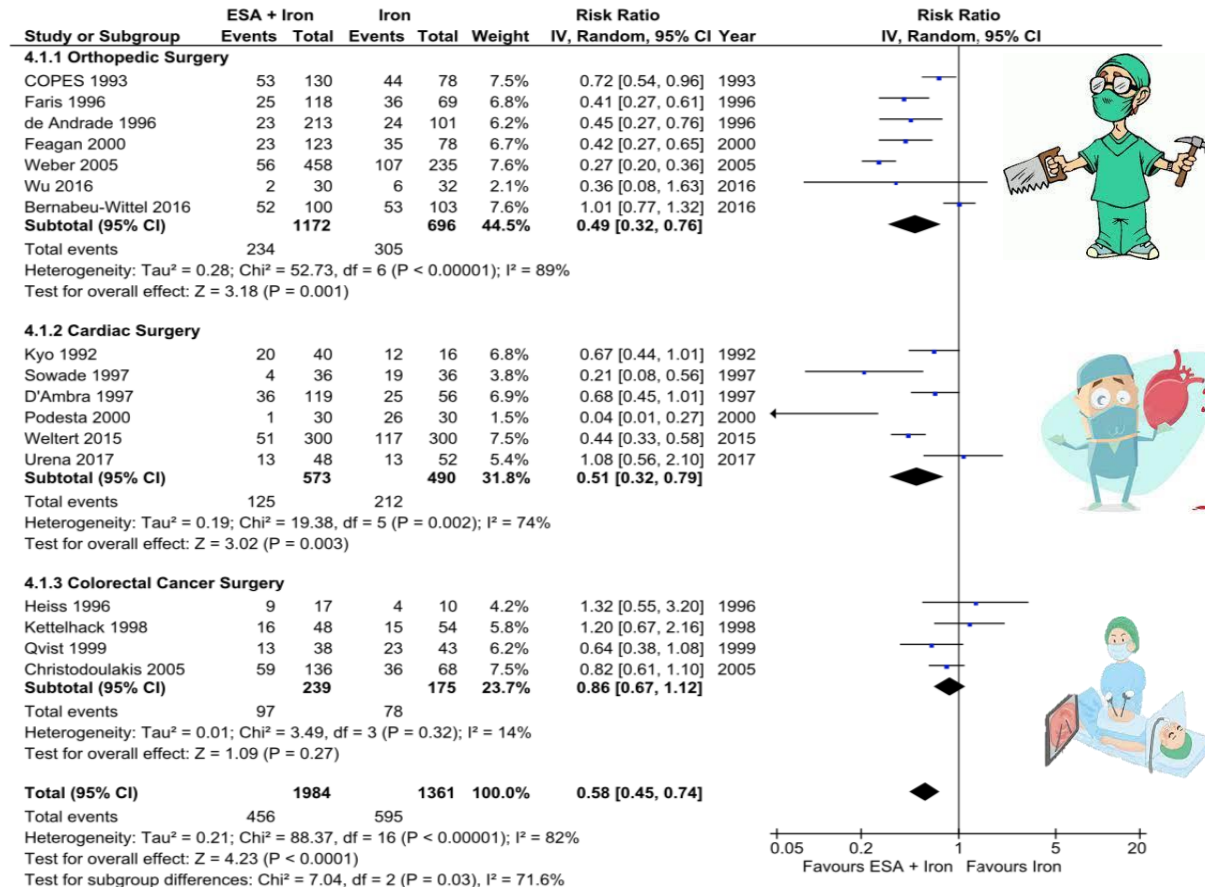


Preoperative EPO:
which surgery?

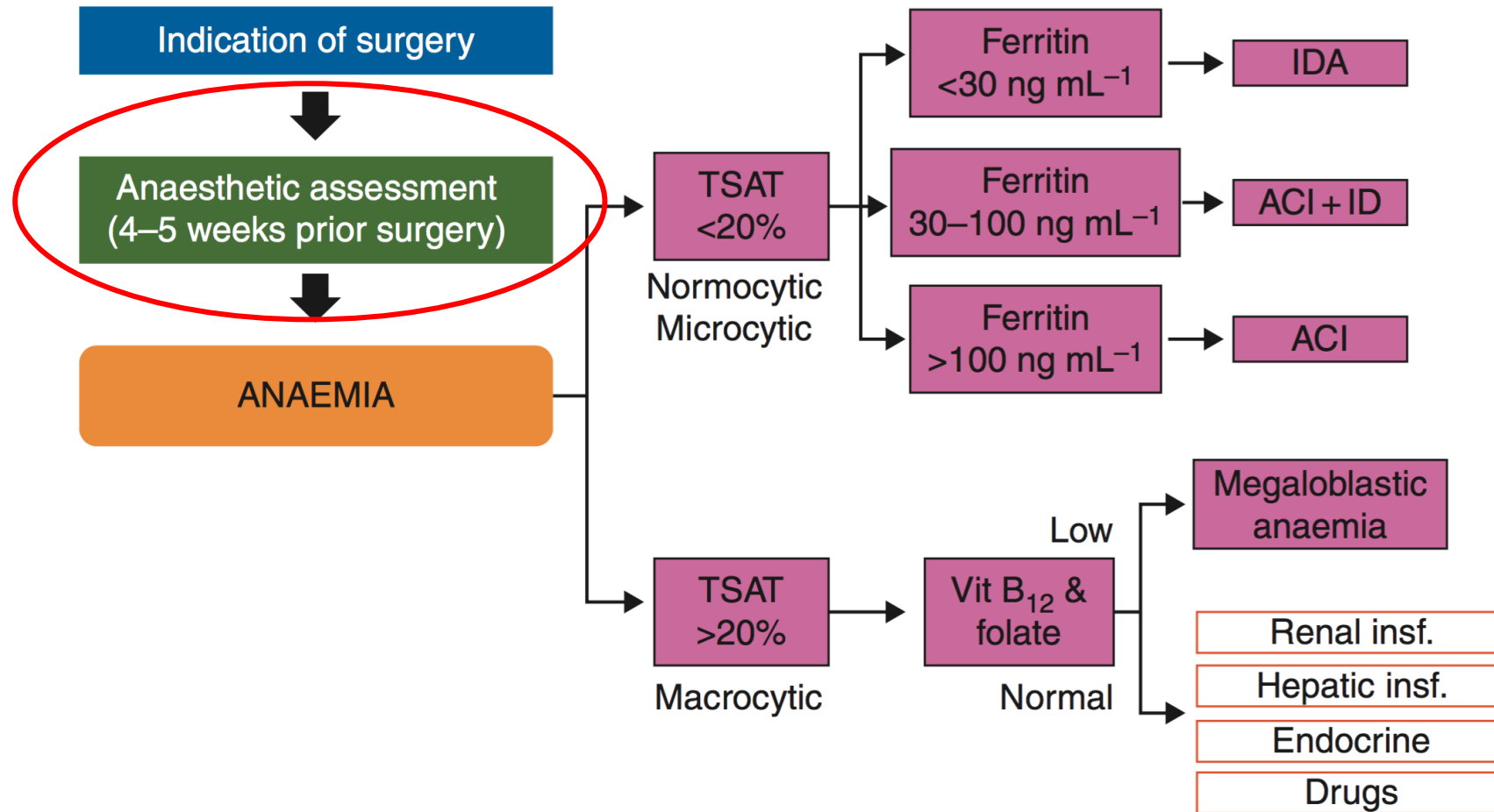
Meta-analysis
(EPO+IRON vs *IRON*)

25 RCT, 4719 pts
RR transfusion 0.58

Kei T, Mistry N, Curley G, et al. Efficacy and safety of erythropoietin and iron therapy to reduce red blood cell transfusion in surgical patients: a systematic review and meta-analysis. *Can J Anaesth.* 2019;66(6):716-731.



THE STANDARD ALGORITHM



Muñoz M, Gómez-Ramírez S, Kozek-Langeneker S, et al. 'Fit to fly': overcoming barriers to preoperative haemoglobin optimization in surgical patients. *Br J Anaesth.* 2015;115(1):15-24.

Effect of ultra-short-term treatment of patients with iron deficiency or anaemia undergoing cardiac surgery: a prospective randomised trial



Donat R Spahn*, Felix Schoenrath*, Gabriela H Spahn, Burkhardt Seifert, Philipp Stein, Oliver M Theusinger, Alexander Kaserer, Inga Hegemann, Axel Hofmann, Francesco Maisano, Volkmar Falk



RCT: 505 cardiac surgery
anemic patients

20 mg/kg ferric
carboxymaltose
40 000 U EPO- α
1 mg Vit B12
5 mg folic acid p.o.

vs placebo

one working day before
surgery

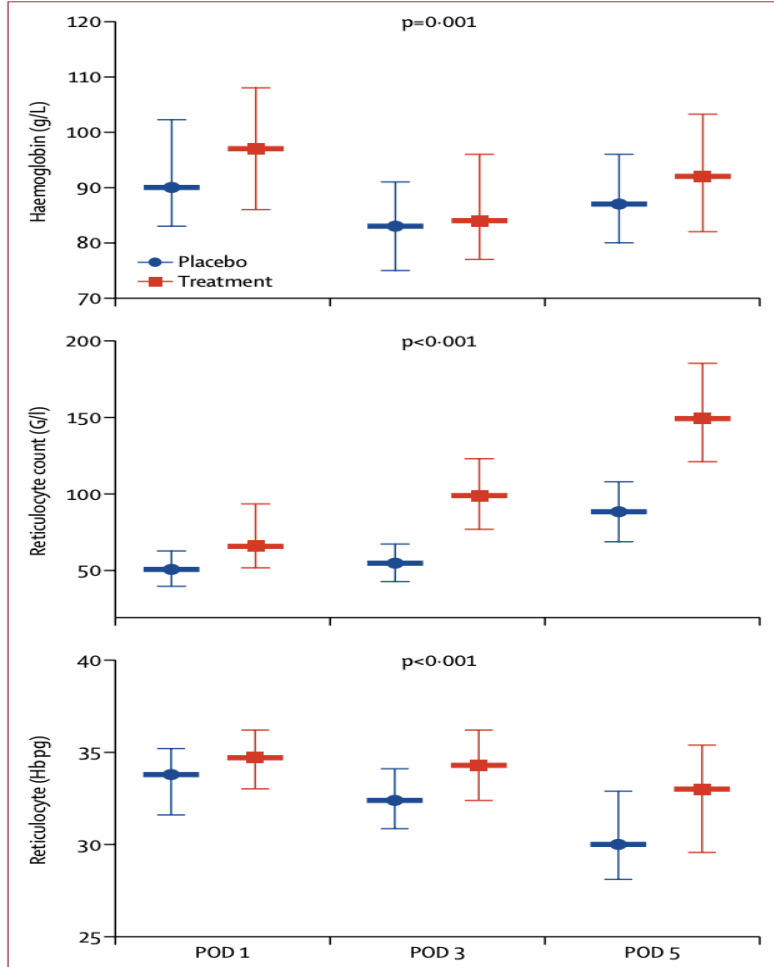
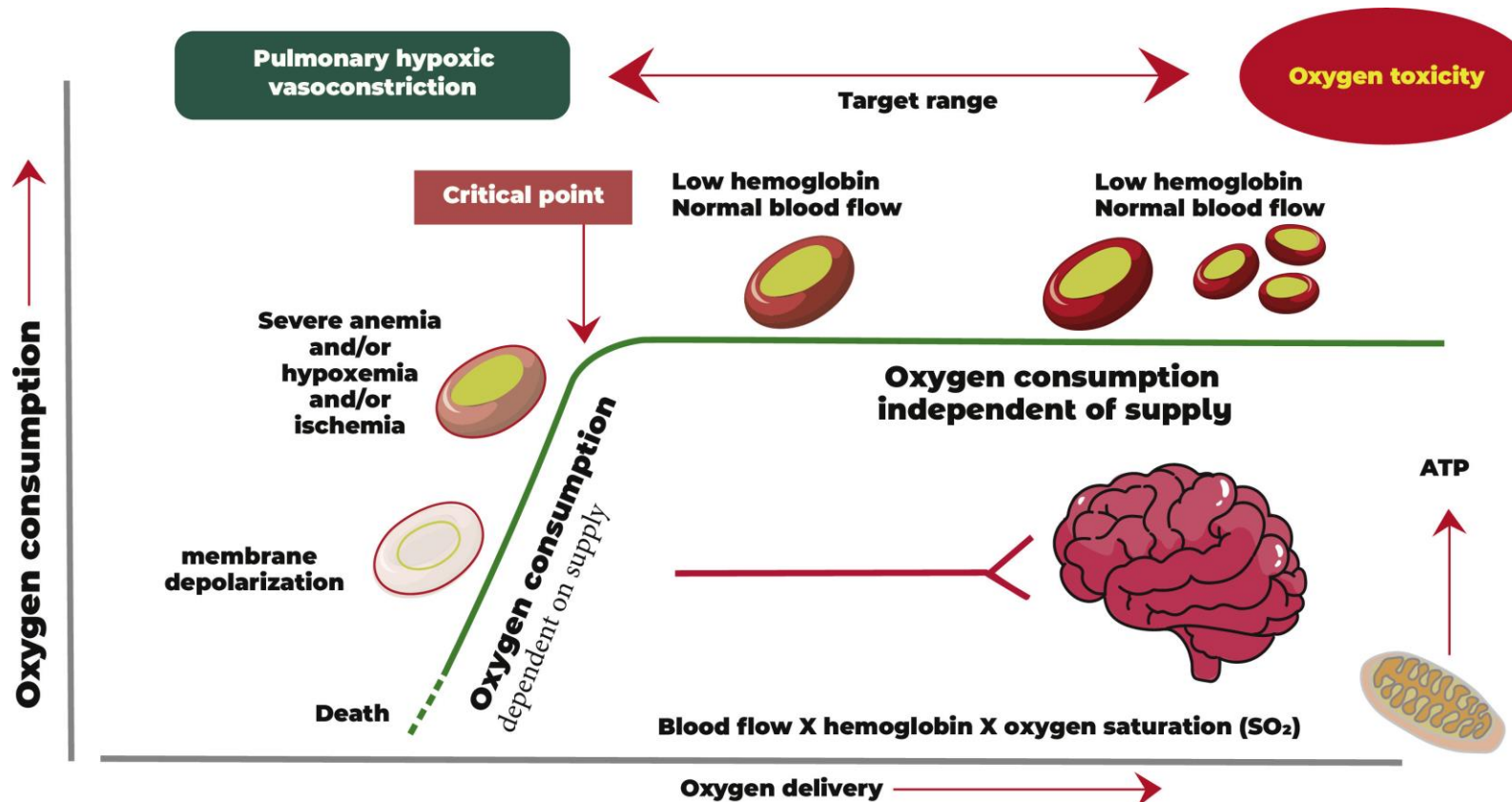


Figure 2: Haemoglobin, reticulocyte count, and reticulocyte Hb content on postoperative days (POD) 1, 3, and 5 according to treatment
p value between treatment and placebo. Data are median (IQR).
Hb=haemoglobin concentration.

	Treatment (n=243)	Placebo (n=241)	p value
RBC units transfused in first 7 days	..	..	0.036
Mean (SD)	1.5 (2.7)	1.9 (2.9)	..
Median (IQR)	0 (0-2)	1 (0-3)	..
Distribution, n (%)			
0	135 (56%)	114 (47%)	..
1	31 (13%)	27 (11%)	..
2	33 (14%)	38 (16%)	..
3	10 (4%)	23 (10%)	..
4	12 (5%)	11 (5%)	..
≥5	22 (9%)	28 (12%)	..

Spahn DR, Schoenrath F, Spahn GH, et al. Effect of ultra-short-term treatment of patients with iron deficiency or anaemia undergoing cardiac surgery: a prospective randomised trial. *Lancet*. 2019;393(10187):2201-2212.

Anaemia tolerance



- Relationship between oxygen delivery and demand.
- product of blood flow and arterial O₂ content.
- DO₂ exceeds oxygen demand by about 4-fold
- When the DO₂ decreases below a critical point, O₂ consumption is impaired, leading to anaerobic metabolism and lactic acidosis.
- One of the vital goals is ensuring the adequacy of DO₂

Rodrigues RDR et al. . Consensus of the Brazilian association of hematology, hemotherapy and cellular therapy on patient blood management: Anemia tolerance mechanisms. Hematol Transfus Cell Ther. 2024 Apr;46 Suppl 1(Suppl 1):S77-S82. doi: 10.1016/j.htct.2024.02.010. Epub 2024 Mar 19.

Anaemia tolerance

Rodrigues RDR et al. . Consensus of the Brazilian association of hematology, hemotherapy and cellular therapy on patient blood management: Anemia tolerance mechanisms. Hematol Transfus Cell Ther. 2024 Apr;46 Suppl 1(Suppl 1):S77-S82. doi: 10.1016/j.htct.2024.02.010. Epub 2024 Mar 19.

Table 1 – Correlation between the main clinical situations and the variables affected by oxygen delivery.

Situation	CaO_2 $1.37 \times \text{Hb} \times \text{SaO}_2 \times \text{PaO}_2$	CO $\text{CO} = \text{SV} \times \text{HR}$	Desired intervention
Anemia (dependent on the hemoglobin level and each patient's comorbidities)	Drop in CaO_2	Can compensate with increase in HR	Improve the supply/Hb production (if possible): correction of the anemia (see the possibility of iron, erythropoietin, etc.)
Severe anemia (hemorrhagic shock)	Drop in CaO_2 dependent on the hemoglobin level	Can compensate with increase in HR, however hypotension and signs of bad clinical perfusion are evident (drop in diuresis, cold and clammy skin, alteration in awareness, etc.)	Consider concentrated red blood cell transfusions and/or volume replacement (escalation of therapy depends on the degree of shock - from I to IV)
Drop in oxygenation (e.g.: lack of intubation, hypoxemic respiratory failure)	Drop in CaO_2	Initial increase in HR as compensatory mechanism; if not resolved, drop in SV and CO – bradycardia and cardiorespiratory arrest	Improve DO_2 depending on underlying cause
Tachyarrhythmia	Initially it is unaffected in well-oxygenated patients	Pathologic increase in HR with impairment of diastolic filling – drop in SV and CO. Can evolve to cardiorespiratory arrest	Treat the arrhythmia according to Advanced Cardiac Life Support guidelines of the American Heart Association
Hypothermia	Initially it is unaffected in well-oxygenated patients – in situations of deep hypothermia (a rare condition), the CaO_2 may be augmented due to an increase in solubility of O_2 in the liquid (plasma)	Initially there is a compensatory increase in the CO to attempt to supply the organism and maintain homeostasis; if it persists the HR and CO drop	Gradual rewarming
Sedation/analgesia	Initially it is unaffected in well-oxygenated patients. In sedated and badly oxygenated patients, it may lead to a drop in the CaO_2	Well indicated, analgesics and sedation normally promote anxiolysis, with consequent reduction in HR, and improvement in diastolic filling, SV and CO. Excessive sedation or inappropriate use of sedative drugs can cause hypotension, a drop in SV and consequently a drop in CO	Adequate analgesia and sedation for each nociceptive stimulation

CaO_2 : Arterial oxygen content; Hb: Hemoglobin; SaO_2 : Oxygen saturation; PaO_2 : Partial pressure of oxygen; CO: Cardiac output; SV: Stroke volume; HR: Heart rate; IAB: intra-aortic balloon; ECMO: extracorporeal membrane oxygenation.

Anaemia tolerance

Rodrigues RDR et al. . Consensus of the Brazilian association of hematology, hemotherapy and cellular therapy on patient blood management: Anemia tolerance mechanisms. Hematol Transfus Cell Ther. 2024 Apr;46 Suppl 1(Suppl 1):S77-S82. doi: 10.1016/j.htct.2024.02.010. Epub 2024 Mar 19.

Table 1 – Correlation between

Situation	Desired intervention	Intervention
Anemia (dependent on the hemoglobin level and each patient's comorbidities)	Improve the supply/Hb production (if possible): correction of the anemia (see the possibility of iron, erythropoietin, etc.) Consider concentrated red blood cell transfusions and/or volume replacement (escalation of therapy depends on the degree of shock - from I to IV)	Improve the supply/Hb production (if possible): correction of the anemia (see the possibility of iron, erythropoietin, etc.) Consider concentrated red blood cell transfusions and/or volume replacement (escalation of therapy depends on the degree of shock - from I to IV)
Severe anemia (hemorrhagic shock)	Improve DO ₂ depending on underlying cause	Improve DO ₂ depending on underlying cause
Drop in oxygenation (e.g.: lack of intubation, hypoxemic respiratory failure)	Treat the arrhythmia according to Advanced Cardiac Life Support guidelines of the American Heart Association Gradual rewarming	Treat the arrhythmia according to Advanced Cardiac Life Support guidelines of the American Heart Association Gradual rewarming
Tachyarrhythmia		
Hypothermia		
Sedation/analgesia	Adequate analgesia and sedation for each nociceptive stimulation	Adequate analgesia and sedation for each nociceptive stimulation

CaO₂: Arterial oxygen content; Hb: hemoglobin; HR: Heart rate; IAB: intra-aortic balloon pump; SV: Stroke volume

3rd Pillar

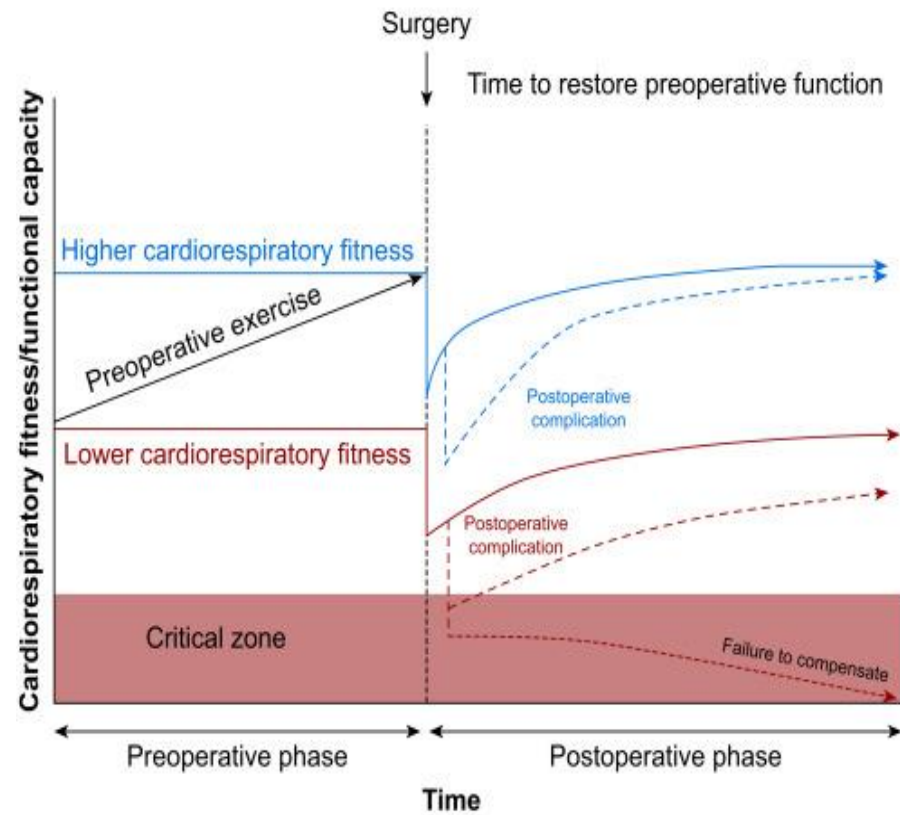
Harness & optimise physiological reserve of anaemia



6th EEMEA Acute Care Experts Meeting
October 15-16, 2025 • Vilnius

werfen

PREHABILITATION - enhancing the body's ability to use oxygen



Higher cardiorespiratory fitness

- Greater capacity/resilience to withstand complications
- Quicker rate of recovery to preoperative fitness/function

Lower cardiorespiratory fitness

- Lower capacity/resilience to withstand complications
- Slower rate of recovery to preoperative fitness/function



"I exercise almost everyday.
Almost on Monday, almost on Tuesday..."



Roxburgh BH, Cotter JD, Campbell HA, et al. Physiological relationship between cardiorespiratory fitness and fitness for surgery: a narrative review. *Br J Anaesth.* 2023

Red Blood Cell Transfusion in the Intensive Care Unit

Senta Jorinde Raasveld, MD; Sanne de Bruin, MD, PhD; Merijn C. Reuland, MD; Claudia van den Oord, MD; Jimmy Schenk, MSc, PhD; Cécile Aubron, MD, PhD; Jan Bakker, MD, PhD; Maurizio Cecconi, MD, PhD; Aarne Feldheiser, MD, PhD; Jens Meier, MD; Marcella C. A. Müller, MD, PhD; Thomas W. L. Scheeren, MD, PhD; Zoe McQuilten, MD, PhD; Andrew Flint, MD; Tarikul Hamid, MD; Michaël Piagnerelli, MD, PhD; Tina Tomić Mahečić, MD; Jan Benes, MD, PhD; Lene Russell, MD, PhD; Hernan Aguirre-Bermeo, MD, PhD; Konstantina Triantafyllopoulou, MD; Vasiliki Chantziara, MD, PhD; Mohan Gurjar, MD; Sheila Nainan Myatra, MD; Vincenzo Pota, MD, PhD; Muhammed Elhadi, MD; Ryszard Gawda, MD, PhD; Mafalda Mourisco, MD; Marcus Lance, MD, PhD; Vojislava Neskovic, MD, PhD; Matej Podbregar, MD, PhD; Juan V. Llau, MD, PhD; Manual Quintana-Diaz, MD, PhD; Maria Cronhjort, MD; Carmen A. Pfortmueller, MD; Nihan Yapici, MD; Nathan D. Nielsen, MD, MSc; Akshay Shah, MD, PhD; Harm-Jan de Grooth, MD, PhD; Alexander P. J. Vlaar, MD, PhD; for the InPUT Study Group

Hemoglobin levels

Threshold predefined, median (IQR), g/dL ^c	8.0 (7.0-9.0)
Restrictive (<7 g/dL)	299 (17.3)
Intermediate (7-9 g/dL)	430 (24.9)
Liberal (>9 g/dL)	459 (26.6)
No threshold stated	539 (31.2)
Before transfusion, g/dL ^d	7.7 (1.6)
Post transfusion, g/dL ^e	9.1 (1.5)
Hb level increase after transfusion, median (IQR), g/dL ^f	1.2 (0.7-2.0)
Change in Hb level (between Hb prior and stated Hb threshold), g/dL ^g	-0.7 (1.5)



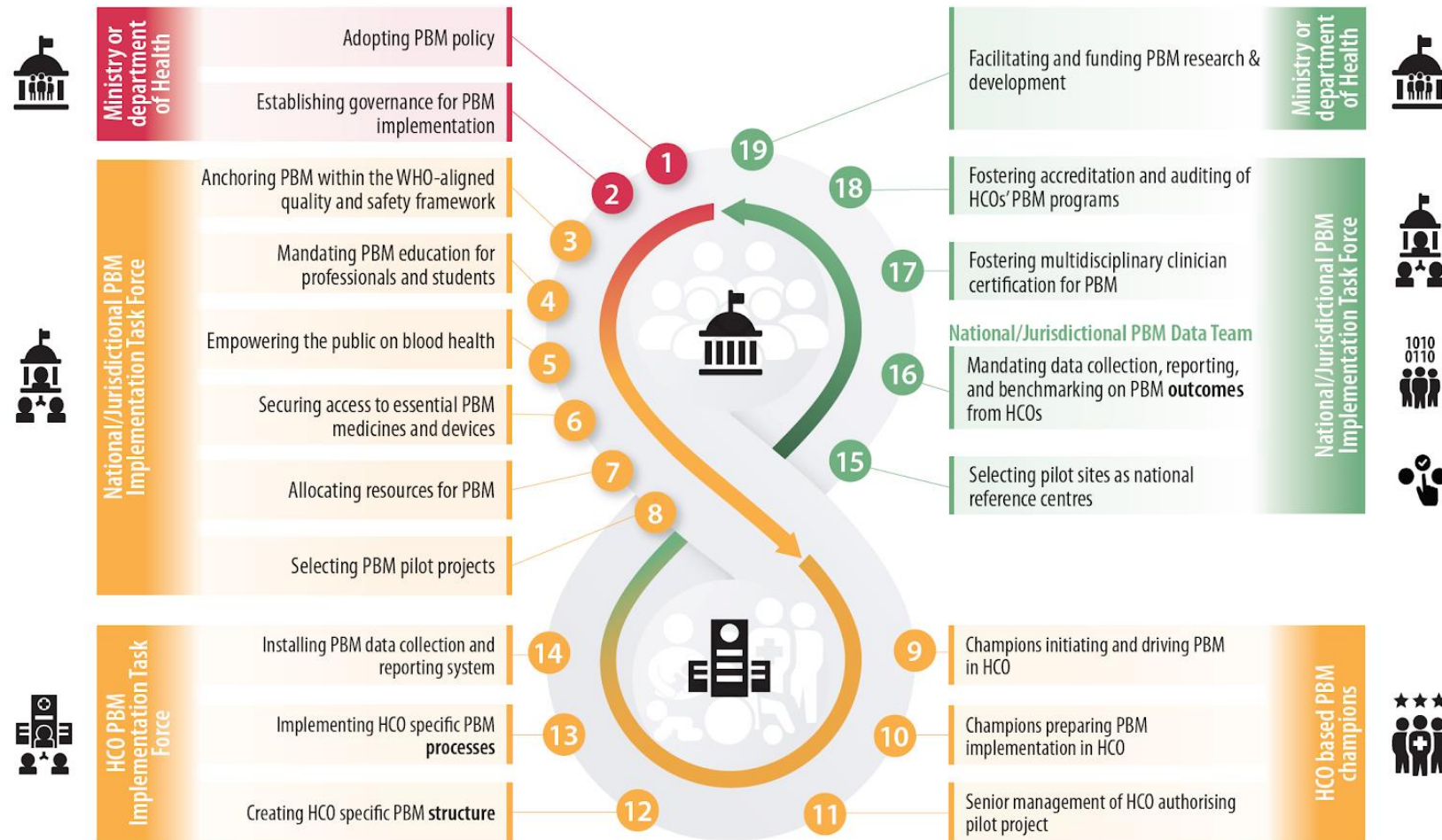
#GRAYZONE

- non-bleeding anaemic, critically ill patients with acute neurologic injuries
- Critically ill patients undergoing ECMO
- anaemic oncologic and haemato-oncologic critically ill patients
- elderly critically ill patients

Transfusion strategies in non-bleeding critically ill adults: a clinical practice guideline from the European Society of Intensive Care Medicine, Intensive Care Med (2020) 46:673–696



Infographic: Option B





-
- Anaemia, bleeding and transfusions are killers! / avoid any of them
 - Prehabilitation is better than rehab.
 - Need a strong and empowered team to implement a PBM program
 - **OUR GOAL- Optimal transfusion practice should provide enough RBCs to maximize clinical outcomes while avoiding unnecessary transfusions.**

