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PERIOPERATIVE ANEMIA

2019

Dr. Ion Chesov, MD, PhD, Associate Prof.

Conflicts of interests

Objectives

- Patient blood Management (PBM)
- Anemia – definition and risks
- Causes
- Pathophysiology
- Anemia assessment
- Clinical Management
- Transfusion thresholds
- Point of care testing
- Take home messages

Patient Blood Management

SABM®
SOCIETY FOR THE ADVANCEMENT OF BLOOD MANAGEMENT

- Patient blood management is the timely application of evidence-based medical and surgical concepts design to maintain hemoglobin concentration, optimize homeostasis and minimize blood loss in an effort to improve patient outcome.

https://www.sabm.org/, accessed on 30.11.19

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https://www.sabm.org/, accessed on 30.11.19

PBM – Blood transfusion

- Severe malaria induced anemia in children
- Major trauma with exsanguination
- Major surgery in severely anemic patients without possibility of preoperative anemia correction
- Very severe intra- / postoperative anemia with signs of cardiovascular insufficiency

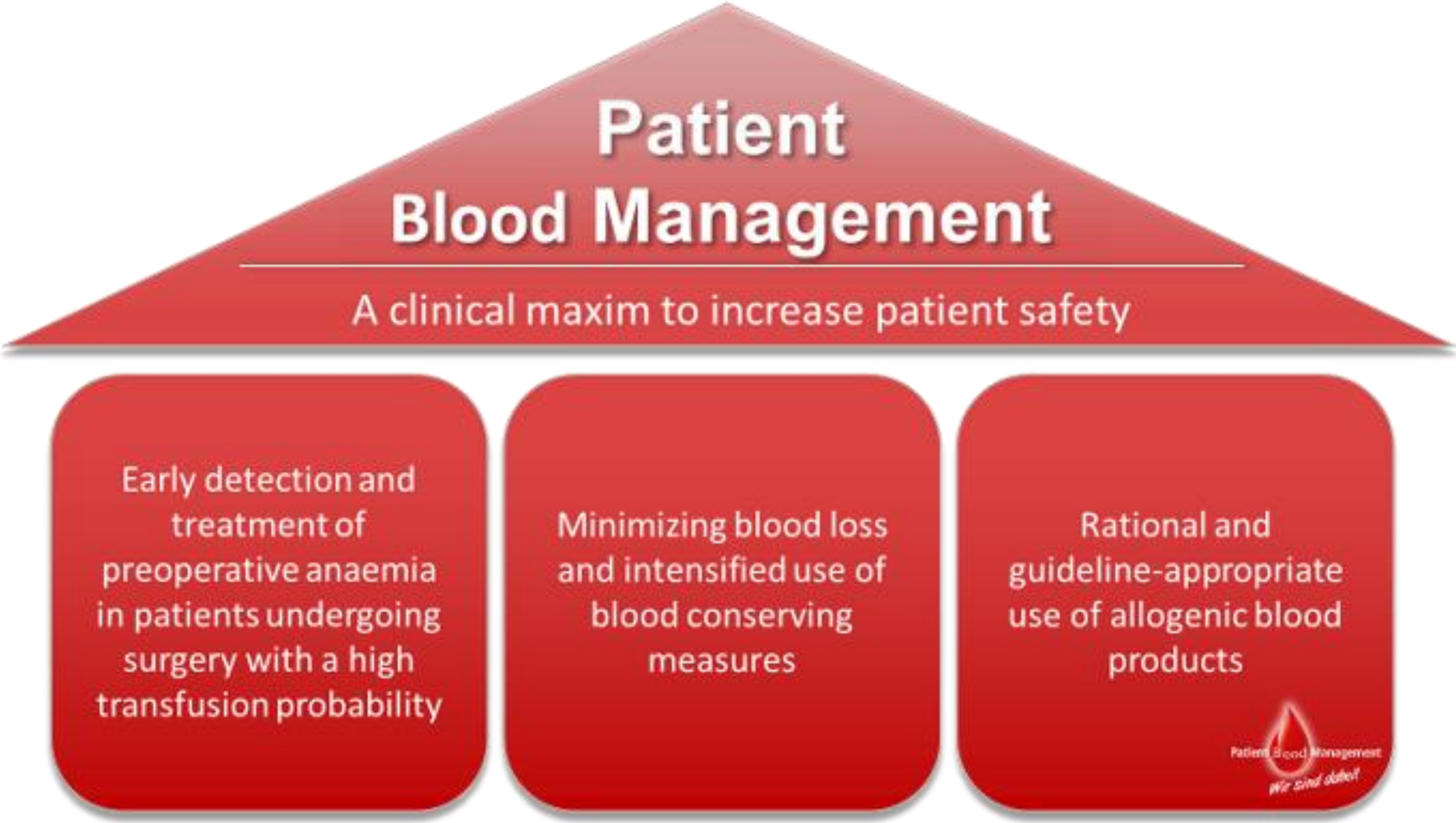
Lackritz, E. M. et al. Lancet (1992) 340: 524
English M. et al. Lancet (2002) 359: 494
Meremikwu M. et al. Cochrane Database Syst Rev 2000:CD001475
Spahn D. R. et al. Crit Care (2013) 17:R76
Spahn D. R. et al. Lancet (2013) 381: 1855
Wu W. C. et al. Ann Surg (2010) 252: 11

PBM – Blood transfusion

- Mortality ⬆
- Length of hospital stay ⬆
- Organ dysfunction ⬆
  - ⇨ Lung injury (TRALI, TACO)
  - ⇨ Renal impairment
  - ⇨ Stroke
  - ⇨ Myocardial infarction
- Infection ⬆
- Transfusion reactions
- Tumor growth promotion ⬆
- Costs ⬆
- Non-Hodgkin lymphoma ⬆

Spahn D. R. et al. Lancet (2013) 381: 1855

PBM key points



Anemia -WHO

- Haemoglobin concentration of less than

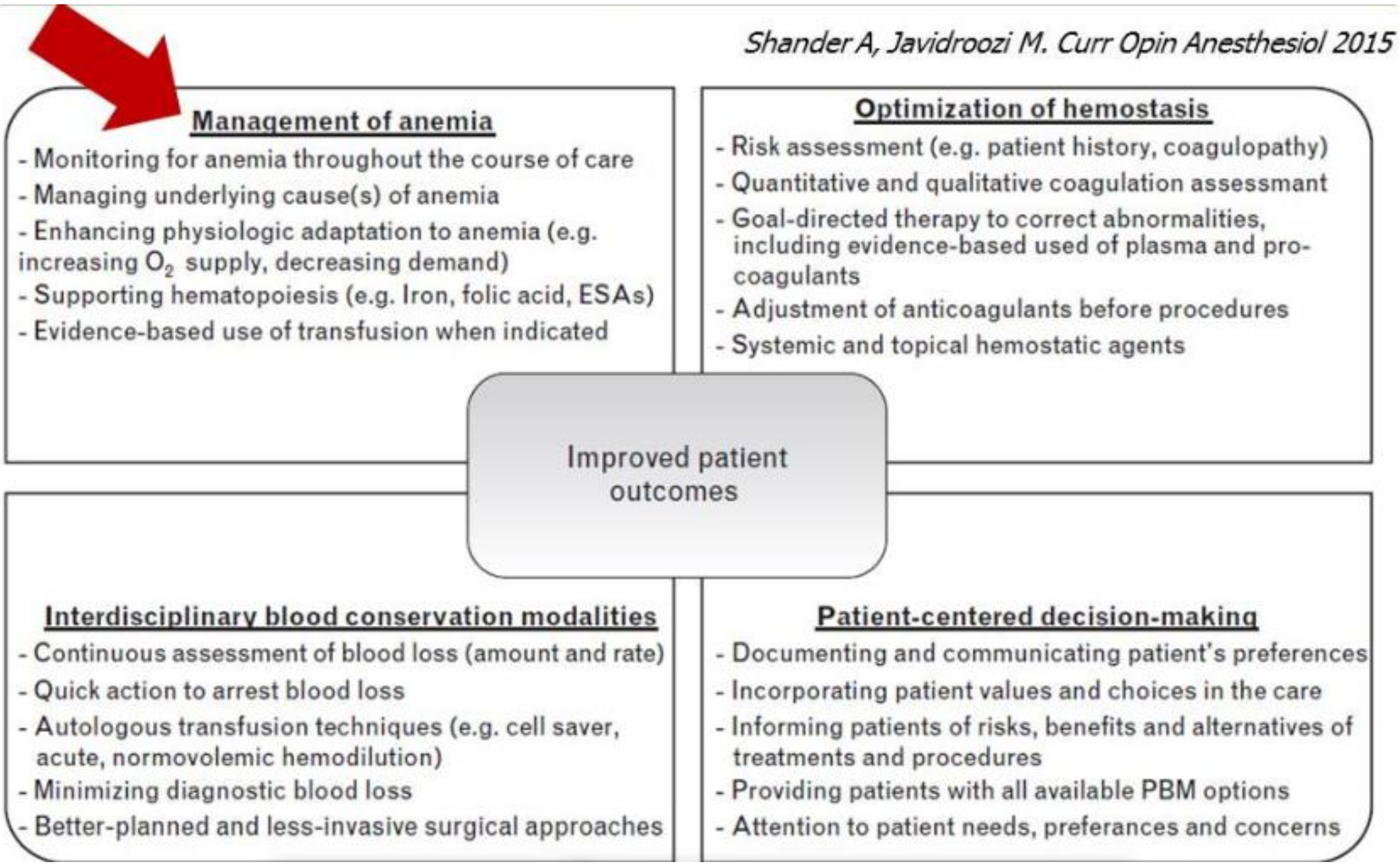
  -130 g dl1 for men

  -120 g dl1 for non-pregnant women.

Table 1 Definitions of anaemia according to the WHO and the NCI schemes. WHO, World Health Organization; NCI, National Cancer Institute

	WHO	NCI
Male	Hb <13 g dl^{-1}	Hb <12 g dl^{-1}
Female	Hb <12 g dl^{-1}	Hb <11 g dl^{-1}

Anemia & PBM

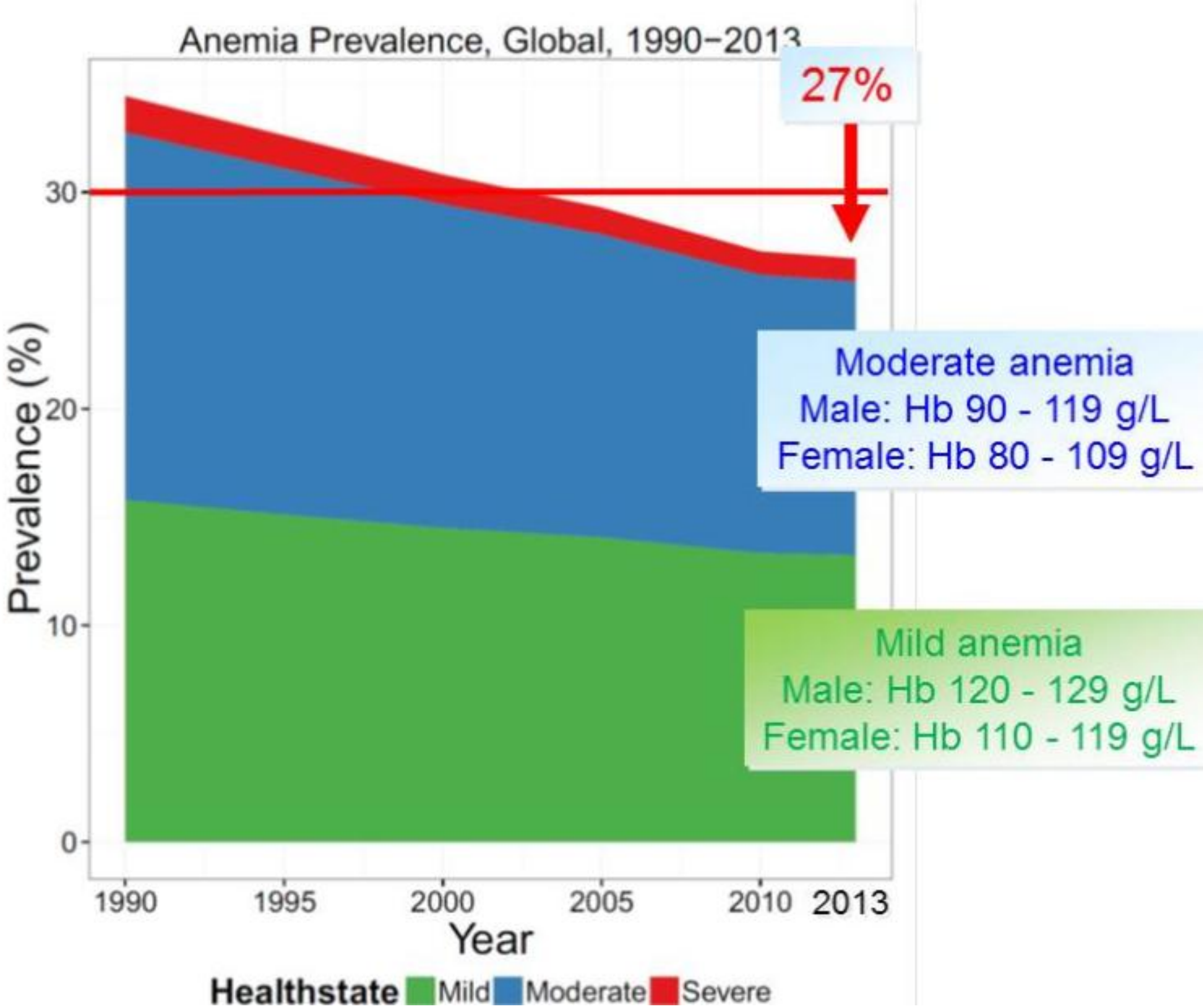

Shander A, Javidroozi M. Curr Opin Anesthesiol 2015
Management of anemia
- Monitoring for anemia throughout the course of care
- Managing underlying cause(s) of anemia
- Enhancing physiologic adaptation to anemia (e.g. increasing O_2 supply, decreasing demand)
- Supporting hematopoiesis (e.g. Iron, folic acid, ESAs)
- Evidence-based use of transfusion when indicated
Optimization of hemostasis
- Risk assessment (e.g. patient history, coagulopathy)
- Quantitative and qualitative coagulation assessmant
- Goal-directed therapy to correct abnormalities, including evidence-based used of plasma and pro-coagulants
- Adjustment of anticoagulants before procedures
- Systemic and topical hemostatic agents
Improved patient outcomes
Interdisciplinary blood conservation modalities
- Continuous assessment of blood loss (amount and rate)
- Quick action to arrest blood loss
- Autologous transfusion techniques (e.g. cell saver, acute, normovolemic hemodilution)
- Minimizing diagnostic blood loss
- Better-planned and less-invasive surgical approaches
Patient-centered decision-making
- Documenting and communicating patient's preferences
- Incorporating patient values and choices in the care
- Informing patients of risks, benefits and alternatives of treatments and procedures
- Providing patients with all available PBM options
- Attention to patient needs, preferances and concerns

Anemia prevalence

- Up to 60% of surgical population
- 5–78% of patients requiringa surgical intervention

Shander A, AmJMed 2004; 116: 58S–69S

GA Hans, Continuing Education in Anaesthesia, Critical Care & Pain, 2013


Anemia Prevalence, Global, 1990−2013
27%
Prevalence (%)
30
20
10
0
1990
1995
2000
2005
2010
2013
Year
Moderate anemia
Male: Hb 90 - 119 g/L
Female: Hb 80 - 109 g/L
Mild anemia
Male: Hb 120 - 129 g/L
Female: Hb 110 - 119 g/L
Healthstate
Mild
Moderate
Severe

Anemia - outcome

Anaesthesia
Peri-operative medicine, critical care and pain
Association of Anaesthetists

Original Article | Free Access

The incidence and importance of anaemia in patients undergoing cardiac surgery in the UK – the first Association of Cardiothoracic Anaesthetists national audit*

A. A. Klein, T. J. Collier, M. S. Brar, C. Evans, G. Hallward, S. N. Fletcher, T. Richards, on behalf of the Association of Cardiothoracic Anaesthetists (ACTA)

First published: 18 March 2016 | https://doi.org/10.1111/anae.13423 | Cited by: 25

Anemia - outcome

- Higher mortality **-2 times more likely to die**
- Higher transfusion requirements for small haemoglobinchanges (10g/dL)
- Longer hospital stays (median 2 days)
- Death linked to severity of anaemia and to gender

Anemia - outcome

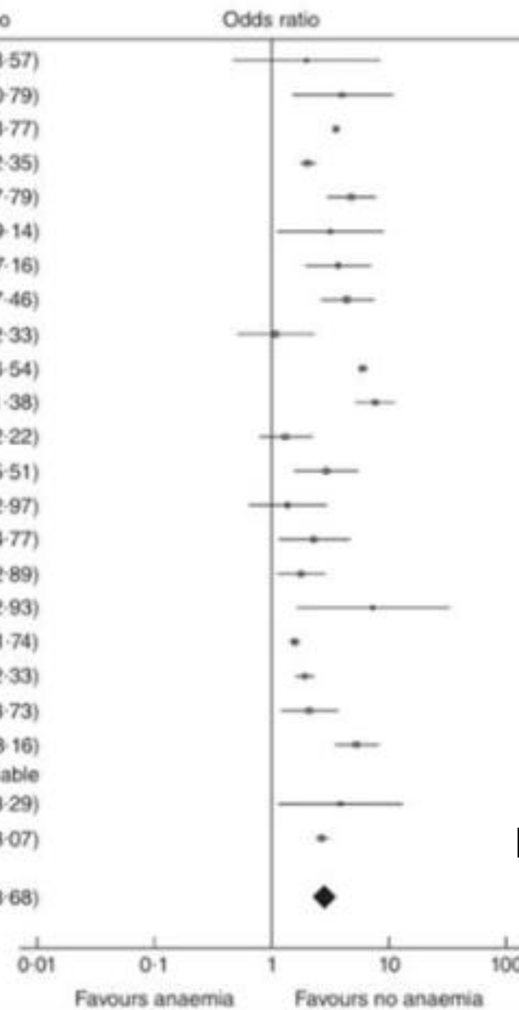
- Increase risk of AKI .
- Poorer surgical outcomes.
- Increase perioperative blood transfusion
- Haematocrit less 39% was associated with an increased risk of 30 day postoperative mortality and cardiac events.

Arora P et, al, J Cardiothorac Vasc Anesth 2012
Browning RM et al, Aust N Z J Obstet Gynaecol 2012
David O et al Anaesth Intensive Care 2013
Klein et al. Anaesthesia June 2016
Wu W et al, J Am Med Assoc 2007; 22: 2481–8

Pre-op anemia

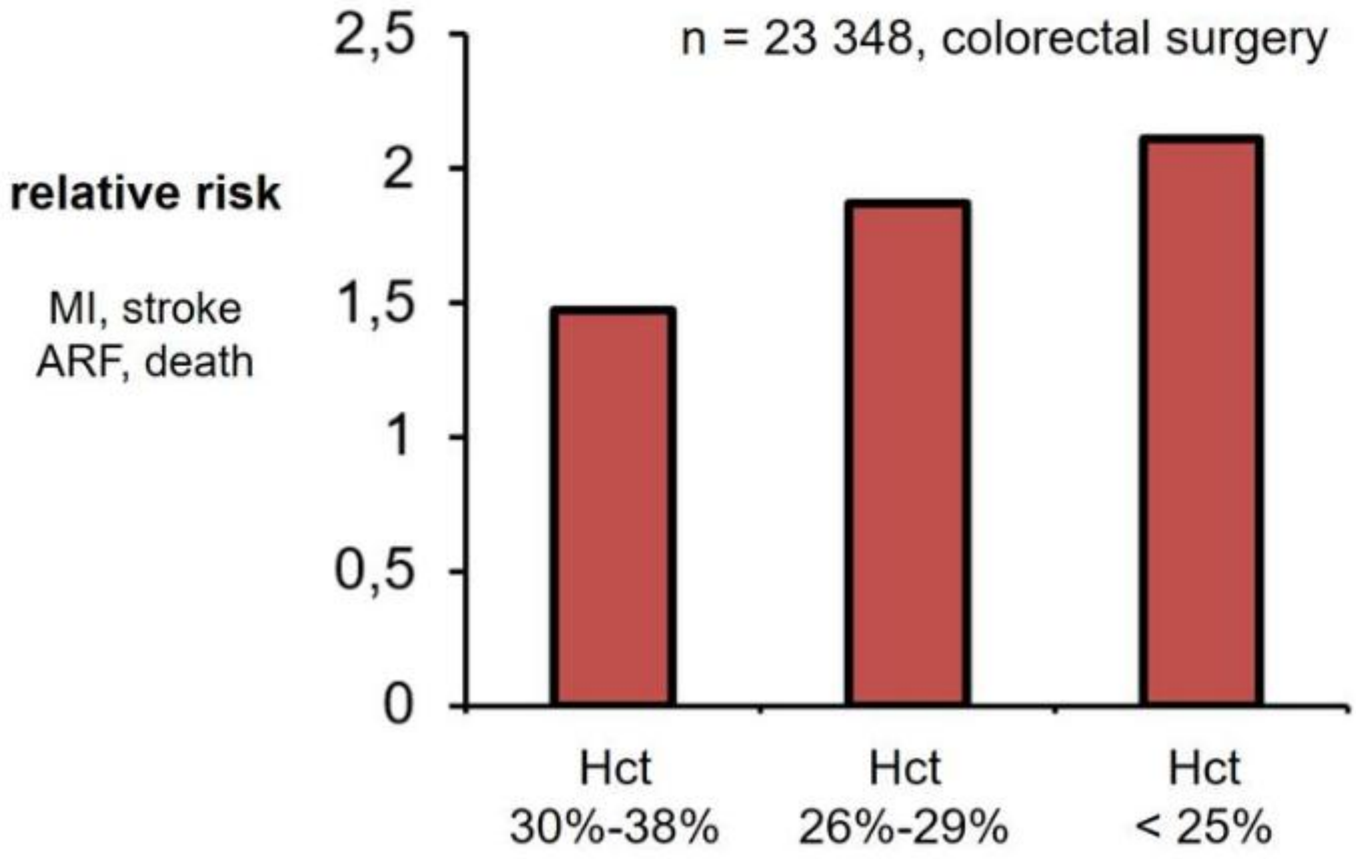
Reference	Year	Mortality: Anaemia	Mortality: No anaemia	Weight (%)	Odds ratio
Gruson *et al.*[26]	2002	5 of 180	3 of 215	1·8	2·02 (0·48, 8·57)
Cladellas *et al.*[22]	2006	9 of 42	10 of 159	2·9	4·06 (1·53, 10·79)
Wu *et al.*[40]	2007	8660 of 132970	3351 of 177341	5·9	3·62 (3·47, 3·77)
Bell *et al.*[20]	2008	325 of 6143	798 of 30196	5·8	2·06 (1·80, 2·35)
Beattie *et al.*[19]	2009	76 of 3047	24 of 4632	4·8	4·91 (3·10, 7·79)
Melis *et al.*[30]	2009	14 of 197	5 of 216	2·8	3·23 (1·14, 9·14)
De Santo *et al.*[23]	2009	25 of 320	16 of 727	4·1	3·77 (1·98, 7·16)
Shirzad *et al.*[37]	2010	26 of 650	35 of 3782	4·6	4·46 (2·67, 7·46)
Munoz *et al.*[31]	2010	12 of 210	19 of 366	3·7	1·11 (0·53, 2·33)
Musallam *et al.*[32]	2011	3192 of 69229	1240 of 158196	5·9	6·12 (5·73, 6·54)
Boening *et al.*[21]	2011	44 of 185	121 of 3126	5·1	7·75 (5·28, 11·38)
Vochteloo *et al.*[39]	2011	30 of 536	31 of 726	4·6	1·33 (0·79, 2·22)
Hung *et al.*[28]	2011	45 of 1463	13 of 1225	4·2	2·96 (1·59, 5·51)
Dubljanin-Raspopovic *et al.*[24]	2011	19 of 185	12 of 158	3·7	1·39 (0·65, 2·97)
Greenky *et al.*[25]	2012	12 of 2991	21 of 12231	3·9	2·34 (1·15, 4·77)
Ranucci *et al.*[34]	2012	51 of 401	30 of 401	4·8	1·80 (1·12, 2·89)
Oshin and Torella[33]	2013	16 of 193	2 of 167	1·8	7·46 (1·69, 32·93)
Saager *et al.*[35]	2013	1288 of 119298	811 of 119298	5·9	1·59 (1·46, 1·74)
Gupta *et al.*[27]	2013	368 of 15272	206 of 16585	5·8	1·96 (1·65, 2·33)
van Straten *et al.*[38]	2013	20 of 351	38 of 1385	4·5	2·14 (1·23, 3·73)
Seicean *et al.*[36]	2013	63 of 5879	37 of 18594	5·1	5·43 (3·62, 8·16)
Jung *et al.*[29]	2013	0 of 125	0 of 463		Not estimable
Zhang *et al.*[41]	2013	22 of 432	3 of 223	2·3	3·93 (1·16, 13·29)
Baron *et al.*[5]	2014	656 of 11295	604 of 27439	5·9	2·74 (2·45, 3·07)
Total		14978 of 371594	7430 of 577851	100·0	2·90 (2·30, 3·68)

Heterogeneity: $\tau^2 = 0{\cdot}24$; $\chi^2 = 768{\cdot}79$, 22 d.f., $P < 0{\cdot}001$; $I^2 = 97\%$
Test for overall effect: $Z = 8{\cdot}88$, $P < 0{\cdot}001$



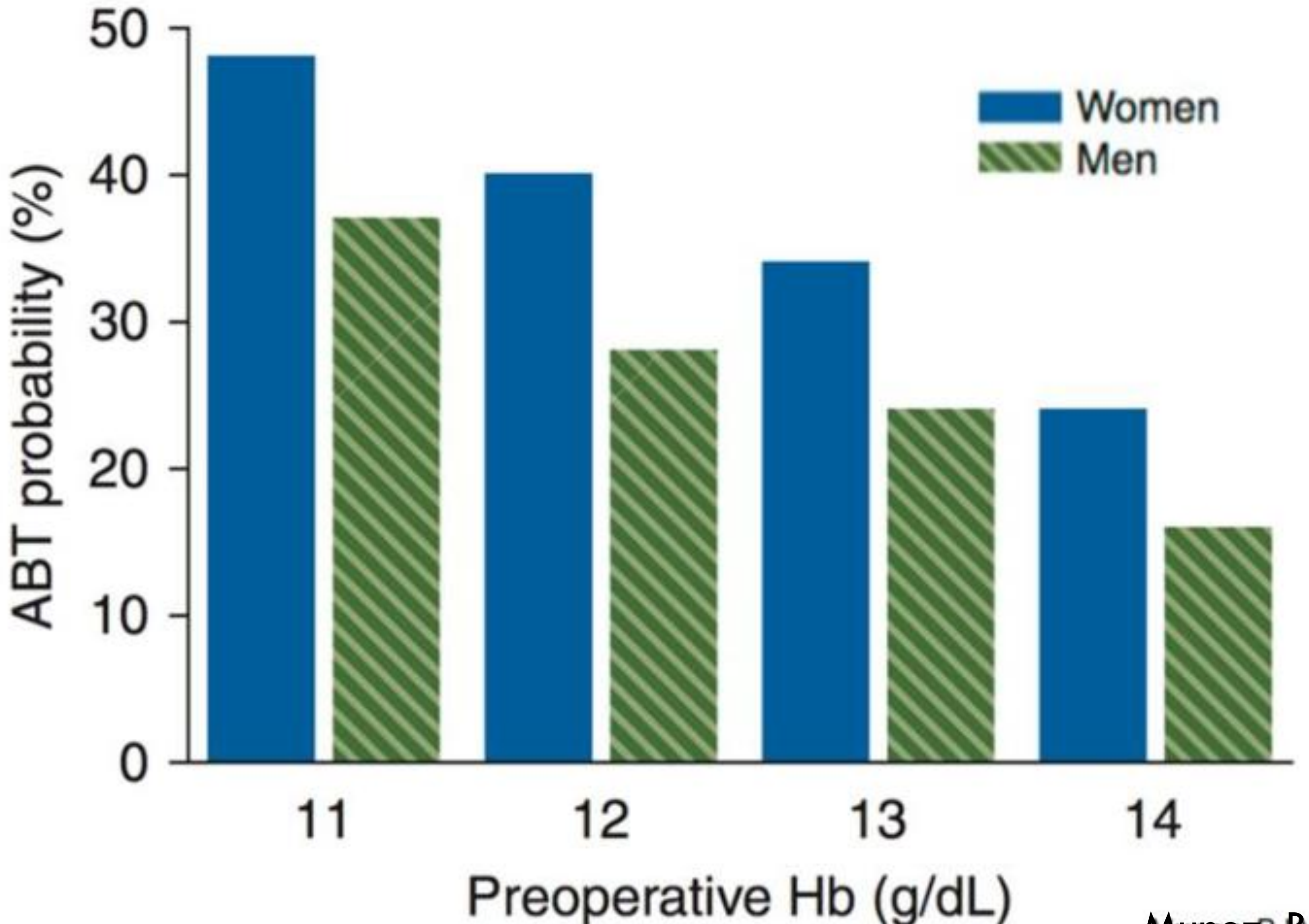
Fowler, BJS, 2015

Pre-op anemia



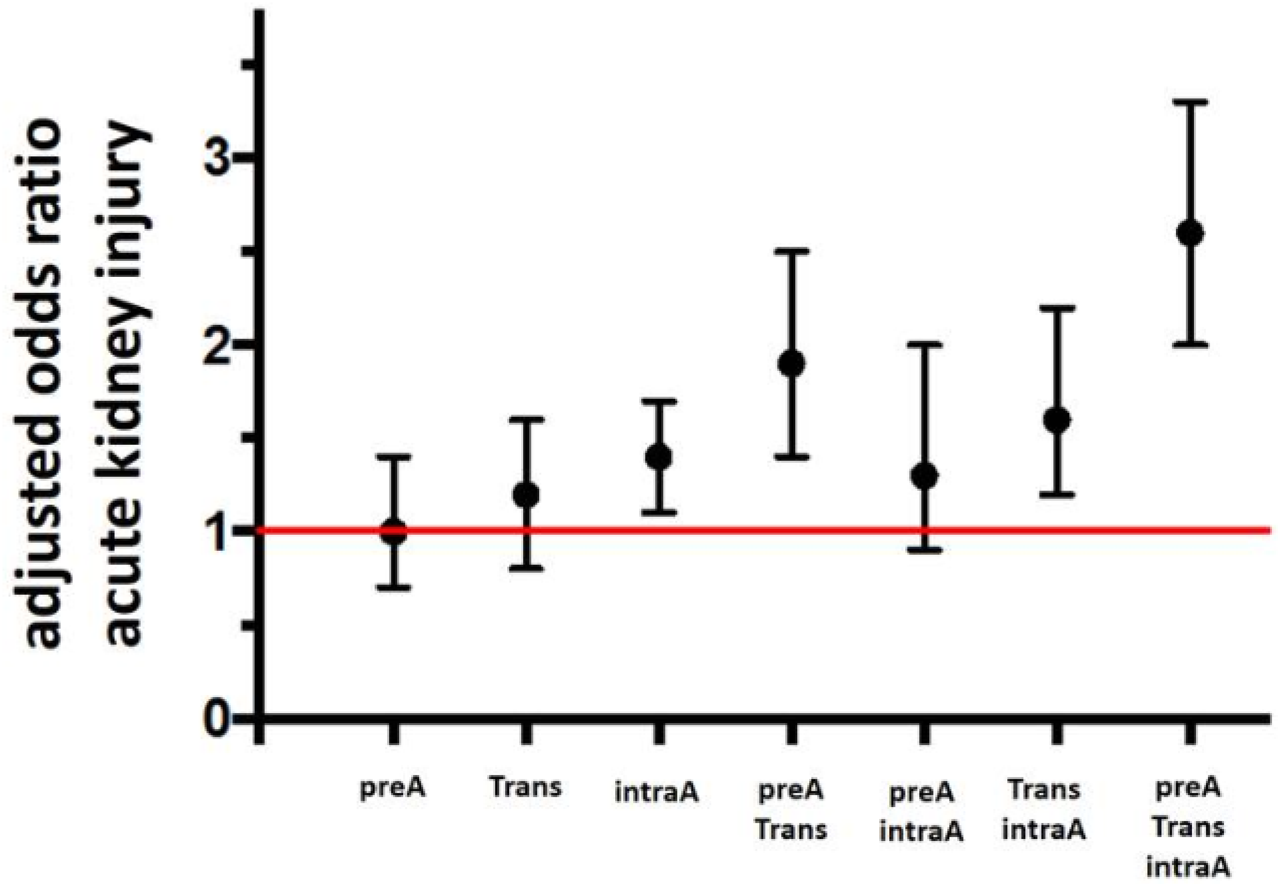
Leichtler, J Am Coll Sur, 2011

Anemia -Transfusion



Munoz, BJA, 2015

Anemia and Transfusion



Karkoutil, Can J Anesth, 2015

Anemia and Transfusion

Anaemia
Blood loss
Transfusion

Ranucci M et al. Ann Thorac Surg 2013;96:478-85

Pathophysiology

- DO2 COSp1:34 Hb SaO2 Юp0:003 PaO2 Ю

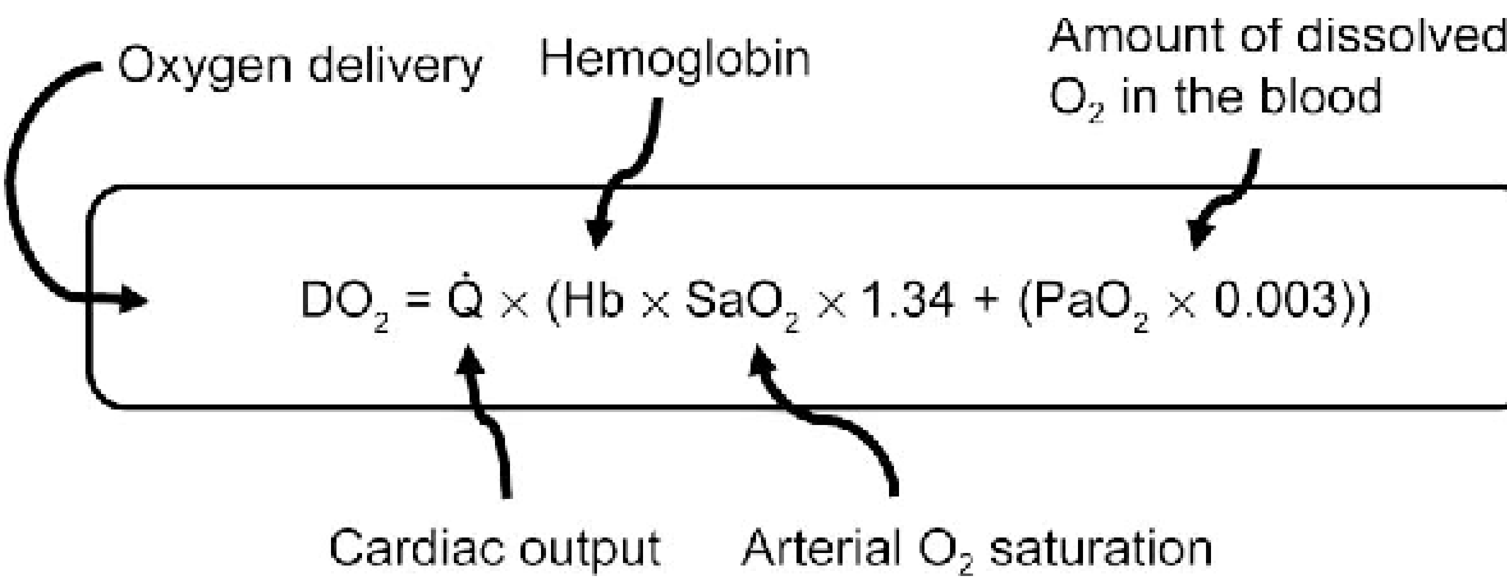


Fig. 1. Equation for oxygen delivery.

Pathophysiology

Table 2 Impact of anaemia on oxygen delivery. Hb, haemoglobin; CaO_2, arterial blood oxygen content; DO_2, oxygen delivery to tissue; CO, cardiac output

Parameter	Hb 15 g dl^{-1}	Hb 7.5 g dl^{-1}
Inspired oxygen (%)	21	21
Pa_{O_2} (kPa)	12	12
Sats (%)	98	98
Dissolved oxygen (ml litre^{-1})	3	3
Hb-bound oxygen (ml litre^{-1})	197	98
Total CaO_2 (ml litre^{-1})	200	101
DO_2 if CO 5 litre min^{-1} (ml min^{-1})	1000	505

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Pathophysiology

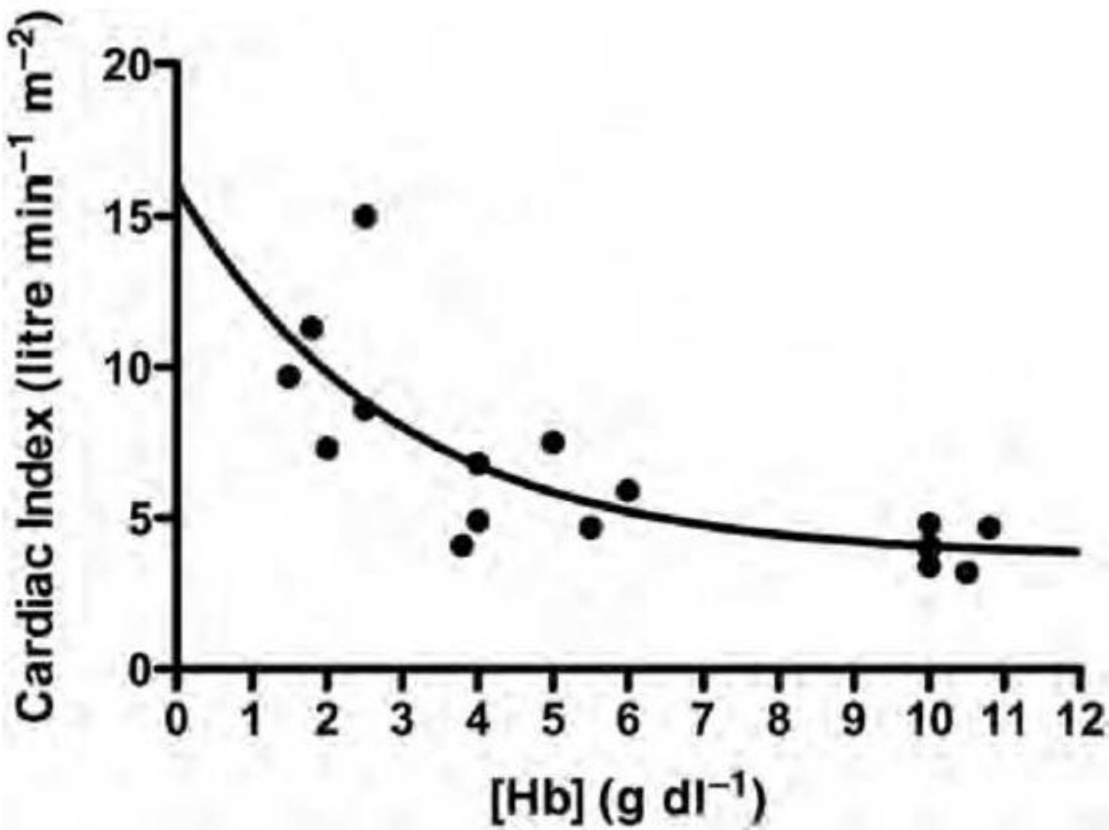

Fig 1 Effect of anaemia on cardiac index. Derived from data from Roy and colleagues.

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Pathophysiology

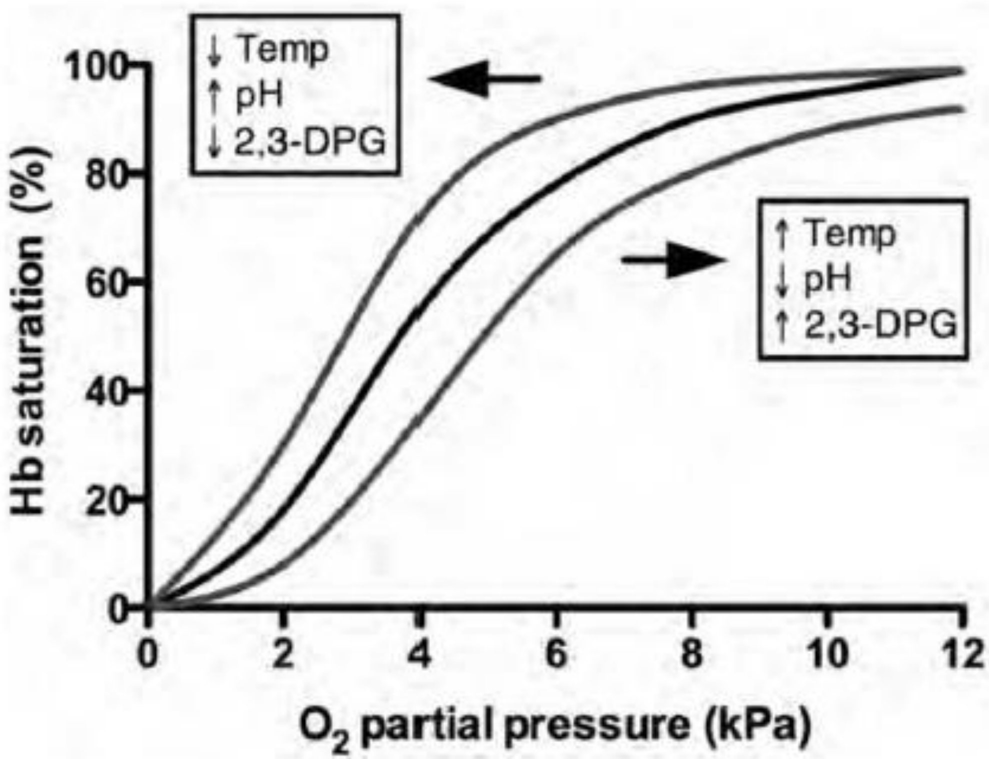

Fig 2 Haemoglobin–ODC. Temp, temperature; 2,3-DPG, 2,3-diphosphoglycerate.

Pathophysiology

Table 3 Causes of imbalance between oxygen supply and demand in the perioperative period

Reduced oxygen delivery

- Reduction in CO due to hypovolaemia or cardiac depression by drugs, e.g. anaesthetic agents
- Decrease in oxygen saturation due to atelectasis, postoperative pneumonia, thromboembolic event
- Further reduction in haemoglobin as a consequence of surgical blood loss or inhibition of erythropoiesis by the altered cytokine milieu
- Increased affinity of haemoglobin for oxygen due to the leftward shift in the ODC by hypothermia

Increased oxygen requirements

- Pain
- Fever
- Shivering
- The stress response

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Causes

- Microcytic anaemia:

  - iron deficiency

  - congenital haemoglobinopathies

  - sideroblastic anaemia

  - Vitamin B6 deficiency

The most common cause in the surgical population is **iron deficiency** *,**

  - medication

*.*World Health Organisation 2014*

**. *Preoperative anaemia Clevenger et al Anaesthesia 2015*

- Normocytic anaemia

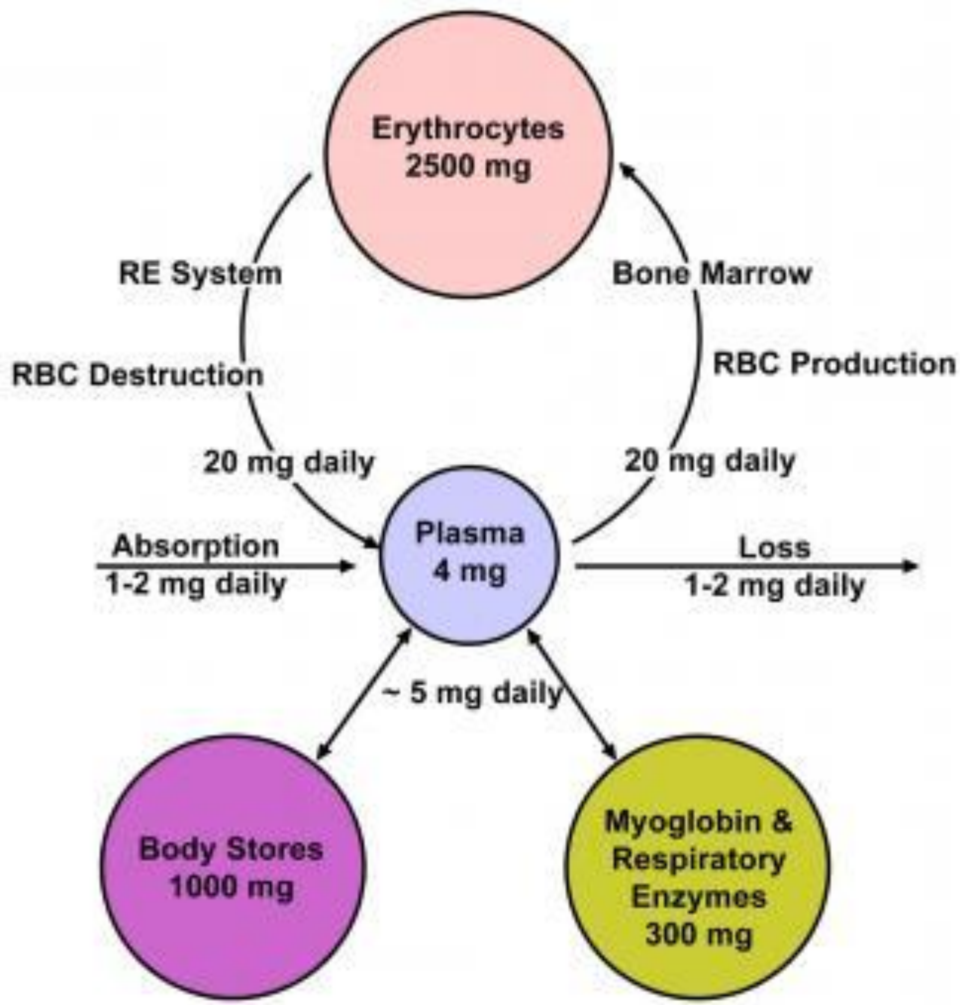
  - chronic disease, aplastic and sickle cell anaemia,

  - haemolysis,

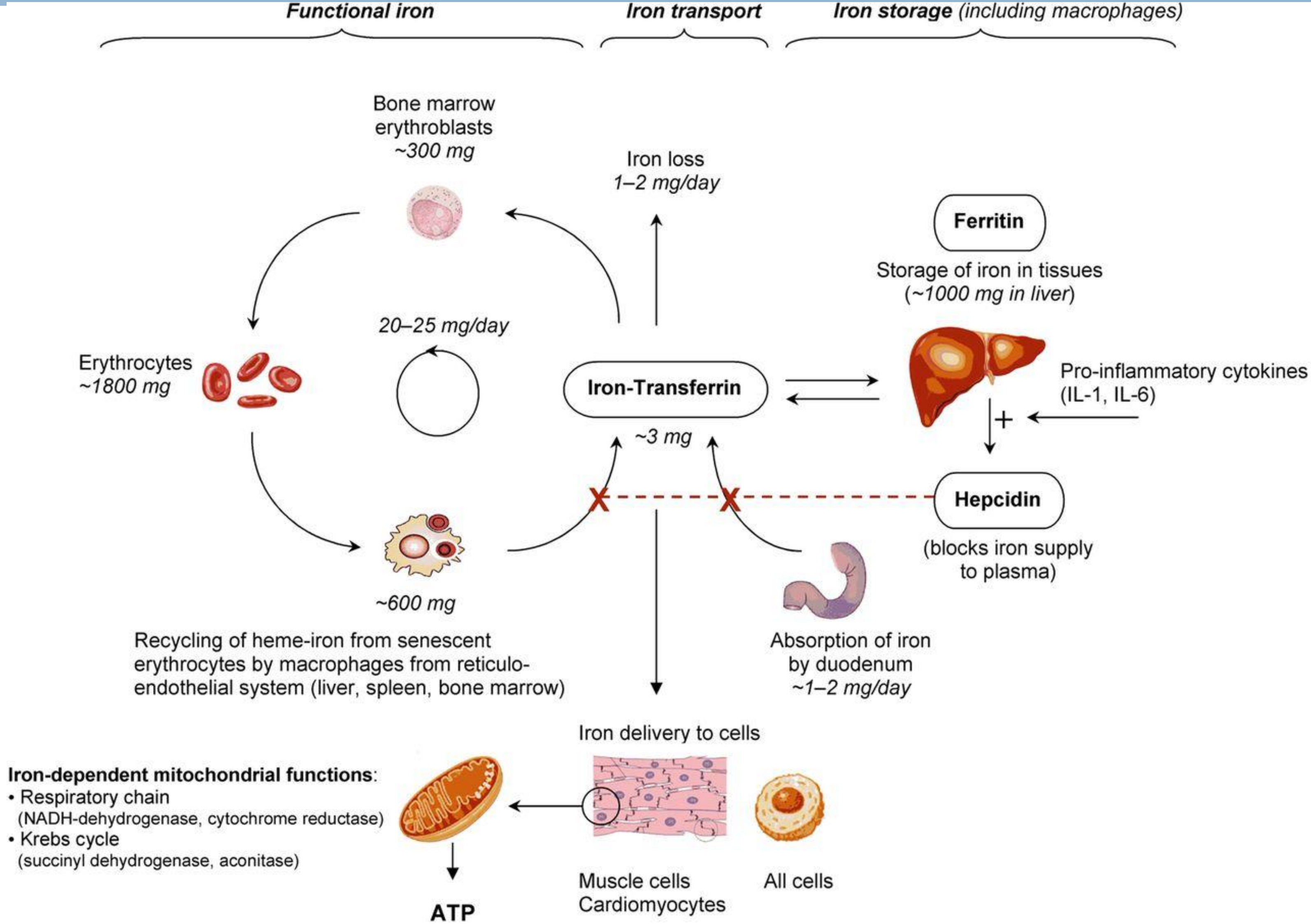
  -pregnancy,

  - riboflavin, and pyridoxine deficiency.

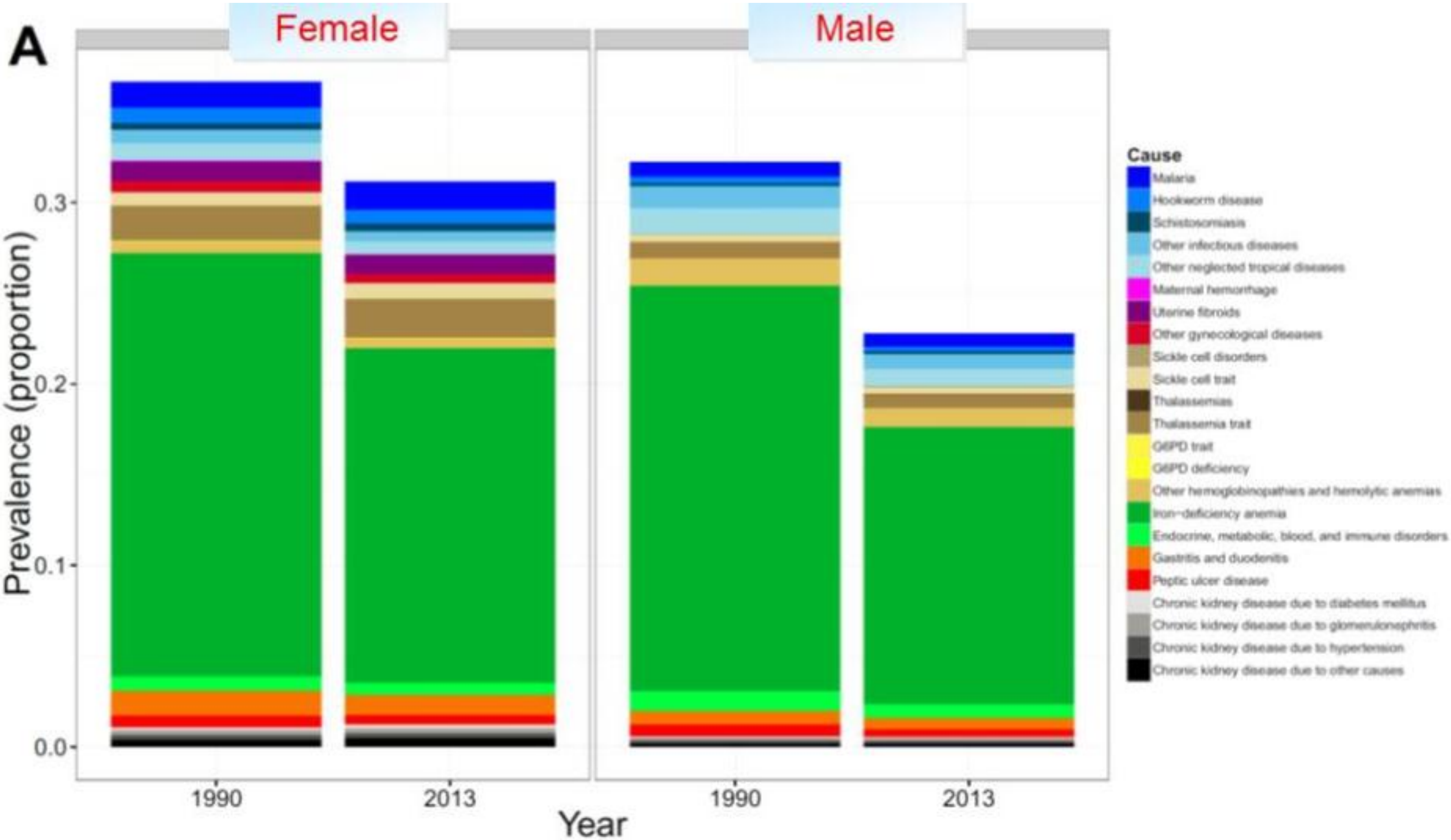
Iron deficiency



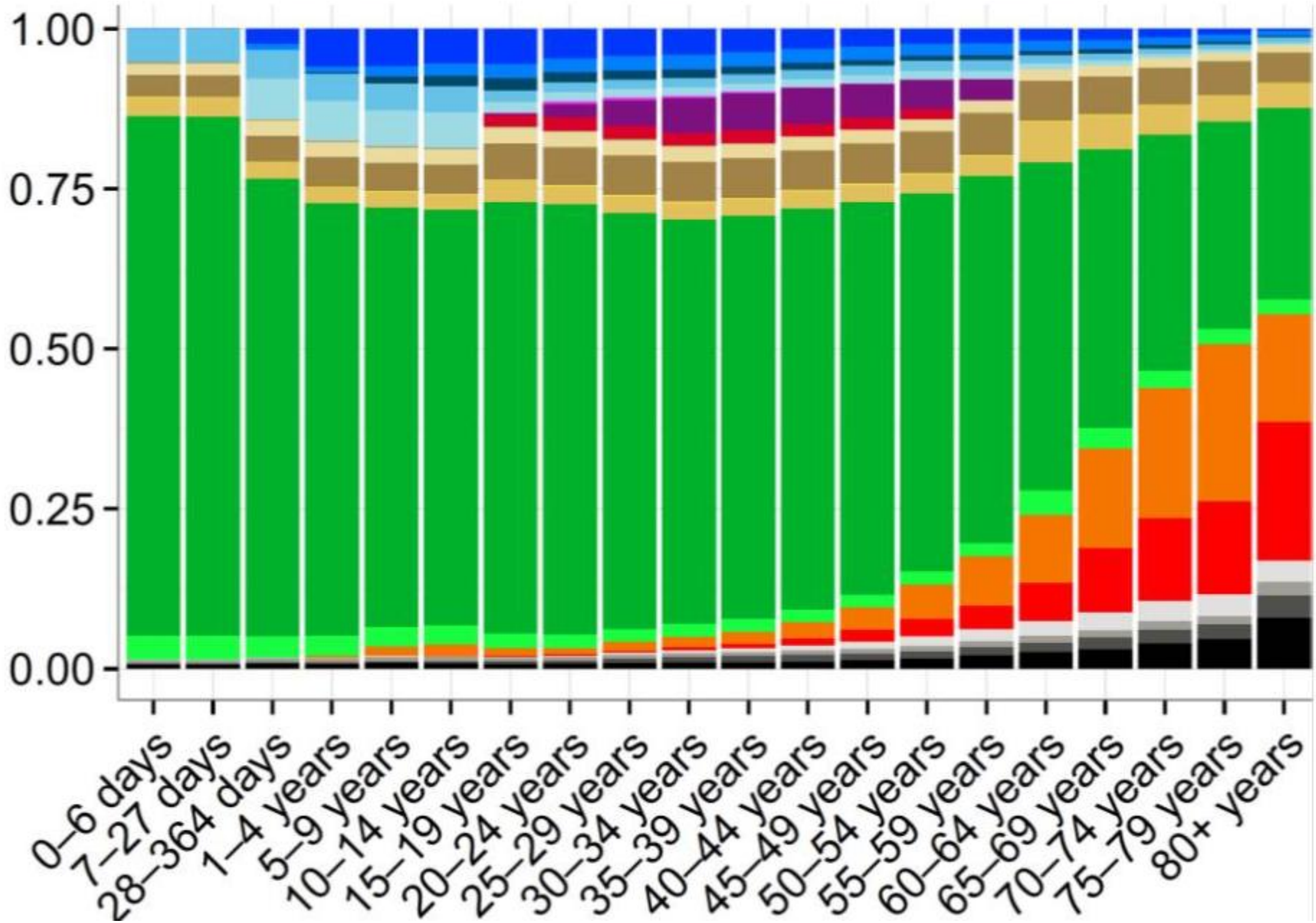
Inflammatory diseases



Causes

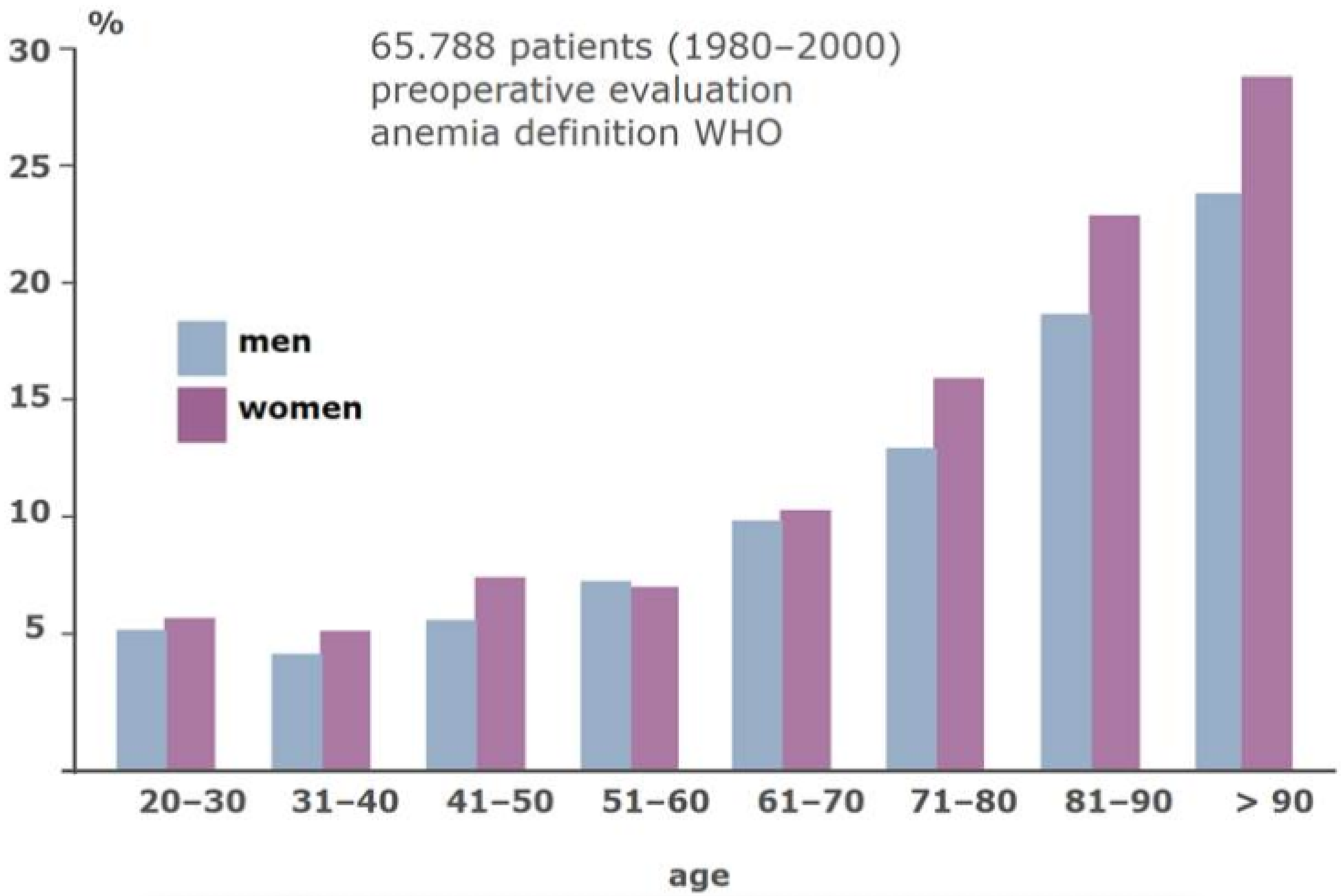


Kassebaum N. J. et al., Hematol Oncol Clin North Am (2016) 30: 247



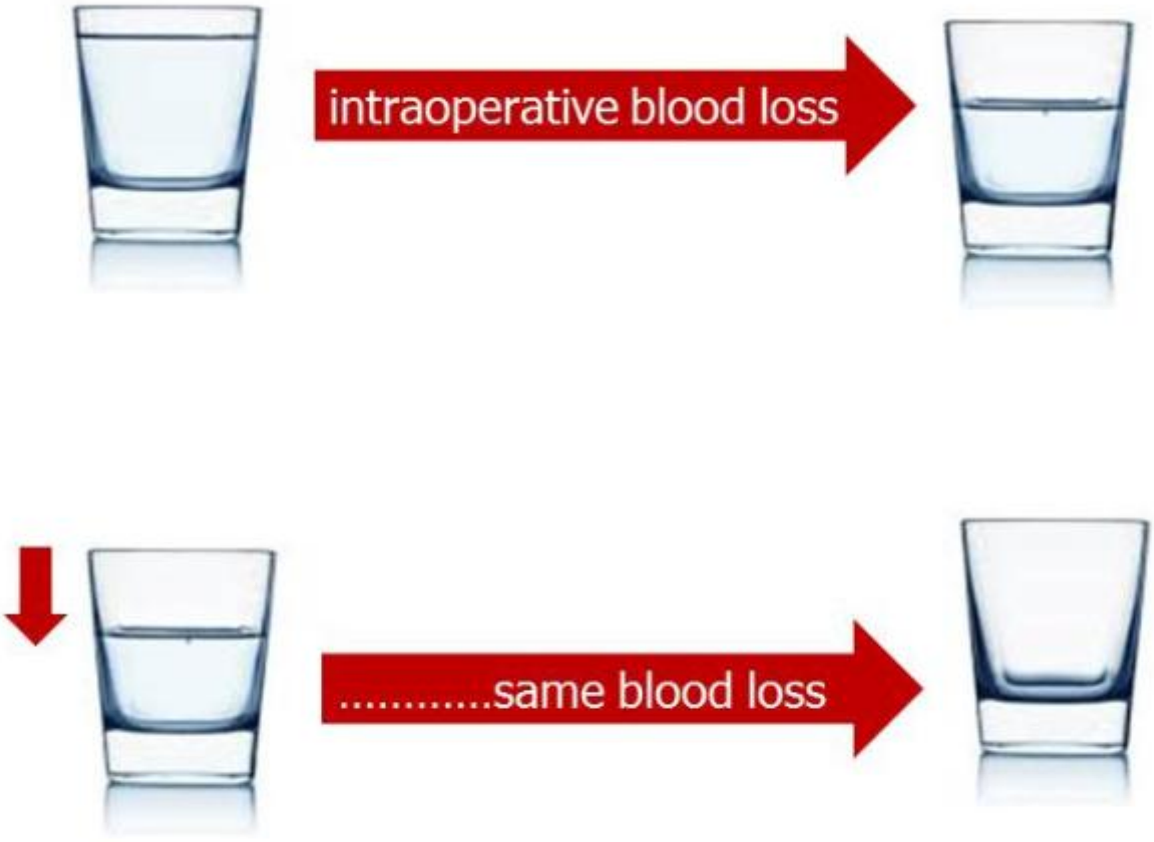
1.00
0.75
0.50
0.25
0.00
0–6 days
7–27 days
28–364 days
1–4 years
5–9 years
10–14 years
15–19 years
20–24 years
25–29 years
30–34 years
35–39 years
40–44 years
45–49 years
50–54 years
55–59 years
60–64 years
65–69 years
70–74 years
75–79 years
80+ years

Age



Kuller, Anësthesist, 2001

Full glass



Clinical approach

EJA

Eur J Anaesthesiol 2017; **34:**332–395

GUIDELINES

Management of severe perioperative bleeding: guidelines from the European Society of Anaesthesiology

First update 2016

Sibylle A. Kozek-Langenecker, Aamer B. Ahmed, Arash Afshari, Pierre Albaladejo, Cesar Aldecoa, Guidrius Barauskas, Edoardo De Robertis, David Faraoni, Daniela C. Filipescu, Dietmar Fries, Thorsten Haas, Matthias Jacob, Marcus D. Lancé, Juan V.L. Pitarch, Susan Mallett, Jens Meier, Zsolt L. Molnar, Niels Rahe-Meyer, Charles M. Samama, Jakob Stensballe, Philippe J.F. Van der Linden, Anne J. Wikkelsø, Patrick Wouters, Piet Wyffels and Kai Zacharowski

Anemia management

monitoring for anaemia throughtout the course of care

correction of underlying causes(s) of anaemia

supporting haematopoiesis (e.g. iron, folic acid, ESAs)

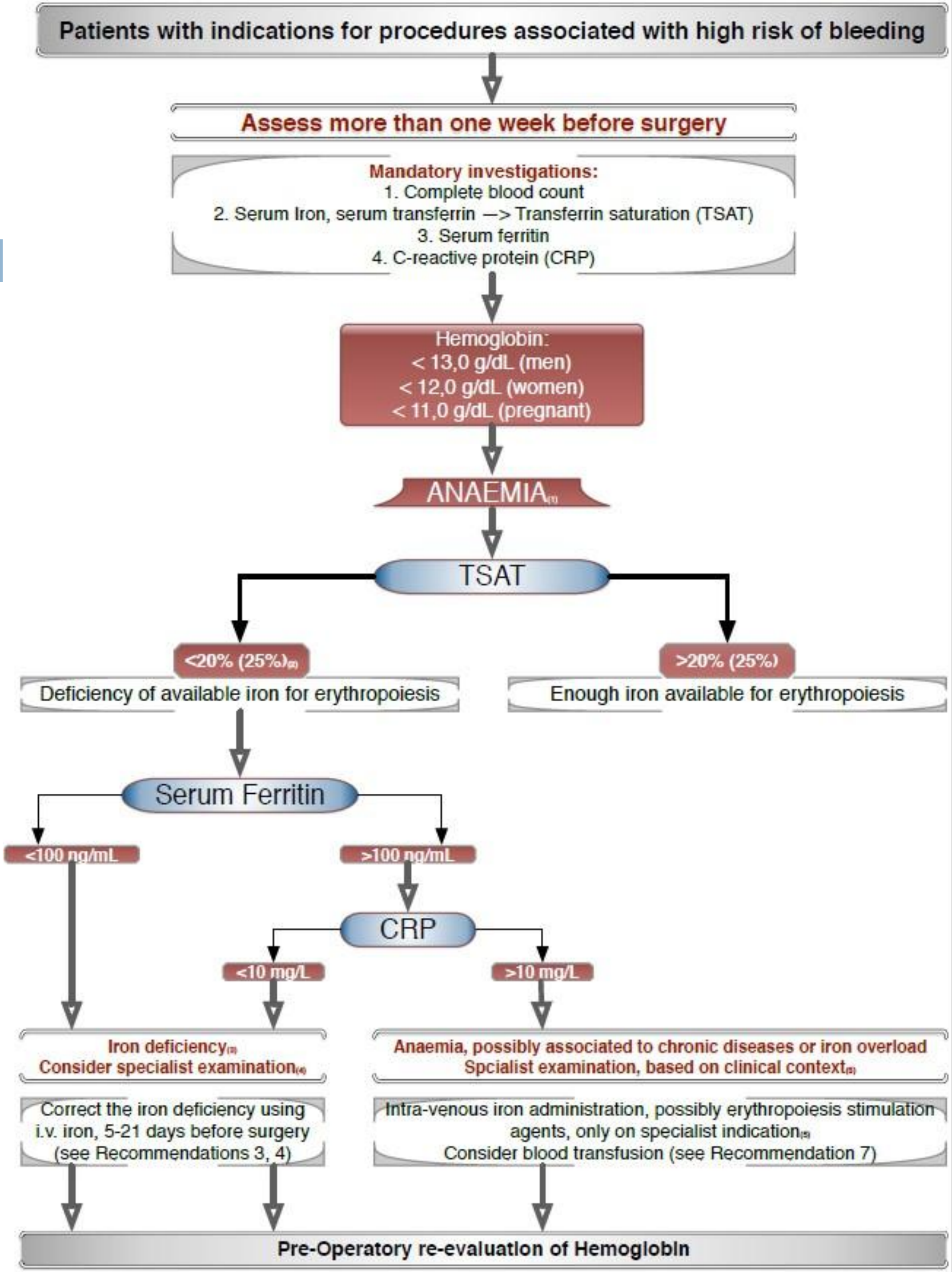
Have a plan

We recommend the application of intervention algorithms incorporating predefined triggers and targets based on .... monitoring to guide individualized ... intervention ....

(1C)

Assessment

- Medical history
- Full blood count



Alternative approach

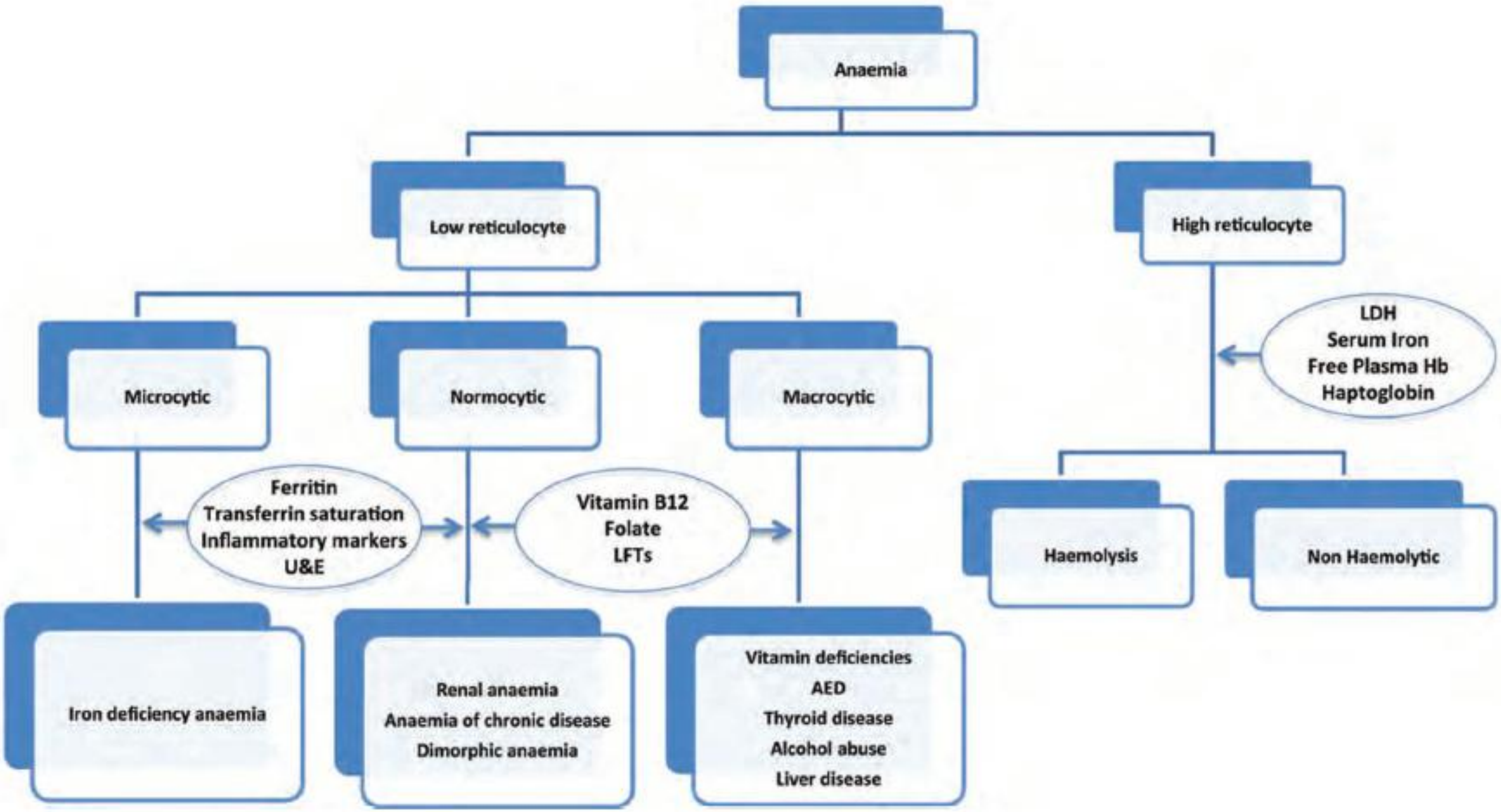


Fig 3 Suggested algorithm for the aetiological diagnosis of preoperative anaemia. U&E, urea and electrolytes; LFTs, liver function tests; LDH, lactate dehydrogenase; AED, anti-epileptic drugs.

Chronic disease vs. Iron deficiency

	Iron deficiency anemia (IDA)	Anemia of chronic disease (ACD)	Anemia of mixed origin (AMO)
Serum ferritin	↓	N or ↑	N
Serum iron	↓	↓	↓
Transferrin	↑	↓ or N	↓
Transferrin saturation	↓	↓	↓
Mean corpuscular volume	↓	↓ or N	↓ or N
Iron-binding capacity	↑	↓	↓ to low N
Serum transferrin receptor	↑	N	↑ or N
Serum transferrin receptor index	High (>2)	Low (<1)	High (>2)
C-reactive protein	N	↑	↑
Erythropoietin	↑	N or slightly ↑	↑ or N
Cytokine levels	N	↑	↑

ESA - guidelines

Preoperative anaemia in adults and children appears to be a strong predictor for perioperative transfusion across various types of conditions and surgeries and may be associated with adverse events.
B

We recommend that patients at risk of bleeding are assessed for anaemia 3 to 8 weeks before surgery.
1C

ESA - guidelines

We recommend that patients at risk of bleeding are assessed for anaemia 3 to 8 weeks before surgery. **1C**

Theusinger OM et al. Blood Transfus 2014; 12:195–203.

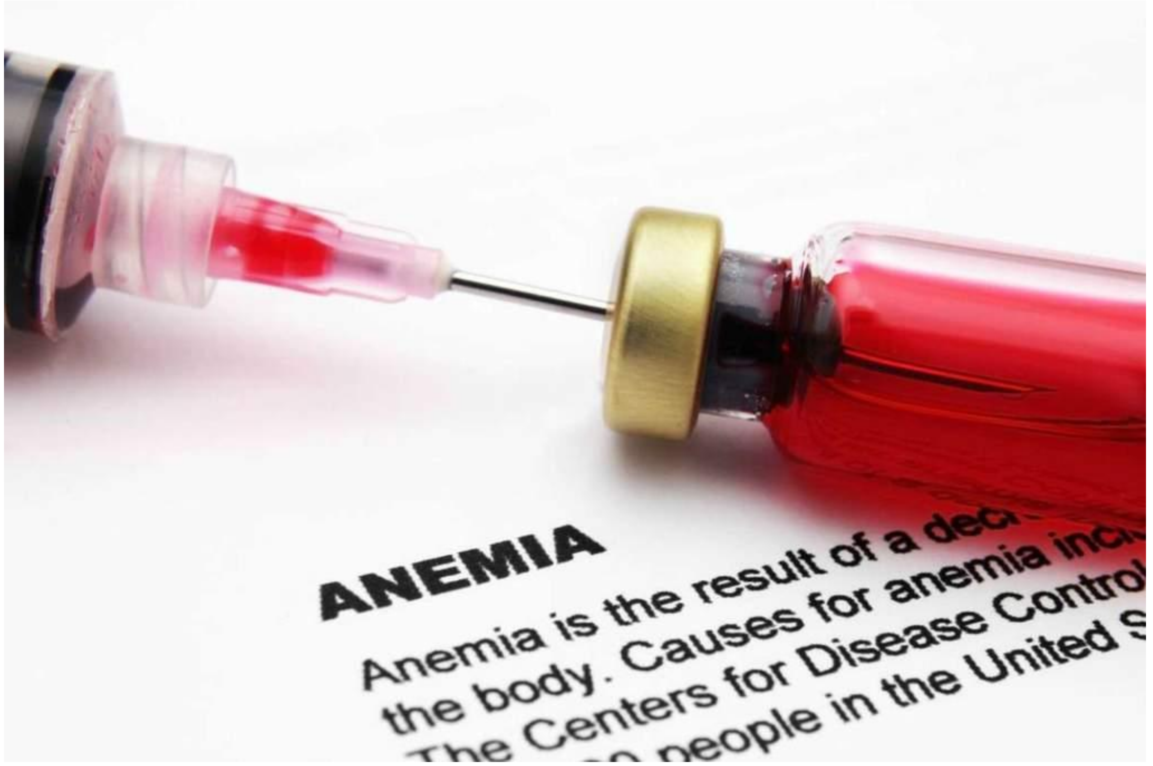
Enko D et al. Anemia 2013; 2013:641876.

Harwin SF et al. Hip Int 2014; 24:69–76.

Qureshi M et al. Transfusion 2012; 52:2063–2064.

ESA - guidelines

If anaemia is present, we recommend identifying the cause (iron deficiency, renal insufficiency or inflammation). 1C



ESA - guidelines

- Treat iron deficiency

We recommend treating iron deficiency with iron supplementation. **1B**

We recommend the use of intravenous iron in preference to oral iron. **1C**

Iron suplementation

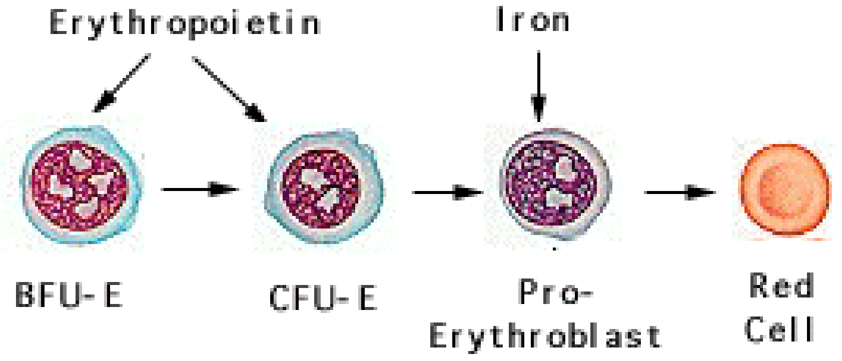
IV: earlier and more robust recovery of Hb

Lin DM, Lin ES, Tran MH.
Efficacy and safety of erythropoietin and intravenous iron in perioperative blood management: a systematic review.
Transfus Med Rev 2013; 27:221–234.

Leahy MF, Roberts H, Mukhtar SA, et al.
A pragmatic approach to embedding patient blood management in a tertiary hospital.
Transfusion 2014; 54:1133–1145.

ESA - guidelines

If other causes of anaemia have been excluded or treated, we suggest erythropoietin-stimulating agents. **2B**



ESA's efficacy

increase in Hb + reduced RBC requirements

Alsaleh K, Alotaibi GS, Almodaimegh HS, et al.
The use of preoperative erythropoiesis-stimulating agents (ESAs) in patients who underwent knee or hip arthroplasty: a meta-analysis of randomized clinical trials.
J Arthroplasty 2013; 28:1463–1472.

Lin DM, Lin ES, Tran MH.
Efficacy and safety of erythropoietin and intravenous iron in perioperative blood management: a systematic review.
Transfus Med Rev 2013; 27:221–234.

ESA's efficacy

effective in knee and hip arthroplasty with preoperative Hb 10-13 g/dl without iron deficiency or after iron supplementation

Doodeman HJ, van Haelst IM, Egberts TC, et al.
The effect of a preoperative erythropoietin protocol as part of a multifaceted blood management program in daily clinical practice (CME).
Transfusion 2013;53:1930–1939.

van Haelst IM, Egberts AC, Doodeman HJ, et al. Occurrence and determinants of poor response to short-term preoperative erythropoietin treatment.
Acta Anaesthesiol Scand 2013; 57:350–357.

ESA-guidelines

If autologous blood donation is performed, we suggest treatment with iron and/or erythropoietin-stimulating agents to avoid preoperative anaemia and increased overall transfusion rates. **2C**

Autologus blood donation

http://www.oegari.at

We recommend preoperative autologous blood donation in procedures involving special groups of patients (**e.g. rare blood types, special antibody constellation**) or at the express **wish of the patient** if there is a high transfusion probability.

ESA guidelines

In patients with preoperative anaemia, we recommend the use of combined therapy with intravenous iron and erythropoietin along with a restrictive transfusion policy. **1C**

Iron + ESA's

effective in knee and hip arthroplasty with preoperative Hb 12 or 13 g/dl:

- ✓ fewer transfusions
- ✓ shorter LOS
- ✓ less readmission

Kotze A, Carter LA, Scally AJ.

Effect of a patient blood management programme on preoperative anaemia, transfusion rate, and outcome after primary hip or knee arthroplasty: a quality improvement cycle.

Br J Anaesth 2012; 108:943–952.

Iron +ESA's + Folate (3-4 weeks)

in anaemic patients
refusing allogeneic transfusions

Harwin SF, Pivec R, Naziri Q, et al.
Is total hip arthroplasty a successful and safe procedure in Jehovah's Witnesses? Mean five-year results.
Hip Int 2014; 24:69–76.

Cladellas M, Farre N, Comin-Colet J, et al.
Effects of preoperative intravenous erythropoietin plus iron on outcome in anemic patients after cardiac valve replacement.
Am J Cardiol 2012; 110:1021–1026.

Iron +ESAs + Folate +B12

modifying the risk of anaemia on RBC transfusions

Theusinger OM, Kind SL, Seifert B, et al.

Patient blood management in orthopaedic surgery: a four-year follow-up of transfusion requirements and blood loss from 2008 to 2011 at the Balgrist University Hospital in Zurich, Switzerland. Blood Transfus 2014; 12:195–203.

ESA guidelines

In non-cancer patients with preoperative anaemia scheduled for elective major surgery, we recommend postponing surgery until anaemia has been corrected. **1C**

ESA guidelines

In patients who are anaemic following surgery, we suggest the use of intravenous iron. **2C**

Post-op Iron

effective in knee and hip arthroplasty,
especially in case of anaemia:

- ✓ fewer transfusions
- ✓ cost neutral

Bisbe E, Molto L, Arroyo R, et al. Randomized trial comparing ferric carboxymaltose vs oral ferrous glycine sulphate for postoperative anaemia after total knee arthroplasty. Br J Anaesth 2014; 113:402–409.

Munoz M, Gomez-Ramirez S, Martin-Montanez E, et al. Cost of postoperative intravenous iron therapy in total lower limb arthroplasty: a retrospective, matched cohort study. Blood Transfus 2014; 12:40–49.

IV iron

dose of isomaltoside [mg iron]=

body weight [kg] x (target – current Hb) [g/dl] x 2.4

+ iron for iron stores [mg iron]

short infusion in 100-250 ml NaCl 0.9% over 30 min (-10 mg/kg)
or 60 min (10-20 mg/kg)

Iron + ESA's+ B12 + Folate

Pragmatic approach „global correction"

1 g isomaltosid IV

+ 40.000 U erythropoietin alpha s.c.

+ 1 mg/day vitamin B12 p.o.

+ 5 mg/day folate p.o.

ESA guidelines

We recommend a target haemoglobin concentration of 7 to 9 g dl^{-1} during active bleeding. **1C**

Post-op transfusion trigger

Tab.: Vereinfachter Algorithmus zur Indikationsstellung einer Erythrozytenkonzentrat-(EK-)Transfusion postoperativ auf der Normalstation.		
Hb level (g/dl)	Clinical criteria: • ability to compensate anaemia? signs of hypoxia? • risk factors: comorbidity? • relevant postOP bleeding?	Decision for pRBC transfusion
< 6		yes (1-2 pRBCs)
6 - 8	compensation adequate no risk factors no relevant postOP bleeding	no
	compensation recuded e.g. ST-segment dynamics, tachycardia > 80 bpm, hypotension, lactate acidosis risk factors present: e.g.. CHD, cardiac failure, stroke, renal dysfunction	yes
8 - 10	compensation adequate	no
	compensation reduced: e.g. ST-segment dynamics, tachycardia > 80 bpm, hypotension, lactate acidosis	yes
> 10		no

Post-op anemia

To be consider

- haemolysis due to, e.g. hypotonic solutions , sepsis, incompatible transfusion
- clinically apparent or occult blood loss from or into the gastro-intestinal tract
- inappropriately low erythropoietin synthesis and secretion due to stress-related inflammation
- diminished responsiveness of erythroid precursor cell to erythropoietin due to inflammation and/or decreased availability of iron (iron sequestration)
- nutritional deficiencies (e.g., vitamin B_{12}, folic acid) and pharmacological interactions
- haemodilution due to (excessive) fluid administration

Post-op

volume monitoring

Restrictive vs. Liberal

The NEW ENGLAND JOURNAL of MEDICINE

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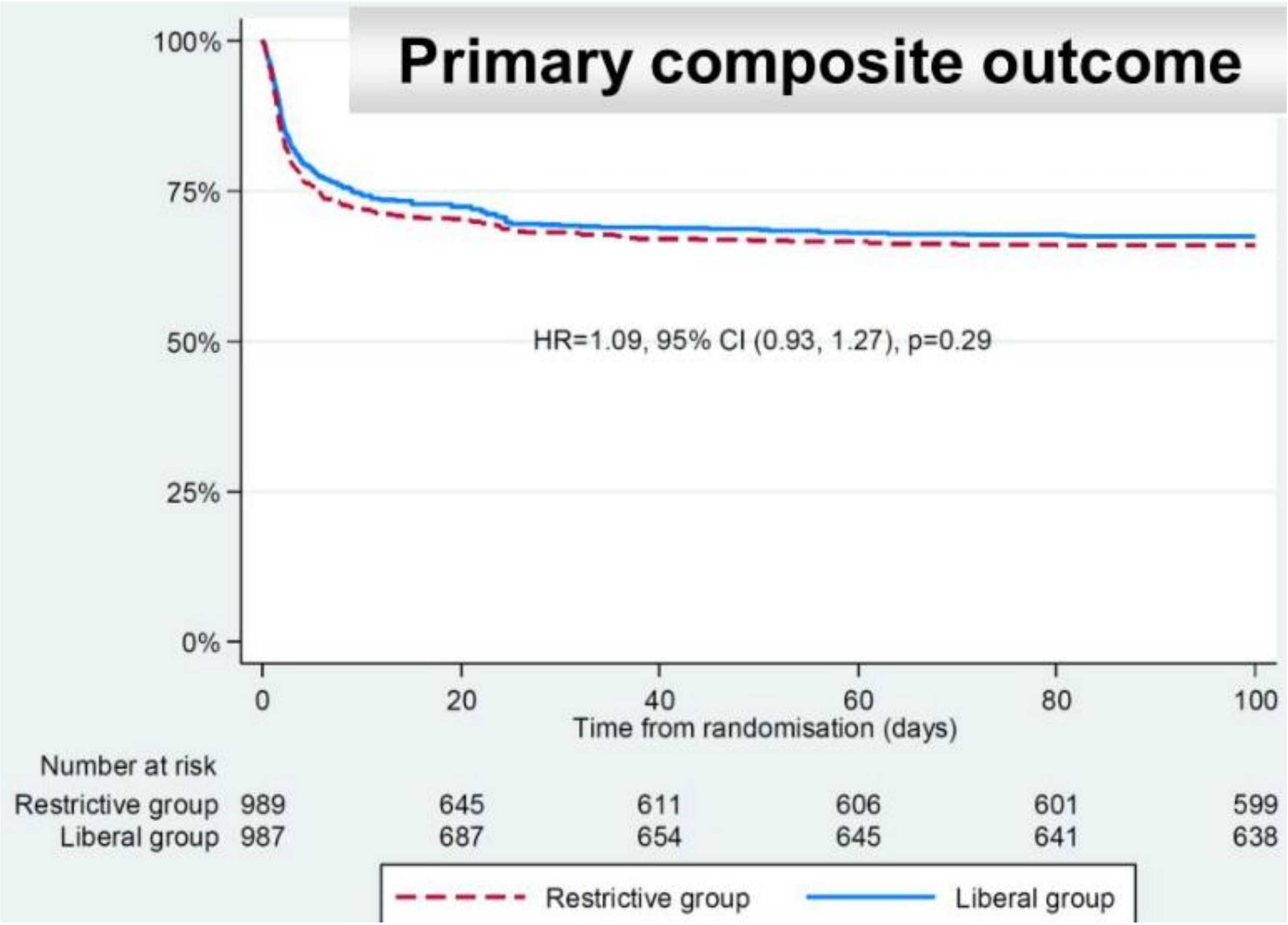
Liberal or Restrictive Transfusion after Cardiac Surgery

Gavin J. Murphy, F.R.C.S., Katie Pike, M.Sc., Chris A. Rogers, Ph.D., Sarah Wordsworth, Ph.D., Elizabeth A. Stokes, M.Sc., Gianni D. Angelini, F.R.C.S., and Barnaby C. Reeves, D.Phil., for the TITRe2 Investigators*

- PRT in 2007 patients undergoing cardiac surgery and having a postop. Hb < 9.0 g/dL
- Hb transfusion trigger: 7.5 g/dL vs. 9.0 g/dL
- Primary outcome = 3 months composite of
  - ⇨ Serious infection / Ischemic event
  - ⇨ Myocardial infarction / AKI
  - ⇨ Infarction of the gut

Murphy G. J. et al. New Engl J Med (2015) 372: 997

Restrictive vs. Liberal



Restrictive vs. Liberal

ORIGINAL ARTICLE

Restrictive or Liberal Red-Cell Transfusion for Cardiac Surgery

- PRT in 5243 patients undergoing cardiac surgery on CPB having a EuroSCORE ≥ 6
- Hb transfusion trigger: <7.5 g/dL vs. <9.5 g/dL OR / ICU and <8.5 g/dL on the regular ward
- Primary outcome = 28 days composite of Death / MI / Stroke / new renal failure with dialysis
- Secondary outcomes
  - ⇨ RBC transfusions
  - ⇨ Clinical outcomes

This article was published on November 12, 2017, at NEJM.org.

Mazer C. D. et al. New Engl J Med (2017) epub

Restrictive vs. Liberal

Table 3. Primary and Secondary Outcomes in the Per-Protocol Population.

Characteristic	Restrictive Threshold (N=2430)	Liberal Threshold (N=2430)	Odds Ratio or Hazard Ratio (95% CI)
Primary outcome			
Composite-outcome event — no./total no. (%)	276/2428 (11.4)	303/2429 (12.5)	0.90 (0.76–1.07)
Death — no./total no. (%)	74/2427 (3.0)	87/2429 (3.6)	0.85 (0.62–1.16)
Stroke — no./total no. (%)	45/2428 (1.9)	49/2429 (2.0)	0.92 (0.61–1.38)
Myocardial infarction — no./total no. (%)	144/2428 (5.9)	144/2429 (5.9)	1.00 (0.79–1.27)
New-onset renal failure with dialysis — no./total no. (%)	61/2428 (2.5)	72/2429 (3.0)	0.84 (0.60–1.19)

Table 2. Transfusion Outcomes in the Per-Protocol Population.

Characteristic	Restrictive Threshold (N=2430)	Liberal Threshold (N=2430)	Odds Ratio or Rate Ratio (95% CI)
Red-cell transfusions after randomization			
≥1 Unit of red cells — no. (%)	1271 (52.3)	1765 (72.6)	0.41 (0.37–0.47)
No. of units of red cells transfused			
Median	2	3	0.85 (0.82–0.88)*

Mazer C. D. et al. New Engl J Med (2017) epub

Restrictive vs. Liberal

EDITORIAL

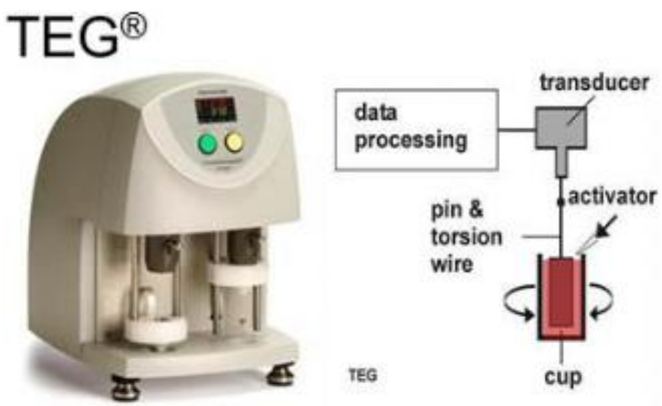
Transfusion Threshold of 7 g per Deciliter — The New Normal

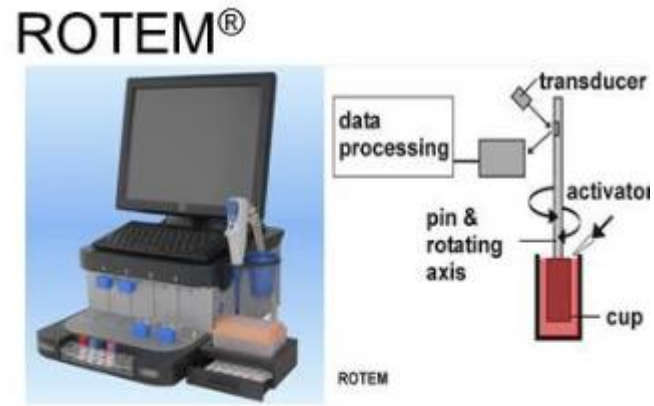
Paul C. Hébert, M.D., and Jeffrey L. Carson, M.D.

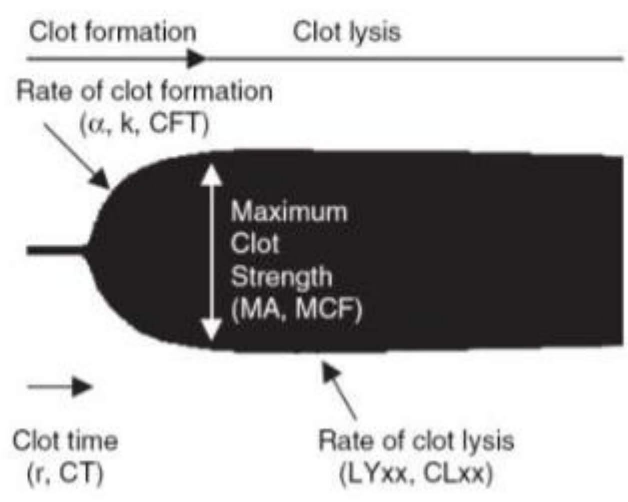
We believe it has become abundantly clear that a transfusion threshold of 7 g per deciliter should become the new normal, recommended in all critically ill patients, including those with severe sepsis and septic shock. To speed up adoption, we should ensure that clinical practice

Hébert P. C. et al. New Engl J Med (2014) 371: 1459

Point of care testing

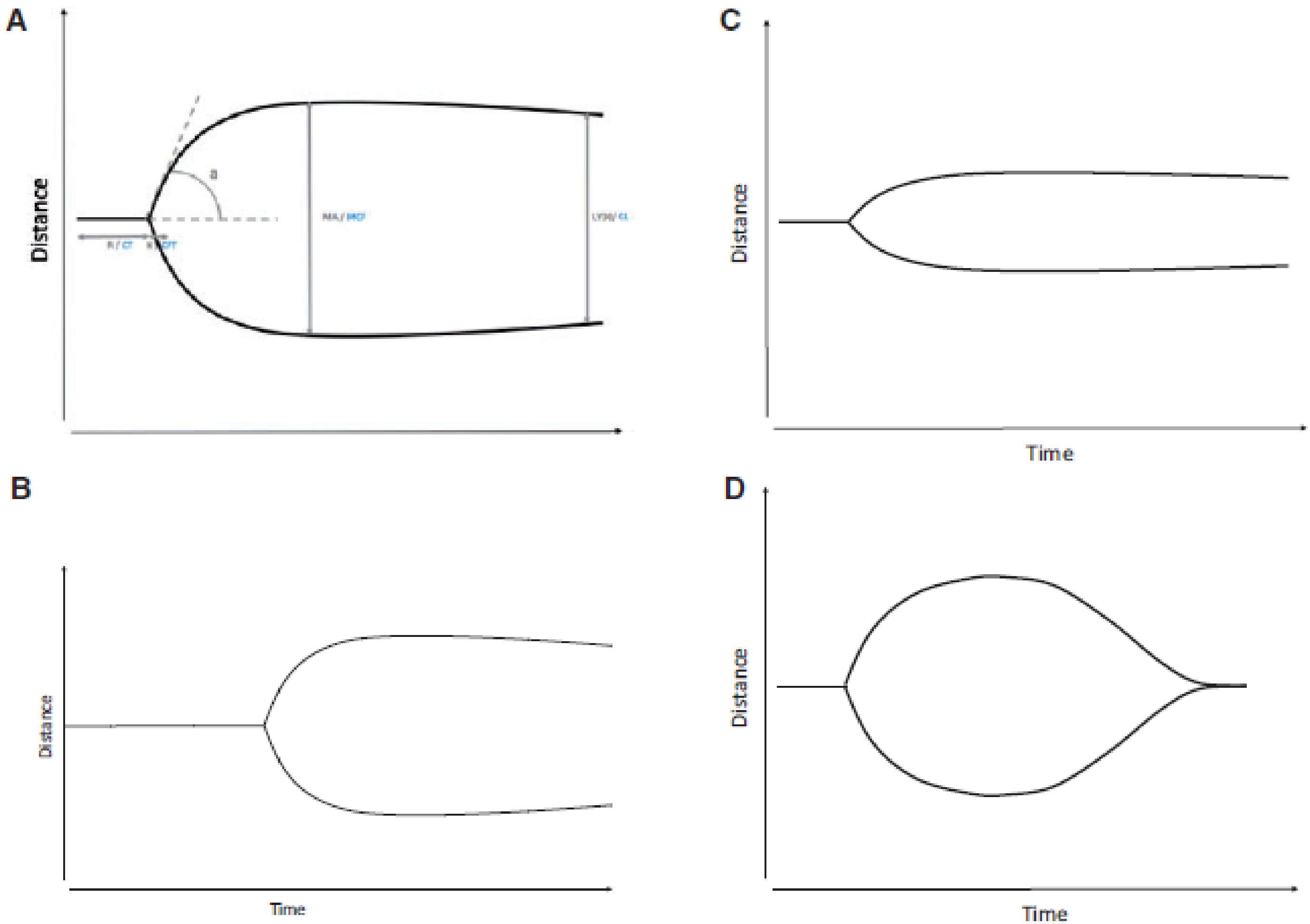






Ganter M.T. et al., Anesth Analg (2008) 106: 1366

Point of care testing



Rotem analysisi

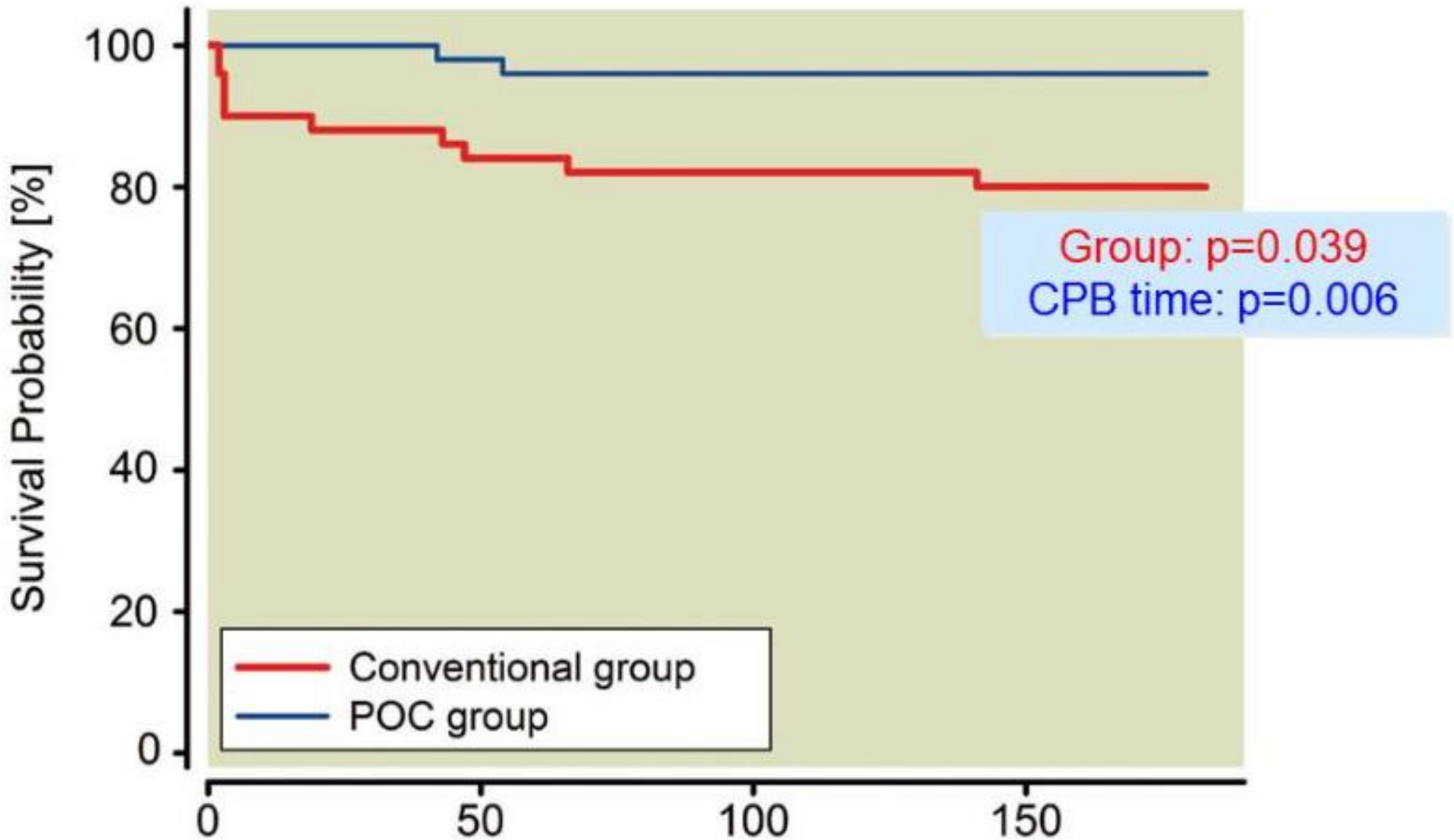
	CT (s)	CFT (s)	Amplitudinea după CT (mm)		MCF* (mm)	Indicele de liză a trombului (%)	
			10 min. A10	20 min. A20		30 min CLI30	60 min CLI60
INTEM	100-240	30-110	44-66	50-71	50-72	94-100	85-100
EXTEM	38-79	34-159	43-65	50-71	50-72	94-1000	85-100
HEPTEM	100-240**	30-110			50-72		
FIBTEM			7-23	8-24	9-25***		
APTEM	38-79	34-159			50-72		

Conventional test vs. Rotem

	Conventional	ROTEM®	p value
RBC % transfused (%)	98	84	0.031
RBC units / patient	5	3	0.001
FFP % transfused (%)	80	40	0.001
FFP units / patient	5	0	0.001
PC % transfused (%)	66	56	0.412
PC units / patient	2	2	0.010
Fibrinogen % administered (%)	60	64	0.837
Fibrinogen units / patient	2	2	0.481
PCC % administered (%)	52	44	0.433
rFVIIa % administered (%)	24	2	0.002
Cost of hemotherapy (Euro)	3109	1658	0.001

Weber C. F. et al. Anesthesiology (2012) 117: 531

Conventional test vs. Rotem



Weber C. F. et al. Anesthesiology (2012) 117: 531

Active bleeding

Stop bleeding

↓

Perfusion

Stop hemorrhage

- Keep patient alive

  - permissive hypotension

  - limit fluid infusion (dilution)

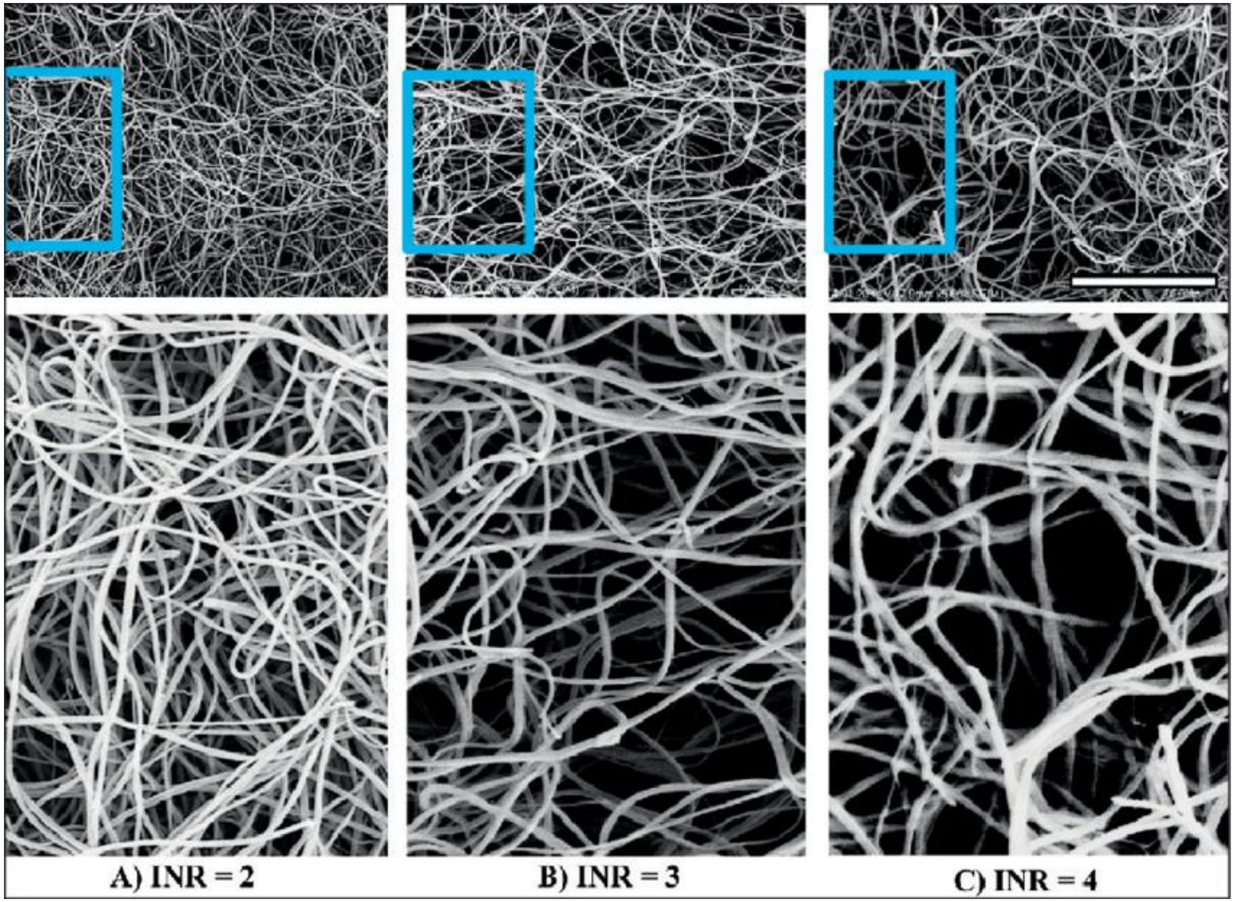
- Stop hemorrhage

  - early surgery, damage control

- Maintain coagulation competence

  - target coagulopathy

Disease coagulopathy ?



FIBRINOLYSIS

Disease coagulopathy

- Antifibrinolitic: TxA
- 1.0 gr. i.v. over 10 min.
- if necessary after 30 min 1.0 gr. i.v./10 min
- first 3 hours

- Co-factors: Ca^{++}, Ph, Temperature control

Take home messages

- Anaemia and allogenic blood transfusion are independent risk factors for poor postoperative outcomes: morbidity and mortality.
- One-third of patients are found to be anaemic on pre-assessment.
- PBM is a concept with the goal of avoiding unnecessary blood transfusions to improve patient outcomes and safety.
- Iron deficiency requires iron supplementation.