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# PATIENT BLOOD MANAGEMENT: WHAT, WHY AND HOW

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**Commitment to Excellence: Blood Matters 2018**

**November 16, 2018 Halifax, NS**

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# Outline

- What is patient blood management (PBM)
- Why patient blood management?
- When and where should it be implemented?

# What is Patient Blood Management (PBM)?

## Society for the Advancement of Blood Management (SABM)

- Timely application of evidence-based medical and surgical concepts designed to maintain hemoglobin concentration, optimize hemostasis and minimize blood loss in an effort to improve patient outcome

SOCIETY FOR THE ADVANCEMENT OF BLOOD MANAGEMENT®

## World Health Organization (WHO)

- Patient-focused, evidence-based and systematic approach to optimize the management of patient and transfusion of blood products for quality and effective patient care
- Designed to improve patient outcomes through the safe and rational use of blood and blood products and by minimizing unnecessary exposure to blood products

World Health Organization

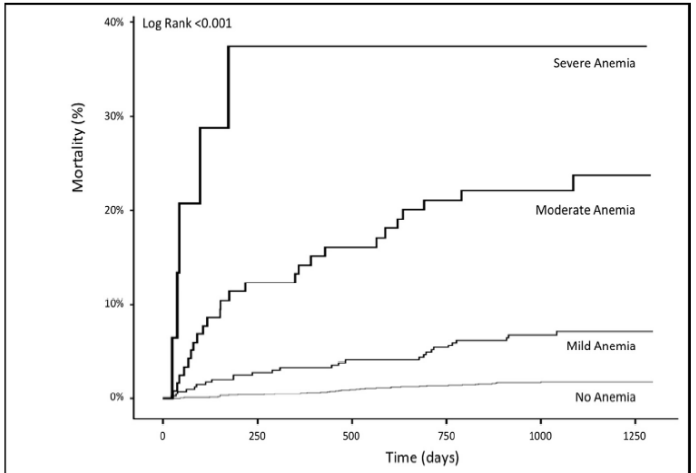
# Rationale for PBM in Perioperative Setting

- Perioperative anemia is common
  - 11-76% of preoperative patients and up to 90% of postoperative patients are anemic
- Perioperative anemia is bad
  - associated with adverse outcomes including mortality, AKI and infection
- Perioperative anemia leads to allogeneic RBC transfusion
- Perioperative allogeneic RBC transfusion is associated with adverse outcomes including mortality

Beris 2008; Carson 1996; Meybohm & Zacharowski 2011; Freedman et al 2008; Bernard et al 2009; Fowler et al 2015

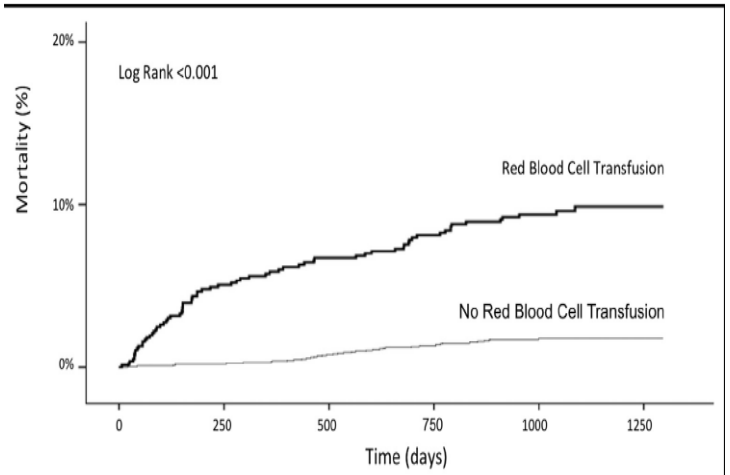
# Even Mild Pre-operative Anemia is Bad

- Association Between Anemia, Bleeding and Transfusion with Long-term Mortality Following Non-cardiac Surgery
  - 3050 patients undergoing Ortho Sx: 17.6% anemic, 1% had bleeding, 25% got at least 1 RBC




| | | | | | | |
|---|---|---|---|---|---|---|
| At Risk: | 2722 | 2683 | 2662 | 2643 | 2070 | 284 |
| No Anemia: | 2185 | 2176 | 2164 | 2155 | 1678 | 226 |
| Mild Anemia: | 400 | 389 | 384 | 379 | 302 | 35 |
| Moderate Anemia: | 121 | 107 | 103 | 98 | 83 | 22 |
| Severe Anemia: | 16 | 11 | 11 | 11 | 7 | 1 |

**Figure 1** Preoperative anemia and long-term mortality following surgery.




| | | | | | | |
|---|---|---|---|---|---|---|
| At Risk: | 3050 | 3007 | 2982 | 2960 | 2319 | 306 |
| RBCT: | 766 | 728 | 716 | 706 | 542 | 68 |
| No RBCT: | 2284 | 2279 | 2266 | 2254 | 1777 | 238 |

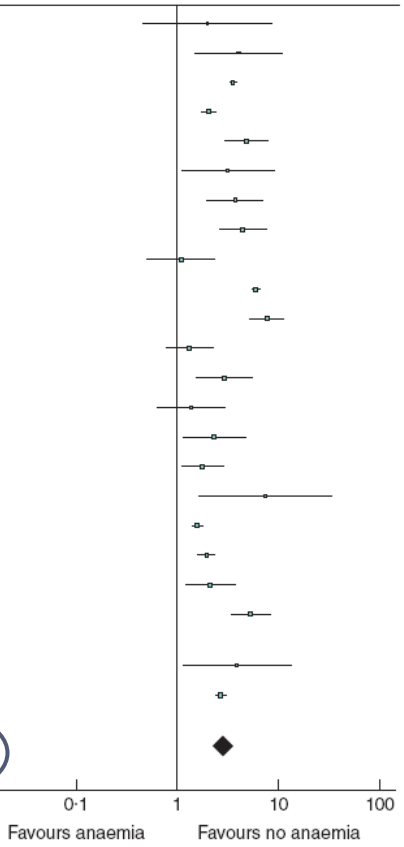
**Figure 2** Red blood cell transfusion (RBCT) and long-term mortality following surgery.

Smilowitz et al 2016

# Pre-op Anemia Associated with Worse Perioperative Mortality

| 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) |

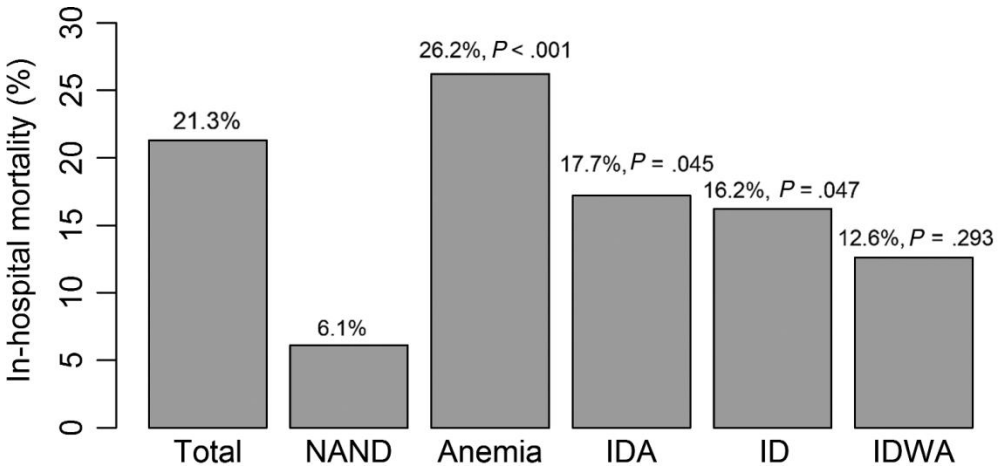
Heterogeneity: $\tau^2 = 0{\cdot}24$; $\chi^2 = 768{\cdot}79$, 22 d.f., $P < 0{\cdot}001$; $I^2 = 97\%$
Test for overall effect: $Z = 8{\cdot}88$, $P < 0{\cdot}001$




- 24 studies
- 949,445 patients
- 371,594 patients (39%) were anemic

Fowler et al 2015

# Prevalence and Prognostic Impact of Anemia and Iron Deficiency in Patients Hospitalized in an Internal Medicine Ward: The PRO-IRON study



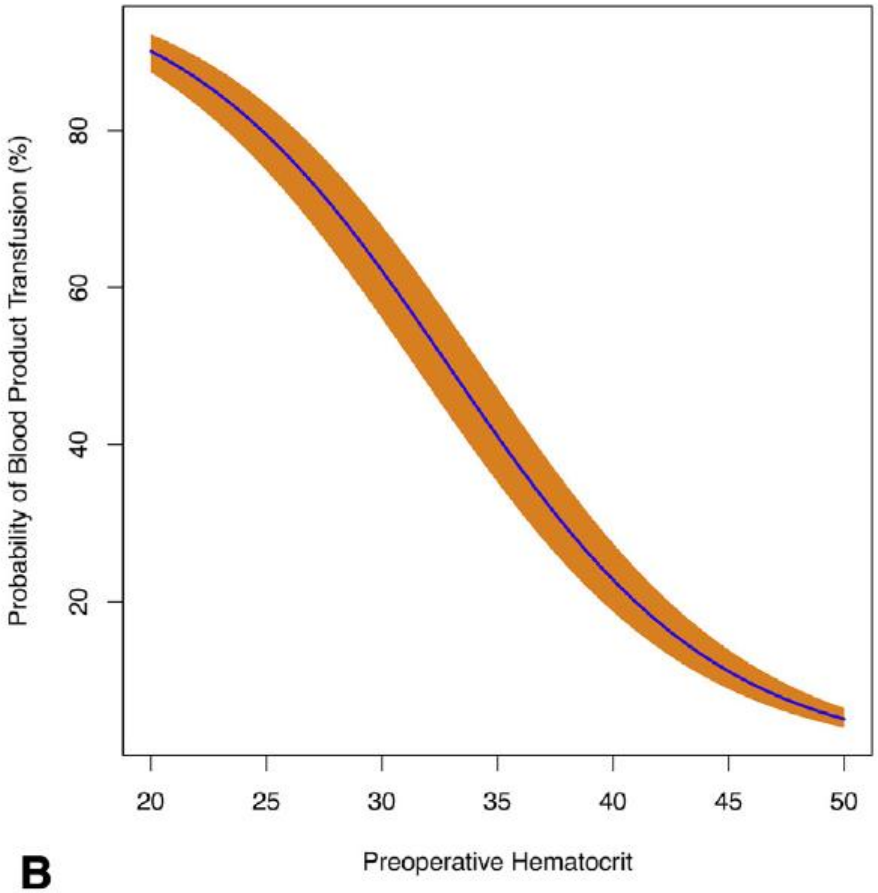

- 1-year prospective study, 771 admitted GIM patients in Portugal

- Prevalence of
- anemia 67%
- iron deficiency anemia 41%
- iron deficiency 58%
- iron deficiency without anemia 18%

Anemia and iron deficiency are highly prevalent and negatively impact in-hospital mortality

**Fonseca et al 2017**

# Perioperative Anemia Leads to Allogeneic RBC Transfusion

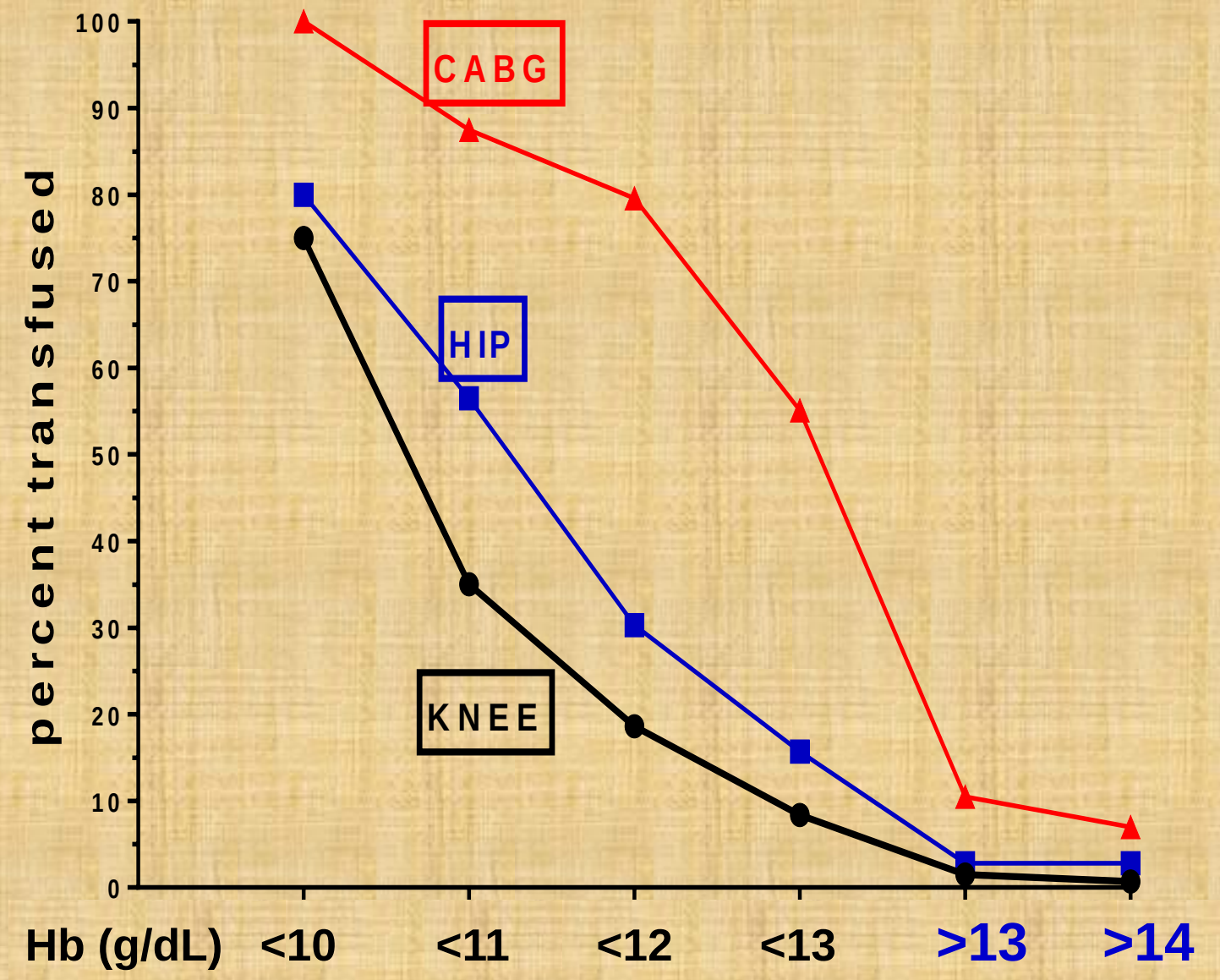



33,411 patients undergoing primary, isolated CABG between January 2007 and December 2017 at 19 cardiac surgery centers in U.S.

LaPar et al 2018

2014

# Effect of preoperative Hb level on transfusion rate




ONTraC
ontario transfusion coordinators

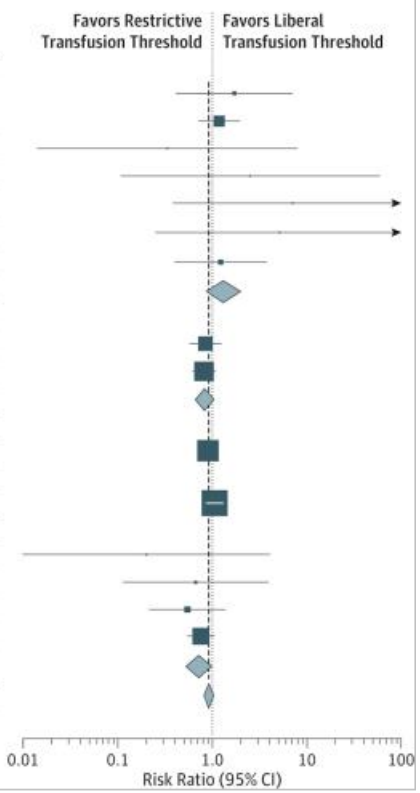
# Perioperative RBC Transfusion Associated with Stroke/MI

- Retrospective cohort study of hospital administrative data
- 1,583,819 adults in 346 U.S. hospitals
  - who underwent non-cardiac, non-intracranial, non-vascular surgery and who required a stay of at least one night in hospital
- 41,421 (2.6%) patients received at least one unit of RBC within 48 hours of surgery
- 8,044 (0.51%) experienced the composite outcome of stroke/myocardial infarction
- Hierarchical logistic regression adjusted for comorbidities and demographics with random effects by hospital: transfusion of as little as one unit was associated with an OR 2.33 (95% CI 1.90 to 2.86) for perioperative stroke/myocardial infarction

Whitlock et al 2015

# Increased Infection in Liberal vs. Restrictive Transfusion RCTs

| Source | Restrictive Transfusion Threshold: No. of Events | Restrictive Transfusion Threshold: Total No. of Patients | Liberal Transfusion Threshold: No. of Events | Liberal Transfusion Threshold: Total No. of Patients | Risk Ratio (95% CI) |
|---|---|---|---|---|---|
| **Cardiac** | | | | | |
| Bracey et al,[20] 1999 | 5 | 212 | 3 | 216 | 1.70 (0.41-7.02) |
| Hajjar et al,[21] 2010 | 29 | 249 | 25 | 253 | 1.18 (0.71-1.95) |
| Cholette et al,[22] 2011 | 0 | 31 | 1 | 31 | 0.33 (0.01-7.88) |
| Cooper et al,[23] 2011 | 1 | 23 | 0 | 19 | 2.50 (0.11-58.06) |
| Shehata et al,[24] 2012 | 3 | 25 | 0 | 25 | 7.00 (0.38-128.87) |
| Carson et al,[10] 2013 | 2 | 54 | 0 | 55 | 5.09 (0.25-103.64) |
| de Gast-Bakker et al,[25] 2013 | 6 | 53 | 5 | 54 | 1.22 (0.40-3.76) |
| Subtotal $I^2 = 0.0\%$, ($P = .78$) | | | | | 1.30 (0.85-1.97) |
| **Critical care** | | | | | |
| Hébert et al,[26] 1999 | 42 | 418 | 50 | 420 | 0.84 (0.57-1.24) |
| LaCroix et al,[27] 2007 | 65 | 320 | 79 | 317 | 0.82 (0.61-1.09) |
| Subtotal $I^2 = 0.0\%$, ($P = .89$) | | | | | 0.83 (0.65-1.04) |
| **Gastrointestinal** | | | | | |
| Villanueva et al,[11] 2013 | 84 | 444 | 94 | 445 | 0.90 (0.69-1.17) |
| **Low birthweight** | | | | | |
| Kirpalani et al,[28] 2006 | 96 | 223 | 93 | 228 | 1.06 (0.85-1.31) |
| **Orthopedic** | | | | | |
| Carson et al,[29] 1998 | 0 | 42 | 2 | 42 | 0.20 (0.01-4.04) |
| Grover et al,[30] 2006 | 2 | 109 | 3 | 109 | 0.67 (0.11-3.91) |
| Foss et al,[31] 2009 | 6 | 60 | 11 | 60 | 0.55 (0.22-1.38) |
| Carson et al,[33] 2011 | 56 | 1009 | 74 | 1007 | 0.76 (0.54-1.06) |
| Subtotal $I^2 = 0.0\%$, ($P = .77$) | | | | | 0.72 (0.53-0.97) |
| **Overall** $I^2 = 0.0\%$, ($P = .62$) | | | | | 0.92 (0.81-1.03), $P = .16$ |




Forest Plot of Risk Ratios for Infection Comparing Restrictive vs Liberal Transfusion Strategies by Patient Type

Rohde et al 2014

18 trials (7593 patients)

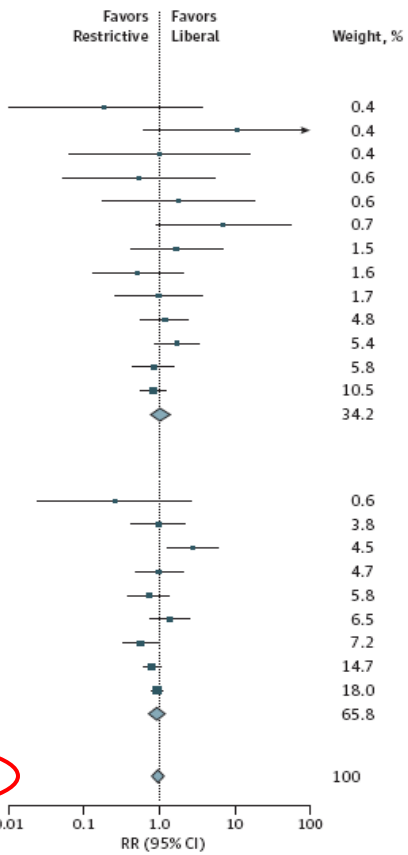
Among **hospitalized patients**, a restrictive RBC transfusion strategy was associated with a reduced risk of health care-associated infection vs. a liberal transfusion strategy.

Implementing restrictive strategies may have the potential to lower the incidence of health care-associated infection

# 30 day Mortality in Restrictive vs. Liberal Transfusion RCTs

Figure 1. Comparison of 30-Day Mortality Using Restrictive vs Liberal Hemoglobin Transfusion Thresholds in Randomized Clinical Trials

| Source | Restrictive Transfusion Threshold: No. of Deaths | Restrictive Transfusion Threshold: Total No. | Liberal Transfusion Threshold: No. of Deaths | Liberal Transfusion Threshold: Total No. | RR (95% CI) | Weight, % |
|---|---|---|---|---|---|---|
| Restrictive threshold, hemoglobin <8 to 9 g/dL | | | | | | |
| Lotke et al,[75] 1999 | 0 | 62 | 0 | 65 | Not estimable | |
| Blair et al,[53] 1986 | 0 | 26 | 2 | 24 | 0.19 (0.01-3.67) | 0.4 |
| Foss et al,[63] 2009 | 5 | 60 | 0 | 60 | 11.00 (0.62-194.63) | 0.4 |
| Carson et al,[58] 1998 | 1 | 42 | 1 | 42 | 1.00 (0.06-15.47) | 0.4 |
| Webert et al,[86] 2008 | 1 | 29 | 2 | 31 | 0.53 (0.05-5.58) | 0.6 |
| Cooper et al,[61] 2011 | 2 | 23 | 1 | 21 | 1.83 (0.18-18.70) | 0.6 |
| Carson et al,[56] 2013 | 7 | 55 | 1 | 55 | 7.00 (0.89-55.01) | 0.7 |
| Parker,[78] 2013 | 5 | 100 | 3 | 100 | 1.67 (0.41-6.79) | 1.5 |
| Bracey et al,[54] 1999 | 3 | 215 | 6 | 222 | 0.52 (0.13-2.04) | 1.6 |
| Bush et al,[55] 1997 | 4 | 50 | 4 | 49 | 0.98 (0.26-3.70) | 1.7 |
| Hajjar et al,[68] 2010 | 15 | 249 | 13 | 253 | 1.17 (0.57-2.41) | 4.8 |
| Gregersen et al,[64] 2015 | 21 | 144 | 12 | 140 | 1.70 (0.87-3.32) | 5.4 |
| Jairath et al,[72] 2015 | 14 | 257 | 25 | 382 | 0.83 (0.44-1.57) | 5.8 |
| Carson et al,[60] 2011 | 43 | 1009 | 52 | 1007 | 0.83 (0.56-1.22) | 10.5 |
| Subtotal | 121 | 2321 | 122 | 2451 | 1.05 (0.78-1.40) | 34.2 |
| Heterogeneity: $\tau^2 = 0.02$; $\chi^2_{12} = 13.14$; $P = .36$; $I^2 = 9\%$ | | | | | | |
| Tests for overall effect: z score = 0.31; $P = .76$ | | | | | | |
| Restrictive threshold, hemoglobin <7 g/dL | | | | | | |
| DeZern et al,[87] 2016 | 1 | 59 | 2 | 30 | 0.25 (0.02-2.69) | 0.6 |
| Hébert et al,[70] 1995 | 8 | 33 | 9 | 36 | 0.97 (0.42-2.22) | 3.8 |
| de Almeida et al,[79] 2015 | 23 | 101 | 8 | 97 | 2.76 (1.30-5.87) | 4.5 |
| Lacroix et al,[74] 2007 | 14 | 320 | 14 | 317 | 0.99 (0.48-2.04) | 4.7 |
| Walsh et al,[85] 2013 | 12 | 51 | 16 | 49 | 0.72 (0.38-1.36) | 5.8 |
| Murphy et al,[76] 2015 | 26 | 1000 | 19 | 1003 | 1.37 (0.76-2.46) | 6.5 |
| Villanueva et al,[84] 2013 | 19 | 416 | 34 | 417 | 0.56 (0.32-0.97) | 7.2 |
| Hébert et al,[69] 1999 | 78 | 418 | 98 | 420 | 0.80 (0.61-1.04) | 14.7 |
| Holst et al,[71] 2014 | 168 | 502 | 175 | 496 | 0.95 (0.80-1.13) | 18.0 |
| Subtotal | 349 | 2900 | 375 | 2865 | 0.94 (0.74-1.19) | 65.8 |
| Heterogeneity: $\tau^2 = 0.05$; $\chi^2_8 = 16.09$; $P = .04$; $I^2 = 50\%$ | | | | | | |
| Tests for overall effect: z score = 0.53; $P = .59$ | | | | | | |
| Overall | 470 | 5221 | 497 | 5316 | 0.97 (0.81-1.16) | 100 |
| Heterogeneity: $\tau^2 = 0.04$; $\chi^2_{21} = 29.75$; $P = .10$; $I^2 = 29\%$ | | | | | | |
| Tests for overall effect: z score = 0.29; $P = .77$ | | | | | | |
| Tests for subgroup differences: $\chi^2_1 = 0.34$; $P = .56$; $I^2 = 0\%$ | | | | | | |




The size of the data markers indicates the weight of the trial; RR, relative risk. Trials published after 2012 have been published since the prior AABB transfusion guidelines.

Carson et al 2016

# The Real Cost of RBC Transfusion

Activity-based costs of RBC transfusion

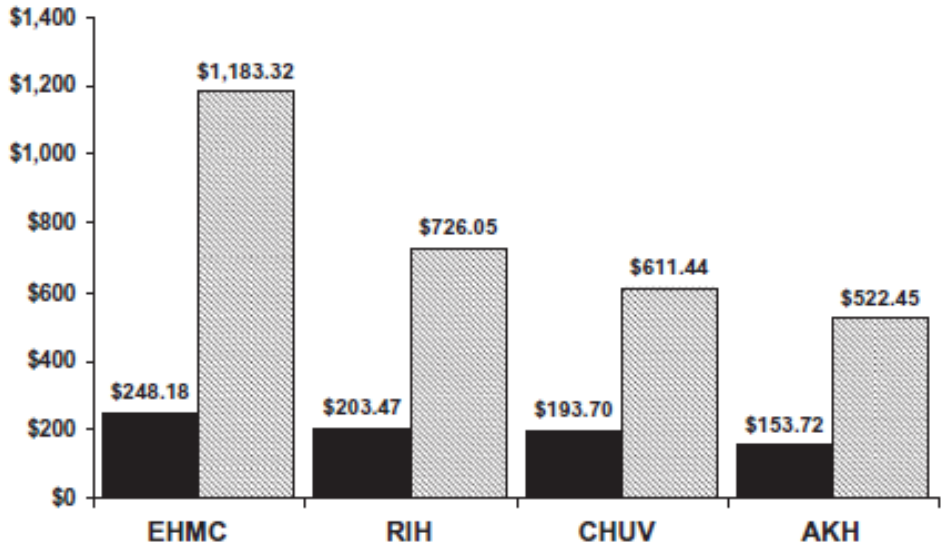



Fig. 2. Mean acquisition costs (■) and total ABC model costs (▧) per unit of blood. Mean per-unit acquisition costs included

Shander *et al* 2010; Spradrow et al 2016

To sum up:

- Unchanged or inferior patient outcomes
- Increased health care system expenditures
- Pressure on blood donor collection facilities and risk of blood shortage
- Iron deficiency in blood donors

# Elements of PBM

1. Diagnosis and treatment of anemia
2. Appropriate use of blood components (ex. Restrictive RBC transfusion triggers)
3. Reduction in unnecessary phlebotomy
4. Minimally invasive surgery and good surgical technique
5. Autotransfusion, cell salvage
6. Management of coagulopathy
   - Timely discontinuation and/or reversal of anticoagulant or antiplatelet drugs, etc.
   - Use of hemostatic agents (ex. Anti-fibrinolytic agents)
7. Many, many others…

# Personalized PBM

- *"Blood management is most successful when **multidisciplinary proactive** programs are in place so that these strategies can be **individualized** to specific patients"*

- ***"Patient-centered"***
  - Communication (risks, benefits, preferences, and values)


Goodnough and Shander 2007; Spahn and Goodnough 2013

# Improved Outcomes and Reduced Costs Associated with a Health System-wide PBM Program

| | 1st Pillar<br>Optimise red cell mass | 2nd Pillar<br>Minimise blood loss & bleeding | 3rd Pillar<br>Harness & optimise physiological reserve of anaemia |
|---|---|---|---|
| PREOP | • Detect anaemia<br>• Identify underlying disorder(s) causing anaemia<br>• Manage disorder(s)<br>• Refer for further evaluation if necessary<br>• Treat suboptimal iron stores/iron deficiency/anaemia of chronic disease/iron-restricted erythropoiesis<br>• Treat other haematinic deficiencies<br>• Note: Anaemia is a contraindication for elective surgery | • Identify and manage bleeding risk<br>• Minimise iatrogenic blood loss<br>• Procedure planning and rehearsal | • Assess/optimise patient's physiological reserve and risk factors<br>• Compare estimated blood loss with patient-specific tolerable blood loss<br>• Formulate patient-specific management plan using appropriate blood conservation modalities to minimise blood loss, optimise red cell mass and manage anaemia |
| INTRAOP | • Time surgery with haematological optimisation | • Meticulous haemostasis and surgical techniques<br>• Blood-sparing surgical devices<br>• Anaesthetic blood conserving strategies<br>• Autologous blood options<br>• Maintain normothermia<br>• Pharmacological/haemostatic agents | • Optimise cardiac output<br>• Optimise ventilation and oxygenation |
| POSTOP | • Optimise erythropoiesis<br>• Be aware of drug interactions that can increase anaemia | • Vigilant monitoring and management of post-operative bleeding<br>• Avoid secondary haemorrhage<br>• Rapid warming / maintain normothermia (unless hypothermia specifically indicated)<br>• Autologous blood salvage<br>• Minimise iatrogenic blood loss<br>• Haemostasis/anticoagulation management<br>• Prophylaxis of upper GI haemorrhage<br>• Avoid/treat infections promptly<br>• Be aware of adverse effects of medication | • Optimise anaemia reserve<br>• Maximise oxygen delivery<br>• Minimise oxygen consumption<br>• Avoid/treat infections promptly<br>• Restrictive transfusion thresholds |

**Perioperative multidisciplinary multimodal patient-specific team approach**

Transfusion Volume 57, Issue 6, pages 1347-1358, 2 FEB 2017 DOI: 10.1111/trf.14006
http://onlinelibrary.wiley.com/doi/10.1111/trf.14006/full#trf14006-fig-0002

# Improved Outcomes and Reduced Costs Associated with a Health System-wide PBM Program

- Retrospective study: 605,046 patients in 4 major adult tertiary-care hospitals 2008-2014, Western Australia
- Results
  - Units of RBC, FFP, and platelets per admission decreased 41% ($p<0.001$), a saving of US$18,078,258 and US$78 million to US$97 million in estimated activity-based savings
  - Mean pre-transfusion Hgb decreased from 7.9 g/dL to 7.3 g/dL ($p < 0.001$); single-unit RBC transfusions increased from 33.3% to 63.7% ($p < 0.001$).
  - Anemic elective surgery admissions decreased from 20.8% to 14.4% ($p = 0.001$).
  - Risk-adjusted reductions in **hospital mortality** (odds ratio [OR], 0.72; 95% confidence interval [CI], 0.67-0.77; $p < 0.001$), **length of stay** (incidence rate ratio, 0.85; 95% CI, 0.84-0.87; $p < 0.001$), **hospital-acquired infections** (OR, 0.79; 95% CI, 0.73-0.86; $p < 0.001$), and **acute myocardial infarction-stroke** (OR, 0.69; 95% CI, 0.58-0.82; $p < 0.001$).

Leahy et al 2017

# Anemia is a Common Problem

- General population
  - 30% of the world's population is anemic
    - 30-50% is due to iron deficiency
- Hospitalized patients
  - 11-76% of **preoperative** patients and up to 90% of postoperative patients are anemic
  - 45% of **general medical** inpatients are anemic
  - **ICU**
    - The majority of patients (86%) are anemic on ICU admission By day 8, 97% are anemic, and by day 13, 100% are anemic
    - 100% of ICU patients are anemic at discharge, 80% at Day 28 and 25% at 6 months post discharge
  - Incidence of anemia increases within processes of care

Kassebaum et al 2014; Beris et al 2008; Lin et al 2013; Thomas et al 2010; Lasocki et al 2014

# Burden of Anemia

- Associated with fatigue, decreased cognitive function, poor work productivity and poor quality of life
- Economic burden (reduced work productivity, increased social and healthcare expenditures)
  - Worldwide anemia causes 68.36 (95% uncertainty interval [UI], 40.98 to 107.54) million years lived with disability which accounts for 8.8% of the total for all conditions in 2010 [95% UI, 6.3% to 11.7%]).

Kassebaum et al 2014

# Burden of Anemia

- Risk factor for adverse outcomes
  - In **young children**, iron deficiency anemia may have irreversible effects on cognitive and motor development
  - In **pregnant women**, anemia may lead to pre-term delivery, low birth weight, child and maternal mortality
  - In **elderly**, anemia is a risk factor for frailty and multidimensional loss of function, and is associated with falls, increased mortality and hospitalization
  - Anemia is associated with worse outcomes in many **disease states** (heart failure, COPD, etc.) and perioperatively

Cleland et al 2016; Sharma et al 2016; Zilinski et al 2014; Juarez-Cedillo et al 2014; Penninx et al 2006

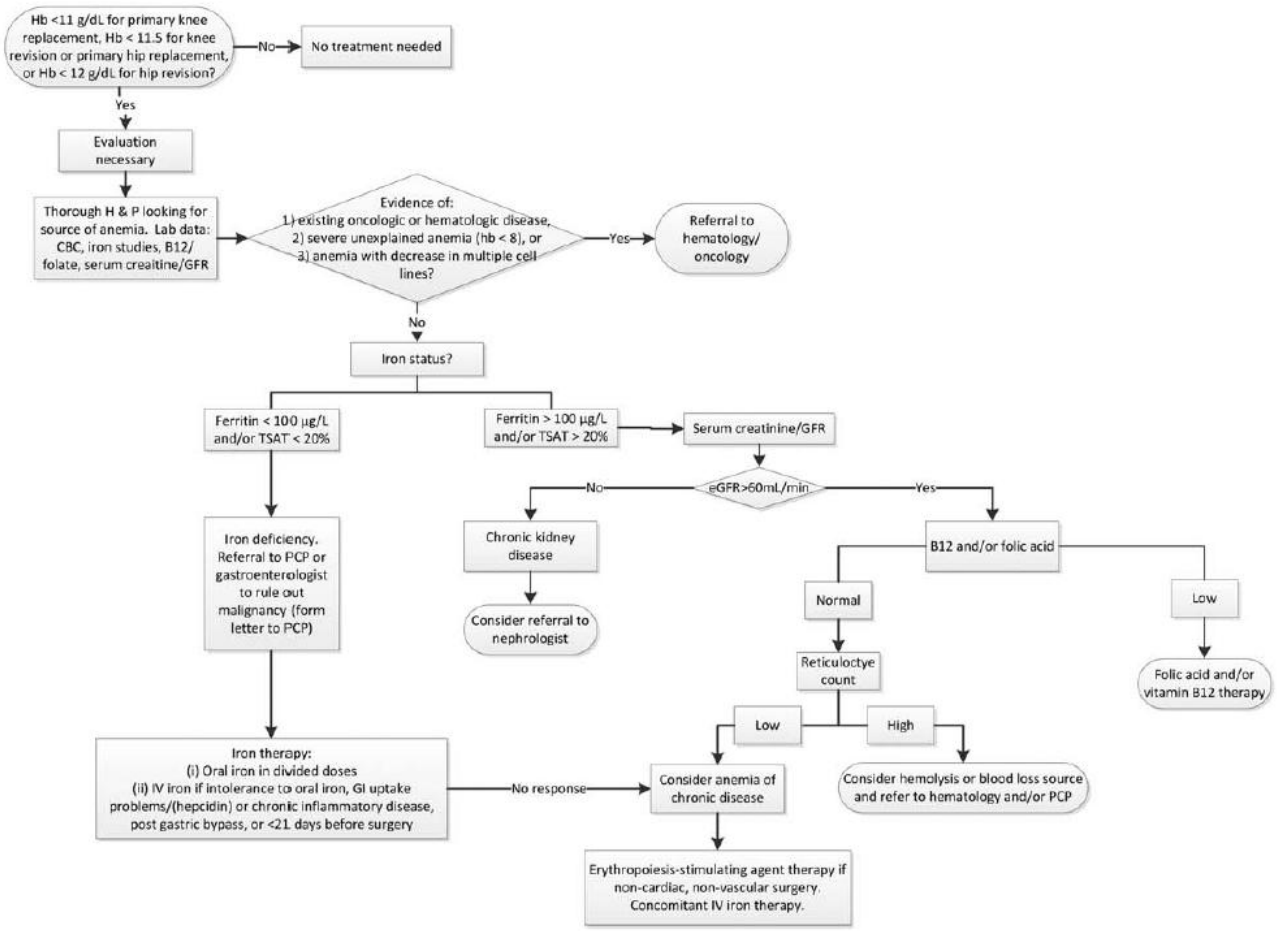
# HIS Chronicles

- “Regarding her normocytic anemia (Hb 96g/L), it appears primarily to be ACI with a likely element of iron deficiency; however, her anemia does not need to be corrected preoperatively. It is within safe limits”
- “I understand that she has severe iron deficiency anemia (Hb 77g/L) but this surgery is associated with a minimal blood loss”

# What Can I Do?

- Does patient have anemia?
- Is anemia due to a known underlying disease?
  - If no, investigate for causes
- Can anemia be treated?
  - consider risks & benefits
- Should anemia be treated?
  - The answer is almost always yes
  - Imperative
    - Impending surgery, active bleeding, symptoms

# Anemia: Differential Diagnosis




Guinn et al 2015

# Causes of Anemia in Older Patients

**Table 2. Distribution of types of anemia in persons 65 years and older, United States: NHANES III, phase 2, 1991 to 1994**

| Anemia | No. in the United States | Type, % | All anemia, % |
|---|---|---|---|
| **With nutrient deficiency** | | | |
| Iron only | 467 000 | 48.3 | 16.6 |
| Folate only | 181 000 | 18.8 | 6.4 |
| $B_{12}$ only | 166 000 | 17.2 | 5.9 |
| Folate and $B_{12}$ | 56 000 | 5.8 | 2.0 |
| Iron with folate or $B_{12}$ or both | 95 000 | 9.9 | 3.4 |
| Total | 965 000 | 100.0 | 34.3 |
| **Without nutrient deficiencies** | | | |
| Renal insufficiency only | 230 000 | 12.4 | 8.2 |
| ACI, no renal insufficiency | 554 000 | 30.0 | 19.7 |
| Renal insufficiency and ACI | 120 000 | 6.5 | 4.3 |
| UA | 945 000 | 51.1 | 33.6 |
| Total | 1 849 000 | 100.0 | 65.7 |
| Total, all anemia | 2 814 000 | NA | 100.0 |

1/3

1/3

1/3

(MDS 6%)

NA indicates not applicable. MDS = Myelodysplastic syndrome

Guralnik et al. Blood 2004;104:2263-8

# Iron Deficiency

- Most common nutritional deficiency
  - Women: 8-42%
    - Pregnant women: 18-56%
  - Orthopedic surgery: anemia 15-20% with 1/3 IDA
  - Cardiac surgery: 37% with iron deficiency
  - Colorectal cancer surgery: 38% with microcytic anemia (presumed IDA)
  - ICU patients: 26% are iron deficient on admission

Shander and Spahn 2010; Piednoir 2011; Acher 2003; Litton et al 2015

# Don't Transfuse RBCs for Iron Deficiency Without Hemodynamic Instability

- *Blood transfusion has become a routine medical response despite cheaper and safer alternatives in some settings.*
- *Preoperative patients with iron deficiency and patients with chronic iron deficiency without hemodynamic instability (even with low Hb levels) should be given oral and/or intravenous (IV) iron.*

# Iron Replacement

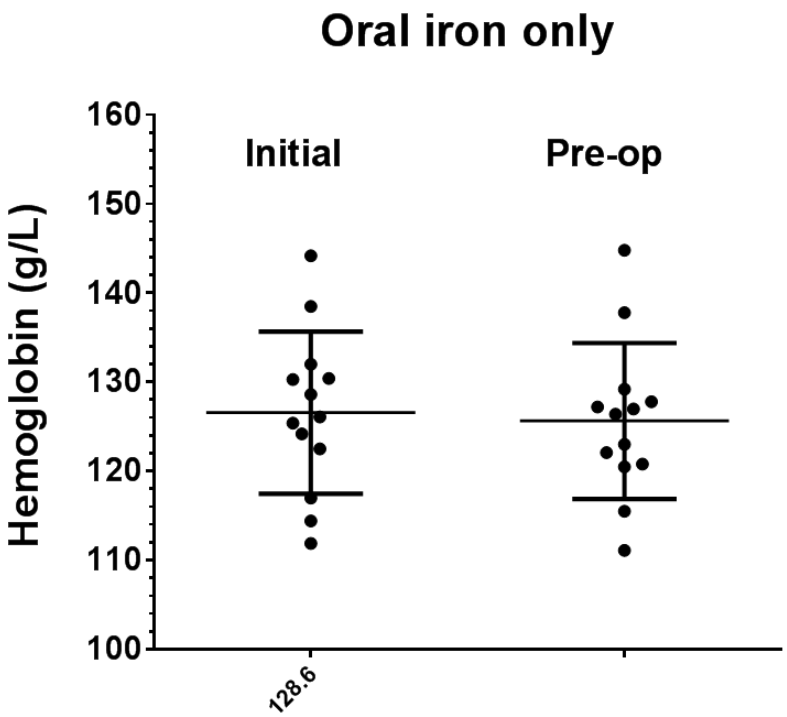
## Oral

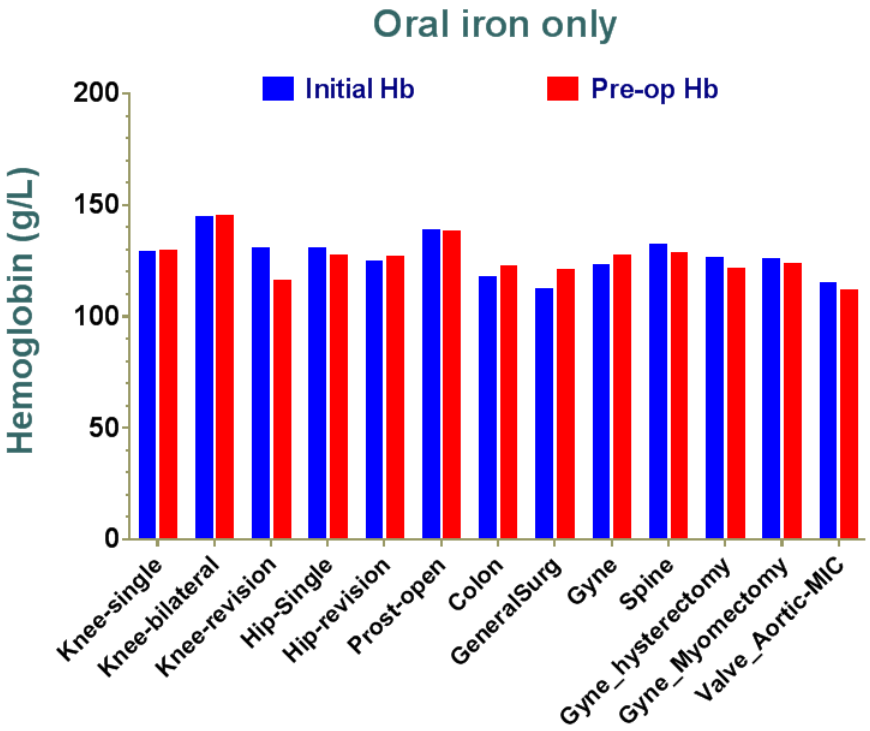
- Cons
  - For stable, well patients
  - Poorly absorbed (other medications, infection, inflammation) and poorly tolerated (adherence is an issue!)
  - Need time to see effect; not suitable for severe anemia, active bleeding, impending surgery
- Pros
  - Cheap and widely available

## Intravenous

- Cons
  - Contraindication: acute infection
  - Challenges: expense, availability, administration
  - Risk of anaphylaxis
- Pros
  - May be given to ill patients
  - No concerns about absorption
  - Fast response

# Efficacy of Pre-operative Oral Iron




ONTraC data, c/o Dr. J. Freedman

# Efficacy of IV iron in Reducing Requirement for RBC Transfusion

| Study | No of events/total: Treatment | No of events/total: Control | Weight (%) | Relative risk (95% CI) |
|---|---|---|---|---|
| **IV iron *v* oral iron** | | | | |
| Al 2005[18] | 0/45 | 1/45 | 0.3 | 0.33 (0.01 to 7.97) |
| Auerbach 2004[22] | 9/78 | 10/79 | 3.7 | 0.91 (0.39 to 2.12) |
| Auerbach 2010[23] | 41/116 | 48/122 | 17.6 | 0.90 (0.65 to 1.25) |
| Bayoumeu 2002[25] | 0/24 | 1/23 | 0.3 | 0.32 (0.01 to 7.48) |
| Breymann 2008[30] | 1/227 | 0/117 | 0.3 | 1.55 (0.06 to 37.82) |
| Dangsuwan 2010[33] | 5/22 | 14/22 | 3.8 | 0.36 (0.16 to 0.82) |
| Froessler 2013[37] | 1/101 | 3/97 | 0.6 | 0.32 (0.03 to 3.03) |
| Garrido-Martin 2012[38] | 20/54 | 27/53 | 11.7 | 0.73 (0.47 to 1.13) |
| Henry 2007[41] | 11/63 | 20/124 | 5.7 | 1.08 (0.55 to 2.12) |
| Kochhar 2012[48] | 0/50 | 1/50 | 0.3 | 0.33 (0.01 to 7.99) |
| Meyer 1996[59] | 0/21 | 2/21 | 0.3 | 0.20 (0.01 to 3.93) |
| Steensma 2011[78] | 20/164 | 43/326 | 9.5 | 0.92 (0.56 to 1.52) |
| Weisbach 1999[87] | 6/30 | 5/60 | 2.3 | 2.40 (0.80 to 7.23) |
| Westad 2008[88] | 4/59 | 11/70 | 2.3 | 0.43 (0.14 to 1.28) |
| Subtotal: P=0.45, $I^2$=0% | 118/1054 | 186/1209 | 58.6 | 0.82 (0.67 to 1.00) |
| **IV iron *v* no iron** | | | | |
| Edwards 2009[34] | 0/34 | 2/26 | 0.3 | 0.15 (0.01 to 3.08) |
| Hedenus 2007[40] | 2/33 | 1/34 | 0.5 | 2.06 (0.20 to 21.65) |
| Karkouti 2006[43] | 4/21 | 4/10 | 2.0 | 0.48 (0.15 to 1.52) |
| Kim 2007[46] | 12/30 | 29/45 | 9.8 | 0.62 (0.38 to 1.01) |
| Madi-Jebara 2004[57] | 17/80 | 9/40 | 5.1 | 0.94 (0.46 to 1.93) |
| Na 2011[60] | 11/54 | 29/54 | 7.3 | 0.38 (0.21 to 0.68) |
| Pedrazzoli 2008[64] | 2/73 | 5/76 | 1.1 | 0.42 (0.08 to 2.08) |
| Serrano-Trenas 2011[72] | 33/100 | 41/100 | 15.3 | 0.80 (0.56 to 1.16) |
| Subtotal: P=0.33, $I^2$=14% | 81/425 | 120/385 | 41.4 | 0.64 (0.49 to 0.85) |
| Subtotal: P=0.34, $I^2$=9% | 199/1479 | 306/1594 | 100.0 | 0.74 (0.62 to 0.88) |

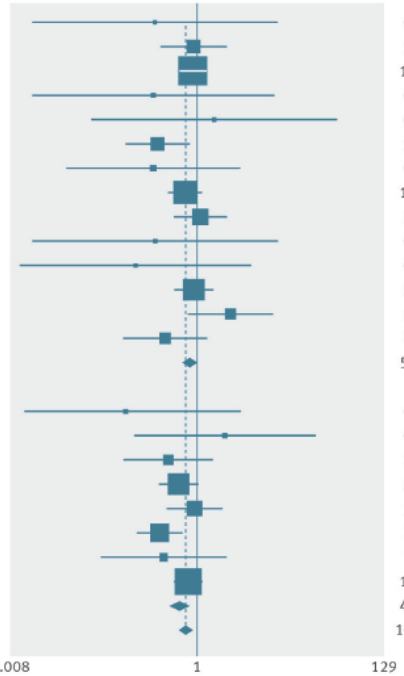


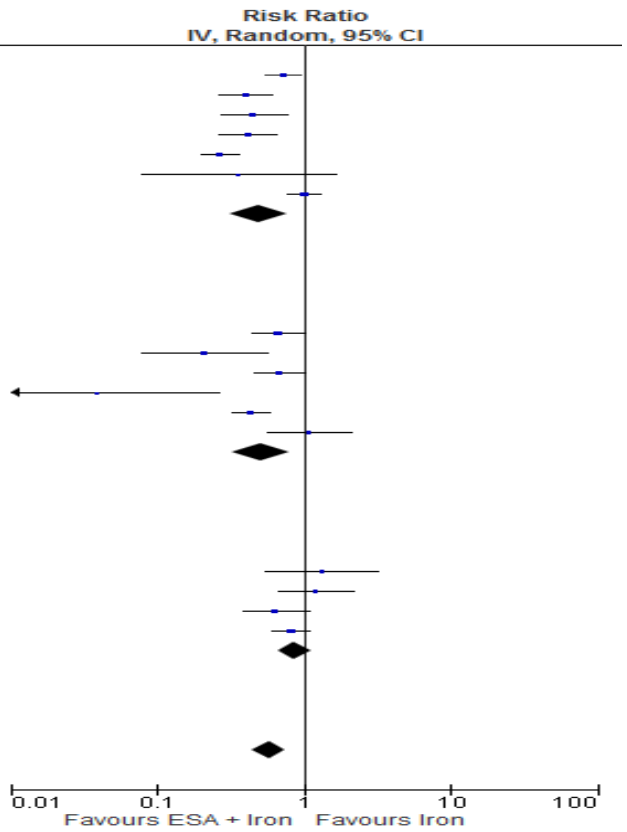

**Fig 3** Risk of red blood cell transfusion in patients who received intravenous iron compared with oral iron and no iron. Weights are from random effects analysis

- Systematic review and meta-analysis of RCTs
- 22 studies (3321 participants)
- IV iron was associated with a significant reduction in RBC transfusion risk
  - **Risk ratio 0.74** (95% CI 0.62 to 0.88), without significant heterogeneity ($I^2$=9%, P=0.3)
  - Especially when used with ESAs or in patients with a lower baseline plasma ferritin concentration

Litton et al 2013

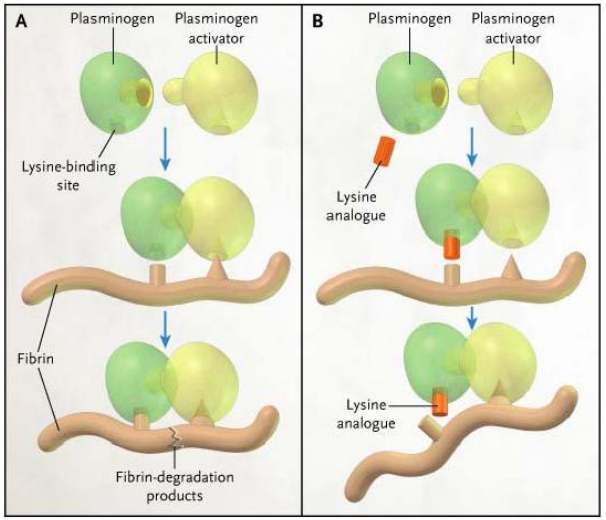
# Efficacy of ESA + iron vs. Iron in Reducing RBC Transfusion (patients transfused)

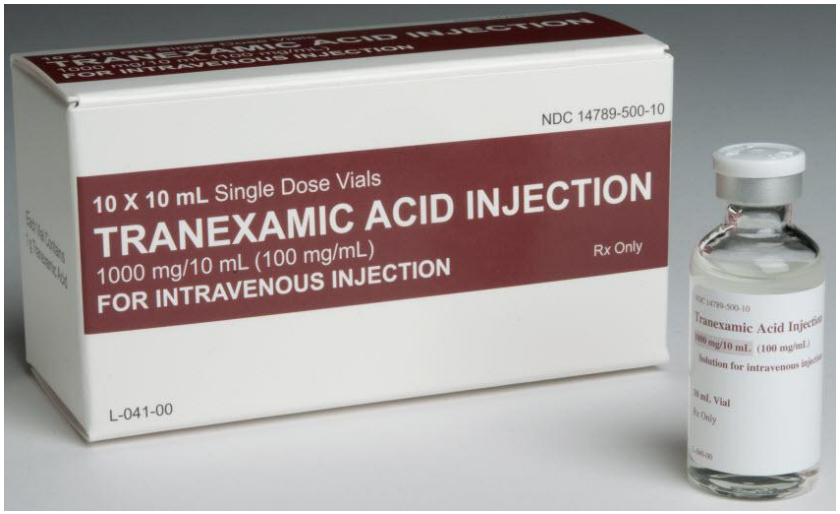
| Study or Subgroup | ESA + Iron Events | ESA + Iron Total | Iron Events | Iron Total | Weight | Risk Ratio IV, Random, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| **4.1.1 Orthopedic Surgery** | | | | | | | |
| COPES 1993 | 53 | 130 | 44 | 78 | 7.5% | 0.72 [0.54, 0.96] | 1993 |
| Faris 1996 | 25 | 118 | 36 | 69 | 6.8% | 0.41 [0.27, 0.61] | 1996 |
| de Andrade 1996 | 23 | 213 | 24 | 101 | 6.2% | 0.45 [0.27, 0.76] | 1996 |
| Feagan 2000 | 23 | 123 | 35 | 78 | 6.7% | 0.42 [0.27, 0.65] | 2000 |
| Weber 2005 | 56 | 458 | 107 | 235 | 7.6% | 0.27 [0.20, 0.36] | 2005 |
| Wu 2016 | 2 | 30 | 6 | 32 | 2.1% | 0.36 [0.08, 1.63] | 2016 |
| Bernabeu-Wittel 2016 | 52 | 100 | 53 | 103 | 7.6% | 1.01 [0.77, 1.32] | 2016 |
| **Subtotal (95% CI)** | | **1172** | | **696** | **44.5%** | **0.49 [0.32, 0.76]** | |
| Total events | 234 | | 305 | | | | |
| Heterogeneity: Tau² = 0.28; Chi² = 52.73, df = 6 (P < 0.00001); I² = 89% | | | | | | | |
| Test for overall effect: Z = 3.18 (P = 0.001) | | | | | | | |
| **4.1.2 Cardiac Surgery** | | | | | | | |
| Kyo 1992 | 20 | 40 | 12 | 16 | 6.8% | 0.67 [0.44, 1.01] | 1992 |
| Sowade 1997 | 4 | 36 | 19 | 36 | 3.8% | 0.21 [0.08, 0.56] | 1997 |
| D'Ambra 1997 | 36 | 119 | 25 | 56 | 6.9% | 0.68 [0.45, 1.01] | 1997 |
| Podesta 2000 | 1 | 30 | 26 | 30 | 1.5% | 0.04 [0.01, 0.27] | 2000 |
| Weltert 2015 | 51 | 300 | 117 | 300 | 7.5% | 0.44 [0.33, 0.58] | 2015 |
| Urena 2017 | 13 | 48 | 13 | 52 | 5.4% | 1.08 [0.56, 2.10] | 2017 |
| **Subtotal (95% CI)** | | **573** | | **490** | **31.8%** | **0.51 [0.32, 0.79]** | |
| Total events | 125 | | 212 | | | | |
| Heterogeneity: Tau² = 0.19; Chi² = 19.38, df = 5 (P = 0.002); I² = 74% | | | | | | | |
| Test for overall effect: Z = 3.02 (P = 0.003) | | | | | | | |
| **4.1.3 Colorectal Cancer Surgery** | | | | | | | |
| Heiss 1996 | 9 | 17 | 4 | 10 | 4.2% | 1.32 [0.55, 3.20] | 1996 |
| Kettelhack 1998 | 16 | 48 | 15 | 54 | 5.8% | 1.20 [0.67, 2.16] | 1998 |
| Qvist 1999 | 13 | 38 | 23 | 43 | 6.2% | 0.64 [0.38, 1.08] | 1999 |
| Christodoulakis 2005 | 59 | 136 | 36 | 68 | 7.5% | 0.82 [0.61, 1.10] | 2005 |
| **Subtotal (95% CI)** | | **239** | | **175** | **23.7%** | **0.86 [0.67, 1.12]** | |
| Total events | 97 | | 78 | | | | |
| Heterogeneity: Tau² = 0.01; Chi² = 3.49, df = 3 (P = 0.32); I² = 14% | | | | | | | |
| Test for overall effect: Z = 1.09 (P = 0.27) | | | | | | | |
| **Total (95% CI)** | | **1984** | | **1361** | **100.0%** | **0.58 [0.45, 0.74]** | |
| Total events | 456 | | 595 | | | | |
| Heterogeneity: Tau² = 0.21; Chi² = 88.37, df = 16 (P < 0.00001); I² = 82% | | | | | | | |
| Test for overall effect: Z = 4.23 (P < 0.0001) | | | | | | | |
| Test for subgroup differences: Chi² = 7.04, df = 2 (P = 0.03), I² = 71.6% | | | | | | | |




Kei et al (in press)

# Reduce Bleeding: Tranexamic Acid (TXA)




- Mechanism of action
- Decreases plasmin formation and fibrinolysis
- Cheap and widely available
- Can be given intravenously, orally, or topically
- Metabolism minimal and excretion via urine (>95% unchanged)
- Half-life: 2-11h
- Favourable side effect profile

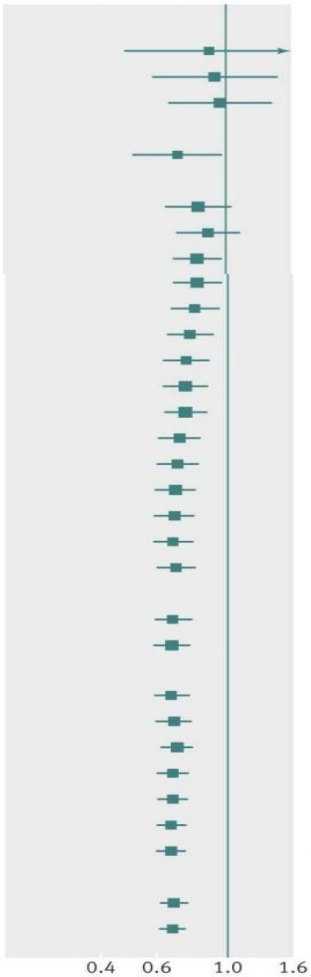
# TXA in Elective Surgery


- Systematic review by Ker et al
  - 129 trials, 10,488 patients
  - TXA reduced probability of receiving a blood transfusion by a third (risk ratio 0.62, 95% confidence interval 0.58 to 0.65; P<0.001).
    - Cumulative meta-analysis: reliable evidence that TXA reduces the need for transfusion has been available for over 10 years!
  - Effect of TXA on MI (0.68, 0.43 to 1.09; P = 0.11), stroke (1.14, 0.65 to 2.00; P = 0.65), DVT (0.86, 0.53 to 1.39; P = 0.54), and PE (0.61, 0.25 to 1.47; P=0.27) uncertain
  - Fewer deaths occurred in the TXA group (0.61, 0.38 to 0.98; P = 0.04)

Ker et al 2012; Henry et al 2011

# Effect of TXA on Transfusion

| Trial | No with outcome/ No in group: Tranexamic acid | No with outcome/ No in group: Control | Risk ratio (95% CI) |
|---|---|---|---|
| Horrow 1990[52] | Not reported | Not reported | Not reported |
| Horrow 1991[53] | 12/37 | 16/44 | 0.89 (0.49 to 1.64) |
| Coffey 1995[28] | 9/16 | 8/14 | 0.93 (0.59 to 1.45) |
| Horrow 1995[54] | 37/121 | 7/24 | 0.97 (0.67 to 1.41) |
| Karski 1995[63] | Not reported | Not reported | Not reported |
| Benoni 1996[10] | 8/43 | 24/43 | 0.71 (0.51 to 0.98) |
| Boylan 1996[14] | Not reported | Not reported | Not reported |
| Hardy 1998[49] | 28/42 | 27/44 | 0.83 (0.65 to 1.04) |
| Benoni 2000[12] | 9/20 | 4/19 | 0.89 (0.71 to 1.11) |
| Tanaka 2001[114] | 47/73 | 26/26 | 0.82 (0.69 to 0.97) |
| Casati 2001[18] | 2/20 | 4/20 | 0.81 (0.68 to 0.96) |
| Benoni 2001[11] | 4/18 | 8/20 | 0.79 (0.67 to 0.94) |
| Casati 2002[20] | 11/29 | 19/29 | 0.77 (0.65 to 0.90) |
| Husted 2003[55] | 2/20 | 7/20 | 0.75 (0.63 to 0.88) |
| Casati 2004[19] | 9/52 | 13/50 | 0.74 (0.63 to 0.87) |
| Diprose 2005[33] | 20/60 | 27/60 | 0.74 (0.64 to 0.86) |
| Johansson 2005[60] | 8/47 | 23/53 | 0.71 (0.61 to 0.82) |
| Karski 2005[62] | 24/147 | 41/165 | 0.70 (0.61 to 0.81) |
| Kuitunen 2005[70] | 5/20 | 12/20 | 0.69 (0.60 to 0.79) |
| Vaněk 2006[117] | 3/32 | 6/30 | 0.68 (0.59 to 0.79) |
| Orpen 2006[94] | 1/15 | 3/14 | 0.68 (0.59 to 0.78) |
| Murphy 2006[89] | 13/50 | 14/50 | 0.69 (0.60 to 0.79) |
| Maddali 2007[78] | Not reported | Not reported | Not reported |
| Jimenez 2007[59] | 9/24 | 19/26 | 0.68 (0.60 to 0.78) |
| Sadeghi 2007[105] | 12/32 | 20/35 | 0.68 (0.60 to 0.77) |
| Chen 2008[25] | 0/26 | 0/29 | Not estimable |
| Elwatidy 2008[37] | 4/32 | 12/32 | 0.67 (0.59 to 0.76) |
| Wong 2008[121] | 23/73 | 30/74 | 0.68 (0.60 to 0.76) |
| Later 2009[73] | 57/99 | 73/103 | 0.70 (0.63 to 0.78) |
| Taghaddomi 2009[113] | 8/50 | 27/50 | 0.67 (0.61 to 0.75) |
| Zufferey 2010[131] | 24/57 | 32/53 | 0.68 (0.61 to 0.75) |
| Gungorduk 2010[48] | 2/330 | 7/330 | 0.67 (0.61 to 0.74) |
| Dadure 2011[30] | 7/19 | 14/20 | 0.67 (0.60 to 0.74) |
| McConnell 2011[81] | 0/22 | 0/22 | Not estimable |
| Greiff 2011[46] | 27/30 | 31/33 | 0.68 (0.62 to 0.75) |
| Crescenti 2011[1] | 34/100 | 55/100 | 0.68 (0.62 to 0.74) |



# Tranexamic Acid for Joint Replacement Surgery

***PLEASE NOTE CHANGES TO PROTOCOL FOR TOTAL KNEE SURGERY***

**RATIONALE:**

- TXA is known to reduce transfusion and blood loss in TKA / THA
- Transfusion rates for TKA and THA remain approx 15-20% at SMH, and are expected to be significantly reduced by TXA (target of 5-10% expected)
- Treatment is inexpensive and not associated with complications in appropriately selected patients

**WHOM TO TREAT:**

- *Most* patients having elective Knee or Hip Arthroplasty
- Primary Surgery as well as Re-do Surgery
- Anemic and Non-anemic Patients

**SUGGESTED REGIMEN FOR ADMINISTRATION:** *NOTE CHANGES to TKA*

**Total Hip Arthroplasty:** 20mg/kg IV, given prior to skin incision
**Total Knee Arthroplasty:** 20mg/kg IV, given prior to skin incision (*don't wait for tourniquet deflation as previously suggested*)

- Dose is to be given by anesthesiologist (not ordered for pre-op administration by nurse)
- Medication may be given by syringe bolus or infused with pump over 5-10 minutes, as preferred by anesthesiologist

In order to maximize allotted budget for this initiative:

- Use multi-dose (ie. 5g / 50cc) vials where possible, conserving remainder
- Round patient weight only to nearest 5kg (ie nearest 100mg or 1cc or drug)

**CONTRAINDICATIONS:**

- There are no known absolute contra-indications to TXA in total joint replacement
- TXA is not shown to cause thrombosis assuming routine post-op thromboprophylaxis
- **However, use caution and consider withholding therapy in:**
  - Recent (< 6 months) MI, Stroke, DVT or other thrombotic event
  - Drug-eluting coronary stent within 12 months of placement
  - Known hypercoagulable or thrombotic condition (e.g. Protein C/S/ATIII deficiency, Factor V Leiden, Lupus Anticoagulant, Metastatic CA, Thrombocytosis *etc.*)
  - Contra-indication to routine post-op thromboprophylaxis

St. Michael's

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# St. Michael's TXA in Arthroplasty Initiative

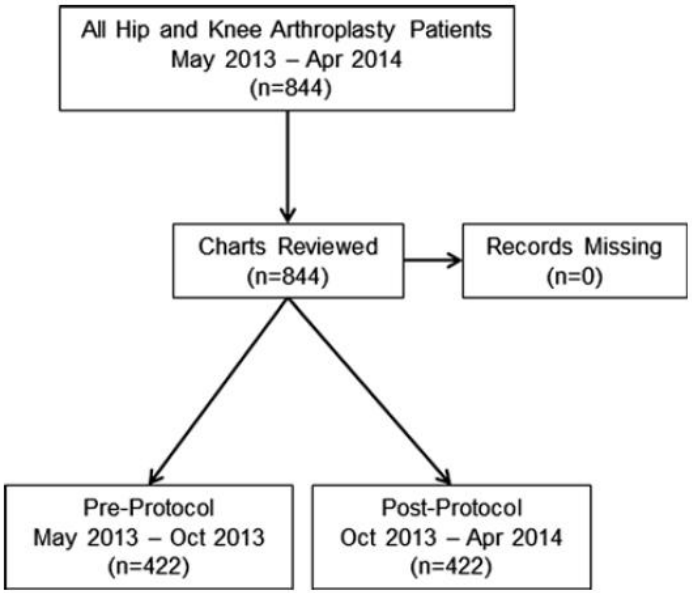


**Fig. 1** Flow diagram of patients and data included within this retrospective study

Protocolized universal TXA therapy reduces RBC transfusion

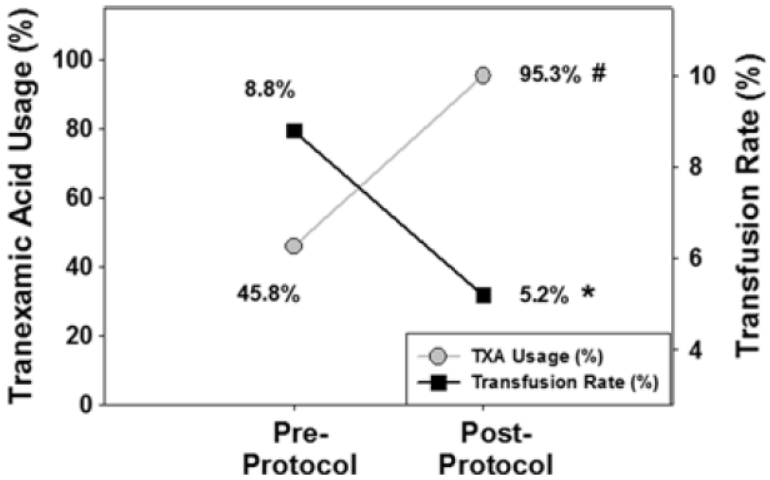


**Fig. 2** Rate of tranexamic acid (TXA) utilization (grey circles) and red blood cell transfusion (black squares) before and after initiating the TXA protocol (black symbols, Pre-Protocol *vs* Post-Protocol, $n$ = 422 per group). There was a significant increase in the proportion of patients receiving TXA and a reduction in the proportion of patients receiving a transfusion after implementation of the protocol (*$P$ = 0.043 and #$P < 0.001$, Chi square analysis)

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Baker, Pavenski et al 2015

# A Rationale for Universal Tranexamic Acid in Major Joint Arthroplasty

- TXA use increased from 32.3% to 92.2%, while transfusion rates decreased from 10.3% to 4.8% ($p < 0.001$)
- Postoperative Day 3 Hb increased from 95.8 to 101.4 g/L ($p < 0.001$)
- Logistic regression demonstrated reduced transfusion in post-protocol subgroups regardless of sex, anemia, or BMI ($p < 0.001$)
- No increase in adverse events was observed ($p = 0.8451$).

- Conclusion: Universal TXA was associated with a reduction of RBC transfusion overall and in clinically relevant subgroups, strengthening the rationale for universal therapy

Pavenski, Ward et al 2018

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# Avoid Unnecessary Transfusions

- Restrictive RBC Transfusion Triggers and Single Unit Transfusions
  - Don't transfuse more units of blood than absolutely necessary
    - *A restrictive threshold (7.0-8.0g/dL) should be used for the vast majority of hospitalized, stable patients without evidence of inadequate tissue oxygenation (evidence supports a threshold of 8.0g/dL in patients with existing cardiovascular disease). Transfusion decisions should be influenced by symptoms and hemoglobin (Hb) concentration.*
    - *Single unit red blood cell (RBC) transfusions should be the standard for nonbleeding hospitalized patients. Additional units should only be prescribed after reassessment of the patient and their Hb value*

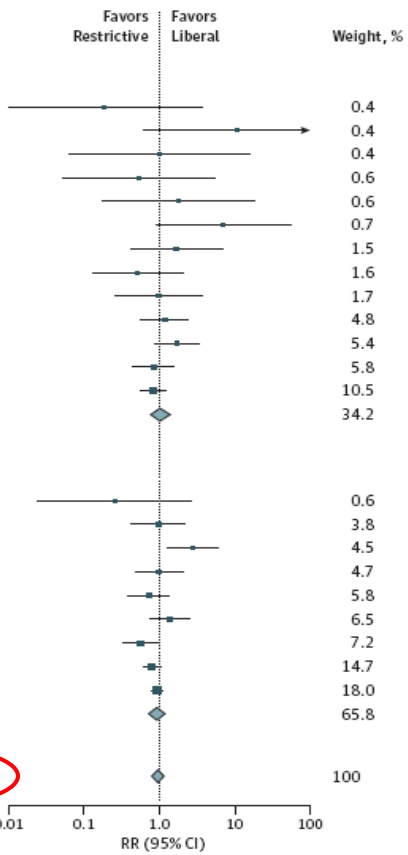
AABB Choosing Wisely 2014

Advancing Transfusion and Cellular Therapies Worldwide

# 30 day Mortality in Restrictive vs. Liberal Transfusion Triggers

Figure 1. Comparison of 30-Day Mortality Using Restrictive vs Liberal Hemoglobin Transfusion Thresholds in Randomized Clinical Trials

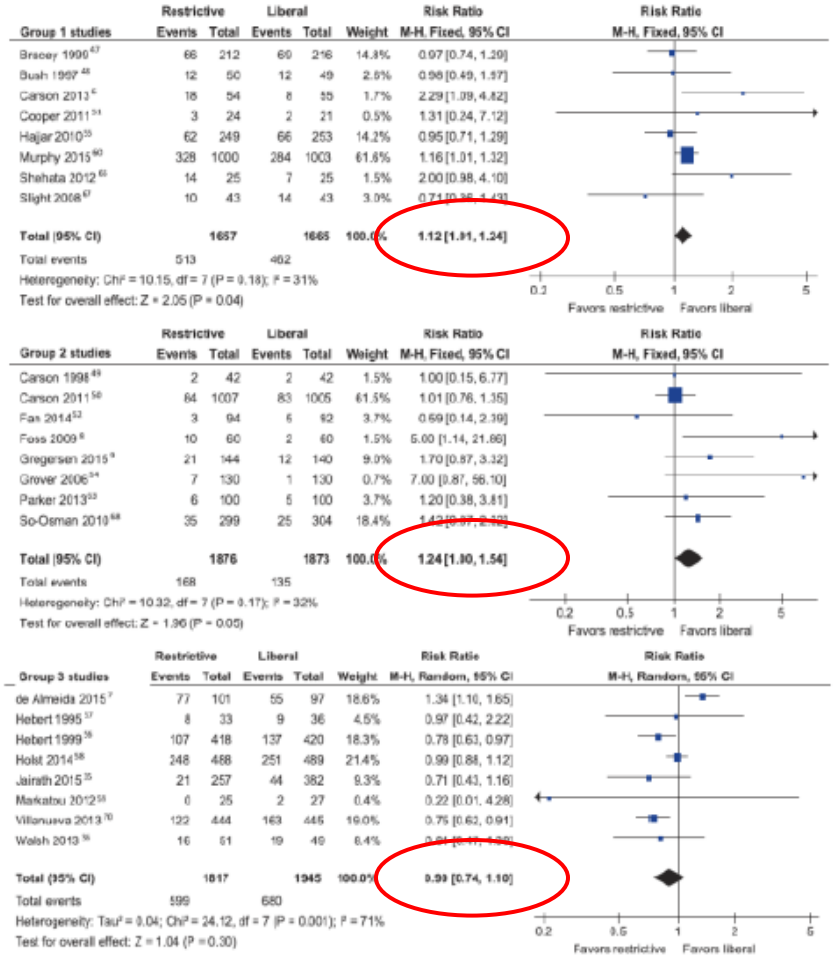
| Source | Restrictive Transfusion Threshold: No. of Deaths | Restrictive Transfusion Threshold: Total No. | Liberal Transfusion Threshold: No. of Deaths | Liberal Transfusion Threshold: Total No. | RR (95% CI) | Weight, % |
|---|---|---|---|---|---|---|
| Restrictive threshold, hemoglobin <8 to 9 g/dL | | | | | | |
| Lotke et al,[75] 1999 | 0 | 62 | 0 | 65 | Not estimable | |
| Blair et al,[53] 1986 | 0 | 26 | 2 | 24 | 0.19 (0.01-3.67) | 0.4 |
| Foss et al,[63] 2009 | 5 | 60 | 0 | 60 | 11.00 (0.62-194.63) | 0.4 |
| Carson et al,[58] 1998 | 1 | 42 | 1 | 42 | 1.00 (0.06-15.47) | 0.4 |
| Webert et al,[86] 2008 | 1 | 29 | 2 | 31 | 0.53 (0.05-5.58) | 0.6 |
| Cooper et al,[61] 2011 | 2 | 23 | 1 | 21 | 1.83 (0.18-18.70) | 0.6 |
| Carson et al,[56] 2013 | 7 | 55 | 1 | 55 | 7.00 (0.89-55.01) | 0.7 |
| Parker,[78] 2013 | 5 | 100 | 3 | 100 | 1.67 (0.41-6.79) | 1.5 |
| Bracey et al,[54] 1999 | 3 | 215 | 6 | 222 | 0.52 (0.13-2.04) | 1.6 |
| Bush et al,[55] 1997 | 4 | 50 | 4 | 49 | 0.98 (0.26-3.70) | 1.7 |
| Hajjar et al,[68] 2010 | 15 | 249 | 13 | 253 | 1.17 (0.57-2.41) | 4.8 |
| Gregersen et al,[64] 2015 | 21 | 144 | 12 | 140 | 1.70 (0.87-3.32) | 5.4 |
| Jairath et al,[72] 2015 | 14 | 257 | 25 | 382 | 0.83 (0.44-1.57) | 5.8 |
| Carson et al,[60] 2011 | 43 | 1009 | 52 | 1007 | 0.83 (0.56-1.22) | 10.5 |
| Subtotal | 121 | 2321 | 122 | 2451 | 1.05 (0.78-1.40) | 34.2 |
| Heterogeneity: $\tau^2 = 0.02$; $\chi^2_{12} = 13.14$; $P = .36$; $I^2 = 9\%$ | | | | | | |
| Tests for overall effect: z score = 0.31; $P = .76$ | | | | | | |
| Restrictive threshold, hemoglobin <7 g/dL | | | | | | |
| DeZern et al,[87] 2016 | 1 | 59 | 2 | 30 | 0.25 (0.02-2.69) | 0.6 |
| Hébert et al,[70] 1995 | 8 | 33 | 9 | 36 | 0.97 (0.42-2.22) | 3.8 |
| de Almeida et al,[79] 2015 | 23 | 101 | 8 | 97 | 2.76 (1.30-5.87) | 4.5 |
| Lacroix et al,[74] 2007 | 14 | 320 | 14 | 317 | 0.99 (0.48-2.04) | 4.7 |
| Walsh et al,[85] 2013 | 12 | 51 | 16 | 49 | 0.72 (0.38-1.36) | 5.8 |
| Murphy et al,[76] 2015 | 26 | 1000 | 19 | 1003 | 1.37 (0.76-2.46) | 6.5 |
| Villanueva et al,[84] 2013 | 19 | 416 | 34 | 417 | 0.56 (0.32-0.97) | 7.2 |
| Hébert et al,[69] 1999 | 78 | 418 | 98 | 420 | 0.80 (0.61-1.04) | 14.7 |
| Holst et al,[71] 2014 | 168 | 502 | 175 | 496 | 0.95 (0.80-1.13) | 18.0 |
| Subtotal | 349 | 2900 | 375 | 2865 | 0.94 (0.74-1.19) | 65.8 |
| Heterogeneity: $\tau^2 = 0.05$; $\chi^2_8 = 16.09$; $P = .04$; $I^2 = 50\%$ | | | | | | |
| Tests for overall effect: z score = 0.53; $P = .59$ | | | | | | |
| Overall | 470 | 5221 | 497 | 5316 | 0.97 (0.81-1.16) | 100 |
| Heterogeneity: $\tau^2 = 0.04$; $\chi^2_{21} = 29.75$; $P = .10$; $I^2 = 29\%$ | | | | | | |
| Tests for overall effect: z score = 0.29; $P = .77$ | | | | | | |
| Tests for subgroup differences: $\chi^2_1 = 0.34$; $P = .56$; $I^2 = 0\%$ | | | | | | |




The size of the data markers indicates the weight of the trial; RR, relative risk. Trials published after 2012 have been published since the prior AABB transfusion guidelines.

Carson et al 2016

# Risk of MI, Arrhythmia, Unstable Angina, Stroke, AKI, Mesenteric or Peripheral Ischemia and Mortality




Group 1

Patients with CVS Disease Undergoing CVS Treatments

Group 2

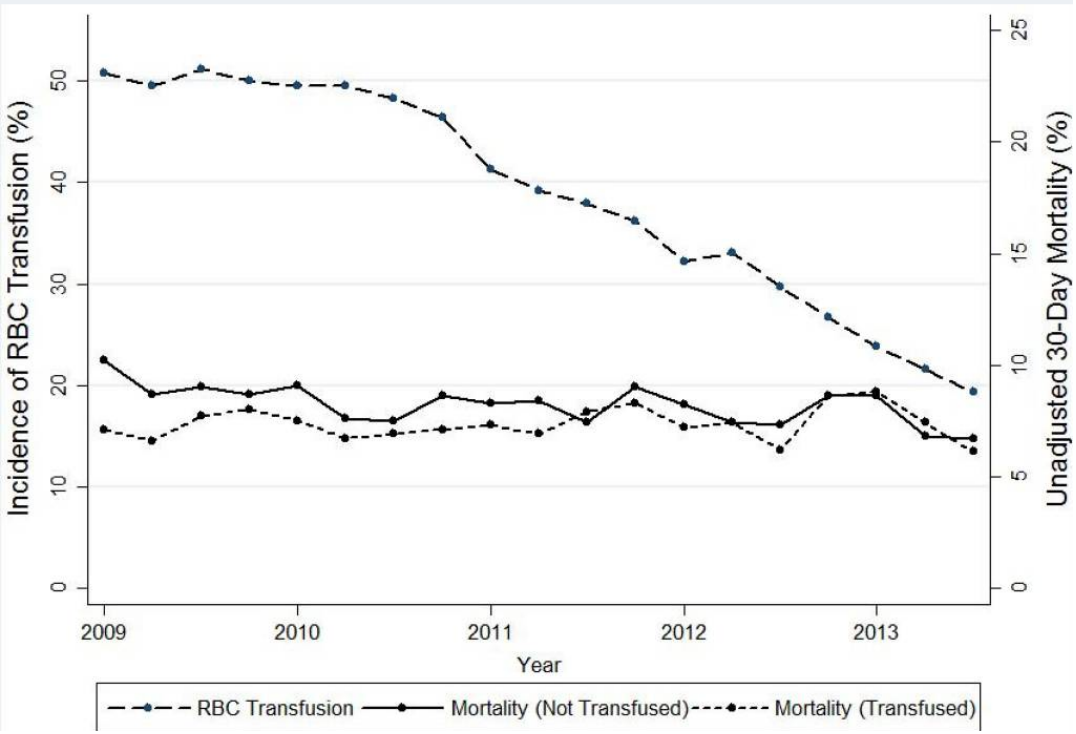
Elderly Patients Undergoing Orthopedic Procedures

Group 3

Mixed Medical/Surgical Patients in Acute Care Units

Hovaguimian and Myles Anesthesiology 2016

# Inpatient RBC Transfusion Incidence and Unadjusted 30-Day Mortality




The most pronounced decline in RBC transfusion incidence in patients with a nadir Hgb between 8 and 9 g/dL (n=76,392)

**Not** associated with differences in 30-day mortality rates when comparing transfused vs. non-transfused patients

Roubinian et al 2014

# Single Unit RBC Transfusions


Based on experience from RCTs:

- ***Single unit*** *red blood cell (RBC) transfusions should be the standard for non-bleeding hospitalized patients*
- *Additional units should only be prescribed after reassessment of the patients and their hemoglobin value*

# Unnecessary Diagnostic Phlebotomy

- The mean volume of blood phlebotomized during a hospitalization on a GIM ward is 74.6 mL.
  - After adjusting for other factors, every 100 mL of phlebotomy associated with decrease in Hgb of 7 g/L
- Average daily blood sampling volume in ICU is 40-50mL
  - May contribute to up to 20% of the total blood loss during an ICU stay leading to anemia
  - After one week in the ICU, equivalent to the volume of one unit of RBC

Thavendiranathan et al 2005; Riessen et al 2015

# Unnecessary Diagnostic Phlebotomy

- 17,676 non-anemic patients admitted with AMI
- Hospital acquired anemia (HAA) occurred in 57.5% of patients
  - Moderate-severe HAA (20.1% of patients) was independently associated with worse mortality
  - While more phlebotomy blood loss occurred on the first 2 days of hospitalization, significant phlebotomy blood loss occurred each subsequent day of hospitalization, likely due to “routine, scheduled laboratory draws”
  - Significant variability in the incidence of HAA across 57 U.S. hospitals studied

- To sum up: Unnecessary phlebotomy leads to patient anemia (and transfusions), unnecessary healthcare expenditures and patient discomfort

Salisbury et al 2011; Salisbury et al 2014

# Avoid Unnecessary Phlebotomy

- **Don't perform serial blood counts on clinically stable patients**
  - *Blood counts should only be obtained on hospitalized patients when there is reason to believe that a new clinically significant abnormality will be detected. For stable patients, serial blood counts are unlikely to detect clinically significant abnormalities but can contribute to iatrogenic anemia.*

# Why is PBM Frequently Lost in Translation?

- In Canada, transfusion is deemed to be free while PBM costs money to the hospital or patient
- Perceived (and actual) difficulty in pursuing transfusion alternatives
- Lack of organizational commitment/buy-in
- Lack of interdisciplinary commitment
- Lack of knowledge of alternatives
- Lack of champions
- Lack of resources
- Lack of time
- Complacency

Based on Meybohm et al 2016

# Instead of Conclusions, Call to Action

- PBM reduces transfusion needs, morbidity and mortality, length of hospital stay and costs
- PBM = patient safety
- Get involved. Start by
  - Treating anemia in your patient
  - Not causing anemia in your patient
  - Not ordering an unnecessary transfusion

# SAVE BLOOD, SAVE LIVES

Nature April 2 2015