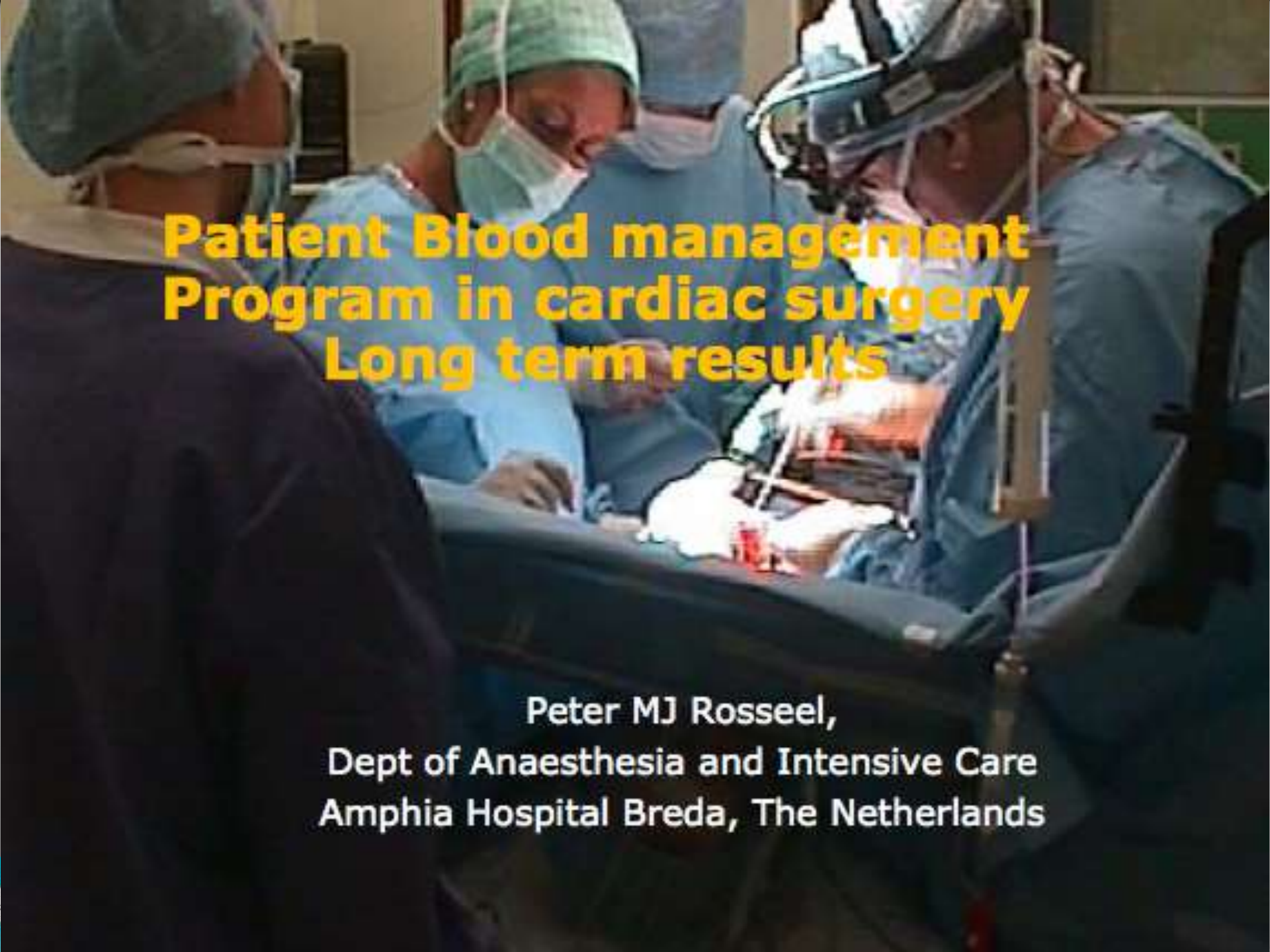


Patient Blood management Program in cardiac surgery Long term results

Peter MJ Rosseel,
Dept of Anaesthesia and Intensive Care
Amphia Hospital Breda, The Netherlands

Amphia Hospital, Breda

Teaching non-university Hospital

- 1500 OHO/year, no congenital, no HTx
- 26 bed ICU,
- Referral center for Jehova's witnesses

No disclosures

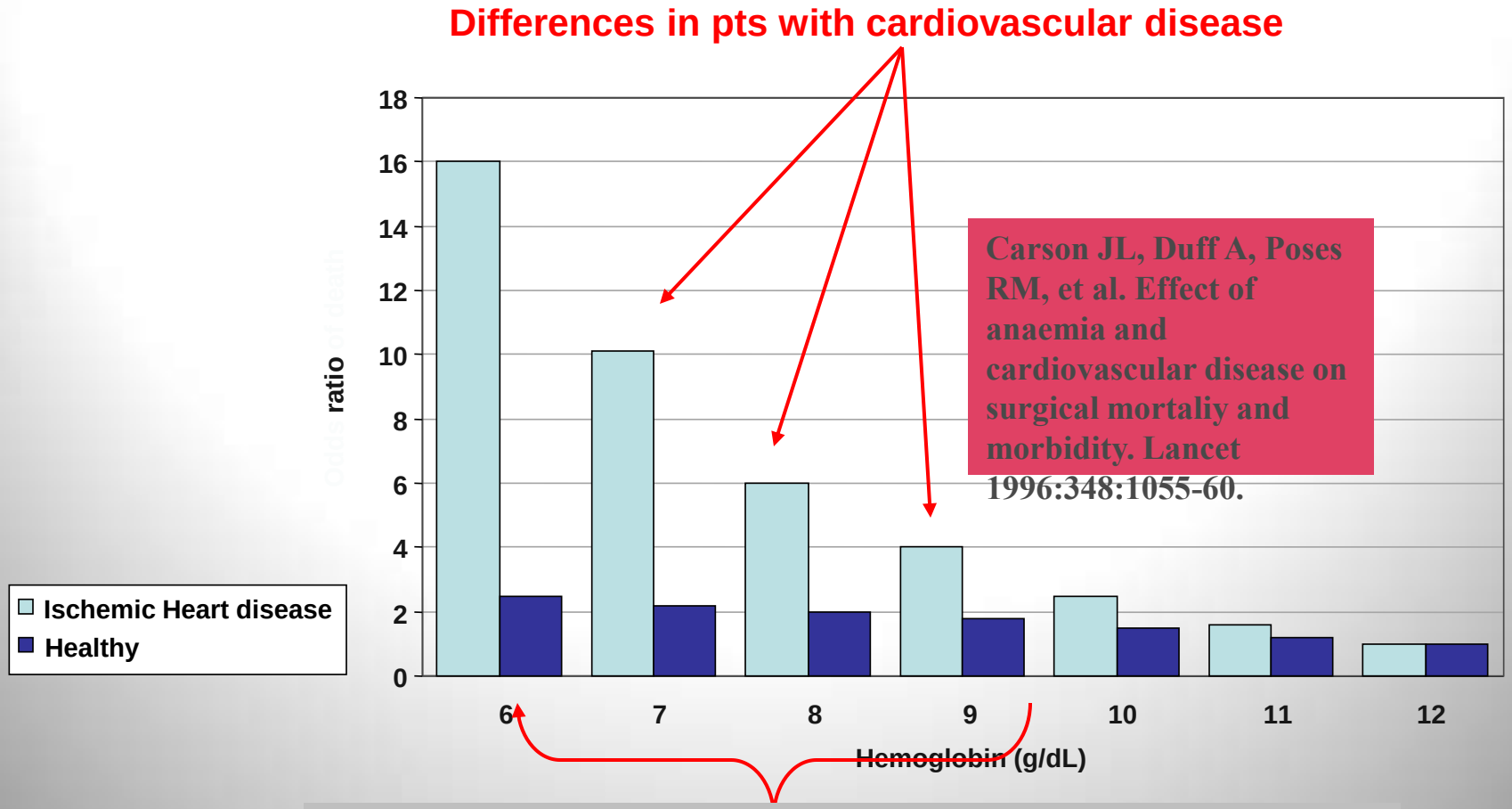
Summary

- Anaemia, Blood Loss & Transfusion
- From Jehova to PBM implementation
- Problems Encountered
- Surveillance & Follow up
- Conclusions &

Premises

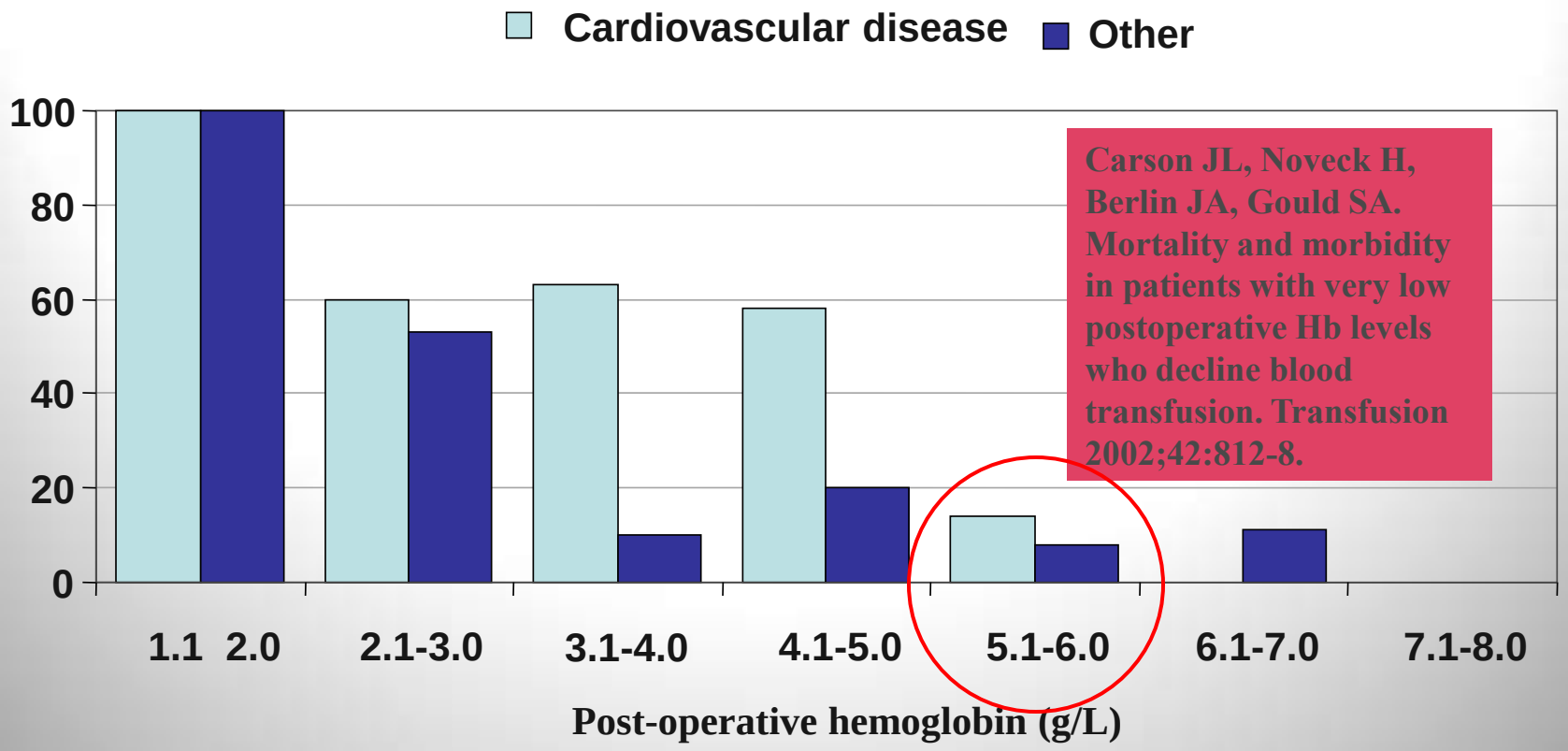

THE GOOD THE BAD and THE UGLY
Patient Blood Management
Il Buono
Transfusion
Il Cattivo
THE GOOD THE BAD and THE UGLY
THE GOOD THE BAD and THE UGLY
Blood Loss & Anaemia
Il Brutto

Pre-operative Hb and odds ratio for mortality in 1958 Jehovah's witness patients



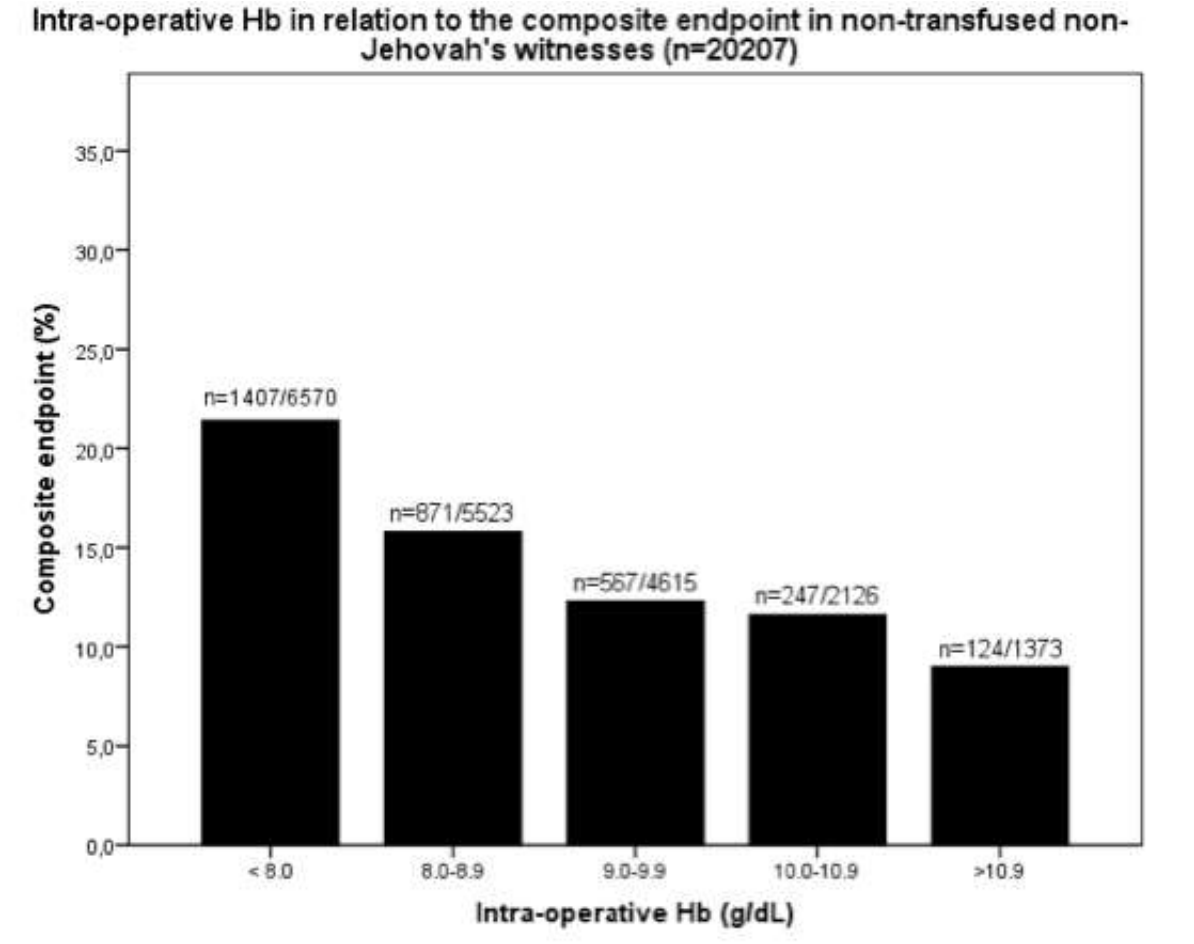
AND IF THE HB IS VERY LOW……

A value of 6.0 makes a lot of sense as a lower limit



Carson JL, Noveck H, Berlin JA, Gould SA. Mortality and morbidity in patients with very low postoperative Hb levels who decline blood transfusion. Transfusion 2002;42:812-8.

Intra-operative Anaemia in cardiac surgery – Non JW



Hoogervorst, Transfusion 2014

CME An update on mortality and morbidity in patients with very low postoperative hemoglobin levels who decline blood transfusion

Aryeh Shander, Mazyar Javidroozi, Sajjad Naqvi, Oshuare Aregbeyen, Mustafa Çaylan, Selma Demir, and Anna Juhl

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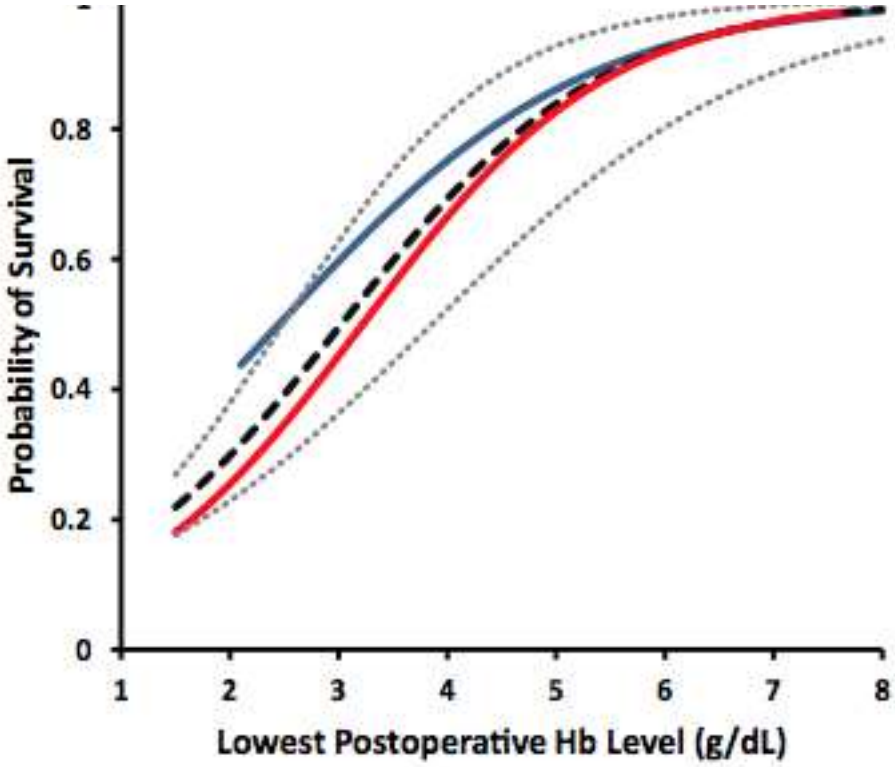
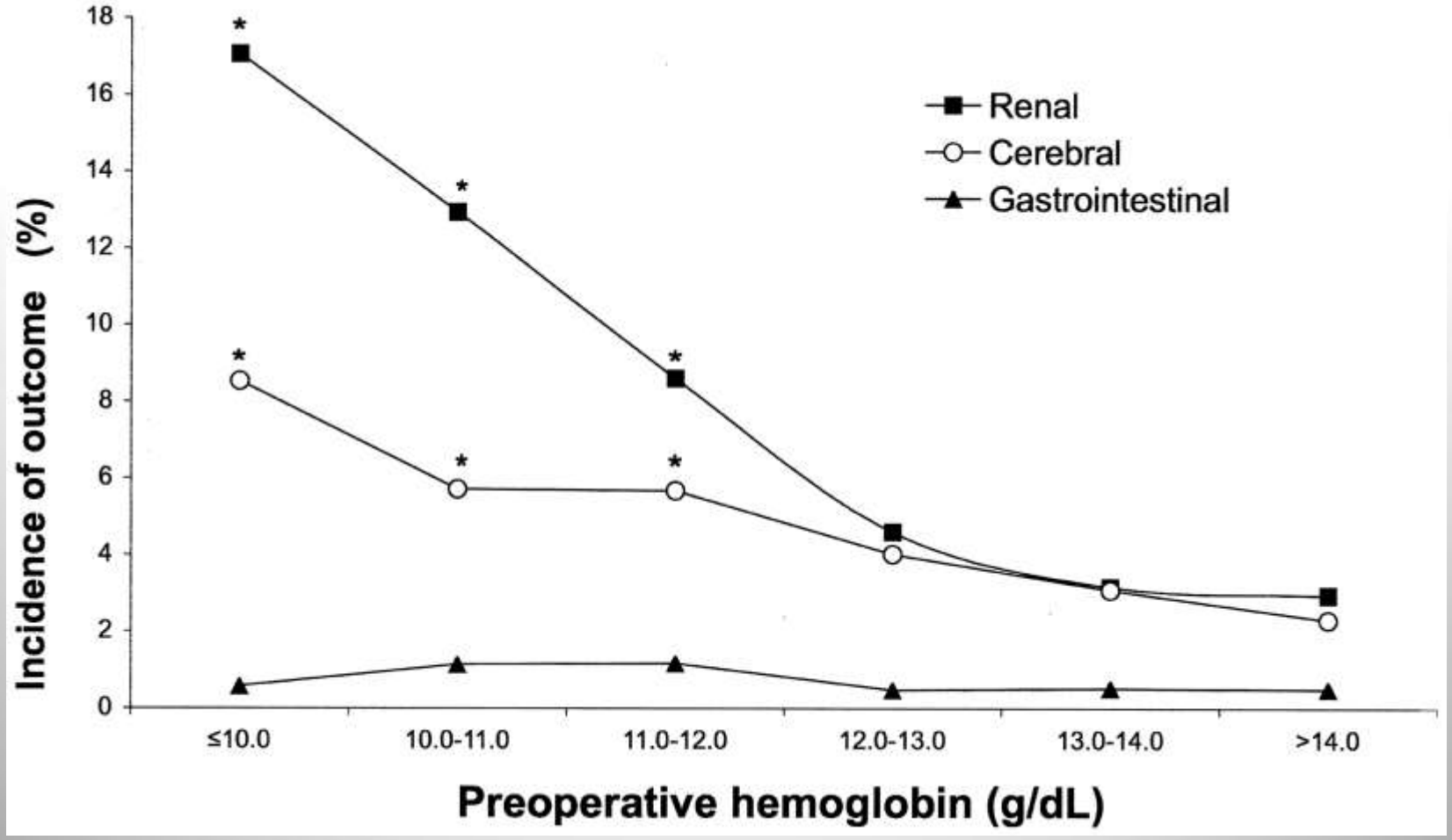


Impact of Preoperative Anemia on Outcome in Patients Undergoing Coronary Artery Bypass Graft Surgery

Cristina Tudor, Stephanie A. Snyder-Ramos, Patrick Moehnle, and Dennis T. Mangano

Circulation
Volume 116(5):471-479
July 31, 2007

Incidence of different noncardiac outcomes for all patients vs preoperative hemoglobin level



Kulier A et al. Circulation. 2007;116:471-479

Anemia - conclusions

- High physiologic tolerance
- M&M increase if Hb <5-6gr%
- Relative Hb decrease relevant
- Preop anemia impacts on M&M
- Less tolerance in coronary disease
- Brain & kidney most at risk

The Good, the Bad and the Ugly

- Blood conservation
- Anaemia & Blood Loss
- Transfusion

TRIM

TRALI

Malaria

Infection

Transmission of VIH, CJF,…

Mortality

Cancer recurrence

GVH

Transfusion reactions

TRIM

TRALI

Malaria

Infection

Transmission of VIH, CJF,…

Mortality

Cancer recurrence

GVH

Transfusion reactions

Variation in Use of Blood Transfusion in Coronary Artery Bypass Graft Surgery

Elliott Bennett-Guerrero, MD
Yue Zhao, PhD
Sean M. O'Brien, PhD
T. B. Ferguson Jr, MD
Eric D. Peterson, MD, MPH
James S. Gammie, MD
Howard K. Song, MD, PhD

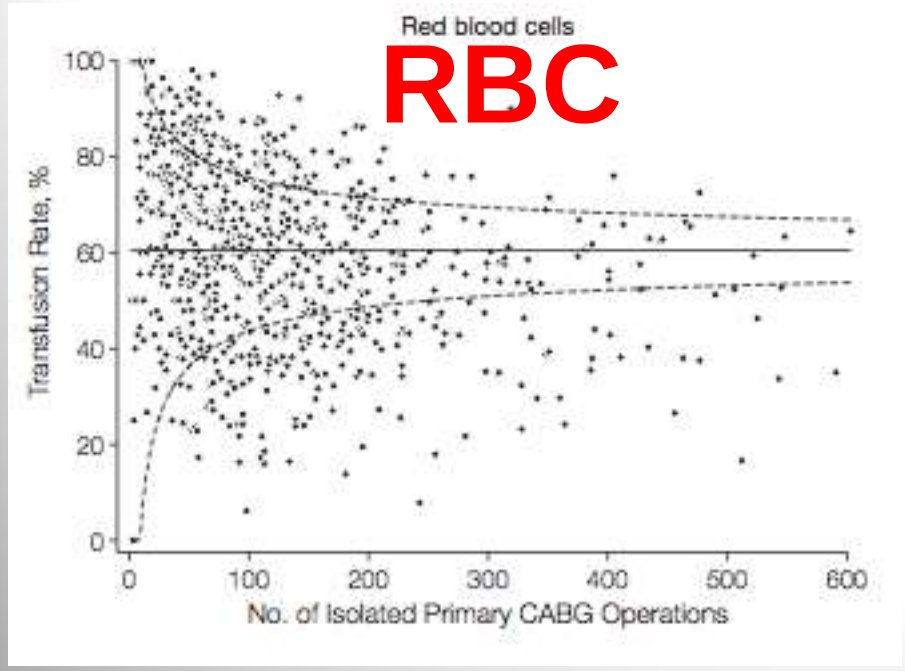
Context Perioperative blood transfusions are costly and have safety concerns. As a result, there have been multiple initiatives to reduce transfusion use. However, the degree to which perioperative transfusion rates vary among hospitals is unknown.

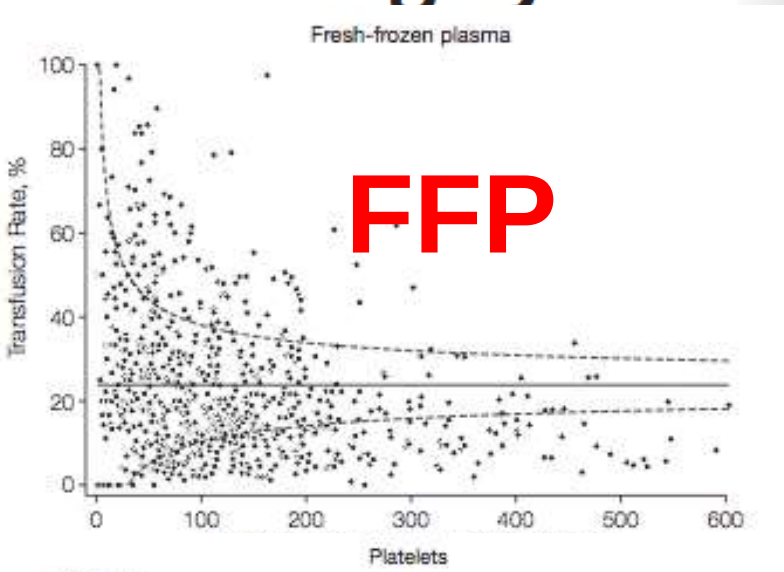
Objective To assess hospital-level variation in use of allogeneic red blood cell (RBC), fresh-frozen plasma, and platelet transfusions in patients undergoing coronary artery bypass graft (CABG) surgery.

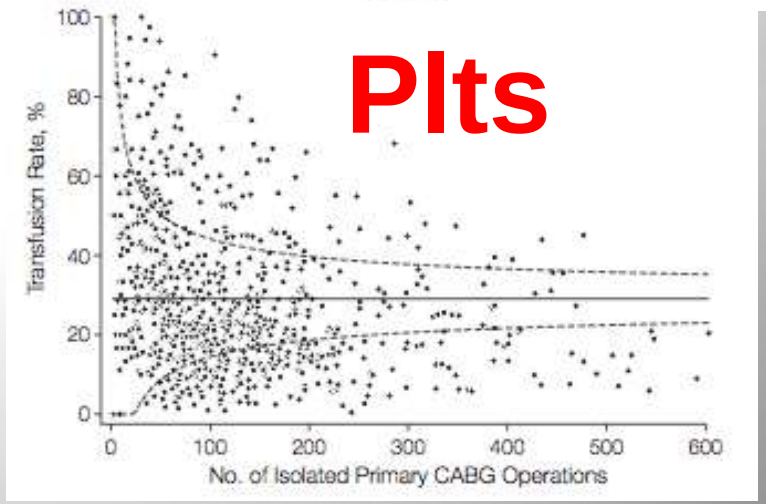
Design, Setting, and Patients An observational cohort of 102 470 patients undergoing primary isolated CABG surgery with cardiopulmonary bypass during calendar year 2008 at 798 sites in the United States, contributing data to the Society of

JAMA, 2010;304:1568-75

Variation in Use of Blood Transfusion in Coronary Artery Bypass Graft Surgery







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Main Outcome Measures Perioperative (intraoperative and postoperative) transfusion of RBCs, fresh-frozen plasma, and platelets.

Results At hospitals performing at least 100 on-pump CABG operations (82 446 cases at 408 sites), the rates of blood transfusion ranged from 7.8% to 92.8% for RBCs, 0% to 97.5% for fresh-frozen plasma, and 0.4% to 90.4% for platelets. Multivariable analysis including data from all 798 sites (102 470 cases) revealed that after adjustment for patient-level risk factors, hospital transfusion rates varied by geographic location ($P=.007$), academic status ($P=.03$), and hospital volume ($P<.001$). However, these 3 hospital characteristics combined only explained 11.1% of the variation in hospital risk-adjusted RBC usage. Case mix explained 20.1% of the variation between hospitals in RBC usage.

Conclusion Wide variability occurred in the rates of transfusion of RBCs and other blood products, independent of case mix, among patients undergoing CABG surgery with cardiopulmonary bypass in US hospitals in an adult cardiac surgical database.

JAMA. 2010;304(14):1568-1575 www.jama.com

PATIENTS WHO UNDERGO CARdiac surgery receive a significant proportion of the 14 million units of allogeneic red blood cells (RBCs) transfused annually in the United States.[1] Numerous observational studies in patients who underwent cardiac surgery have shown an association between RBC transfusion and adverse outcome, including morbidity, mortality, resource utilization, and quality of life.[2-9] To date, no large randomized trials of transfusion thresholds have been conducted in cardiac surgery to our knowledge to address this issue

JAMA, 2010;304:1568-75

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JAMA. 2010;304(14):1568-1575 www.jama.com

JAMA, 2010;304:1568-75

The New England
Journal of Medicine

VOLUME 340 FEBRUARY 11, 1999 NUMBER 6

A MULTICENTER, RANDOMIZED, CONTROLLED CLINICAL TRIAL OF TRANSFUSION REQUIREMENTS IN CRITICAL CARE

PAUL C. HÉBERT, M.D., GEORGE WELLS, PH.D., MORRIS A. BLAJCHMAN, M.D., JOHN MARSHALL, M.D., CLAUDIO MARTIN, M.D., GIUSEPPE PAGLIARELLO, M.D., MARTIN TWEEDDALE, M.D., PH.D., IRWIN SCHWEITZER, M.SC., ELIZABETH YETISIR, M.SC., AND THE TRANSFUSION REQUIREMENTS IN CRITICAL CARE INVESTIGATORS FOR THE CANADIAN CRITICAL CARE TRIALS GROUP*

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association

Increased Mortality, Postoperative Morbidity, and Cost After Red Blood Cell Transfusion in Patients Having Cardiac Surgery

Gavin J. Murphy, Barnaby C. Reeves, Chris A. Rogers, Syed I.A. Rizvi, Lucy Culliford and Gianni D. Angelini

Circulation 2007;116:2544-2552

Transfusion Requirements After Cardiac Surgery

The TRACS Randomized Controlled Trial

Ludhmila A. Hajjar, MD, PhD
Jean-Louis Vincent, MD, PhD
Filomena R. B. G. Galas, MD, PhD
Rosana E. Nakamura, MD
Carolina M. P. Silva, MD
Marilia H. Santos, MD, PhD
Julia Fukushima, MSc
Roberto Kalil Filho, MD, PhD
Denise B. Sierra, MD
Neuza H. Lopes, MD, PhD
Thais Mauad, MD, PhD

Context Perioperative red blood cell transfusion is commonly used to address anemia, an independent risk factor for morbidity and mortality after cardiac operations; however, evidence regarding optimal blood transfusion practice in patients undergoing cardiac surgery is lacking.

Objective To define whether a restrictive perioperative red blood cell transfusion strategy is as safe as a liberal strategy in patients undergoing elective cardiac surgery.

Design, Setting, and Patients The Transfusion Requirements After Cardiac Surgery (TRACS) study, a prospective, randomized, controlled clinical noninferiority trial conducted between February 2009 and February 2010 in an intensive care unit at a university hospital cardiac surgery referral center in Brazil. Consecutive adult patients (n=502) who underwent cardiac surgery with cardiopulmonary bypass were eligible; analysis was by intention-to-treat.

Intervention Patients were randomly assigned to a liberal strategy of blood transfusion (to maintain a hematocrit ≥30%) or to a restrictive strategy (hematocrit ≥24%).

JAMA. 2010;304(14):1559-1567

Restrictive versus liberal transfusion strategy for red blood cell transfusion: systematic review of randomised trials with meta-analysis and trial sequential analysis

Lars B Holst,[1] Marie W Petersen,[1] Nicolai Haase,[1] Anders Perner,[1] Jørn Wetterslev[2]

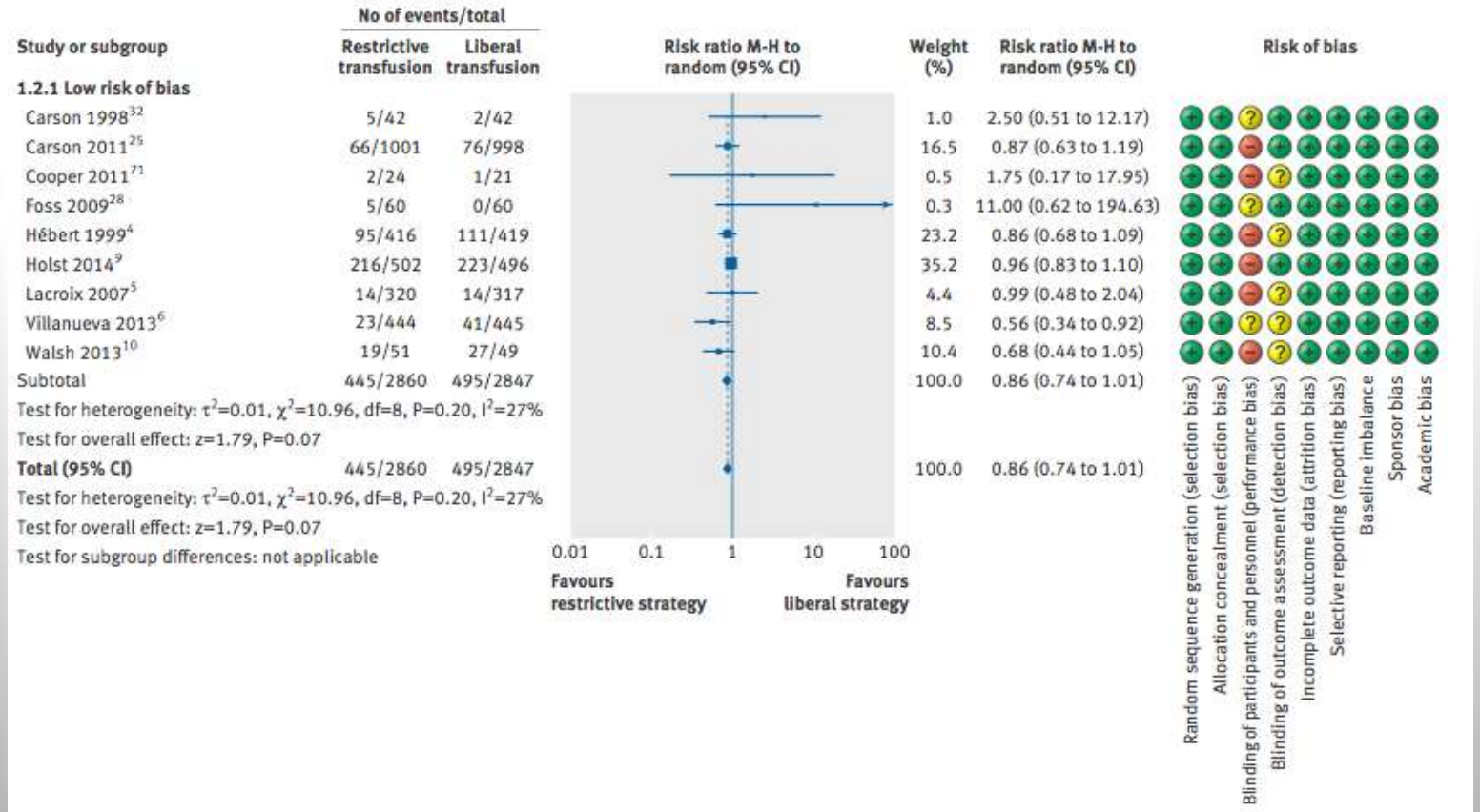


Fig 4 | **Forest plot of mortality in lower risk of bias trials. Size of squares for risk ratio reflects weight of trial in pooled analysis. Horizontal bars represent 95% confidence intervals**

BMJ 2015;350:h1354

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MARCH 12, 2015 VOL. 372 NO. 11

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*

ABSTRACT

NEJM 2015;372:997-1008

British Journal of Anaesthesia 107 (S1): i41–i59 (2011)
doi:10.1093/bja/aer350

BJA

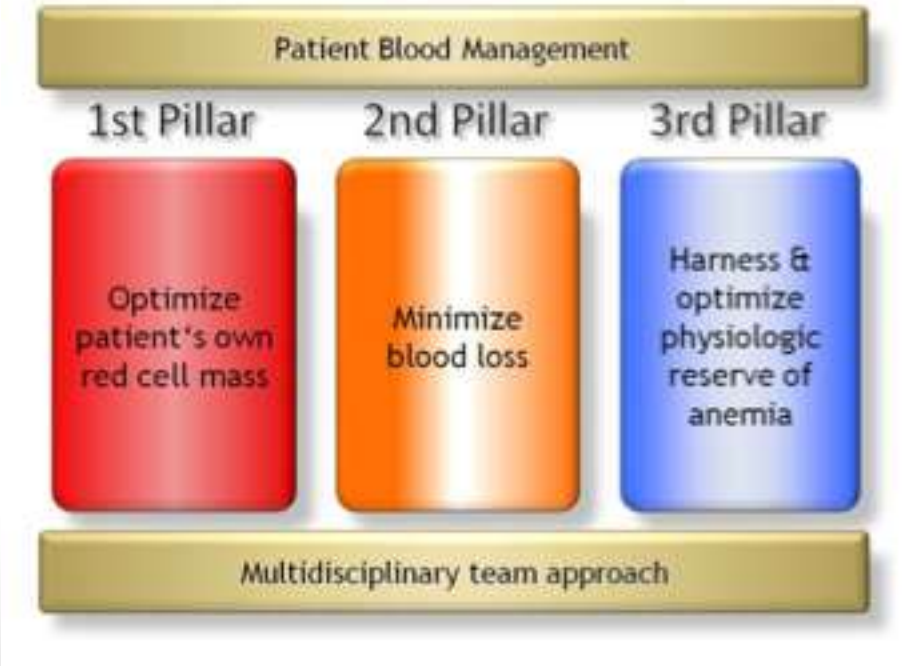
What is really dangerous: anaemia or transfusion?

A. Shander[1,2,3,4*], M. Javidroozi[1], S. Ozawa[5] and G. M. T. Hare[6,7]

- Anaemia & transfusion independently associated with M&M
- Restrictive Transfusion is safe and effective
- ? strategies to
  - optimize haematopoiesis,
  - manipulate physiological responses,
  - minimize blood loss.

From Bloodless Surgery to Patient Blood Management

Aryeh Shander, MD,[1,2] Mazyar Javidroozi, MD, PhD,[1] Seth Perelman, MD,[1] Tom Puzio, MD,[1] Gregg Lobel, MD[1]



EDITORIAL

Patient blood management: a primary theme in transfusion medicine

Patient blood management (PBM) is a clinical, multi-disciplinary approach to optimize the care of patients who may need a transfusion. It is the application of evidence-based medical and surgical concepts to achieve measurable improvements in patient safety and clinical outcomes. Secondary gains can include systemwide cost savings, shorter lengths of stay, and decreased readmissions. The goal is clear and the outcomes are significant, sitting squarely within the "Triple Aim."

Transfusion, October 2014

EDITORIAL

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Transfusion, October 2014

Heart surgery in Jehovah's Witnesses in Breda Lessons learned 1997-2004

P.M.J. Rosseel *, B van der Meer *, M Bentala *, M Verduijn §, N Peek §, N.F. de Keizer §

*** Thoraxcenter Amphia Hospital Breda**

§ Klinische Informatiekunde AMC Amsterdam

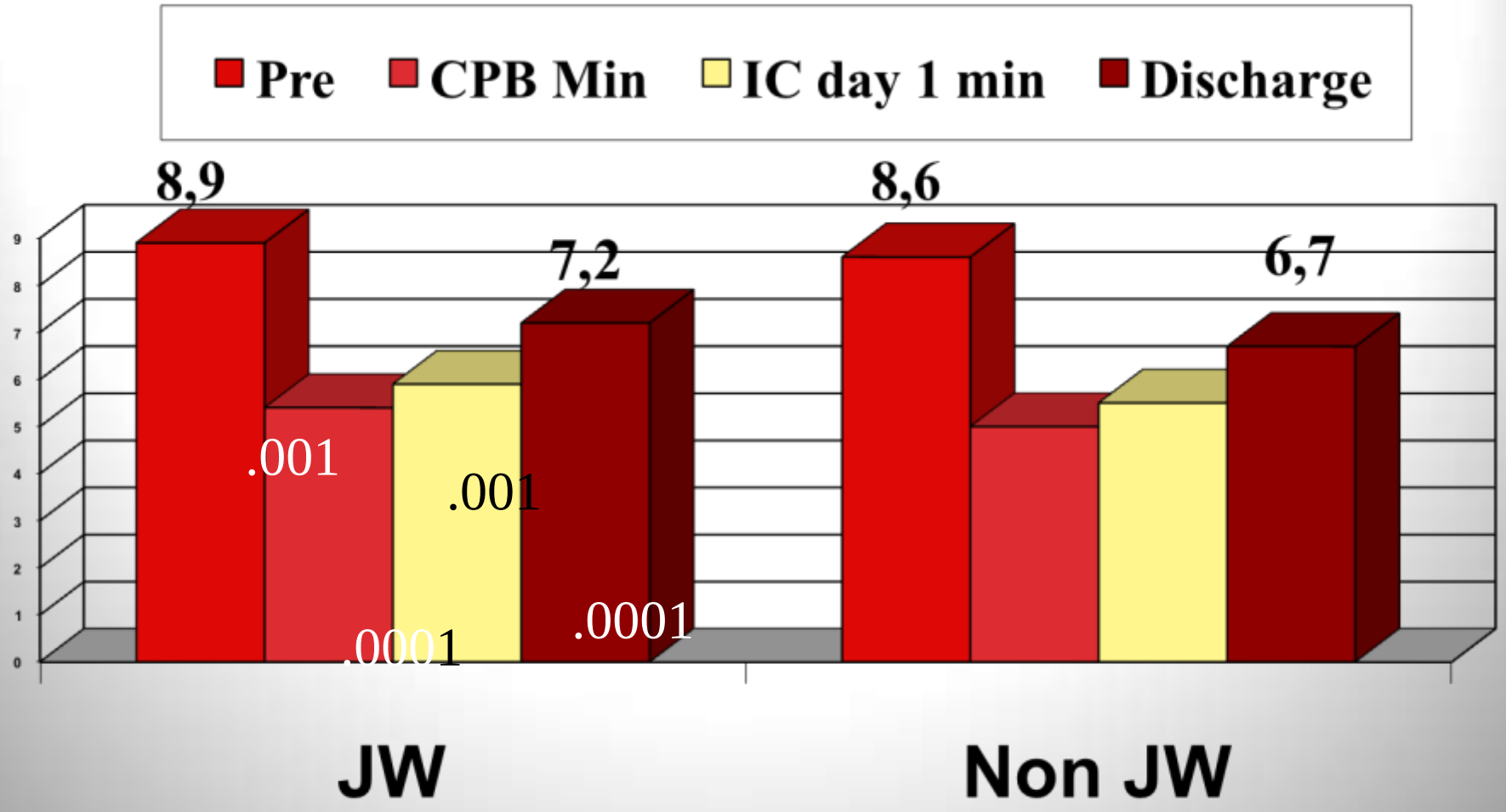
Outcome

	JW (n=116)	Control (n=349)	OR	CI	P
Mortality % (n)	2.6% (3)	1.2% (4)	2.28	0.5 – 10.4	0.285
ELOS % (n)	12.1% (14)	11.8% (41)	1.03	0.5 – 2.0	0.934
MACE % (n)	15.3% (15)	9.9% (29)	1.65	0.9 - 3.2	0.142

Transfusion characteristics

	JW	Control	P
Transfused % (n)	0% (0)	50.9% (5722)	<0.0001
Packed Cells % (n)	0% (0)	48.5% (5451)	<0.0001
FFP % (n)	0% (0)	16.8% (1887)	<0.0001
Trombocytes % (n)	0% (0)	14.6% (1636)	<0.0001
Blood loss 1st 12 h (ml)	587 ± 309	914 ± 650	<0.0001
Resternotomy (%)	3.4%	8.8%	0.045

Hemoglobin evolution



Amphia 2005 situation

- 25-30% of Tx in cardiac surgery
- 7-9 % resternotomies = 150/y = 3/week
- TX exposure = 65% of OHO
- Avg transfusion exposure of all patients
  - = 4.2 IU/patient or
  - = 6.7 IU/transfused patient
  - PC = 250€, FFP= 250€, TC=500€
- € 80.000 / y platelets destroyed

Effect of Anesthesiologist

Blood-management	Anesthesiologist X		Other		Interval	
	N	%	N	%	MIN	MAX
Cyclokapron / Aprotinine	128	94,1	1110	89,7	88,1%	94,1%
Blood loss > 1000 ml.	6	4,4	155	12,5	4,4%	16,3%
Transfused	51	37,5	537	43,4	37,5%	45,6%
Resternotomy	7	5,2	97	7,8	4,7%	9,3%

Effect of Anesthesiologist

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Resternotomy	7	5,2	97	7,8	4,7%	9,3%

Effect of Surgeon

Blood-management	Surgeon Y		Other surgeons		Interval	
	N	%	N	%	MIN	MAX
Cyclokapron / Aprotinine	149	100,0	1089	89,0	51,6%	100,0%
Blood loss > 1000 ml.	9	6,0	152	12,4	6,0%	19,3%
Transfused	53	35,6	535	43,7	35,6%	47,2%
Resternotomy	2	1,3	102	8,3	1,3%	9,8%

Effect of Surgeon

Blood-management	Surgeon Y		Other surgeons		Interval	
	N	%	N	%	MIN	MAX
Cyclokapron / Aprotinine	149	100,0	1089	89,0	51,6%	100,0%
Blood loss > 1000 ml.	9	6,0	152	12,4	6,0%	19,3%
Transfused	53	35,6	535	43,7	35,6%	47,2%
Resternotomy	2	1,3	102	8,3	1,3%	9,8%

How to improve Practice ?

- Look for the evidence
  - Guidelines
  - Expert opinion
- Look for your allies
- Start by getting the basics right - KISS
- Expect resistance & cope with it

From Bloodless Surgery to Patient Blood Management

Aryeh Shander, MD,[1,2] Mazyar Javidroozi, MD, PhD,[1] Seth Perelman, MD,[1] Tom Puzio, MD,[1] Gregg Lobel, MD[1]

	1st Pillar Optimize hematopoiesis	2nd Pillar Minimize blood loss & bleeding	3rd Pillar Harness & optimize tolerance of anemia
Preoperative	• Screen for anemia • Identify underlying disorder(s) causing anemia • Manage underlying disorder(s) • Refer for further evaluation if necessary • Treat iron deficiency, anemia of chronic disease, iron-restricted erythropoiesis • Note: anemia is a contraindication for elective surgery	• Identify and manage bleeding risk (past/family history, current medications, etc) • Minimize iatrogenic blood loss • Procedure planning and rehearsal • Preoperative autologous blood donation (in selected cases or when patient choice)	• Assess/optimize patient's physiological reserve and risk factors • Compare estimated blood loss with patient-specific tolerable blood loss • Formulate patient-specific management plan using appropriate blood conservation modalities to minimize blood loss, optimize red cell mass and manage anemia • Restrictive, evidence-based transfusion strategies
Intraoperative	• Timing surgery with hematological optimization	• Meticulous hemostasis and surgical techniques • Blood-sparing surgical techniques • Anesthetic blood conserving strategies • Autologous blood options • Pharmacological/haemostatic agents	• Optimize cardiac output • Optimize ventilation and oxygenation • Restrictive, evidence-based transfusion strategies
Postoperative	• Treat anemia /iron deficiency • Stimulate erythropoiesis • Be aware of drug interactions that can cause/increase anemia	• Vigilant monitoring and management of post-operative bleeding • Avoid secondary hemorrhage • Rapid warming - maintain normothermia (unless hypothermia specifically indicated) • Autologous blood salvage • Minimize iatrogenic blood loss • Hemostasis/anticoagulation management • Prophylaxis of upper GI hemorrhage • Avoid/treat infections promptly • Be aware of adverse effects of medications	• Optimize tolerance of anaemia • Treat anaemia • Maximize oxygen delivery • Minimize oxygen consumption • Avoid/treat infections promptly • Restrictive, evidence-based transfusion strategies

Figure 2- Patient blood management in practice.

Examples of blood management strategies considered during care of a general surgical patient. Many strategies can also be used in care of non-surgical patients (Modified from Shander A and Goodnough LT. 2006) (8).

Blood conservation program – 4 pillars

- Limit Blood loss
- Blood salvage)
- Decrease Hb trigger
- Decrease logistical losses

1. Preventing blood loss

- Optimize preop anticoagulation
- Meticulous surgical technique
- Minimize cardiotomy suction
- Antifibrinolytics
- Avoiding excessive hemodilution
- Avoid hypothermia
- Standardized heparine/protamine use
- Low Prime (MECC?)
- Rapid resternotomy in case of major blood loss

2. Recuperate blood loss

- Cellsaver available in each OR
- 2 step approach
- Team collaboration

3. Rationalized prescription of transfusion products

- Uniform & EB prescription of Tx : flexible transfusion trigger (4-5-6 FLEXNORM)
- Take into account preoperative risk (EUROscore)
- Motivated prescription mandatory

4. Decrease logistic losses of local bloodbank

- Decrease stocks in WE and at night
- Postop Max. prescription of 1 IU PC, 2 IU FFP and 1 IU TC

Perioperative Blood Transfusion and Blood Conservation in Cardiac Surgery: The Society of Thoracic Surgeons and The Society of Cardiovascular Anesthesiologists Clinical Practice Guideline*

The Society of Thoracic Surgeons Blood Conservation Guideline Task Force: Victor A. Ferraris, MD, PhD (Chair), Suellen P. Ferraris, PhD, Sibu P. Saha, MD, Eugene A. Hessel II, MD, Constance K. Haan, MD, MS, B. David Royston, MD, Charles R. Bridges, MD, ScD, Robert S. D. Higgins, MD, George Despotis, MD, and Jeremiah R. Brown, PhD

The Society of Cardiovascular Anesthesiologists Special Task Force on Blood Transfusion: Bruce D. Spiess, MD, FAHA (Chair), Linda Shore-Lesserson, MD, Mark Stafford-Smith, MD, C. David Mazer, MD, Elliott Bennett-Guerrero, MD, Steven E. Hill, MD, and Simon Body, MB, ChB

Ann Thorac Surg 2007;83:S27– 86

STS & SCA guidelines
Class I recommendations

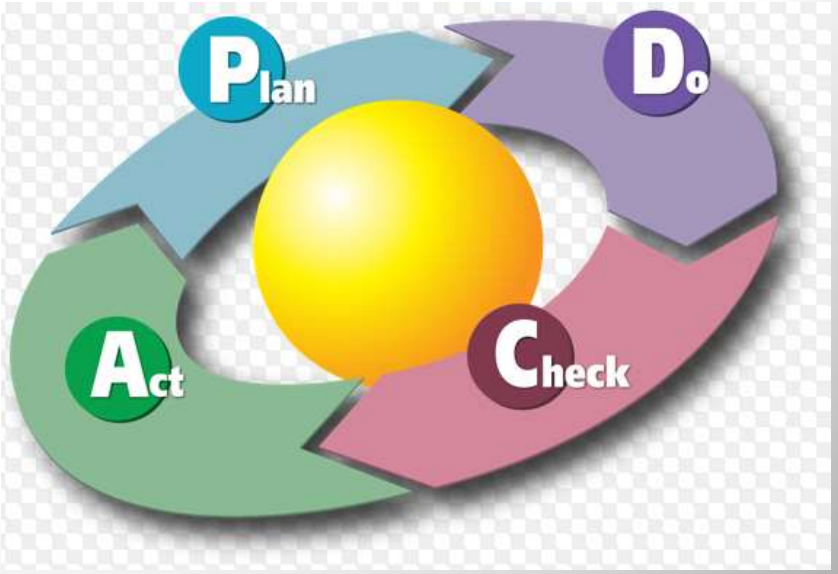
- Identify High Risk Patients (1A)
- Preop Hb and Plts count (1A)
- Use antifibrinolytics (1A)
- Routine cell salvage (1A)
- Multimodality approach including algorhytm (1A)

Class III interventions

- Routine DDAVP
- Routine PEEP
- Plasmapheresis
- Tx for Hb > 10 g/L
- Direct reinfusion of shed blood
- Leucocyte filters
- Topical hemostatic agents based on bovine thrombin
- Dipyridamol

Clinical Practice Improvement Project: « Faster & Better »

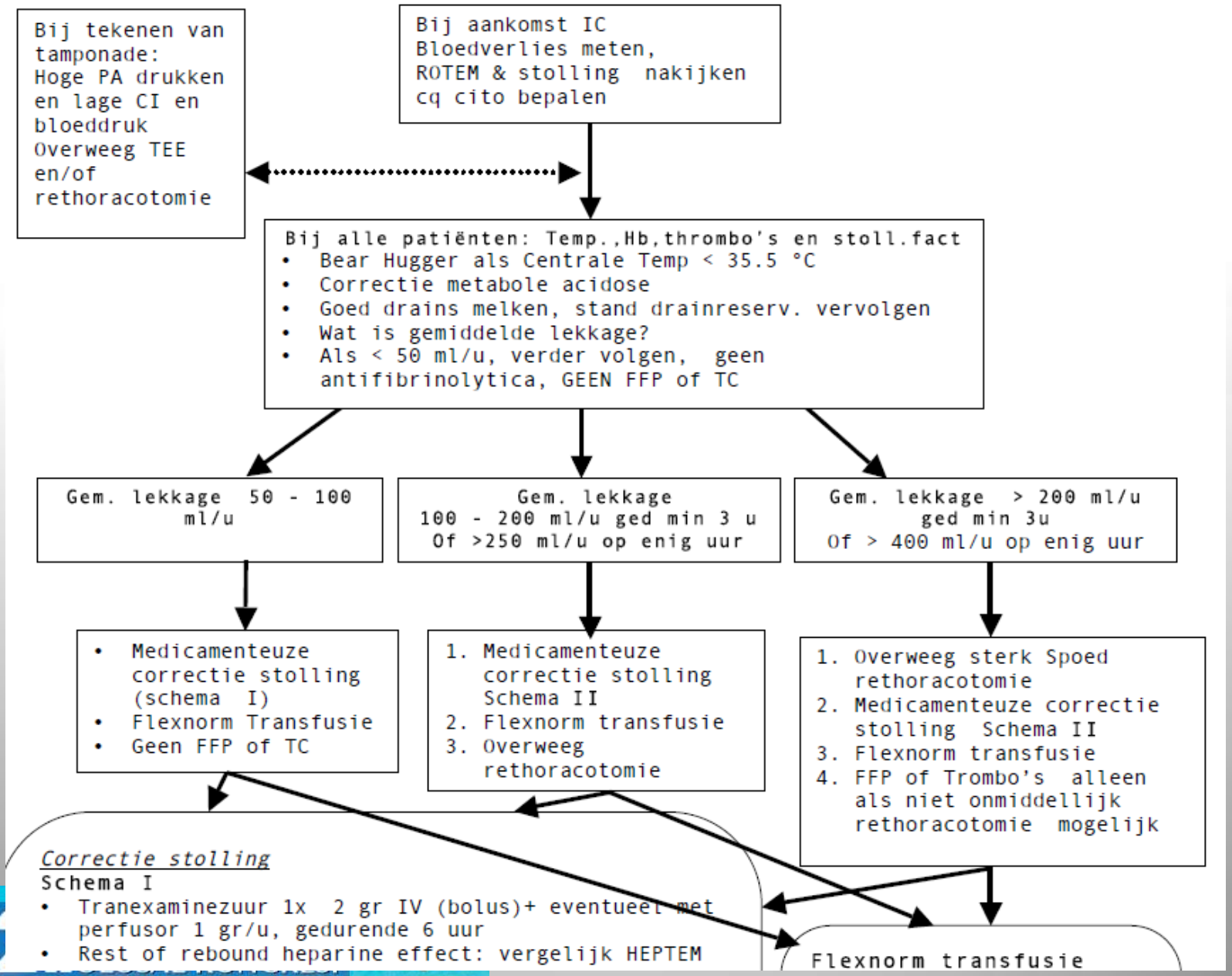
- Plan
- Zero Measurement
- TC wide project
- Teamwork
- Tight time schedule



Clinical Practice Improvement Project: « Faster & Better »

- Time schedule/constraint
- Project
- Teamwork
- SMART

IC Transfusie Flowdiagram - cardiochirurgie

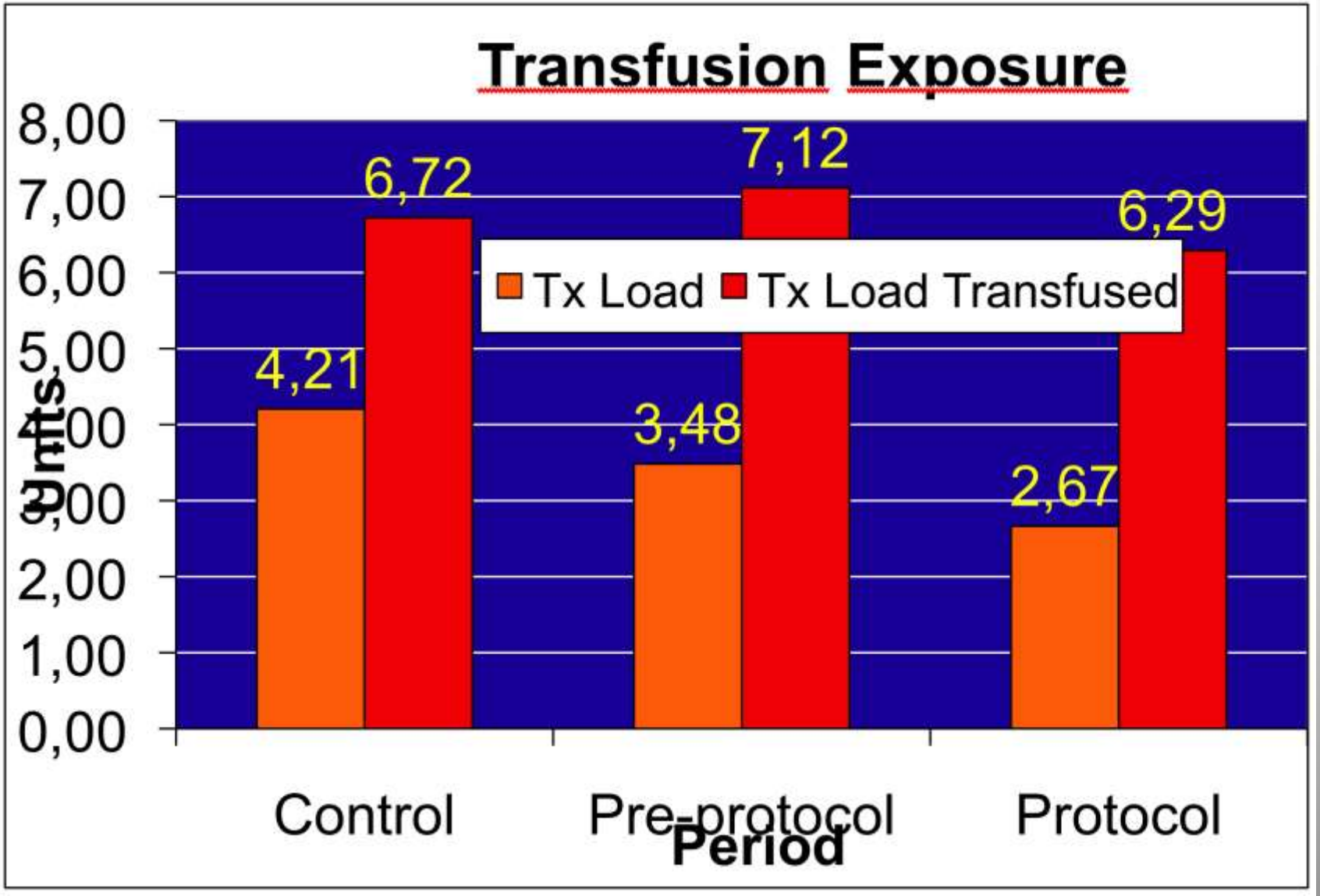


Objectives of project

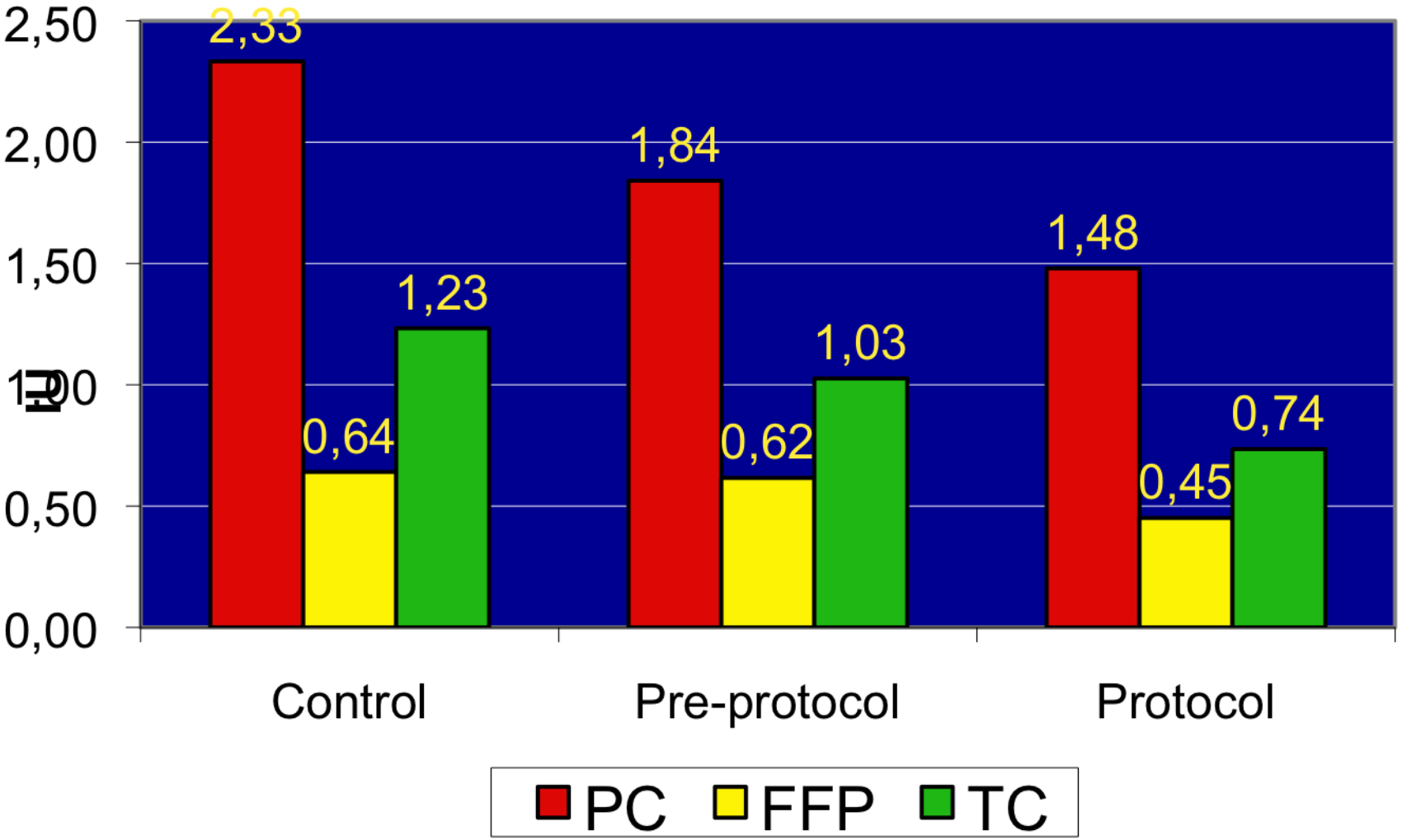
- Reduction of average transfusion exposure in IU transfusion products, taking into account the whole perioperative period, with 50% within the given time frame of 1 march – 30 september 2006.
- Increase the number of "transfusion-free" patients, taking into account the whole perioperative period, with 50% within the given time frame of 1 march – 30 september 2006
- Without worsening of mortality (SMR) and morbidity

The Project – Il Buono

- Multi-disciplinary
- EB Protocol
- PERI-operative
- Motivation & sensibilisation
- Implementation
- Feedback


Transfusion Exposure
8,00
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
Units
4,21
6,72
3,48
7,12
2,67
6,29
Tx Load
Tx Load Transfused
Control
Pre-protocol
Protocol
Period

Transfusion Components



Mortality

	Control	pre-protocol	Project
Euroscore>8	7,7%	10,3%	9,7%
3<Euroscore<8	1,0%	1,4%	1,1%
Euroscore<3	0,0%	0,0%	0,0%

Cost Benefit

- Net “profit » = € 241.259/y.
- € 30.000 below best case scenario (50% reduction)

Conclusions

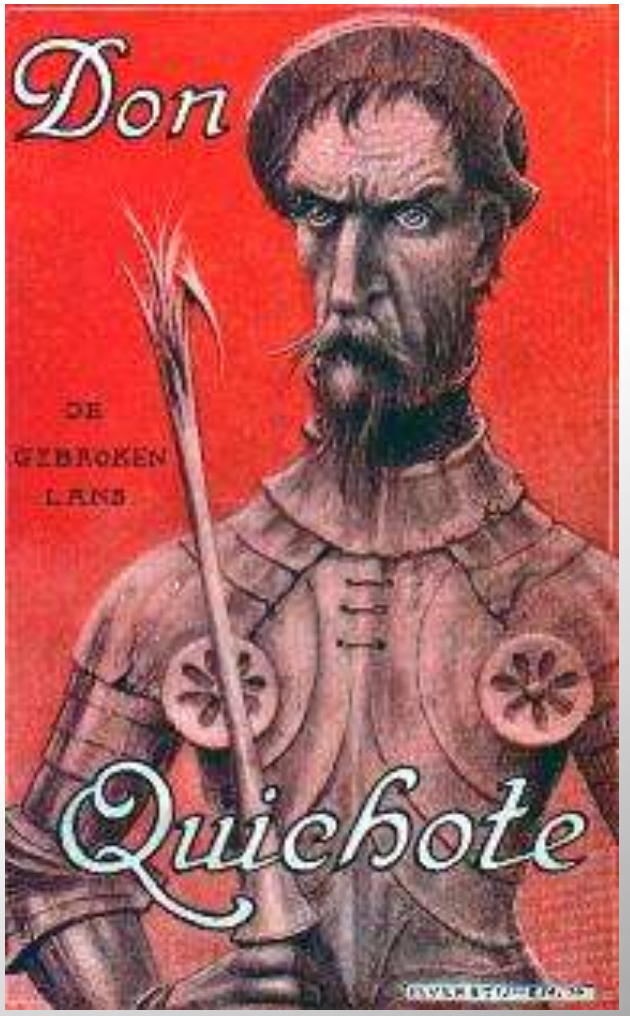
- 50% objective almost obtained
- Reduction in Tx exposure & transfused patients
- More patients with less blood loss
- Insignificant improvement in number of « bleeders « .
- No decrease in resternotomies

Conclusions (2)

- Nice cost benefit
- Hb at discharge = 6,5 +/- 0,9 mmol/L
- No increase in M&M.
- Protocol deviations i.p. aprotinin
- Bleeders difficult to predict
- No coagulation monitoring
- Anticipation on expected coagulation problems

Encountered problems

- Protocol; No reliable measurement of coagulation and platelet function
- Psychological, sociological, group dynamics, fighting prejudices



BMC Medical Informatics and Decision Making

BioMed Central

Research article

Open Access

Factors influencing the implementation of clinical guidelines for health care professionals: A systematic meta-review

Anneke L Francke*, Marieke C Smit, Anke JE de Veer and Patriek Mistiaen

Results: Twelve systematic reviews met our inclusion criteria. No previous systematic meta-reviews meeting all our inclusion criteria were found. Two of the twelve reviews scored high on the checklist used, indicating only "minimal" or "minor flaws". The other ten reviews scored in the lowest of middle ranges, indicating "extensive" or "major" flaws.

A substantial proportion (although not all) of the reviews indicates that effective strategies often have multiple components and that the use of one single strategy, such as reminders only or an educational intervention, is less effective.

Besides, characteristics of the guidelines themselves affect actual use. For instance, guidelines that are easy to understand, can easily be tried out, and do not require specific resources, have a greater chance of implementation.

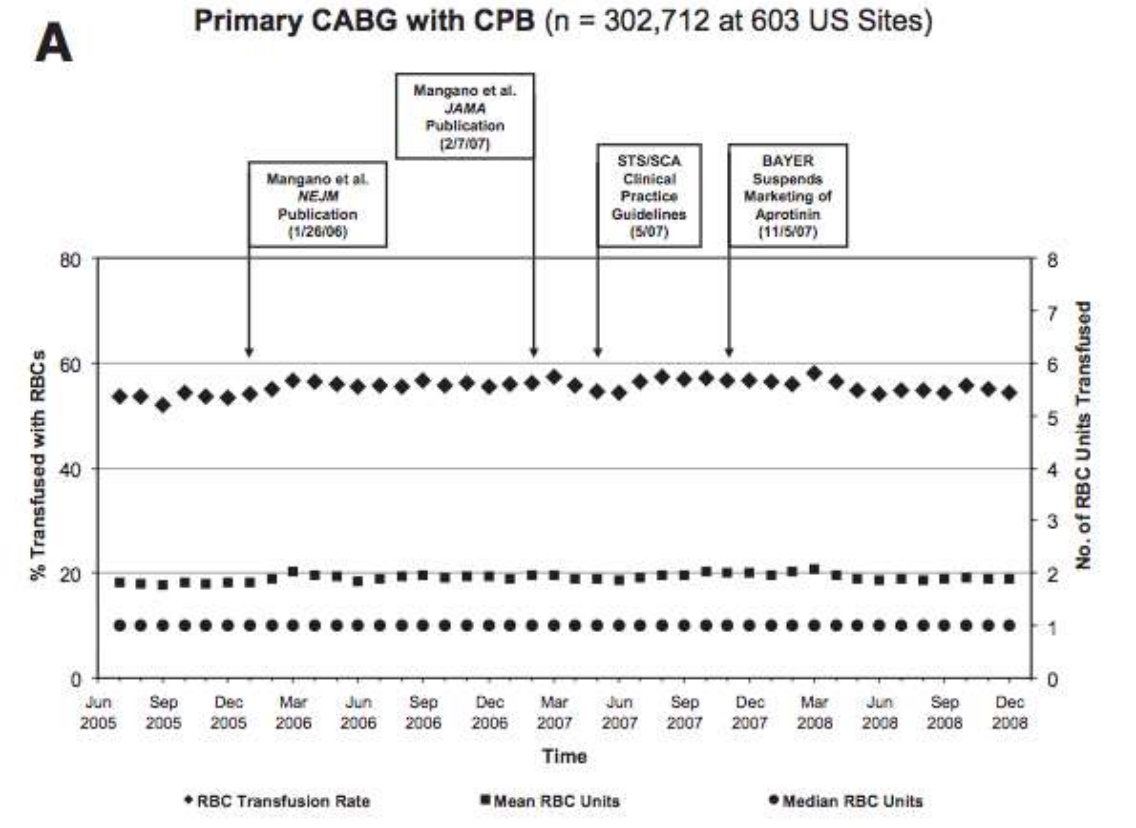
In addition, characteristics of professionals – e.g., awareness of the existence of the guideline and familiarity with its content – likewise affect implementation.

Furthermore, patient characteristics appear to exert influence: for instance, co-morbidity reduces the chance that guidelines are followed.

Finally, environmental characteristics may influence guideline implementation. For example, a lack of support from peers or superiors, as well as insufficient staff and time, appear to be the main impediments.

Temporal Changes in the Use of Blood Products for Coronary Artery Bypass Graft Surgery in North America: An Analysis of the Society of Thoracic Surgeons Adult Cardiac Database

Elliott Bennett-Guerrero, MD,* Howard K. Song, MD, PhD,§ Yue Zhao, PhD,† T.B. Ferguson Jr, MD,¶



JCTVA 2010;24:814-816

Remaining problems

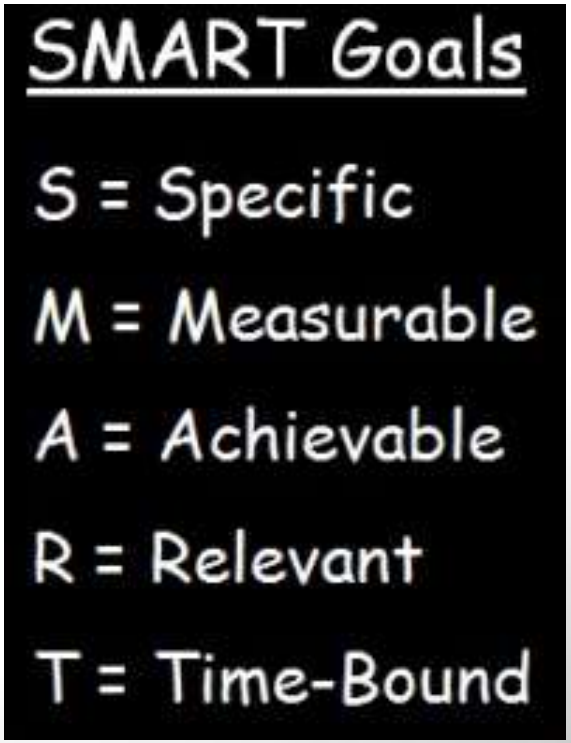
- CRM
  - Protocol compliance
  - Hb trigger still too high?
  - Individual behaviour
- "Technical"
  - Microvascular bleeding
  - Coagulation
  - Flexnorm trigger not very effective
  - Preop anaemia !!!

What happens then?

- Surveillance
- Organical
  - team evolution
  - CP changes (Fluids, Cardioplegia)
- Coagulation protocol
- STS 2011 update

Coagulation protocol

- Introduced in 2009
- ROTEM
  - Stat lab
  - Single Measurement post Protamin
- Component therapy introduced in algorhytm
- Central lab 2013



2011 Update to The Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists Blood Conservation Clinical Practice Guidelines*

The Society of Thoracic Surgeons Blood Conservation Guideline Task Force:
Victor A. Ferraris, MD, PhD (Chair), Jeremiah R. Brown, PhD, George J. Despotis, MD, John W. Hammon, MD, T. Brett Reece, MD, Sibu P. Saha, MD, MBA, Howard K. Song, MD, PhD, and Ellen R. Clough, PhD

The Society of Cardiovascular Anesthesiologists Special Task Force on Blood Transfusion:
Linda J. Shore-Lesserson, MD, Lawrence T. Goodnough, MD, C. David Mazer, MD, Aryeh Shander, MD, Mark Stafford-Smith, MD, and Jonathan Waters, MD

The International Consortium for Evidence Based Perfusion:
Robert A. Baker, PhD, Dip Perf, CCP (Aus), Timothy A. Dickinson, MS, Daniel J. FitzGerald, CCP, LP, Donald S. Likosky, PhD, and Kenneth G. Shann, CCP

Ann Thorac Surg 2011;91:944–82

Shift of Evidence in 2011

- Aprotinine IA ➔ IIIB
- Upgrade of evidence
  - Increase preop RC mass (EPO)
  - Cell saver for rest prime
  - Minimize hemodilution (Mecc, INH, UF, Cell saver, Microplegia)
  - Use Topical hemostatic agents
  - Plasmapheresis may be useful IIa (A)
  - MUF as well in Adults
- Amended
  - Plt P2Y12 receptor blockers (3 days=OK)
  - POC ADP non responder identification Multiplate

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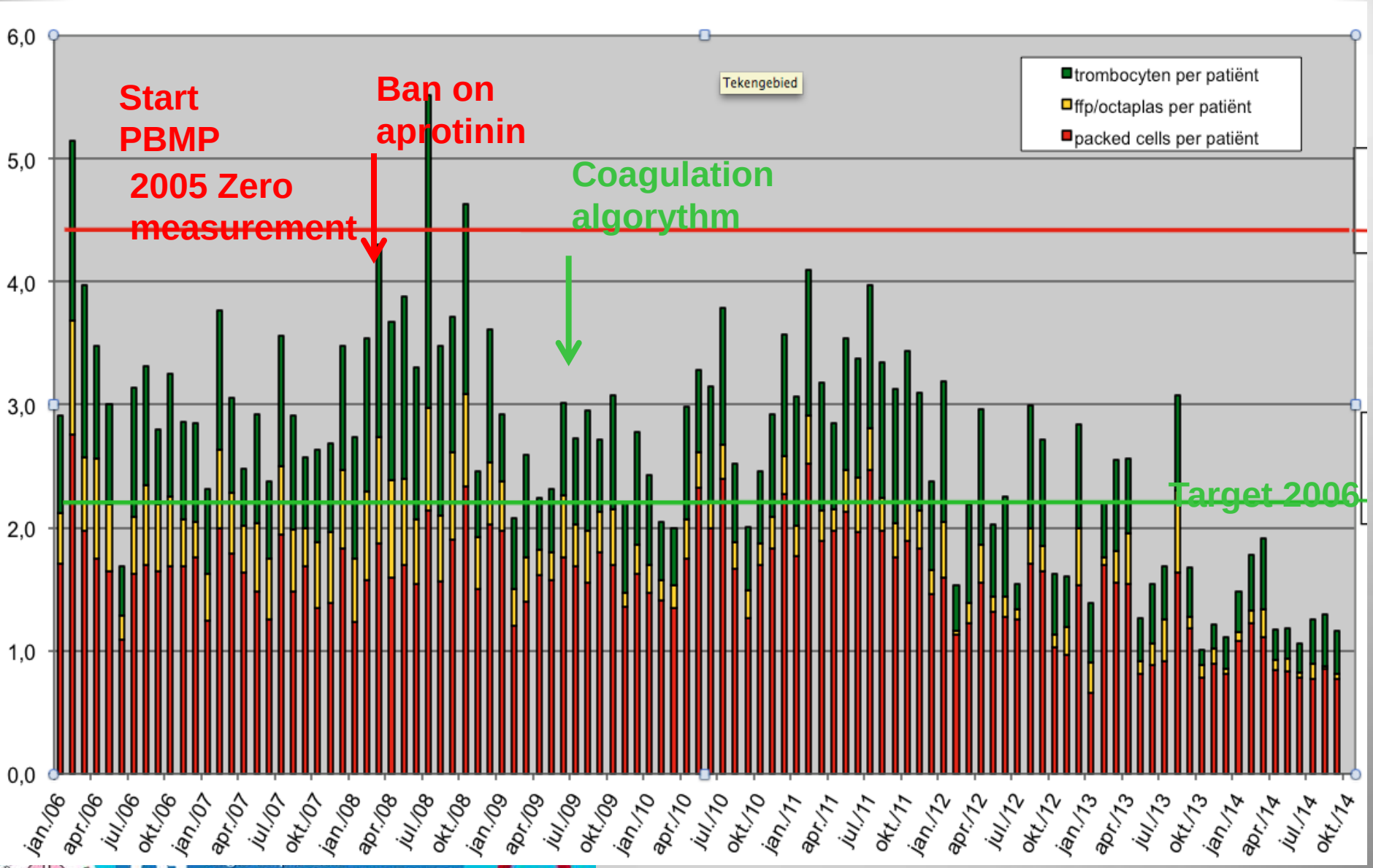
  - Plt P2Y12 receptor blockers (3 days=OK)
  - POC ADP non responder identification Multiplate

Additions in 2011

- ASA + postop plt blockers increase bleeding (exc recent DES)
- EPO + iron (←→ EPO alone)
- FFP or Cryo if serious bleeding and fractionated products unavailable
- PPC for Coumadin reversal (FFP if insufficient level of Factor VII
- FFP OK for massive bleeding
- Profylactic FFP = IIIA
- FFP IIIA for non bleeding Coumadin reversal

It probably matters more how you do it than what you do
+ multimodality (EB) strategies
+ multidisciplinary approach
+TQM

- MECC
- Vacuum assist venous drainage
- Biocompatible ECC circuit
- MUF IN ADULT



Variable	JW (N=225)	<2006 (N=8084)	2006-2009 (N=4199)	>2009 (N=6688)
General				
Age (mean±sd)	67.12 ± 10.3	65.97 ± 10.2	67.55 ± 10.3	68.39 ± 10.2
Female (%)	27.6	27.5	30.2	30.1
Body mass index (mean±sd)	28.2 ± 4.3	27.1 ± 3.9	27.2 ± 4.2	27.4 ± 4.3
Type of surgery				
Isolated CABG (%)	59.6	70.4	58.6	49.9
Isolated valve operation (%)	24.0	15.5	22.1	26.4
Combined CABG+valve operation (%)	12.4	10.8	15.2	14.5
Other (%)	4.0	3.3	4.1	9.2
Reoperation (%)	4.0	7.2	6.8	6.8
Elective surgery (%)	96.0	93.2	91.2	88.7
Co-morbidity				
EuroSCORE (mean±SD; median)	4.91 ± 2.9 5	5.41 ± 3.8 5	5.86 ± 3.7 5	5.92 ± 3.6 6
- EuroSCORE > 8 (%)	11.1	19.0	22.2	21.0
- EuroSCORE < 3 (%)	22.2	24.2	18.7	16.9
Diabetes mellitus (%) (= type 1+2)	24.1	18.6	20.1	21.5
Ejection fraction >50 (%)	76.2	78.0	75.6	60.4
Ejection fraction <25 (%)	9.9	4.4	5.0	22.0
Infarction < 4 weeks (%)	7.3	9.9	12.3	13.8
CVA/TIA (%)	11.2	9.2	11.2	11.3
Hemoglobin (mean±sd)	9.09 ± 0.69	8.65 ± 0.98	8.51 ± 1.06	8.47 ± 1.03
Creatinine (mean±sd; median)	89.28 ± 23.0; 85	95.08 ± 54.6; 87	98.67 ± 81.4; 87	92.50 ± 54.6; 84
Preoperative treatment				
Aspirin (%)	57.8	56.5	56.4	57.2
< 3 days before surgery (%) of users	23.9	33.9	52.0	70.2
Clopidogrel (%)	14.5	14.2	24.5	21.4
< 3 days before surgery (%) of users	13.8	33.8	58.2	72.6
Nitroglycerin, intravenous (%)	5.8	8.5	7.5	6.7

Intraoperative variables	JW	<2006	2006-2009	>2009
Off pump surgery (%)	14.2	11.0	11.3	10.3
AOX	62.5±39.5; 61	66.0±41.9; 62	67.1±42.0; 64	65.5±42.2; 60
ECC	90.7±55.0; 87	98.8±61.9; 93	98.5±60.5; 93	98.5±62.1; 91
OR duration	260.2±130.4; 243	258.2±93.0; 245	246.7±85.9; 233	238.7±88.7; 225
Minimal OR temp	34.2±2.0; 34.2	32.7±2.2; 32.6	34.1±1.8; 34.0	34.8±1.9; 35.4
Cell saver use (%)	62.7	10.4	68.6	69.4
Cell saved volume (ml)	457±267; 425	767±983; 500	623±346; 580	630±335; 600
Antifibrinolytics				
- Aprotinin (%)	29.7	18.1	8.8	0.3
- Tranexamic acid (%)	53.3	16.6	79.7	89.5
Heparin in mg	324±120; 300	335±126; 300	379±137; 375	331±134; 350

Mean ± SD; median

Blood transfustion related variable	JW	<2006	2006-2009	>2009	p-value
Number of patients	225	8084	4199	6688	
Blood loss first 12 postop h (mean, median, interquartile range)	429.2; 325	890.1; 725	697.7 ; 550	368.8; 250	<0.001
Major blood loss first 12 postop hours	9.8	20.2	19.5	6.1	<0.001
Non allogeneic blood transfusion (%)	99.6	43.5	51.6	54.4	<0.001
Transfused allogeneic blood products in units (mean, median)	..	3.23; 1	2.41; 0	1.97; 0	<0.001
Major transfusion (>4IU) (%)	..	21.0	15.7	12.3	<0.001
Non Major blood loss in first 12 hours	..	..	..	..	..
Transfused allogeneic blood products in units (mean, median)	..	1.80; 0	1.34; 0	1.49; 0	<0.001
Transfused packed cells in units given (mean, median)	..	1.41; 0	1.05; 0	1.24; 0	<0.001
Minimal operative hemoglobin (mean±sd)	5.87 ± 0.96	5.07 ± 0.87	5.43 ± 0.95	5.79 ± 1.10	<0.001
Maximal hematocrit in first day ICU (mean±sd)	34.8 ± 4.0	31.6 ± 3.5	32.3 ± 3.9	34.3 ± 4.2	<0.001
Hemoglobin at hospital discharge (mean±sd)	6.99 ± 1.03	6.69 ± 0.80	6.45 ± 0.81	6.36 ± 0.83	<0.001
Desmopressine (%)	8.1	..	6.1	3.1	<0.001
PCC (%)	4.3	0	5.1	6.5	0.004
per patient, ml (mean, median)	41.2; 30	..	27.6; 20	25.0; 20	0.005

- Decrease in blood loss
- Less bleeders
- Less resternotomies
- Decreased Tx
- Increase in PCC, fibrinogen use
- Slight decrease in discharge Hb

Key Factors of CPI Process

- Simple Process interventions work best
- Bottom up approach – KISS
- SMART Goals
- Multimodality – Multidisciplinary - Perioperative effort
- Ongoing Team effort
- Surveillance
- Human factors - CRM (Sociology, psychology, group dynamics and informal leaderschip)

We know what to do but perform poorly in implementing it in our daily practice …
Teamwork may be the missing link

Conclusion

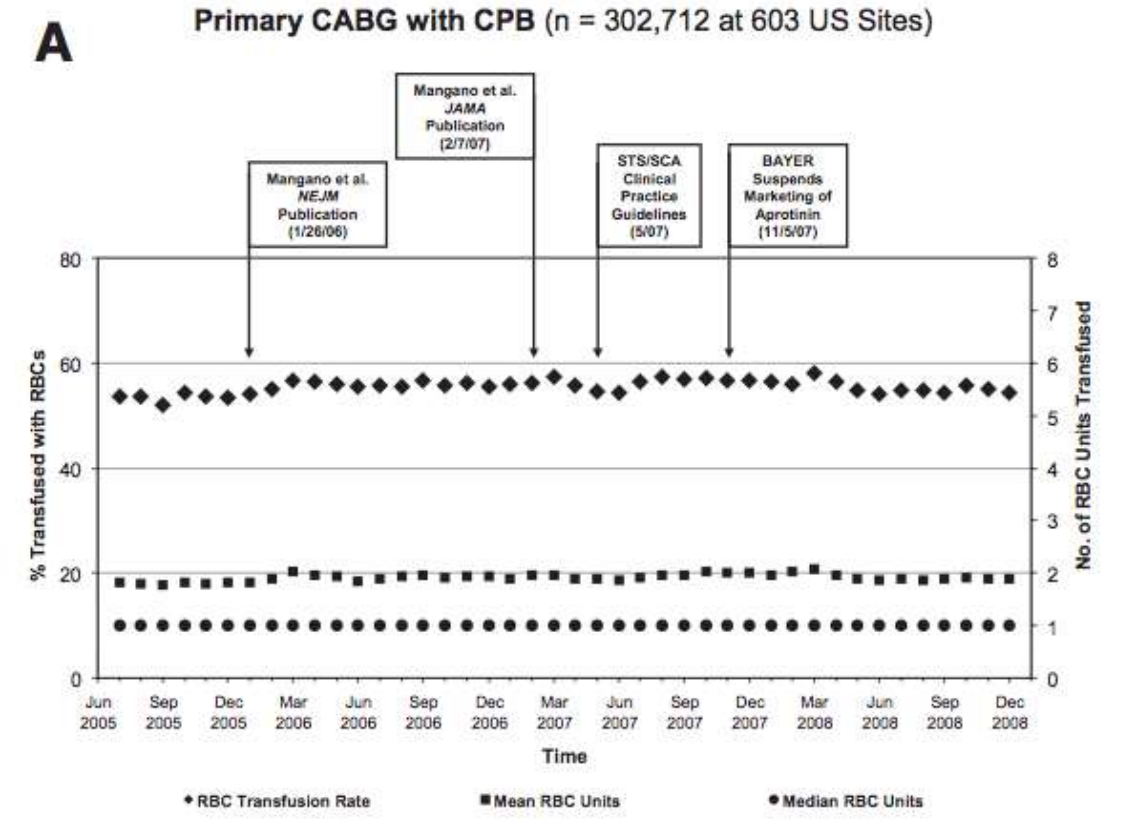
- PBM
  - Effective in saving blood transfusion
  - Safe
  - Cost beneficial
  - Adequate response to scarcity of blood
- Is an important CTVA determinant of global quality and outcome
- BUT IT IS A TEAM EFFORT


teşekkür ederim


KEEP
CALM
AND
BECOME A
JEHOVAH WITNESS

Temporal Changes in the Use of Blood Products for Coronary Artery Bypass Graft Surgery in North America: An Analysis of the Society of Thoracic Surgeons Adult Cardiac Database

Elliott Bennett-Guerrero, MD,* Howard K. Song, MD, PhD,§ Yue Zhao, PhD,† T.B. Ferguson Jr, MD,¶



JCTVA 2010;24:814-816

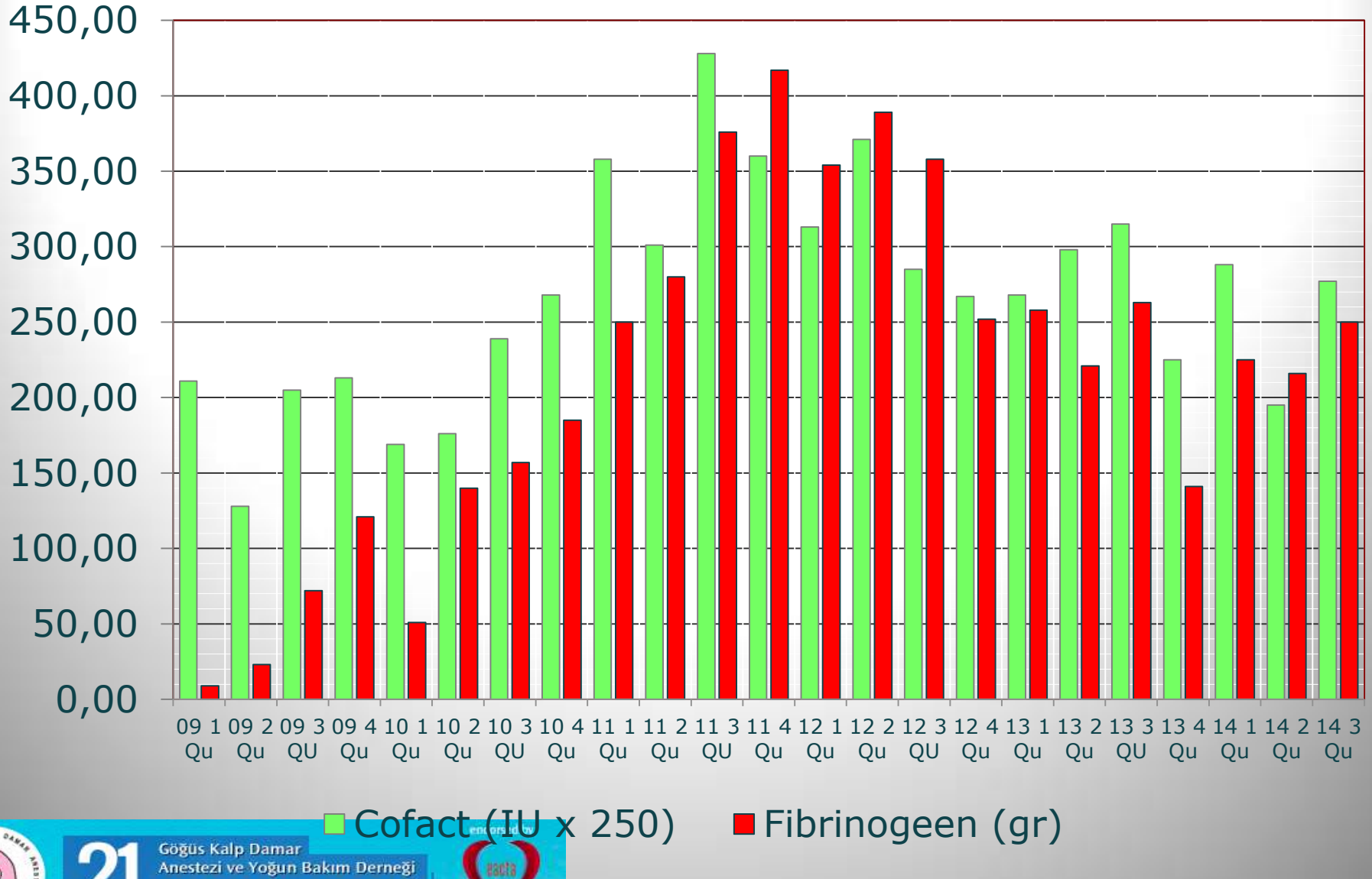
The Good, the Bad and the Ugly

- Anaemia & Blood Loss
- Transfusion
- Patient Blood Management

6 C's of Team Working

Blood transfustion related variable	JW	<2006	2006-2009	>2009	p-value
Number of patients	225	8084	4199	6688	
Mortality	(0.9%)	241 (3.0%)	3.5%	3.0%	
Myocardial Infarction	6.2%	11.1%	7.1%	4.8%	

Fibr. &Cofact:
Consumption OR + IC 2009-2013



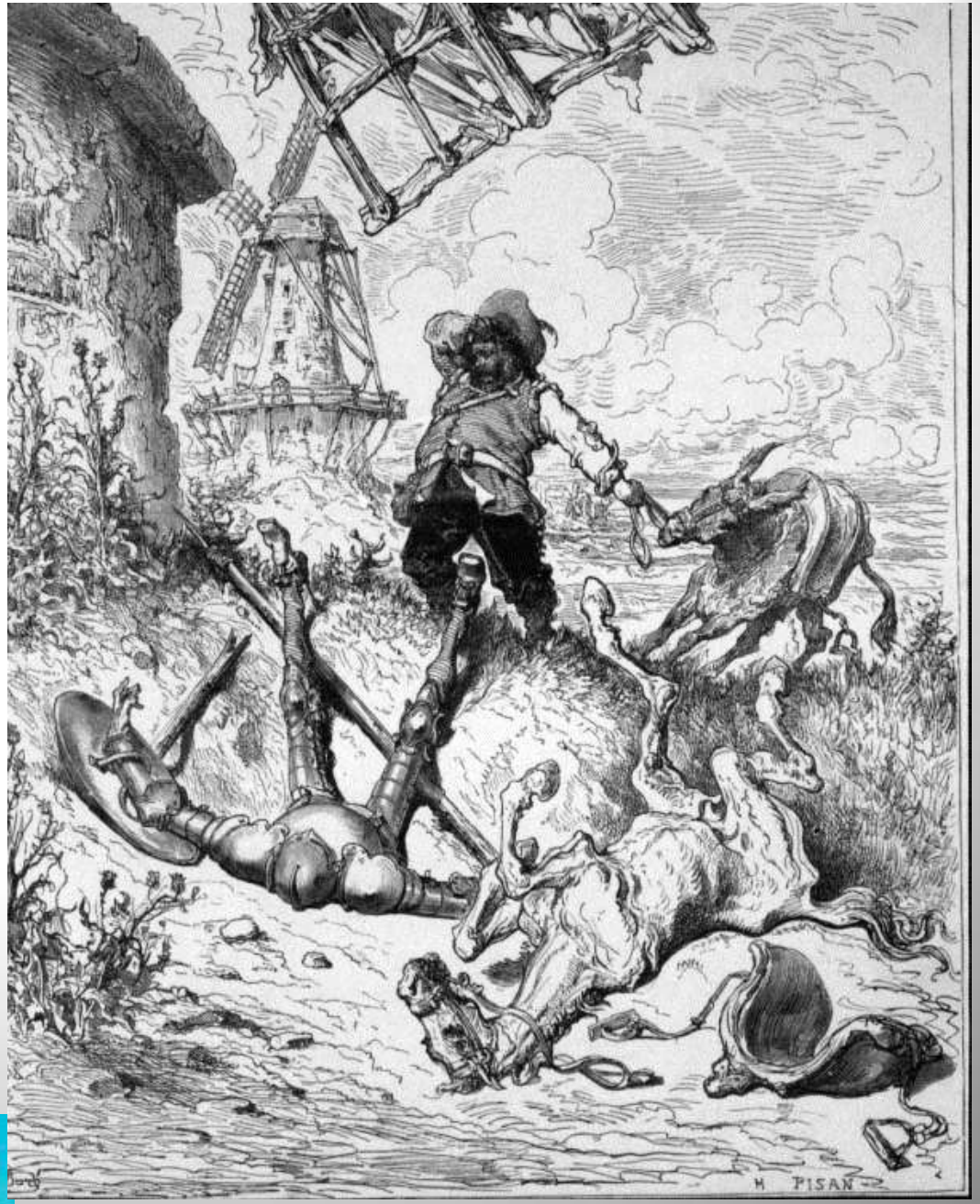

Questions?

Teamwork @ at the cutting edge

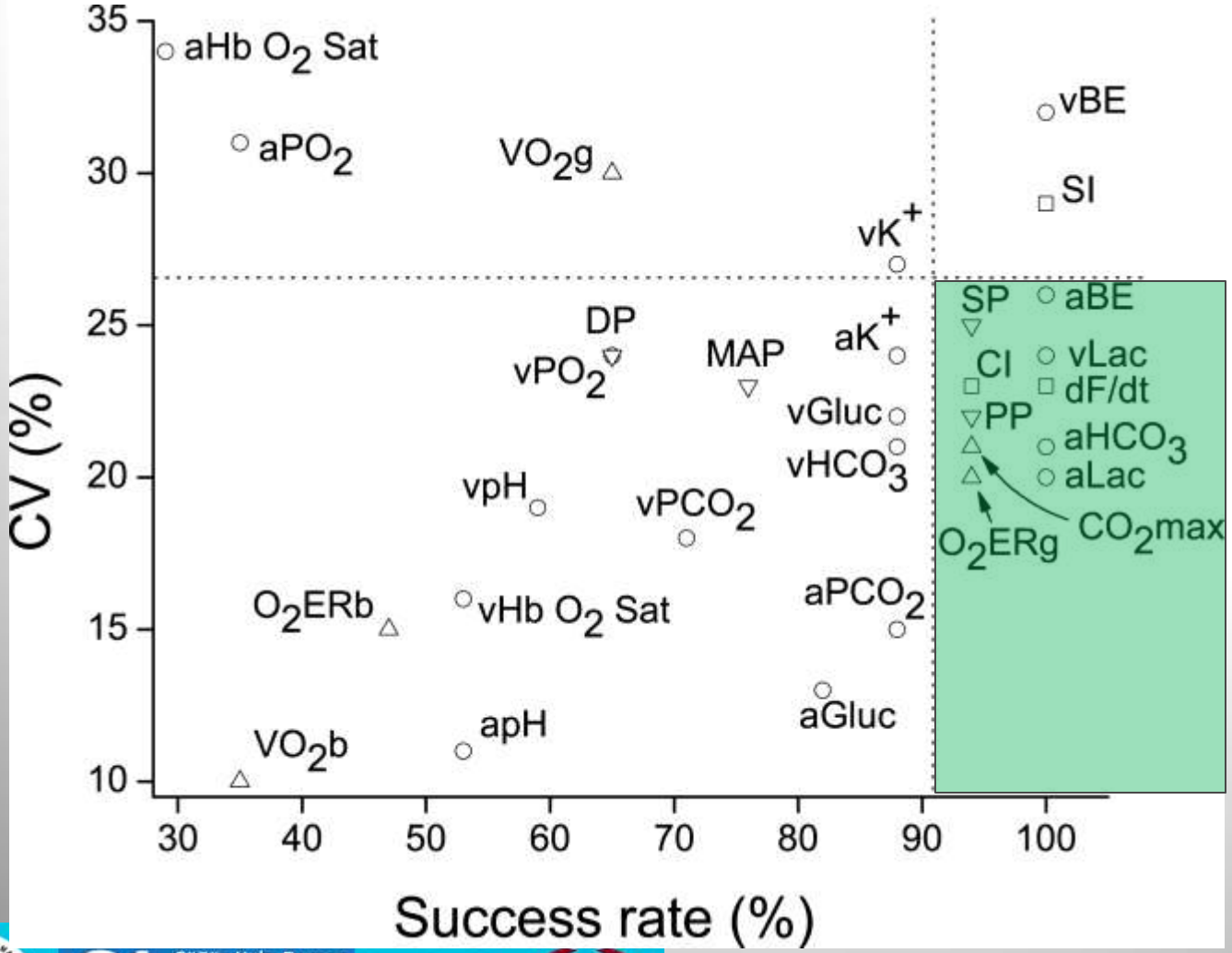
We know better what to do than to implement it effectively in daily practice

...Team work may be the missing link

- ✓Therefore EACTA 2012 choose teamwork between cardiothoracic surgeons, anesthesiologists, perfusionists and intensivists as the central theme for its Annual Meeting 2012
- ✓These specialties will interact in a very interdisciplinary program, including several perfusionists .
- ✓the meeting will end with a multidisciplinary debate around the teamwork theme
- ✓We are inviting the European Perfusionist Community to participate in EACTA 2012 that will be held in Amsterdam from Wednesday 23d to


H PISAN

Coefficient of variation and success rate for predicting critical DO2 during isovolemic hemodilution in rats



Torres Filho, I. P. et al. Am J Physiol Heart Circ Physiol 288: H1071-H1079 2005

Transfusion algorithms

- 7 RCT tested transfusion algoritms w/ POC testing
- 6/7 reduced Tx or resternotomy rate irrespective of
  - Type of POC
  - Algorithm

Pre-operative Hb and odds ratio for mortality in 1958 Jehovah's witness patients

Differences in pts with cardiovascular dise

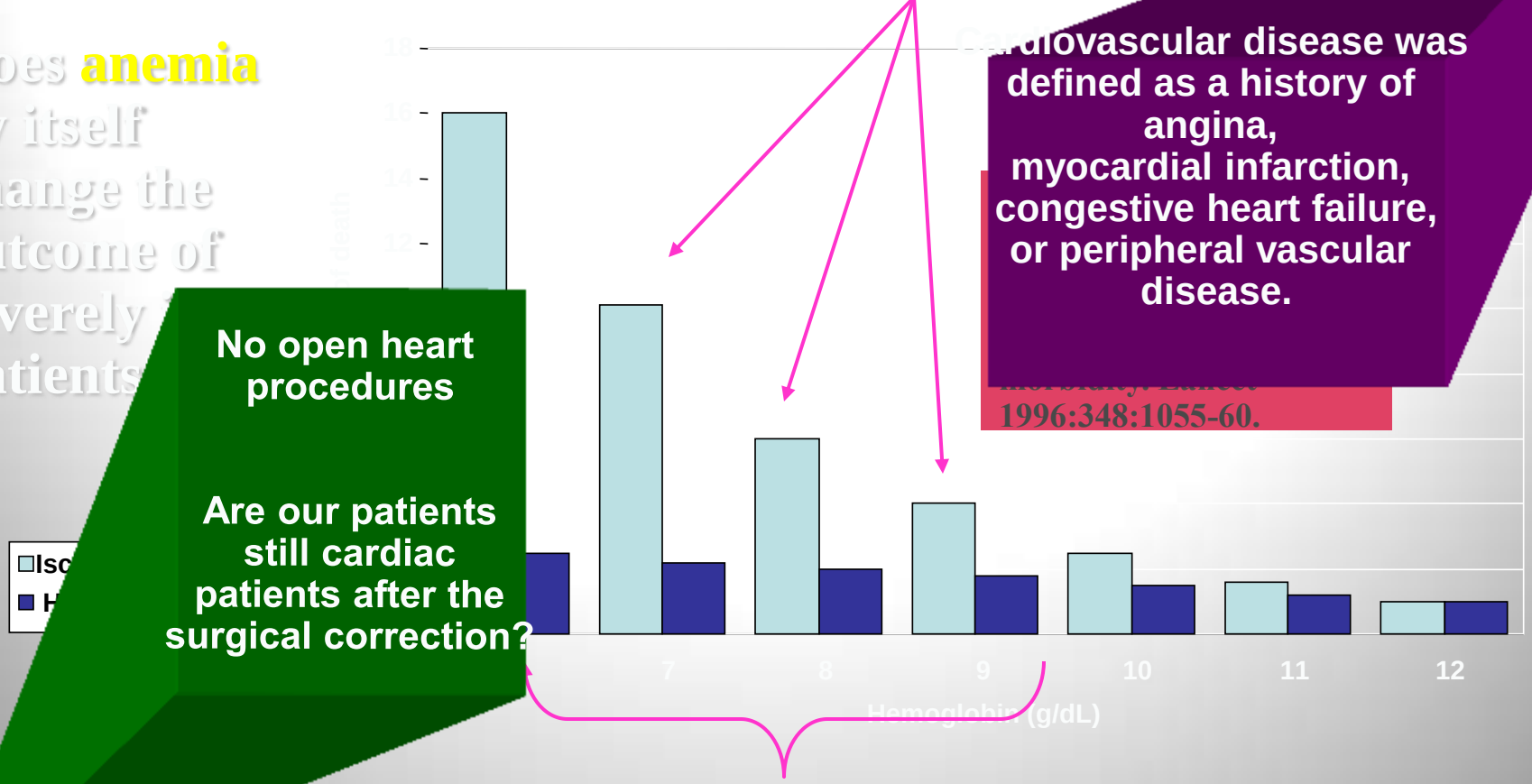
Does anemia by itself change the outcome of severely patients

Cardiovascular disease was defined as a history of angina, myocardial infarction, congestive heart failure, or peripheral vascular disease.

1996:348:1055-60.

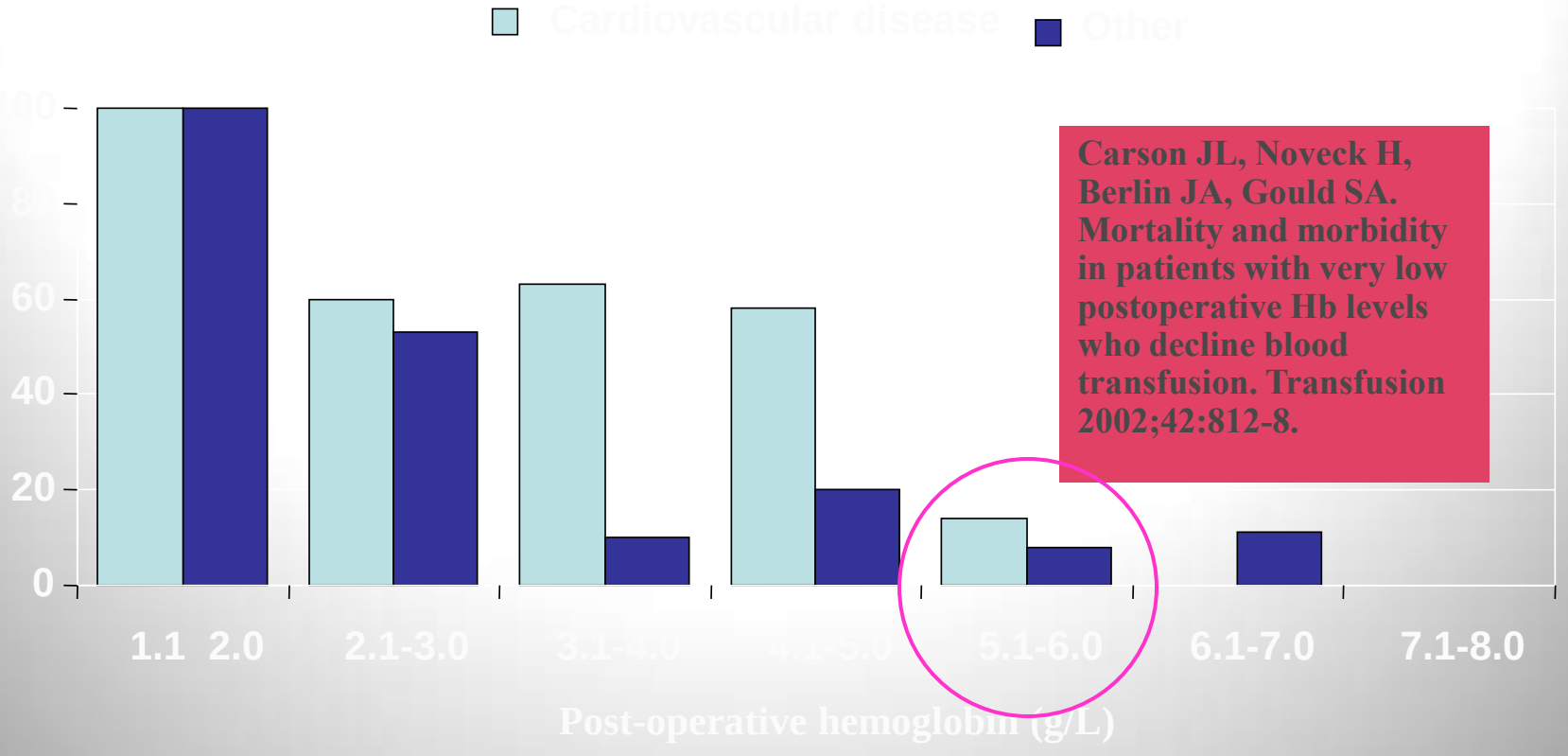
No open heart procedures

Are our patients still cardiac patients after the surgical correction?



No differences in pts without cardiovascular disease

AND IF THE HB IS VERY LOW……



Carson JL, Noveck H, Berlin JA, Gould SA. Mortality and morbidity in patients with very low postoperative Hb levels who decline blood transfusion. Transfusion 2002;42:812-8.

A value of 6.0 makes a lot of sense as a lower limit

ACC/AHA classifcation on Practice Guidelines

- **Classification of Recommendations**
  - Class I: Evidence and/or general agreement of usefulness and efficacy .
  - Class II: Conflicting evidence and/or a divergence of opinion about the usefulness/efficacy .
    - IIa. Weight of evidence/opinion is in favor
    - IIb. Usefulness/efficacy is less well established.
  - Class III: Evidence and/or general agreement that the treatment is not useful/effective, and in some cases may be harmful.
- **Level of Evidence**
  - Level A Data derived from multiple randomized clinical trials
  - Level B Data derived from a single randomized trial, or non-randomized studies
  - Level C Consensus opinion of experts

Table 8. Amphia transfusion risk LR model developed on the training data (n=3803)

Variable	Beta	OR	95% CI	p-value
Constant	-1.74	0.2		
Age (per 5 years over 60)[a]	0.21	1.2	1.2-1.3	<0.001
Female	0.89	2.4	2.0-3.0	<0.001
Body mass index level (25-34.9, 20-24.9, <20)[b]	0.71	2.0	1.8-2.4	<0.001
Isolated CABG	-0.35	0.7	0.6-0.9	0.001
Nonisolated surgery	0.82	2.3	1.7-3.1	<0.001
Reoperation	0.43	1.5	1.1-2.1	0.006
Nonelective surgery	0.71	2.0	1.4-2.9	<0.001
Diabetes mellitus	0.23	1.3	1.0-1.5	0.020
Ejection fraction level (25-49.9, < 25)[c]	0.21	1.2	1.0-1.4	0.004
Hemoglobin < 8.4	1.33	3.8	3.1-4.5	<0.001
Creatinine level (120-149.9, >150)[c]	0.54	1.7	1.4-2.1	<0.001
Using blood conservation protocol	-0.88	0.4	0.3-0.5	<0.001

[a] 1 point for every 5 years

[b] 3 levels, in case of second level double points, in case of third level three points

[c] 2 levels, in case of second level double points

Developing a Blood Conservation Program in Cardiac Surgery

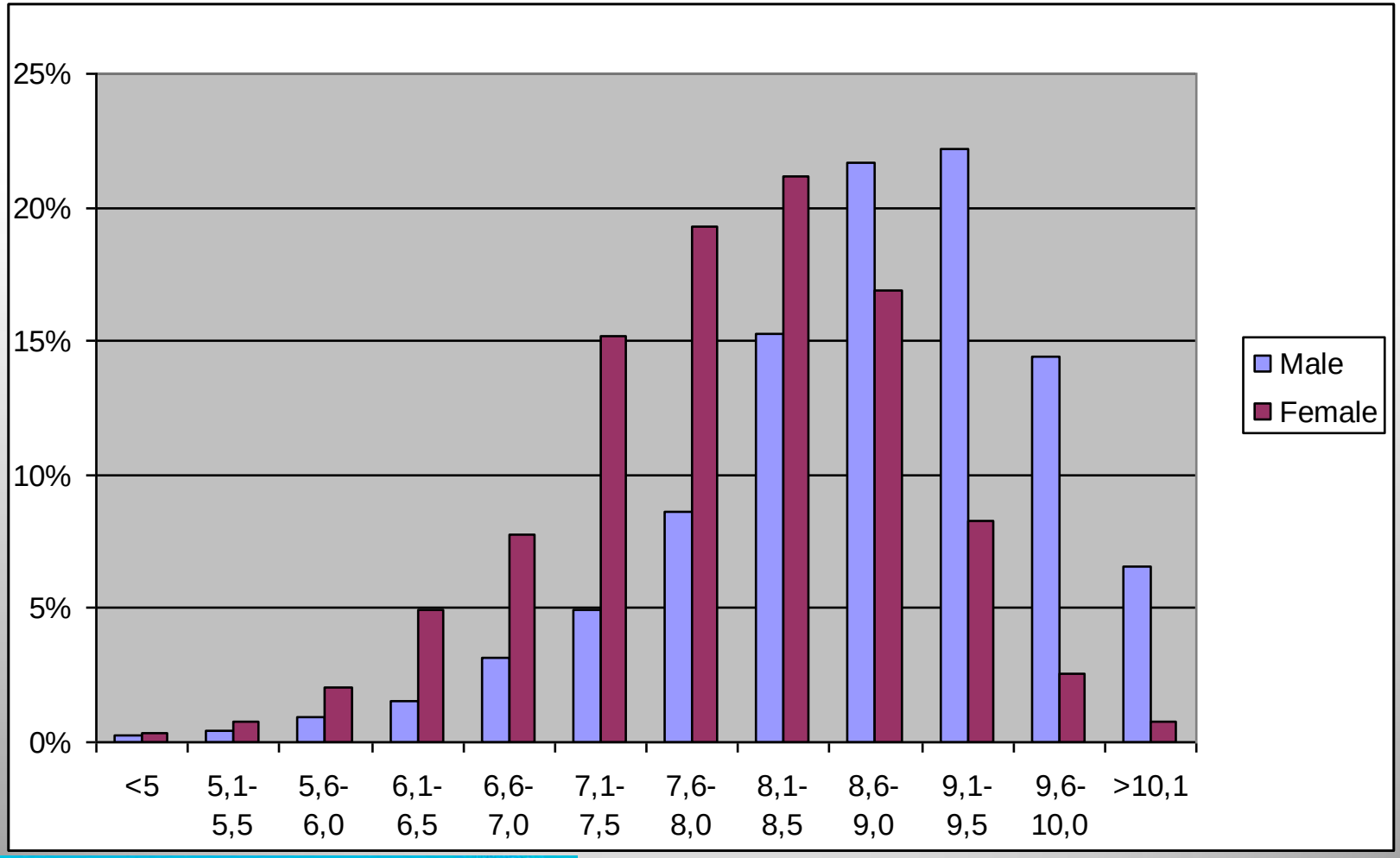
Abe DeAnda Jr, MD, FACS, FAHA

Comparison of Transfusion Rates, Hemoglobin (Hg) Levels, and Adverse Outcomes Between the Control Group (PRE) and Blood Conservation Group (POST)

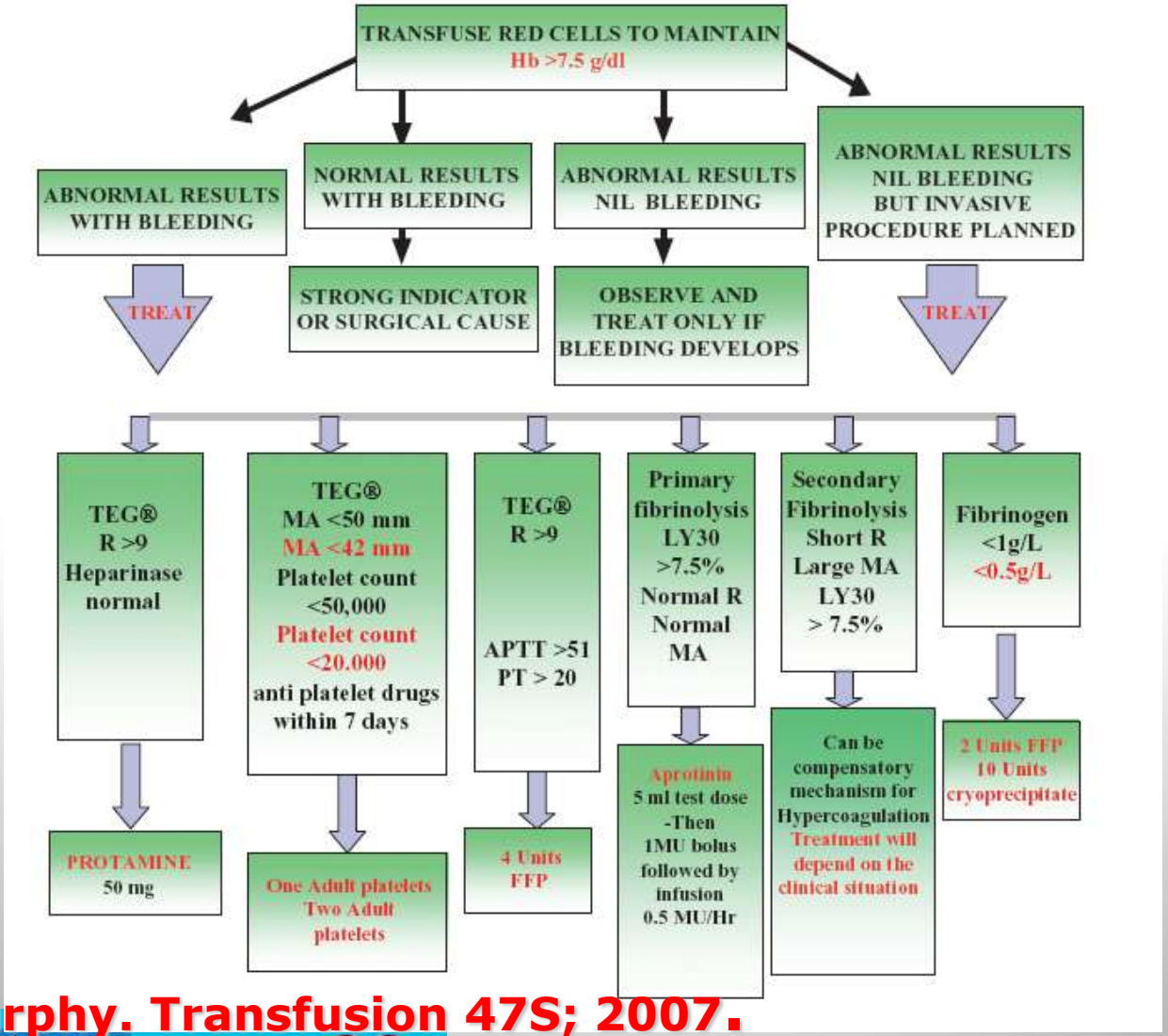
	PRE	POST
Number of patients (n)	521	477
All products transfused (%)	79	39*
RBCs transfused (%)	35	16*
Preoperative Hg (g/dL)	12.2	12.2
ICU entry Hg (g/dL)	10.8	9.2*
Discharge Hg (g/dL)	10.8	9.2*
Any adverse outcome (%)†	51.8	33.5*
MI (%)	0.5	0.4
Respiratory failure (%)	9.7	8.3
Infection (%)	5.9	5.4
Death (%)‡	7.7	7.3
Balloon pump required (%)	15	6.1*
2 or more catecholamines (%)	43.1	23.3*
Renal failure (%)	5.1	2.8*
Reoperation for bleeding (%)	4.8	1.4*

Am J Med Qual 2006;

Cardiosurgical Population Amphia Hospital 2006-09 N=5576



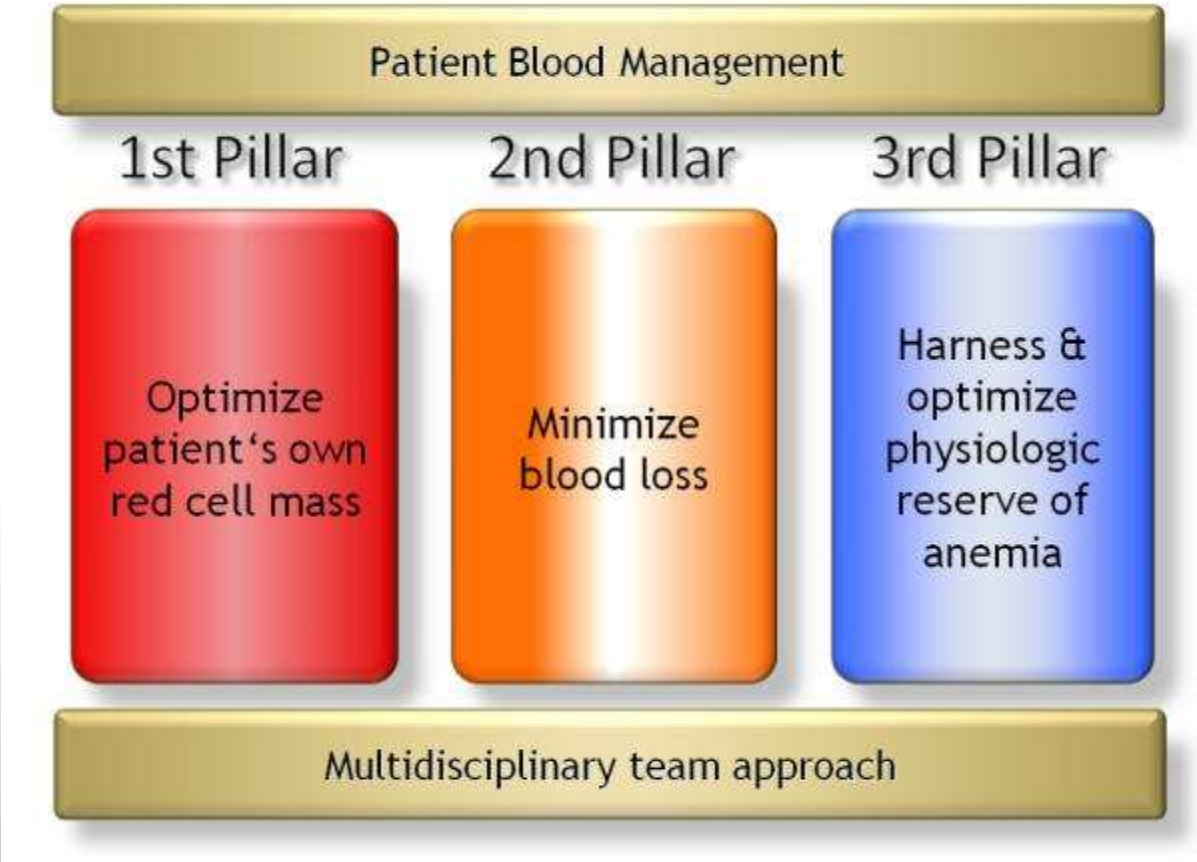
Transfusion algorhytm

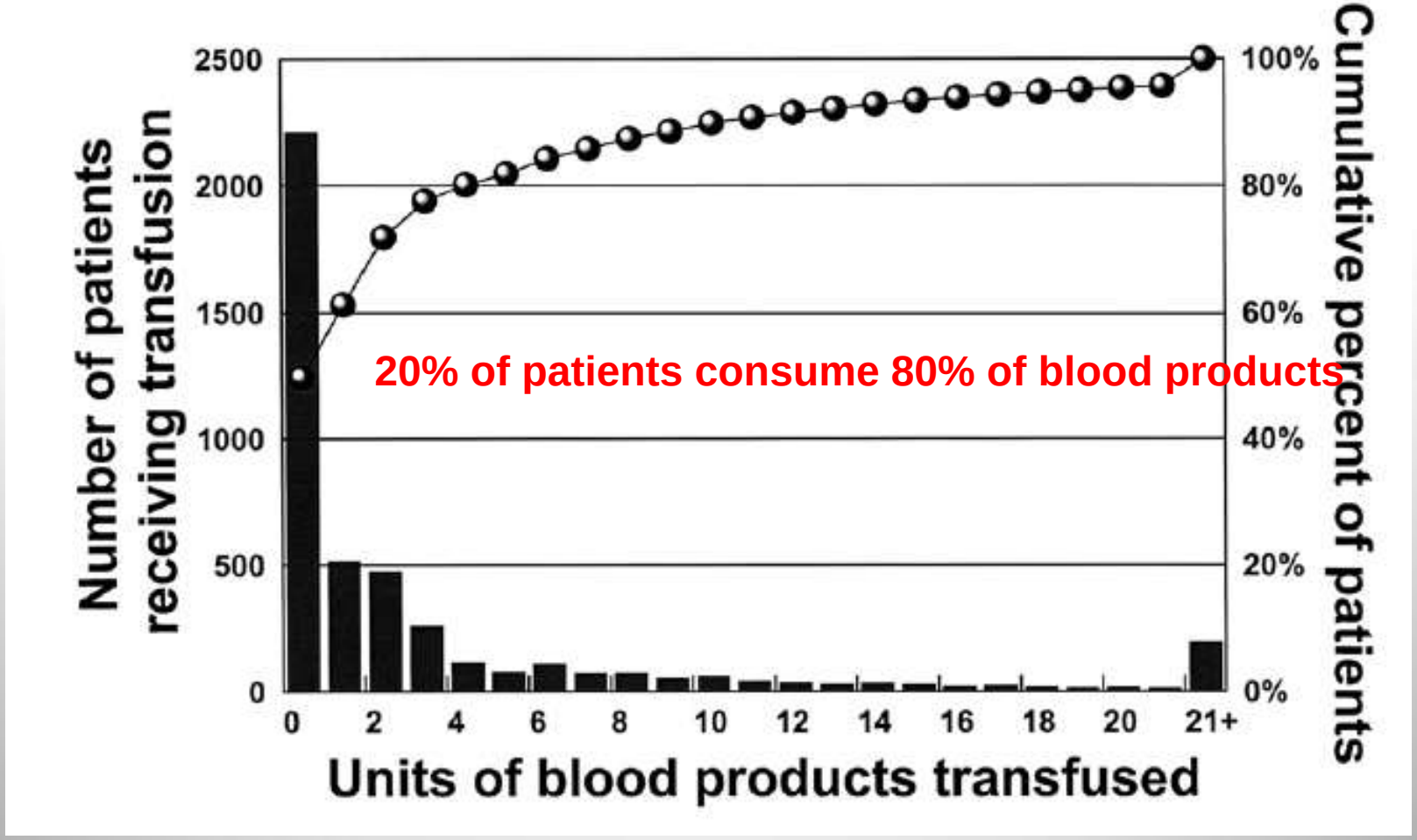


ME Murphy. Transfusion 47S; 2007.

From Bloodless Surgery to Patient Blood Management

Aryeh Shander, MD,[1,2] Mazyar Javidroozi, MD, PhD,[1] Seth Perelman, MD,[1] Tom Puzio, MD,[1] Gregg Lobel, MD[1]





Ferraris, 1995, Texas Heart Inst J

British Journal of Anaesthesia **107** (S1): i41–i59 (2011)
doi:10.1093/bja/aer350

BJA

What is really dangerous: anaemia or transfusion?

A. Shander[1,2,3,4*], M. Javidroozi[1], S. Ozawa[5] and G. M. T. Hare[6,7]

Table 2 Recent studies evaluating clinical outcomes of anaemia in various patient populations. The non-systematic search included the PubMed-indexed English-language manuscripts published between August 2009 and August 2011. WHO criteria: anaemic if Hb <120 g litre^{-1} for women and Hb <130 g litre^{-1} for men. CABG, coronary artery bypass grafting; CHF, chronic heart failure; CPB, cardiopulmonary bypass; Hb, haemoglobin; Hct, haematocrit; HF, heart failure; HR, hazard ratio; ICH, intracerebral haemorrhage; ICU, intensive care unit; MI, myocardial infarction; NA, not applicable; OR, odds ratio; PCI, percutaneous intervention; STEMI, ST-segment elevation myocardial infarction

Study	Population	Anaemia prevalence (and definition)	Findings on anaemia
Cardiac surgeries			
Carrascal and colleagues[105]	227 80-to-90-yr-old patients who underwent CPB	41.9% (WHO criteria)	In multivariate analysis, immediate postoperative Hct <24% (OR 2.78, $P=0.039$) and transfusion (OR 10.57, $P<0.01$) were independent predictors for in-hospital mortality
De Santo and colleagues[108]	1214 patients undergoing CABG	28% in preoperative period (WHO criteria)	Anaemia was an independent predictor of acute kidney injury (OR 2.06)
Ranucci and colleagues[96]	3003 patients undergoing CPB without receiving blood transfusions during hospital stay	NA; mean preoperative and lowest CPB Hct values were 40.4% and 27.8%, respectively	After adjustment for the other explanatory variables, preoperative Hct and lowest Hct on CPB were independent risk factors for major morbidity

British Journal of Anaesthesia 107 (S1): i41–i59 (2011)
doi:10.1093/bja/aer350

BJA

What is really dangerous: anaemia or transfusion?

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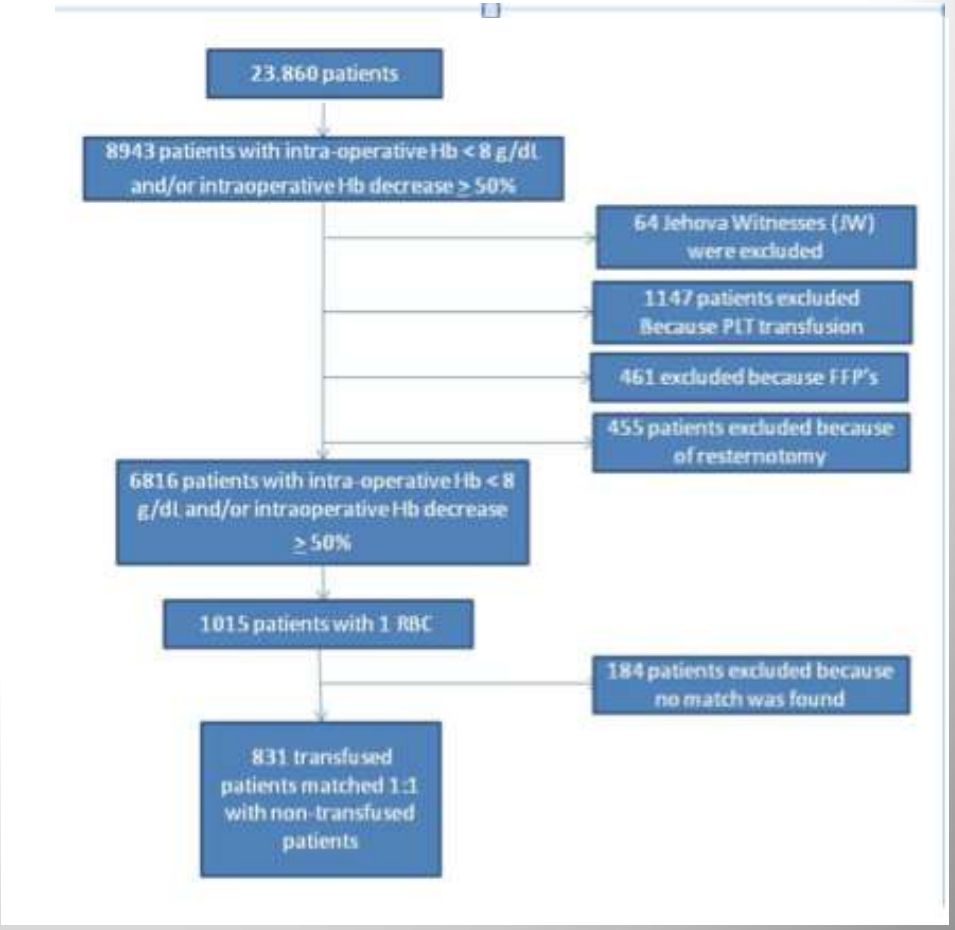
Ischaemic heart diseases			
Greenberg and colleagues[95]	1042 patients with STEMI who underwent PCI	20% (Hct <36% for women and <39% for men)	In multivariate analysis, anaemia was associated with an OR of 3.5 ($P<0.01$) for 1 month mortality
Hasin and colleagues[107]	1065 patients with acute MI	34.7% at discharge, 19.5% persistent at follow-up, and 5.2% new-onset at follow-up (WHO criteria)	Marked increase in mortality and heart failure in patients with persistent (HR 1.8) and new-onset anaemia (HR 1.9)
Kruk and colleagues[101]	1880 patients with STEMI treated with primary PCI	21.1% (Hct <36% in women and Hct <39% in men)	In multivariable analysis including important baseline risk factors, anaemia was independently associated with in-hospital death (HR 2.67)
Kurek and colleagues[94]	1497 patients with acute MI treated with PCI	16.6% (WHO criteria)	Multivariate analysis identified anaemia as an independent predictor of any-cause death (HR 1.46, $P<0.05$)

Intra-operative Anaemia in cardiac surgery

- Breda 1997-2013
- All consecutive cardiac surgery
- Anaemia Hb< 8g/dl
  - Part I: JW vs non JW
  - Part II: Single IU RBC Non JW vs no Tx



Optimal Care for Patients Who Are Jehovah's Witnesses

Harvey Jon Schiller, MD

The article by Sniecinski et al. (1) on the treatment of two Jehovah's Witnesses with coagulopathy presents a laudable approach toward improved communication with patients who may offer a rather unique medical challenge. Three aspects of this paper merit comment.

A&A 2007;104:755-56

Blood Transfusion as a Quality Indicator in Cardiac Surgery

Aryeh S. Shander, MD
Lawrence T. Goodnough, MD

In the other study, Bennett-Guerrero et al[5] analyzed data from more than 100 000 patients undergoing coronary artery bypass graft surgery with cardiopulmonary bypass in

JAMA, 2010;304:1610-11

Tolerance of intraoperative hemoglobin decrease during cardiac surgery

Esther Hogervorst,[1] Peter Rosseel,[2] Johanna van der Bom,[1,3] Mohamed Bentala,[2] Anneke Brand,[1] Nardo van der Meer,[2] and Leo van de Watering[1]

TABLE 3. Composite endpoint in relation to RBC transfusion (n = 11,508)

RBC transfusion	Number	Number (%) transfused	Hb decrease ≥ 50%	Hb < 7 g/dL	OR (crude)	95% CI	p value	OR* (adjusted)	95% CI	p value
Category 1	9672	703 (7.3)	–	–	2.67	2.50-2.86	<0.001	1.26	1.17-1.36	<0.001
Category 2	363	157 (43.3)	–	+	0.91	0.74-1.11	0.348	0.57	0.42-0.77	<0.001
Category 3	597	47 (7.9)	+	–	3.00	2.33-3.86	<0.001	0.88	0.55-1.41	0.590
Category 4	876	393 (44.9)	+	+	1.64	1.45-1.84	<0.001	0.95	0.78-1.16	0.618

Transfusion October 2014

Preoperative anaemia and postoperative outcomes in non-cardiac surgery: a retrospective cohort study

Khaled M Musallam, Hani M Tamim, Toby Richards, Donat R Spahn, Frits R Rosendaal, Aida Habbal, Mohammad Khreiss, Fadi S Dahdaleh, Kaivan Khavandi , Pierre M Sfeir, Assaad Soweid, Jamal J Hoballah, Ali T Taher, Faek R Jamali

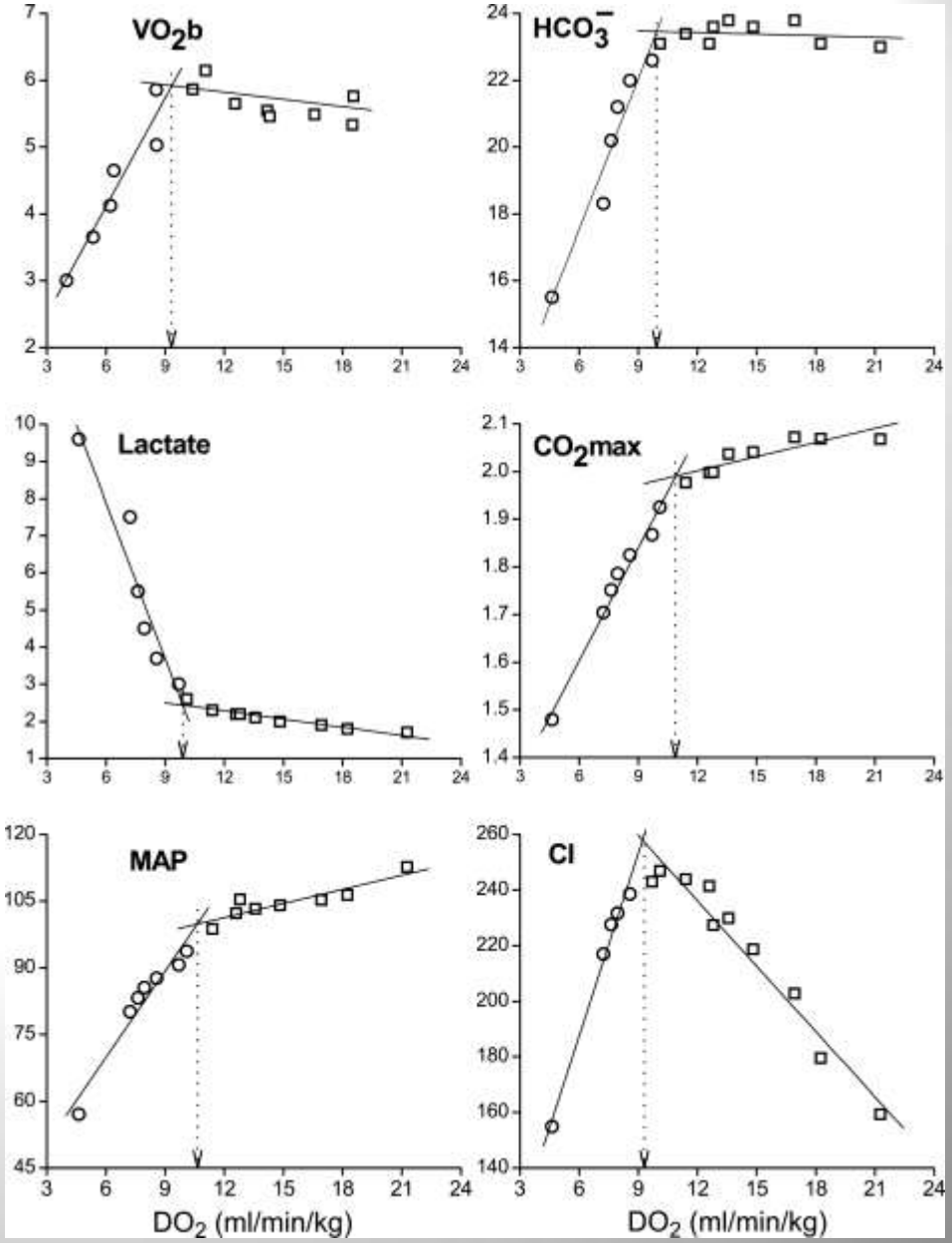
Lancet 2011; 378: 1396–407
Published Online
October 6, 2011
DOI:10.1016/S0140-

Summary

Background Preoperative anaemia is associated with adverse outcomes after cardiac surgery but outcomes after non-cardiac surgery are not well established. We aimed to assess the effect of preoperative anaemia on 30-day postoperative morbidity and mortality in patients undergoing major non-cardiac surgery.

Lancet, October 2006

Torres Filho, I. P. et al.
Am J Physiol Heart Circ Physiol
2005;288: H1071-H1079



ORIGINAL ARTICLE

Tolerance of intraoperative hemoglobin decrease during cardiac surgery

Esther Hogervorst,[1] Peter Rosseel,[2] Johanna van der Bom,[1,3] Mohamed Bentala,[2] Anneke Brand,[1] Nardo van der Meer,[2] and Leo van de Watering[1]

- cardiac surgery, n=11,508 (2001-2011)
- Composite endpoint (mortality, stroke, myocardial infarction, and renal failure.

Transfusion October 2014

Tolerance of intraoperative hemoglobin decrease during cardiac surgery

Esther Hogervorst,[1] Peter Rosseel,[2] Johanna van der Bom,[1,3] Mohamed Bentala,[2] Anneke Brand,[1] Nardo van der Meer,[2] and Leo van de Watering[1]

TABLE 2. Composite endpoint in relation to intraoperative Hb decrease (n = 11,508)

Patient category	Number	Hb decrease ≥ 50%	Hb < 7 g/dL	OR (crude)	95% CI	p value	OR* (adjusted)	95% CI	p value
1 (ref)	9672	–	–	1			1		
2	363	–	+	1.28	1.16-1.42	<0.001	0.93	0.82-1.06	0.309
3	597	+	–	1.08	0.99-1.17	0.064	1.26	1.13-1.41	<0.001
4	876	+	+	1.65	1.55-1.75	<0.001	1.12	1.02-1.22	0.017

Transfusion October 2014

ORIGINAL ARTICLE

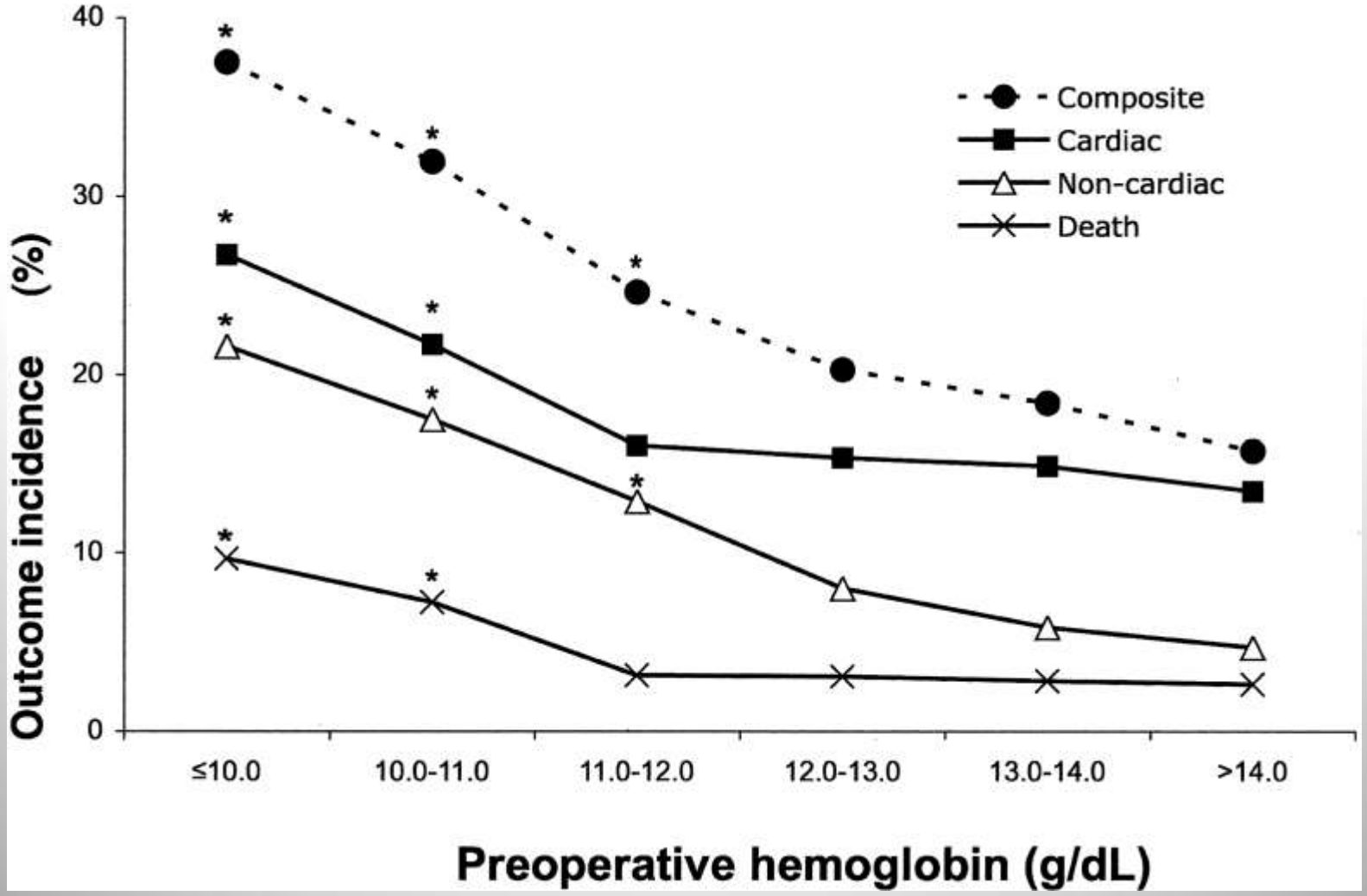
Tolerance of intraoperative hemoglobin decrease during cardiac surgery

Esther Hogervorst,[1] Peter Rosseel,[2] Johanna van der Bom,[1,3] Mohamed Bentala,[2] Anneke Brand,[1] Nardo van der Meer,[2] and Leo van de Watering[1]

- adverse outcome associated with
  - Hb< 7 g/dL
  - a decrease of > 50% irrespective of absolute Hb > of 7.0 g/dL.
- Transfusions advantageous if Hb < 7

Transfusion October 2014

Incidence of postoperative adverse events for all patients vs preoperative hemoglobin level.



Kulier A et al. Circulation. 2007;116:471-479

Major Bleeding, Transfusions, and Anemia: The Deadly Triad of Cardiac Surgery

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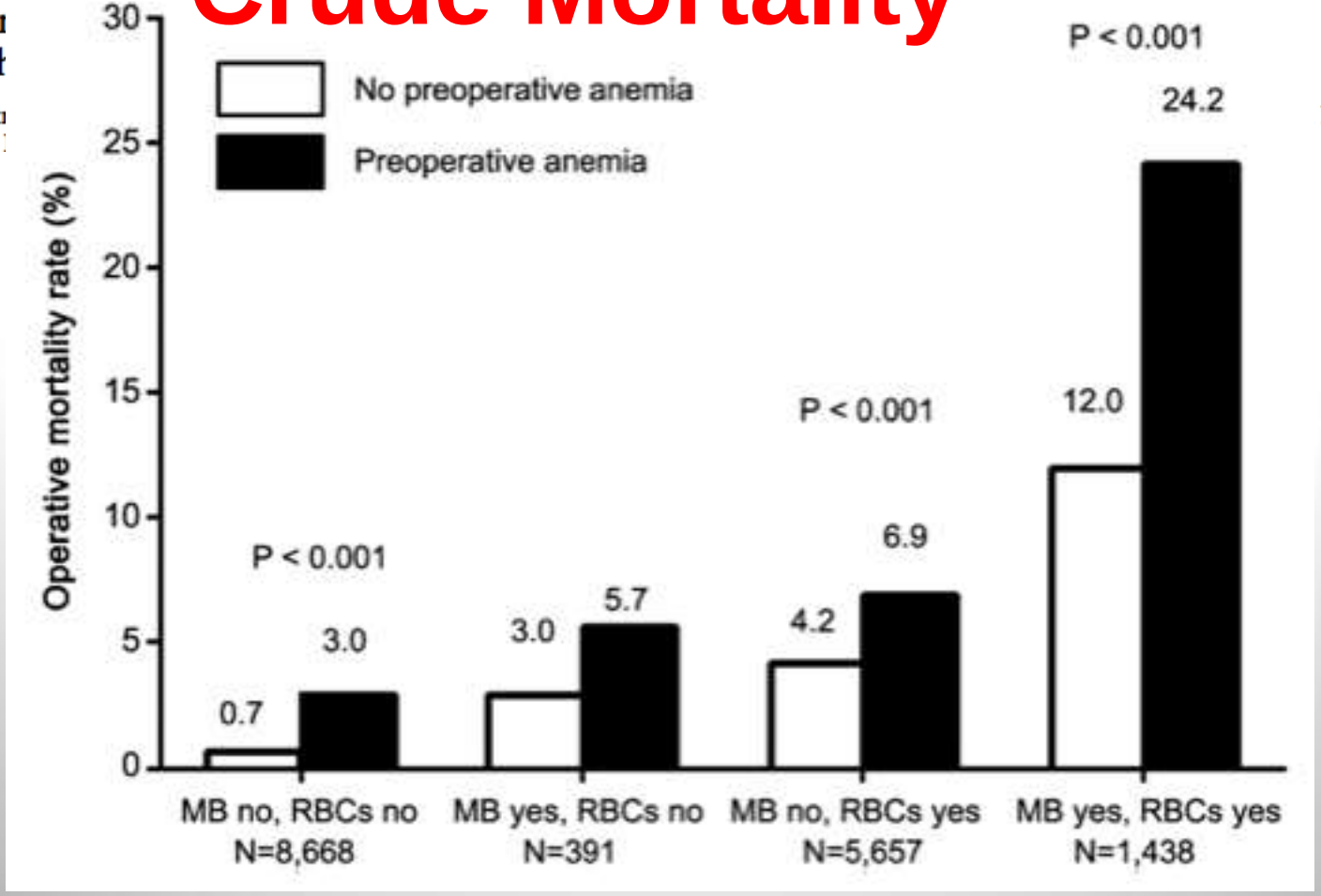
Crude Mortality



Ann Thorac Surg 2013;96:478–85

Major Bleeding, Transfusions, and Anemia: The Deadly Triad of Cardiac Surgery

Marcc [illegible] Ekaterina [illegible], PD
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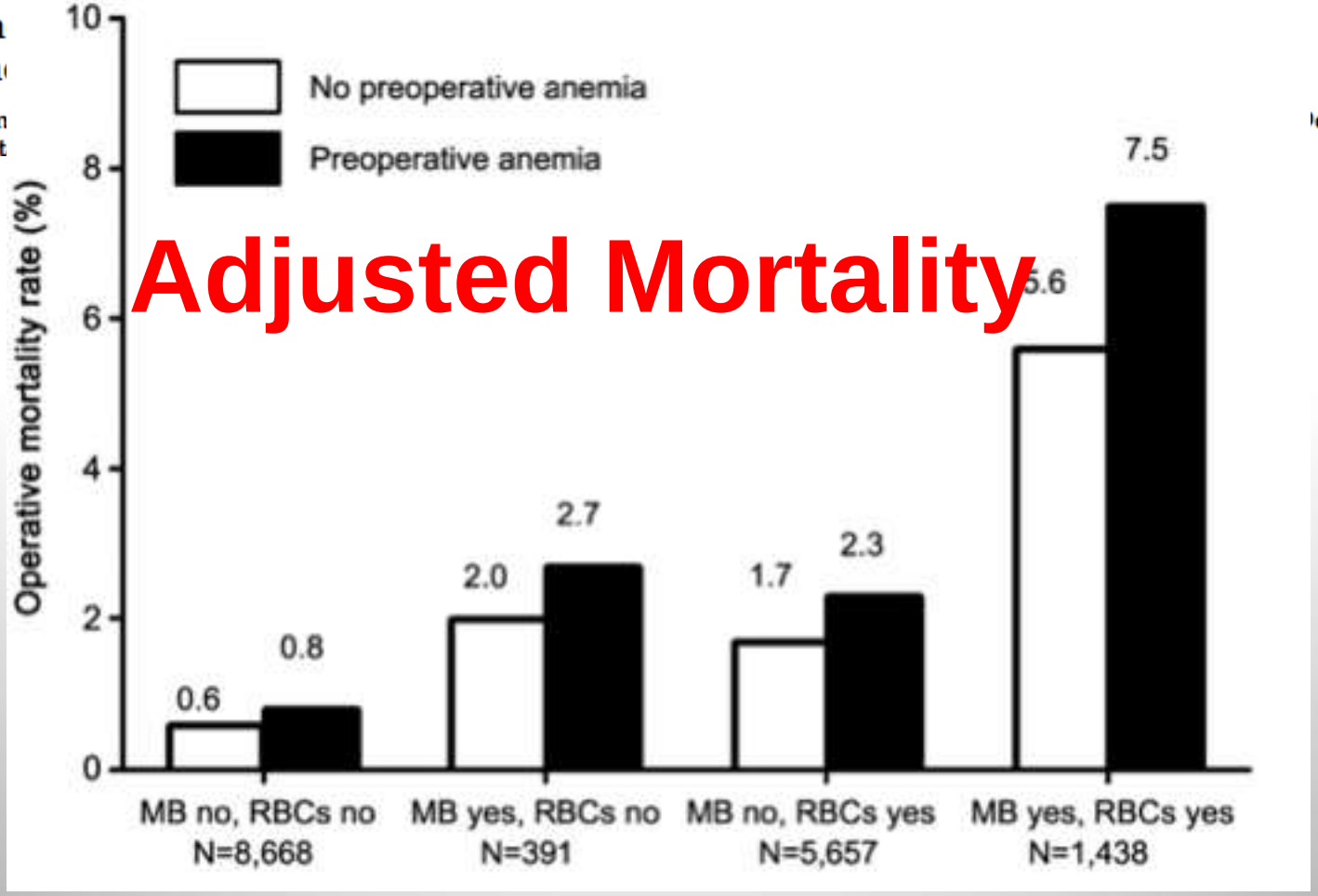
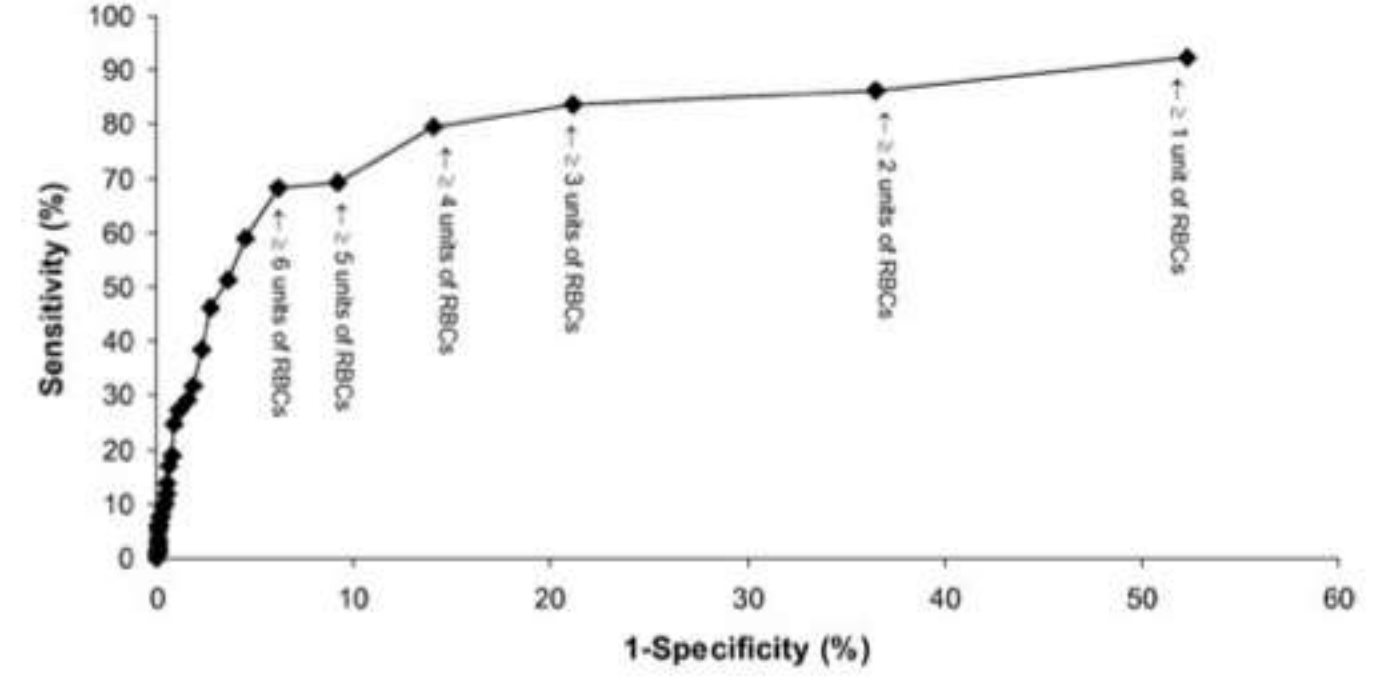


Adjusted Mortality

Ann Thorac Surg 2013;96:478–85

The independent association of massive blood loss with mortality in cardiac surgery

Keyvan Karkouti, Duminda N. Wijeysundera, Terrence M. Yau, W. Scott Beattie, Esamelden Abdelnaem, Stuart A. McCluskey, Mohammed Ghannam, Eric Yeo, George Djaiani, and Jacek Karski



TRANSFUSION 2004;44:1453-1462

The independent association of massive blood loss with mortality in cardiac surgery

Keyvan Karkouti, Duminda N. Wijeysundera, Terrence M. Yau, W. Scott Beattie, Esamelden Abdelnaem, Stuart A. McCluskey, Mohammed Ghannam, Eric Yeo, George Djaiani, and Jacek Karski

TABLE 4. Sensitivity analyses results

Sample	Total number	Number who died	OR	CI	Wald chi-square	P value
Excluding complex cases	6871	76	6.4	2.6-15.5	17.7	<0.0001
Excluding patients who received > 20 RBC units	9163	150	5.9	2.7-12.7	21.0	<0.0001
Excluding patients who received > 12 RBC units	9028	116	7.2	3.1-16.9	21.8	<0.0001
Excluding deaths on day of surgery	9187	145	9.6	4.3-21.1	32.4	<0.0001
Excluding deaths on day of surgery and day after surgery	9167	125	6.4	3.4-12.4	32.5	<0.0001
Including only men	6899	101	5.0	2.4-10.4	18.3	<0.0001
Including only women	2316	68	9.9	2.7-36.3	12.6	0.0004

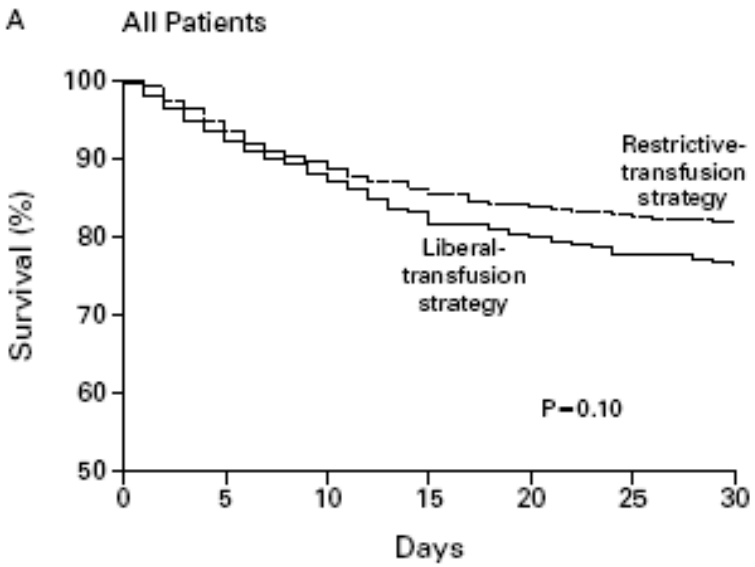
TRANSFUSION 2004;44:1453-1462

The New England
Journal of Medicine

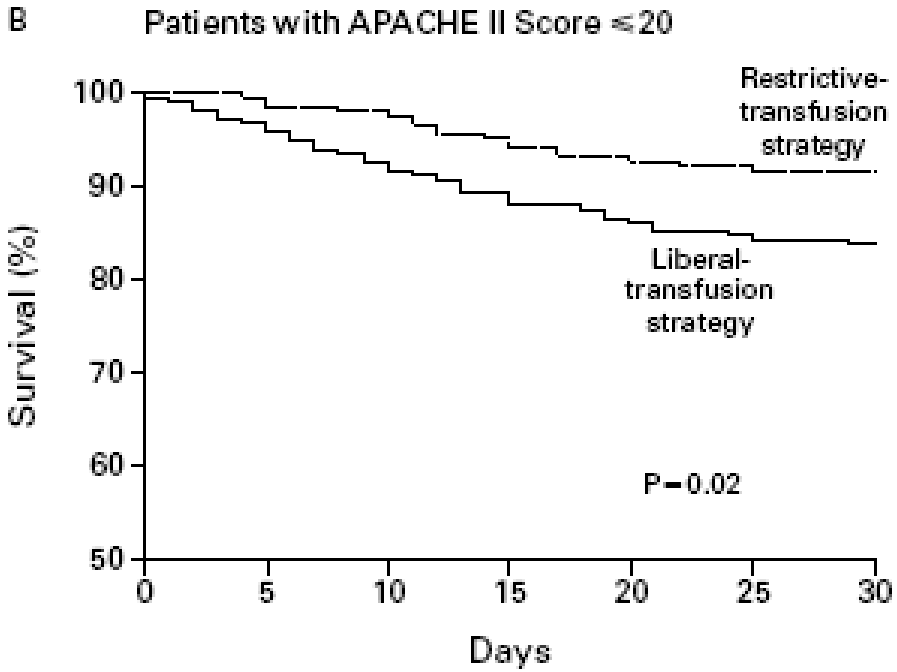
VOLUME 340 FEBRUARY 11, 1999 NUMBER 6

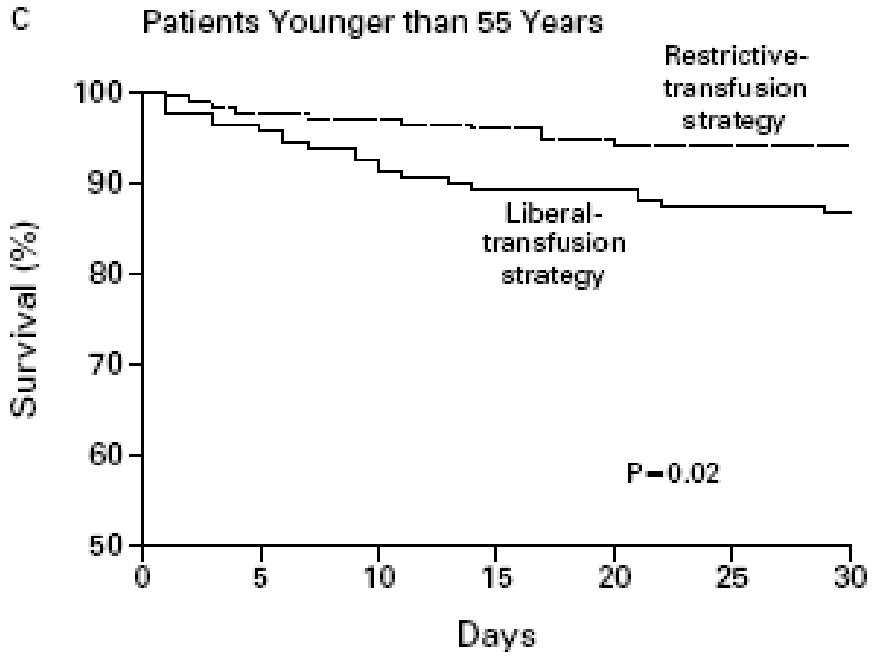
A MULTICENTER, RANDOMIZED, CONTROLLED CLINICAL TRIAL OF TRANSFUSION REQUIREMENTS IN CRITICAL CARE

PAUL C. HÉBERT, M.D., GEORGE WELLS, PH.D., MORRIS A. BLAJCHMAN, M.D., JOHN MARSHALL, M.D., CLAUDIO MARTIN, M.D., GIUSEPPE PAGLIARELLO, M.D., MARTIN TWEEDDALE, M.D., PH.D., IRWIN SCHWEITZER, M.SC., ELIZABETH YETISIR, M.SC., AND THE TRANSFUSION REQUIREMENTS IN CRITICAL CARE INVESTIGATORS FOR THE CANADIAN CRITICAL CARE TRIALS GROUP*



Hebert NEJM, 1999;340: 409





Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association

Increased Mortality, Postoperative Morbidity, and Cost After Red Blood Cell Transfusion in Patients Having Cardiac Surgery

Gavin J. Murphy, Barnaby C. Reeves, Chris A. Rogers, Syed I.A. Rizvi, Lucy Culliford and Gianni D. Angelini

Circulation 2007;116:2544-2552

Transfusion in Coronary Artery Bypass Grafting is Associated with Reduced Long-Term Survival

Colleen Gorman Koch, MD, MS, Liang Li, PhD, Andra I. Duncan, MD, Tomislav Mihaljevic, MD, Floyd D. Loop, MD, Norman J. Starr, MD, and Eugene H. Blackstone, MD

Departments of Cardiothoracic Anesthesia, Quantitative Health Sciences, and Thoracic and Cardiovascular Surgery, The Cleveland Clinic Foundation, Cleveland, Ohio

Background. Perioperative red blood cell (PRBC) transfusion has been associated with early risk for morbid outcomes, but risk related to long-term survival has not been thoroughly explored. Therefore, we examined the influence of PRBC transfusion and component therapy on long-term survival after isolated coronary artery bypass grafting after controlling for the effect of demographics, comorbidities, operative factors, and the early hazard for death.

Methods. The US Social Security Death Index was used to ascertain survival status for 10,289 patients who underwent isolated coronary artery bypass grafting from January 1, 1995 through June 28, 2002. The outcome measure was all-cause mortality during the follow-up period. Unadjusted survival estimates were performed using the Kaplan-Meier techniques. Survival curves for transfusion status were compared with the log-rank test. The parametric decomposition model was used for risk-adjusted survival. A balancing score was calculated for each patient and forced into the final model.

Results. Survival among transfused patients was significantly reduced as compared with nontransfused patients. The instantaneous risk of death displayed a biphasic pattern: a declining hazard phase from the time of the operation (early hazard) up until 6 months postoperatively and then a late hazard that continued out until about 10 years. Transfusion of red cells was associated with a risk-adjusted reduction in survival for both the early (0.34 ± 0.02, $p < 0.0001$) and late phases (0.074 ± 0.016, $p < 0.0001$).

Conclusions. Perioperative PRBC transfusion is associated with adverse long-term sequela in isolated CABG. Attention should be directed toward blood conservation methods and a more judicious use of PRBC.

(Ann Thorac Surg 2006;81:1650–7)

Interactive CardioVascular and Thoracic Surgery 10 (2010) 37–42

www.icvts.org

Institutional report - Coronary

Transfusion of red blood cells: the impact on short-term and long-term survival after coronary artery bypass grafting, a ten-year follow-up

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[a]Department of Cardio-Thoracic Surgery, Catharina Hospital, Michelangelolaan 2, Postbus 1350, 5602 ZA Eindhoven, The Netherlands
[b]Department of Anesthesiology, Catharina Hospital – Brabant Medical School, Eindhoven, The Netherlands and University Hospital Ghent, Ghent, Belgium
[c]Department of Education and Research, Catharina Hospital, Eindhoven, The Netherlands and Department of Medical Psychology, Center of Research on Psychology in Somatic Diseases, Tilburg University, The Netherlands
[d]Department of Anesthesiology, The Feinberg School of Medicine, Northwestern University, Chicago, Illinois, USA

Received 16 June 2009; received in revised form 12 August 2009; accepted 7 September 2009

Abstract

Transfusion of red blood cells (RBC) and other blood products in patients undergoing coronary artery bypass grafting (CABG) is associated with increased mortality and morbidity. We retrospectively analyzed data of patients who underwent an isolated coronary bypass graft operation between January 1998 and December 2007. Mean follow-up was 1696 ± 1026 days, with exclusion of 122 patients lost to follow-up and 80 patients who received 10 units of RBC. Of the remaining patients, 8001 (76.7%) received no RBC, 1621 (15.2%) received 1–2 units of RBC, 593 (5.7%) received 3–5 units and 220 (2.1%) received 6–10 units. The number of transfused RBC was a predictor for early but not for late mortality. When compared to expected survival, survival of patients not receiving any blood product was better, while survival of patients receiving >3 units of RBC was worse. Transfusion of RBC is an independent, dose-dependent risk factor for early mortality after revascularization. Compared to expected survival, receiving no RBC improves patient long-term survival, whereas receiving three or more units of RBC significantly decreases patient survival.

Keywords: Revascularization; Blood cells; Survival; Epidemiology; Coronary disease

Transfusion of 1 and 2 Units of Red Blood Cells Is Associated With Increased Morbidity and Mortality

Gaetano Paone, MD, MHSA, Donald S. Likosky, PhD, Robert Brewer, MD, MHSA, Patricia F. Theurer, BSN, Gail F. Bell, MSN, Chad M. Cogan, MS, and Richard L. Prager, MD, for the Membership of the Michigan Society of Thoracic and Cardiovascular Surgeons

Division of Cardiac Surgery, Henry Ford Hospital, Section of Health Services Research and Quality, Department of Cardiac Surgery, University of Michigan, Michigan Society of Thoracic and Cardiovascular Surgeons Quality Collaborative, Department of Public Health Services, Henry Ford Hospital, and Section of Adult Cardiac Surgery, Department of Cardiac Surgery, University of Michigan, Detroit, Michigan

Background. This study examined the relationship between transfusion of 1 or 2 units of red blood cells (RBCs) and the risk of morbidity and mortality after isolated on-pump coronary artery bypass grafting (CABG).

Methods. A total of 22,785 consecutive patients underwent isolated on-pump CABG between January 1, 2008, and December 31, 2011 in Michigan. We excluded 5,950 patients who received three or more RBC units. Twenty-one preoperative variables significantly associated with transfusion by univariate analysis were included in a logistic regression model predicting transfusion, and propensity scores were calculated. Transfusion and the propensity score covariate were included in additional logistic regression models predicting mortality and each of 11 postoperative outcomes.

Results. Operative mortality for the study cohort of 16,835 patients was 0.8% overall, 0.5% for the 10,884 patients with no transfusion, and 1.3% for the 5,951 patients who received transfusion of 1 or 2 units (odds ratio 2.44; confidence interval 1.74 to 3.42; $p < 0.0001$). The association between transfusion and mortality lessened after propensity adjustment but remained highly significant (odds ratio 1.86; confidence interval 1.21 to 2.87; $p = 0.005$). Of the 11 postoperative outcomes studied, all but sternal wound infection and need for dialysis were also significantly associated with transfusion.

Conclusions. Transfusion of as little as 1 or 2 units of RBCs is common and is significantly associated with increased morbidity and mortality after on-pump CABG. The relationship persists after adjustment for preoperative risk factors. These results suggest that aggressive attempts at blood conservation and avoidance of even small amounts of RBC transfusion may improve outcomes after CABG.

(Ann Thorac Surg 2013;■:■–■)

Liberal versus restrictive transfusion thresholds for patients with symptomatic coronary artery disease

Jeffrey L. Carson, MD,[a] Maria Mori Brooks, PhD,[b] J. Dawn Abbott, MD,[c] Bernard Chaitman, MD,[d] Sheryl F. Kelsey, PhD,[b] Darrell J. Triulzi, MD,[e] Vankeepuram Srinivas, MD,[f] Mark A. Menegus, MD,[f] Oscar C. Marroquin, MD,[g] Sunil V. Rao, MD,[h] Helaine Noveck, MPH,[a] Elizabeth Passano, MS,[b] Regina M. Hardison, MS,[b] Thomas Smitherman, MD,[g] Tudor Vagaonescu, MD,[i] Neil J. Wimmer, MD,[j] and David O. Williams, MD[j] *New Brunswick, NJ; Pittsburgh, PA; Providence, RI; Saint Louis, MO; New York, NY; Durham, NC; and Boston, MA*

Background Prior trials suggest it is safe to defer transfusion at hemoglobin levels above 7 to 8 g/dL in most patients. Patients with acute coronary syndrome may benefit from higher hemoglobin levels.

Methods We performed a pilot trial in 110 patients with acute coronary syndrome or stable angina undergoing cardiac catheterization and a hemoglobin <10 g/dL. Patients in the liberal transfusion strategy received one or more units of blood to raise the hemoglobin level ≥10 g/dL. Patients in the restrictive transfusion strategy were permitted to receive blood for symptoms from anemia or for a hemoglobin <8 g/dL. The predefined primary outcome was the composite of death, myocardial infarction, or unscheduled revascularization 30 days post randomization.

Results Baseline characteristics were similar between groups except age (liberal, 67.3; restrictive, 74.3). The mean number of units transfused was 1.6 in the liberal group and 0.6 in the restrictive group. The primary outcome occurred in 6 patients (10.9%) in the liberal group and 14 (25.5%) in the restrictive group (risk difference = 15.0%; 95% confidence interval of difference 0.7% to 29.3%; $P = .054$ and adjusted for age $P = .076$). Death at 30 days was less frequent in liberal group (n = 1, 1.8%) compared to restrictive group (n = 7, 13.0%; $P = .032$).

Conclusions The liberal transfusion strategy was associated with a trend for fewer major cardiac events and deaths than a more restrictive strategy. These results support the feasibility of and the need for a definitive trial. (Am Heart J 2013;165:964-971.e1.)

American Journal of Cardiology
Volume 108, Issue 8, Pages 1108–1111, October 15, 2011

Conservative Versus Liberal Red Cell Transfusion in Acute Myocardial Infarction (the CRIT Randomized Pilot Study)

Howard A. Cooper, MD, Sunil V. Rao, MD, Michael D. Greenberg, MD, Maria P. Rumsey, MD, Marcus McKenzie, MD, Kirsten W. Alcorn, MD, Julio A. Panza, MD

Transfusion Requirements After Cardiac Surgery

The TRACS Randomized Controlled Trial

Ludhmila A. Hajjar, MD, PhD
Jean-Louis Vincent, MD, PhD
Filomena R. B. G. Galas, MD, PhD
Rosana E. Nakamura, MD
Carolina M. P. Silva, MD
Marilia H. Santos, MD, PhD
Julia Fukushima, MSc
Roberto Kalil Filho, MD, PhD
Denise B. Sierra, MD
Neuza H. Lopes, MD, PhD
Thais Mauad, MD, PhD

Context Perioperative red blood cell transfusion is commonly used to address anemia, an independent risk factor for morbidity and mortality after cardiac operations; however, evidence regarding optimal blood transfusion practice in patients undergoing cardiac surgery is lacking.

Objective To define whether a restrictive perioperative red blood cell transfusion strategy is as safe as a liberal strategy in patients undergoing elective cardiac surgery.

Design, Setting, and Patients The Transfusion Requirements After Cardiac Surgery (TRACS) study, a prospective, randomized, controlled clinical noninferiority trial conducted between February 2009 and February 2010 in an intensive care unit at a university hospital cardiac surgery referral center in Brazil. Consecutive adult patients (n=502) who underwent cardiac surgery with cardiopulmonary bypass were eligible; analysis was by intention-to-treat.

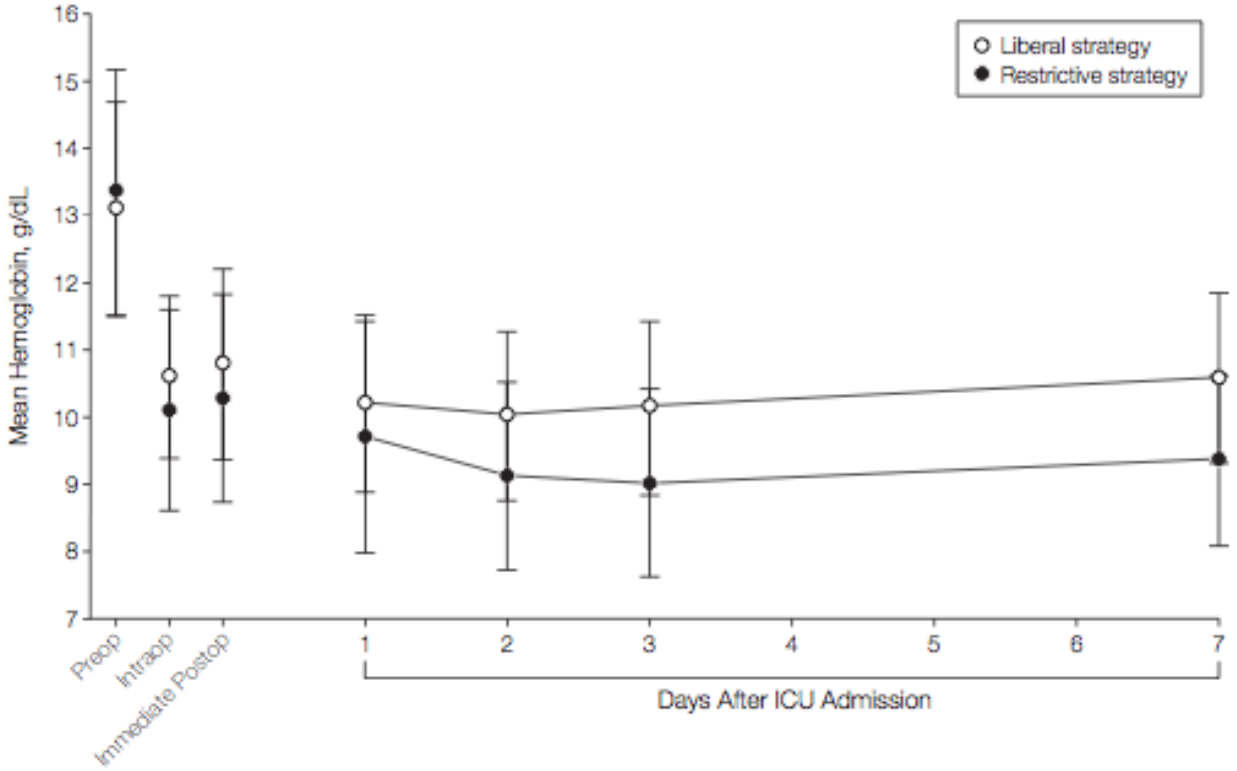
Intervention Patients were randomly assigned to a liberal strategy of blood transfusion (to maintain a hematocrit ≥30%) or to a restrictive strategy (hematocrit ≥24%).

JAMA. 2010;304(14):1559-1567

Transfusion Requirements After Cardiac Surgery

The TRACS Randomized Controlled Trial

Figure 2. Mean Hemoglobin Levels During the Study According to Transfusion Strategy

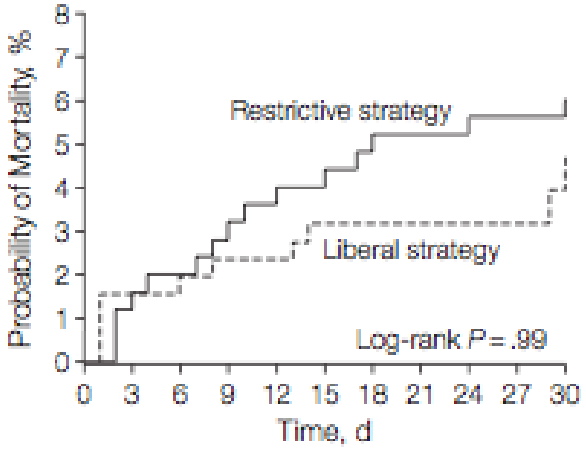


JAMA. 2010;304(14):1559-1567

Transfusion Requirements After Cardiac Surgery

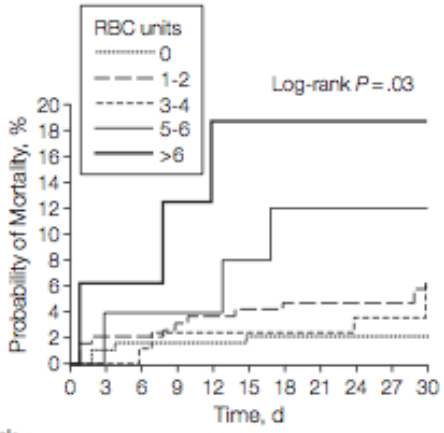
The TRACS Randomized Controlled Trial

Figure 3. Kaplan-Meier Estimates of 30-Day Survival by Transfusion Strategy



No. at risk						
Restrictive	249	244	238	236	235	234
Liberal	253	248	247	245	245	242

Figure 4. Kaplan-Meier Estimates of 30-Day Survival Based on Number of Red Blood Cell (RBC) Units Transfused



No. at risk						
RBC units						
0	186	184	183	182	182	181
1-2	191	187	184	182	182	179
3-4	84	83	82	82	81	80
5-6	25	24	24	22	22	21
>6	16	15	13	13	13	12

JAMA. 2010;304(14):1559-1567

Restrictive versus liberal transfusion strategy for red blood cell transfusion: systematic review of randomised trials with meta-analysis and trial sequential analysis

Lars B Holst,[1] Marie W Petersen,[1] Nicolai Haase,[1] Anders Perner,[1] Jørn Wetterslev[2]

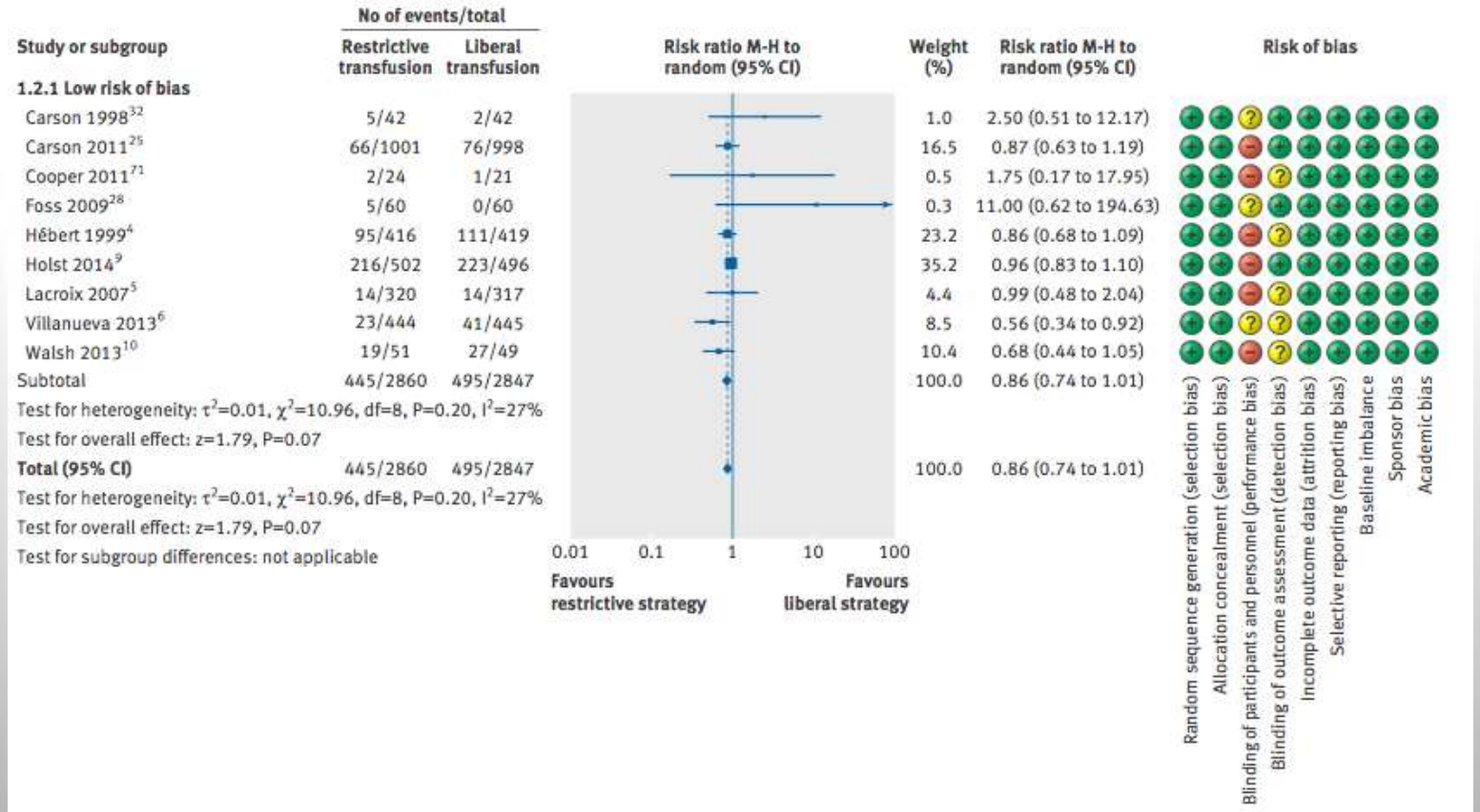
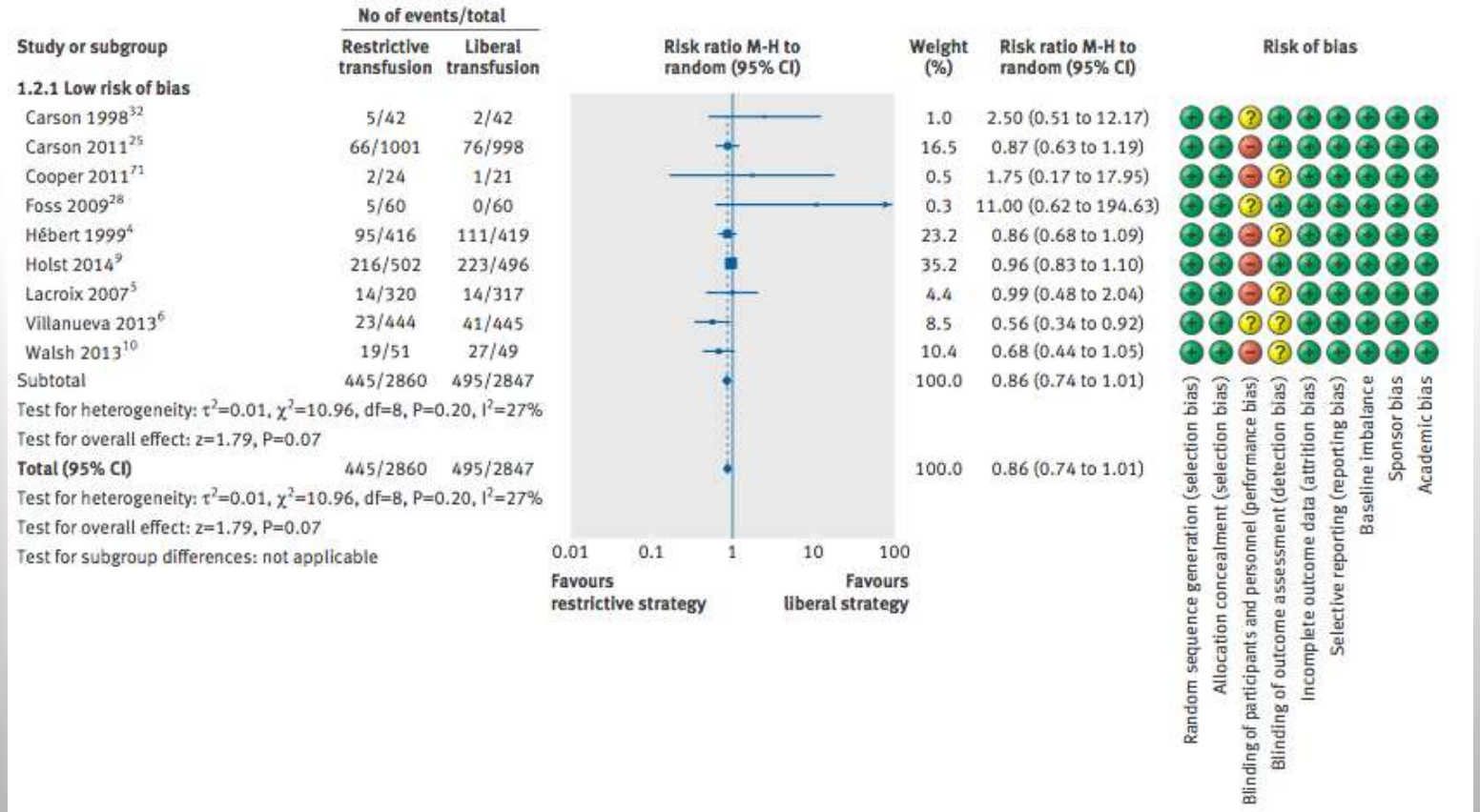


Fig 4 | **Forest plot of mortality in lower risk of bias trials. Size of squares for risk ratio reflects weight of trial in pooled analysis. Horizontal bars represent 95% confidence intervals**

BMJ 2015;350:h1354

Restrictive versus liberal transfusion strategy for red blood cell transfusion: systematic review of randomised trials with meta-analysis and trial sequential analysis

Lars B Holst,[1] Marie W Petersen,[1] Nicolai Haase,[1] Anders Perner,[1] Jørn Wetterslev[2]



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BMJ 2015;350:h1354

Restrictive versus liberal transfusion strategy for red blood cell transfusion: systematic review of randomised trials with meta-analysis and trial sequential analysis

Lars B Holst,[1] Marie W Petersen,[1] Nicolai Haase,[1] Anders Perner,[1] Jørn Wetterslev[2]

Table 3 | Summary of findings including GRADE quality assessment of evidence trials with lower risk of bias

Variables	No of participants (No of studies)	No with event/No in group (%)		Relative risk (95% CI)	Absolute effect	Quality of the evidence (GRADE)	Quality assessment domains
		Restrictive transfusion group	Liberal transfusion group				
All cause mortality, longest follow-up, low risk of bias trials	5707 (9)	445/2860 (15.6)	495/2847 (17.4)	Random effects 0.86 (0.74 to 1.01); I^2=27%; trial sequential analysis adjusted 95% CI 0.67 to 1.12	24 fewer per 1000 (from 45 fewer to 2 more)	Low; critical importance	Inconsistency: not serious*; indirectness: not serious; imprecision: serious†; reporting bias: reporting bias‡
Overall morbidity, lower risk of bias trials	4517 (6)	858/2261 (37.9)	897/2256 (39.8)	Random effects 0.98 (0.85 to 1.12); I^2=60%; trial sequential analysis adjusted 95% CI 0.81 to 1.19	8 fewer per 1000 (from 60 fewer to 48 more)	Very low; critical importance	Inconsistency: serious§; indirectness: not serious; imprecision: serious¶; reporting bias: reporting bias‡
Fatal and non-fatal myocardial infarction in lower risk of bias trials	4730 (7)	59/2369 (2.5)	43/2361 (1.8)	Random effects 1.28 (0.66 to 2.49); I^2=34%; trial sequential analysis adjusted 95% CI 0.40 to 4.13	6 more per 1000 (from 6 fewer to 27 more)	Very low; critical importance	Inconsistency: serious**; indirectness: not serious; imprecision: very serious††; reporting bias: reporting bias‡

BMJ 2015;350:h1354

Restrictive versus liberal transfusion strategy for red blood cell transfusion: systematic review of randomised trials with meta-analysis and trial sequential analysis

Lars B Holst,[1] Marie W Petersen,[1] Nicolai Haase,[1] Anders Perner,[1] Jørn Wetterslev[2]

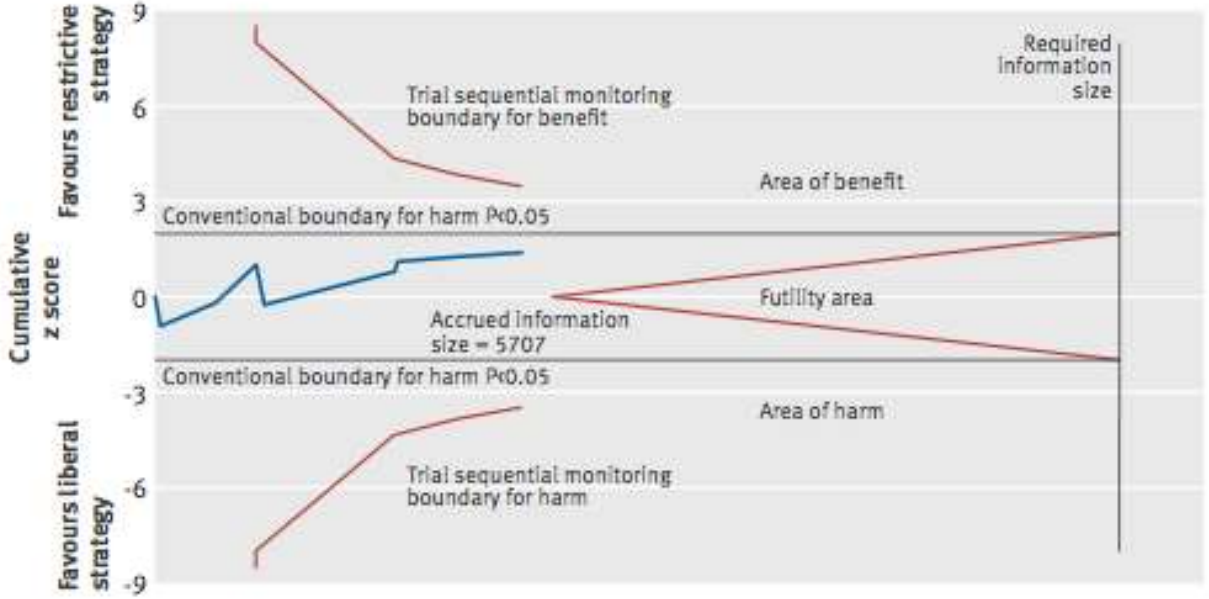

Fig 5 | Trial sequential analysis of nine trials with lower risk of bias reporting all cause mortality, control event proportion of 17.4%, diversity of 56%, a of 5%, power of 80%, and relative risk reduction of 15%. The required information size of 14217 has not been reached and none of the boundaries for benefit, harm, or futility has been crossed, leaving the meta-analysis inconclusive of a 15% relative risk reduction. The trial sequential analysis adjusted 95% confidence interval for a relative risk of 0.86 is 0.67 to 1.12

BMJ 2015;350:h1354

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 OCTOBER 9, 2014 VOL. 371 NO. 15

Lower versus Higher Hemoglobin Threshold for Transfusion in Septic Shock

- Septic shock & Anaemia < 9 g%
- 1 IU RBC
  - if Hb < 7 g%
  - If Hb <9 gr%
- Primary outcome 90 days mortality
- N= 998 (99.3%randomized)
- Similar baseline characteristics.
- Lower-threshold ➔ 1 IU RBC (IQR 0-3)
- High-threshold ➔ 4IU RBC (IQR 2-7)

TRISS group, NEJM, 2014; 371

Transfusion Requirements in Surgical Oncology Patients

A Prospective, Randomized Controlled Trial

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Rosana Ely Nakamura, M.D., Silvia M. R. Fonseca, M.D., Guilherme Cutait, M.D.,
Joseane Inacio Alves, R.N., Mellik Bazan, P.T., Silvia Vieira, R.N., Ana C. Vieira Sandrini, L.D.N.,
Henrique Palomba, M.D., Ph.D., Ulysses Ribeiro, Jr., M.D., Ph.D., Alexandre Crippa, M.D.,
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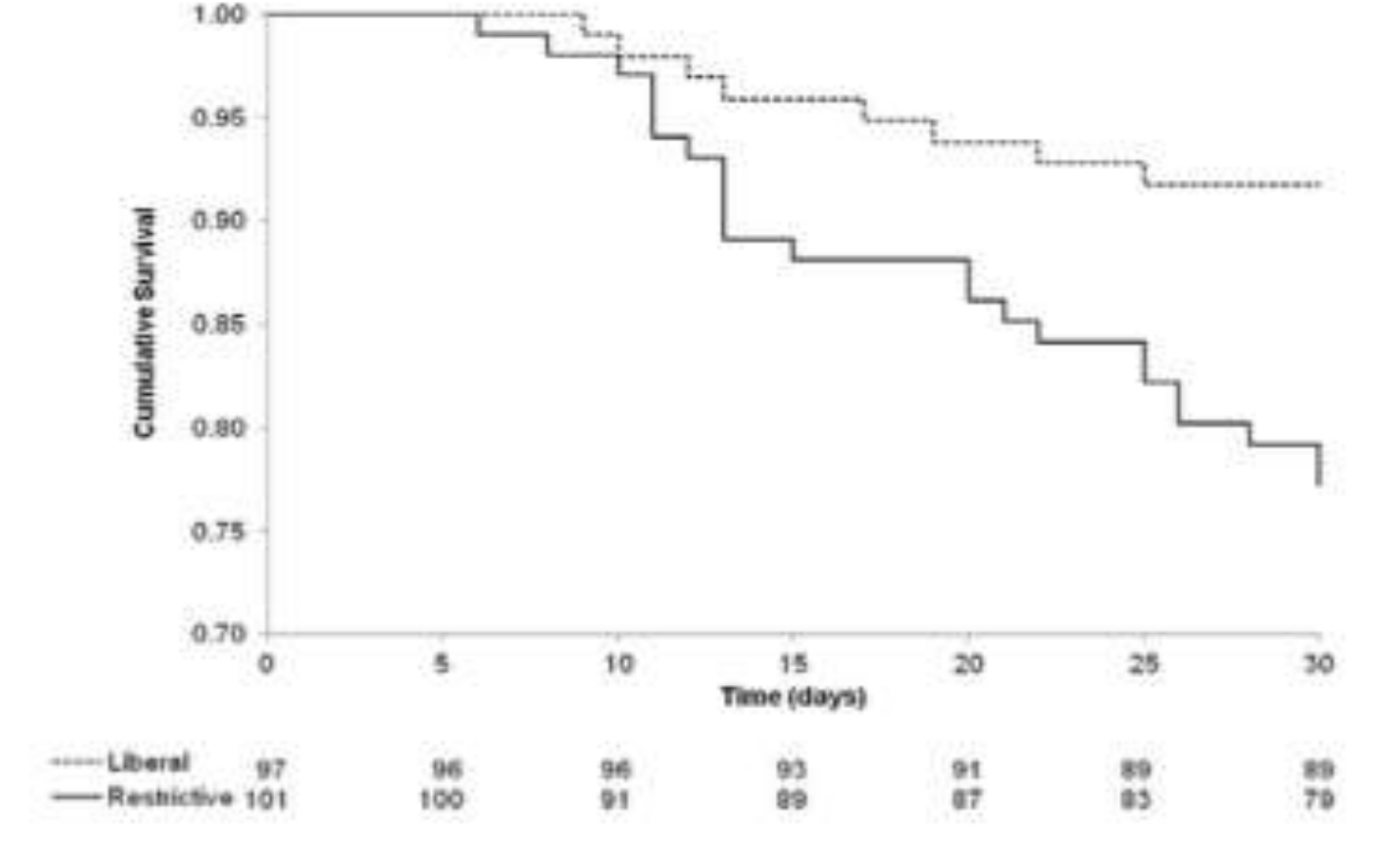
Jose Otavio Costa Auler, Jr., M.D., Ph.D., Andrew Rhodes, M.B., B.S.,
Ludhmila Abrahao Hajjar, M.D., Ph.D.

ANESTHESIOLOGY 2015; 122:29-38

Transfusion Requirements in Surgical Oncology Patients

A Prospective, Randomized Controlled Trial



ANESTHESIOLOGY 2015; 122:29-38

Transfusion Requirements in Surgical Oncology Patients

A Prospective, Randomized Controlled Trial

Background: Several studies have indicated that a restrictive erythrocyte transfusion strategy is as safe as a liberal one in critically ill patients, but there is no clear evidence to support the superiority of any perioperative transfusion strategy in patients with cancer.

Methods: In a randomized, controlled, parallel-group, double-blind (patients and outcome assessors) superiority trial in the intensive care unit of a tertiary oncology hospital, the authors evaluated whether a restrictive strategy of erythrocyte transfusion (transfusion when hemoglobin concentration <7 g/dl) was superior to a liberal one (transfusion when hemoglobin concentration <9 g/dl) for reducing mortality and severe clinical complications among patients having major cancer surgery. All adult patients with cancer having major abdominal surgery who required postoperative intensive care were included and randomly allocated to treatment with the liberal or the restrictive erythrocyte transfusion strategy. The primary outcome was a composite endpoint of mortality and morbidity.

Results: A total of 198 patients were included as follows: 101 in the restrictive group and 97 in the liberal group. The primary composite endpoint occurred in 19.6% (95% CI, 12.9 to 28.6%) of patients in the liberal-strategy group and in 35.6% (27.0 to 45.4%) of patients in the restrictive-strategy group ($P = 0.012$). Compared with the restrictive strategy, the liberal transfusion strategy was associated with an absolute risk reduction for the composite outcome of 16% (3.8 to 28.2%) and a number needed to treat of 6.2 (3.5 to 26.5).

Conclusion: A liberal erythrocyte transfusion strategy with a hemoglobin trigger of 9 g/dl was associated with fewer major postoperative complications in patients having major cancer surgery compared with a restrictive strategy. (ANESTHESIOLOGY 2015; 122:29-38)

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MARCH 12, 2015 VOL. 372 NO. 11

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*

ABSTRACT

NEJM 2015;372:997-1008

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*

Table 3. Outcomes.

Outcome	Restrictive Transfusion Threshold (N=1000)	Liberal Transfusion Threshold (N=1003)	Estimated Treatment Effect	
			Odds Ratio or Hazard Ratio (95% CI)	P Value
Serious infection or ischemic event: primary outcome				
Overall	331/944 (35.1)	317/962 (33.0)	1.11 (0.91–1.34)*	0.30
Infectious event†	[illegible]	[illegible]	1.02 (0.83–1.26)*	0.83
Sepsis	210/982 (21.4)	214/983 (21.8)		
Wound infection	55/921 (6.0)	46/936 (4.9)		
Ischemic event	156/991 (15.7)	139/99 (114.0)	1.16 (0.90–1.49)*	0.26
Permanent stroke	15/989 (1.5)	17/985 (1.7)		
Myocardial infarction	3/987 (0.3)	4/981 (0.4)		
Gut infarction	6/987 (0.6)	1/982 (0.1)		
Acute kidney injury	140/989 (14.2)	122/989 (12.3)		
Stage 1	49/989 (5.0)	40/989 (4.0)		
Stage 2	39/989 (3.9)	35/989 (3.5)		
Stage 3	50/989 (5.1)	46/989 (4.7)		

NEJM 2015;372:997-1008

Liberal or Restrictive Transfusion after Cardiac Surgery

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Serious infection or ischemic event: primary outcome				
Overall	331/944 (35.1)	317/962 (33.0)	1.11 (0.91–1.34)*	0.30
Secondary outcomes				
No. of hours in ICU or high-dependency unit‡				
Median	49.5	45.9	0.97 (0.89–1.06)§	0.53
Interquartile range	21.9–99.7	20.1–94.8		
No. of days in hospital¶				
Median	7.0	7.0	1.00 (0.92–1.10)§	0.94
Interquartile range	5.0–10.0	5.0–10.0		
All-cause mortality at 90 days	42/1000 (4.2)	26/1003 (2.6)	1.64 (1.00–2.67)§	0.045
Clinically significant pulmonary complications	127/979 (13.0)	116/982 (11.8)	1.11 (0.85–1.45)*	0.45
All-cause mortality at 30 days	26/1000 (2.6)	19/1003 (1.9)		

NEJM 2015;372:997-1008

The Independent Effects of Anemia and Transfusion on Mortality After Coronary Artery Bypass

Milo Engoren, MD, N. Neill, MD,
Jennifer L. Vance, M

Department of Anesthesiolog gan; Department of
Anesthesiology, Mercy St. Vin sity of Toledo, Toledo,
Ohio; and Department of Inte on

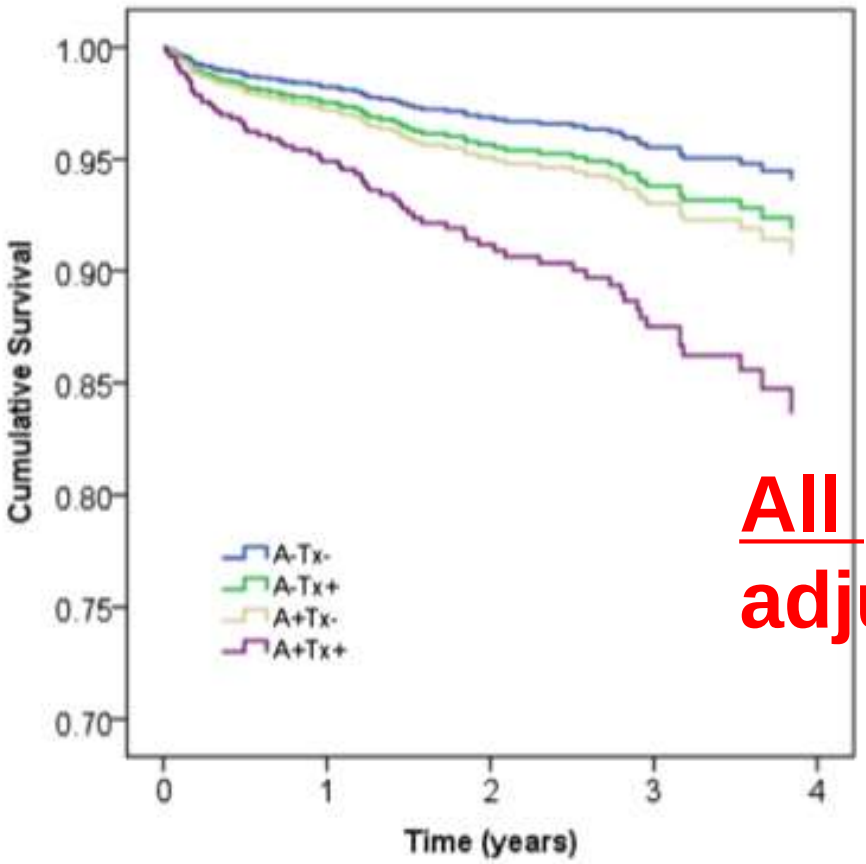

Fig 1. Cox plot of all 922 patients showing the effect of anemia–transfusion interaction on survival after adjustment for the

All patients, adjusted

Ann Thorac Surg 2014;97:514–21

The Independent Effects of Anemia and Transfusion on Mortality After Coronary Artery Bypass

Milo Engoren, MD,
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Anesthesiology, Mercy St. Vin
Ohio; and Department of Inte
N. Neill, MD,
igan; Department of
rsity of Toledo, Toledo,
on

Preop Hb matched patients, adjusted

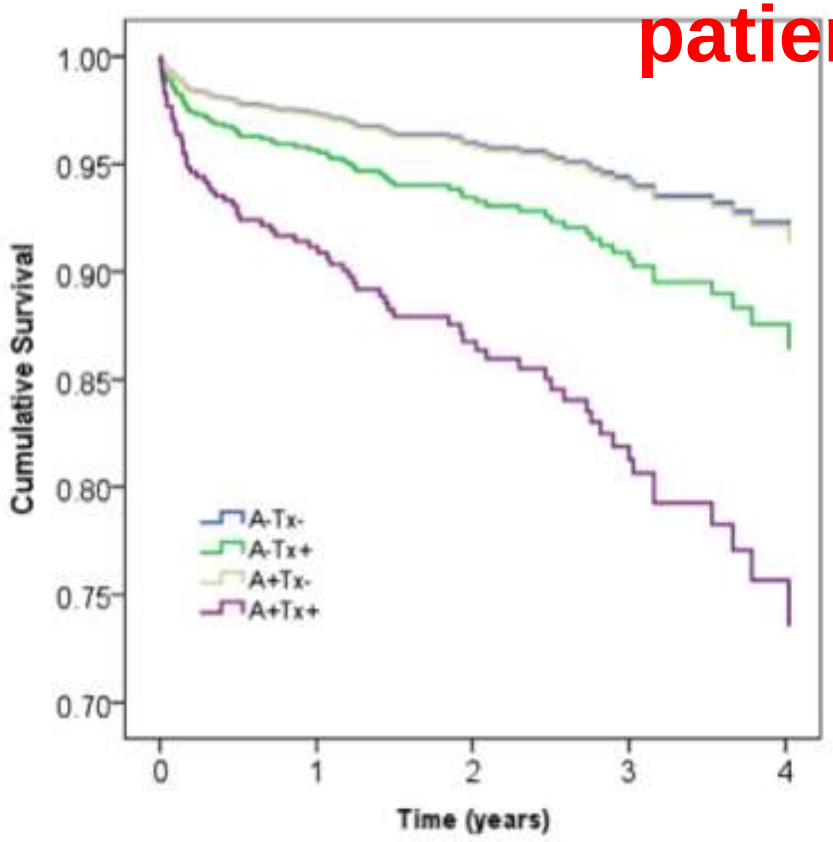


Fig 2. Cox plot of all 624 patients (matched by admit hemoglobin) showing the effect of anemia–transfusion interaction on survival after

Ann Thorac Surg 2014;97:514–21

The Independent Effects of Anemia and Transfusion on Mortality After Coronary Artery Bypass

Milo Engoren, MD, [illegible] N. Neill, MD, Jennifer L. Vance, M

Department of Anesthesiolog[illegible]chigan; Department of Anesthesiology, Mercy St. Vin[illegible]edo, Toledo, Ohio; and Department of Inte[illegible]

Preop Propensity matched patients, adjusted

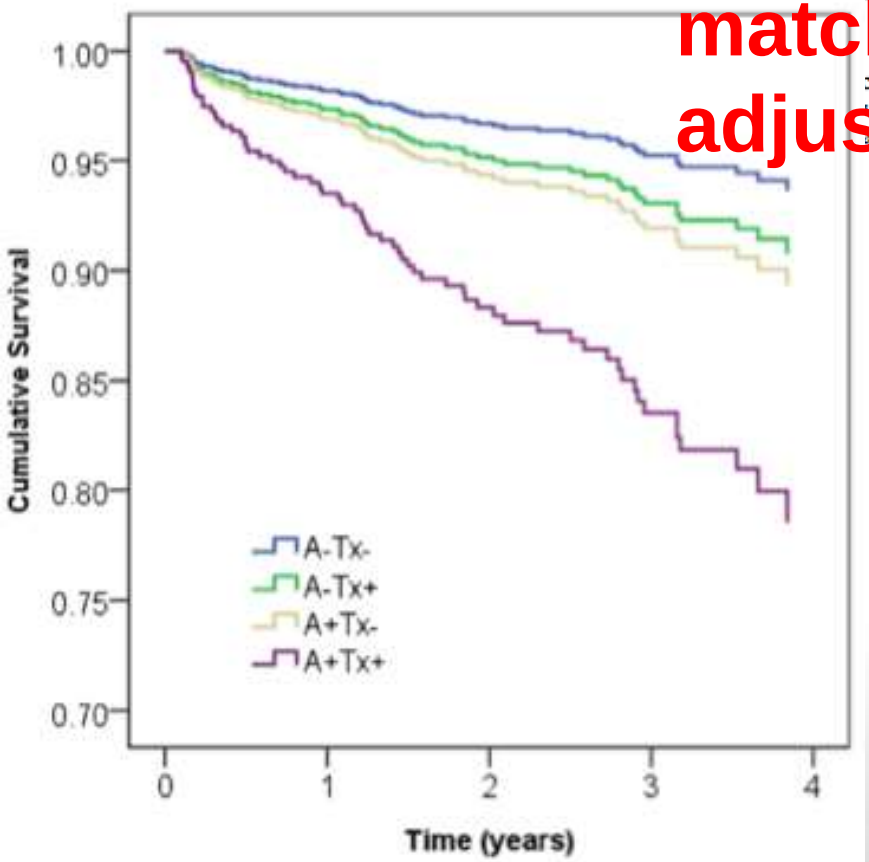


Fig 3. Cox plot of all 576 propensity-matched patients showing the effect of anemia–transfusion interaction on survival after adjustment

Ann Thorac Surg 2014;97:514–21

Update 2013

Bloedbeheer	Anesthesioloog [redacted]		Overige		Interval	
	N	%	N	%	MIN	MAX
Cyclokapron / Aprotinine	91	85,1	1154	89,7	81,9%	96,9%
Bloedverlies > 1000 ml.			57	4,4	0,0%	5,7%
Getransfundeerd	38	35,5	495	38,5	21,9%	54,8%
Resternotomie	6	5,6	64	5,0	0,0%	6,5%

Update 2013

Bloedbeheer	Periode					
	2013		2012		2011	
	N	%	N	%	N	%
Cyclokapron / Aprotinine	1245	89,3	1321	88,3	1390	90,6
Bloedverlies > 1000 ml.	57	4,1	62	4,1	65	4,2
Getransfundeerd	533	38,2	622	41,6	776	50,5
Resternotomie	70	5,0	100	6,7	121	7,9

	17-03-2011 08:00	17-03 16
Hematologie		
Leukocyten	8.2	
Hemoglobine	**7.0**	
Hematocriet	**0.33**	
Erytrocyten	**3.8**	
MCV	85	
MCHC	21.6	
RDW	14.3	
Trombocyten	170	
Bloedgroep	B	
Rhesus Factor	POS	
Irregulaire a.s.	Negatief	
Bloedproducten	besteld	
Chemie		
CRP	**15**	
Natrium	138	
Kalium	4.1	

Patient blood management in cardiac surgery results in fewer transfusions and better outcome

Irwin Gross,[1] Burkhardt Seifert,[2] Axel Hofmann,[2] and Donat R. Spahn[2]

TABLE 2. Blood loss and transfusion outcome*

	Pre-PBM epoch	PBM epoch	p value
RBC loss (mL)	810 ± 426 721 [538-993]	605 ± 369 552 [370-756]	<0.001
Hb (g/dL)			
Before transfusion	7.2 ± 1.4	6.6 ± 1.2	<0.001
After transfusion	8.3 ± 1.3	7.7 ± 1.1	<0.001
% of patients transfused			
RBCs	39.3	20.8	<0.001
FFP	18.3	6.5	<0.001
PLTs	17.8	9.8	<0.001
RBCs (units/patient)	1.28 ± 2.34 0 [0-2]	0.61 ± 1.57 0 [0-0]	<0.001
FFP (units/patient)	0.78 ± 1.98 0 [0-0]	0.23 ± 1.05 0 [0-0]	<0.001
PLTs (units/patient)	0.39 ± 1.03 0 [0-0]	0.17 ± 0.65 0 [0-0]	<0.001
Discharge Hb (g/dL)	9.1 ± 1.2	9.4 ± 1.5	<0.001

* Data are mean ± SD and median [interquartile range] for nonnormally distributed data.

Transfusion 2015;

Patient blood management in cardiac surgery results in fewer transfusions and better outcome

Irwin Gross,[1] Burkhardt Seifert,[2] Axel Hofmann,[2] and Donat R. Spahn[2]

TABLE 3. Clinical and economic outcomes

	Pre-PBM epoch	PBM epoch	p value
Mortality (%)	3.9	4.4	0.642
CVA (%)	3.40	2.10	0.130
Kidney injury (%)	7.60	5.00	0.039
ICU LOS (days)	5.0 ± 7.1	5.0 ± 7.1	0.970
	3 [1-6]	3 [1-6]	
Hospital LOS (days)	12.2 ± 9.6	10.4 ± 8.0	<0.001
	10 [7-15]	8 [6-12]	
30-day readmission rate (%)	0.3	0.1	0.467
Total direct costs ($)	48,375 ± 28,053	44,300 ± 25,915	<0.001
	39,709 [32,470-54,994]	36,906 [29,510-49,967]	

* Data are mean ± SD and median [interquartile range] for nonnormally distributed data.
LOS = length of stay.

Transfusion 2015;

Perceived barriers among physicians for stopping non–cost-effective blood-saving measures in total hip and total knee arthroplasties

Veronique M.A. Voorn,[1] Perla J. Marang-van de Mheen,[1] Manon M. Wentink,[1] Ad A. Kaptein,[2] Ankie W.M.M. Koopman-van Gemert,[3] Cynthia So-Osman,[4] Thea P.M. Vliet Vlieland,[5] Rob G.H.H. Nelissen,[5] and Leti van Bodegom-Vos[1] for the LISBOA Study Group

Transfusion October 2014

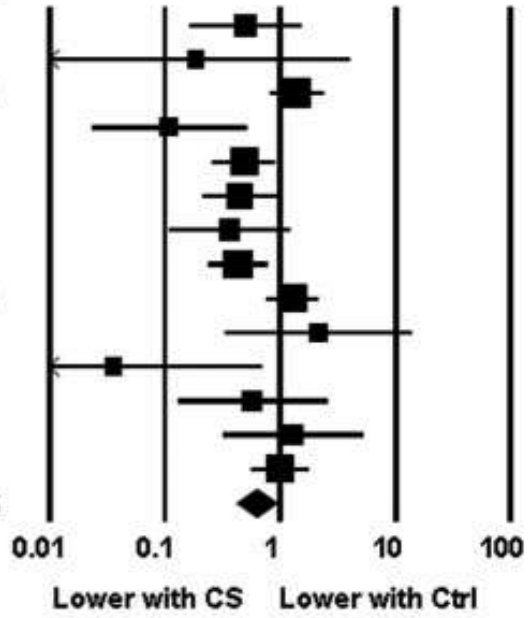
Business case

- Increase in cost
  - Antifibrinolytics
  - Cell saver
    - New device
    - exploitation
  - Project cost
  - Analysis
- savings
  - Bloodtransfusion products
- Not taken into account; other savings e.g. Hospitalisation duration , complications, etc

The Efficacy of an Intraoperative Cell Saver During Cardiac Surgery: A Meta-Analysis of Randomized Trials

Patients Transfused Any Blood Product

Study name	Statistics for each study				Events / Total	
	MH odds ratio	Lower limit	Upper limit	p-Value	CellSaver	Control
Damgaard [8]	0.50	0.17	1.48	0.21	17 / 30	21 / 29
Dietrich [9]	0.18	0.01	4.04	0.28	23 / 25	25 / 25
Djaiani [19]	1.39	0.82	2.35	0.22	67 / 112	59 / 114
Laub [11]	0.11	0.02	0.51	0.01	7 / 19	16 / 19
McGill [12]	0.48	0.26	0.90	0.02	32 / 84	47 / 84
Merville [13]	0.44	0.21	0.92	0.03	21 / 60	33 / 60
Murphy [15]	0.36	0.11	1.22	0.10	5 / 30	11 / 31
Murphy [14]	0.43	0.24	0.77	0.00	45 / 99	64 / 97
Rubens [21]	1.28	0.78	2.10	0.33	55 / 132	48 / 134
Svenmarker [40]	2.15	0.34	13.80	0.42	4 / 17	2 / 16
Tempe [17]	0.04	0.00	0.68	0.03	12 / 20	20 / 20
Wiefferink [44]	0.57	0.13	2.50	0.46	8 / 15	10 / 15
Winton [18]	1.29	0.32	5.17	0.72	6 / 20	5 / 20
Klein [22]	1.00	0.56	1.77	0.99	33 / 102	36 / 111
	0.63	0.43	0.94	0.02	335 / 765	397 / 775



Wang, Bainbridge; Anesth Analg 2009;109:320–30

Mortality and morbidity in patients with very low postoperative Hb levels who decline blood transfusion

Jeffrey L. Carson, Helaine Noveck, Jesse A. Berlin, and Steven A. Gould

Transfusion 2002

- **Retrospective Cohort study (1981-1994)**
- **Jehova Witnesses,**
- **Surgical patients, no cardiac**
- **n=2083 ➔ n=300 with Hb<8gr%**

Mortality and morbidity in patients with very low postoperative Hb levels who decline blood transfusion

Jeffrey L. Carson, Helaine Noveck, Jesse A. Berlin, and Steven A. Gould

- Conclusions
  - If Hb 7-8% =No mortality but morbidity in 9.4%
  - Dramatical M&M if Hb <5-6 gr%
  - Corrected for age, CV disease, Apache II→ OR death 2.5 / gr decrease below 8 gr%