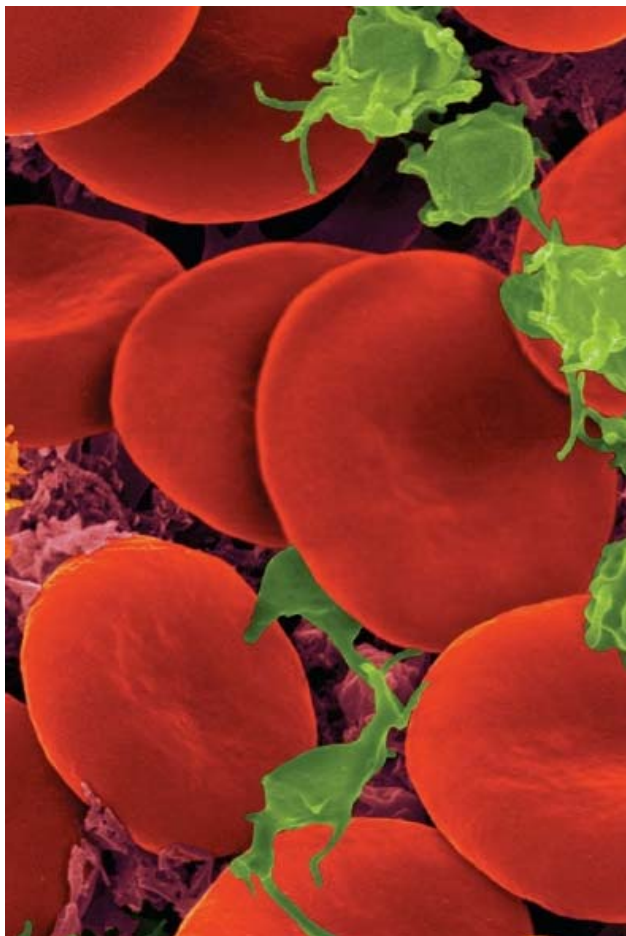




Blood Transfusion Project

Reducing Transfusion in the MARCQI Population



Updated 10/28/16, brh



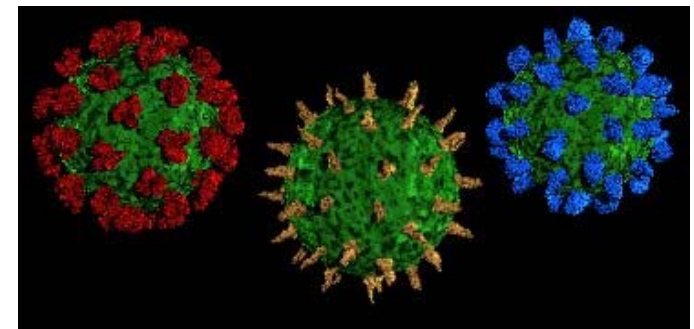
Anemia in Healthy Awake Volunteers

- Critical hemoglobin threshold unknown in humans
- At 6 g/dL
 - Decline in cognitive function
- At 5 g/dL
 - VO_2 maintained
 - ST changes in 5%
 - Memory formation impaired

Lieberman JA, Weiskopf RB, Kelley SD, Feiner J, Noorani M, Leung J, Toy P, Viele M. Critical oxygen delivery in conscious humans is less than $7.3 \text{ ml O}_2 \times \text{kg}(-1) \times \text{min}(-1)$. Anesthesiology. 2000 Feb;92(2):407-13. Lieberman, et al. Anesthesiology 2000

Risks of Blood Transfusion

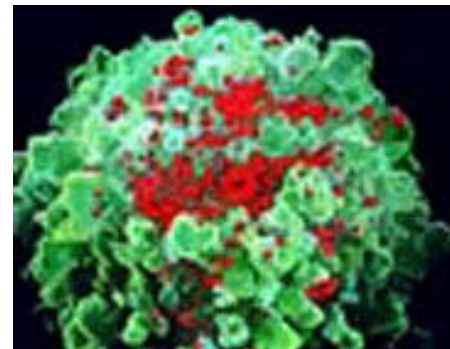
- Viral transmission
- Acute transfusion reactions
- Immunosuppression
- Acute inflammatory response



Infection

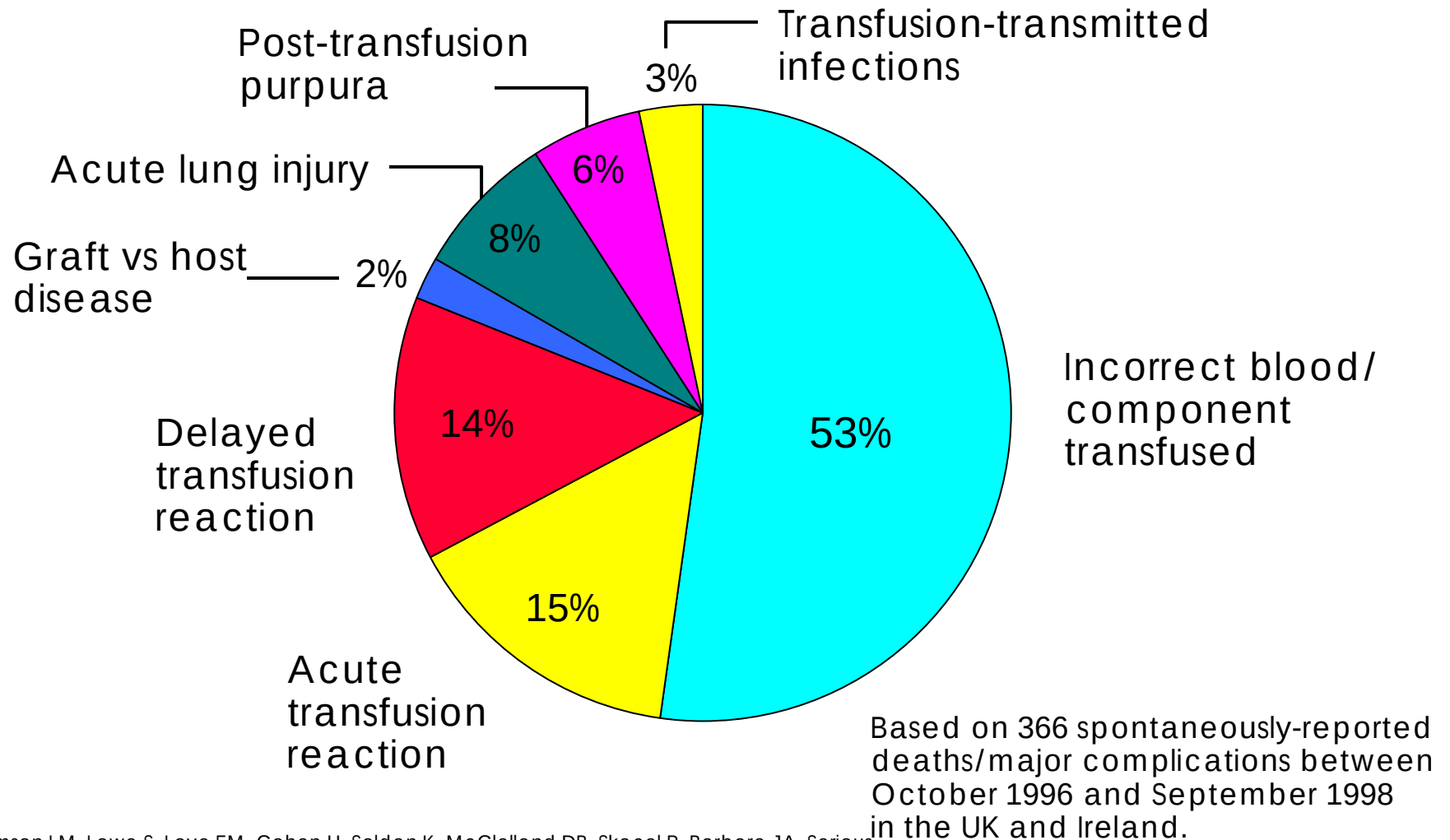


Noninfectious Hazards



Immunosuppression

Serious Hazards of Transfusion

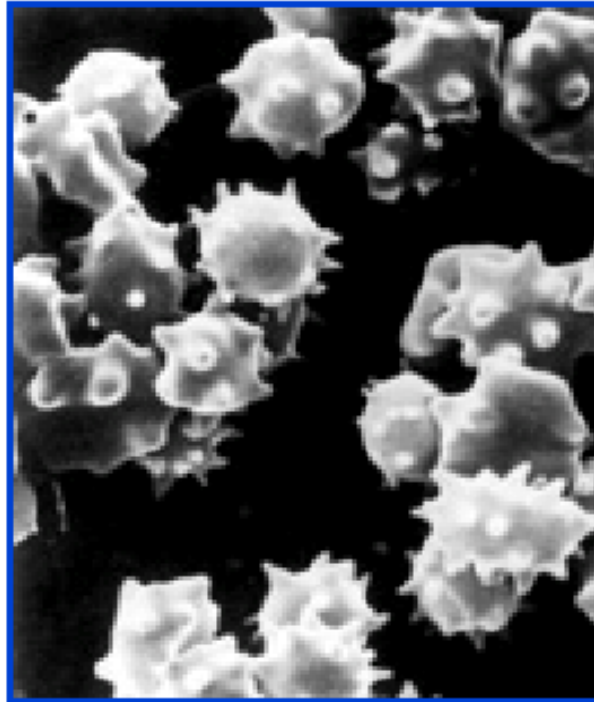


Williamson LM, Lowe S, Love EM, Cohen H, Soldan K, McClelland DB, Skacel P, Barbara JA. Serious hazards of transfusion (SHOT) initiative: analysis of the first two annual reports. BMJ. 1999 Jul 3;319(7201):16-9.

Age of Stored Blood



Day 1



Day 21



Day 35

Hovav T1, Yedgar S, Manny N, Barshtein G. Hovav et al. Alteration of red cell aggregability and shape during blood storage. Transfusion. 1999; 39: 277-281.

Immune Effects of Blood

- Decreased T-cell proliferation
- Decreased CD3, CD4, CD8 T-cells
- Increased Cell-mediated lympholysis
- Increased TNF-alpha
- Increased suppressor T-cell activity
- Reduced natural killer cell activity

TRIM – Transfusion-associated Immunomodulation

McAlister FA1, Clark HD, Wells PS, Laupacis A. Perioperative allogeneic blood transfusion does not cause adverse sequelae in patients with cancer: a meta-analysis of unconfounded studies. Br J Surg. 1998 Feb;85(2):171-8.

Innerhofer P, Luz G, Spötl L, Hobisch-Hagen P, Schobersberger W, Fischer M, Nussbaumer W, Lochs A, Irschick E. Immunologic changes after transfusion of autologous or allogeneic buffy coat-poor versus white cell-reduced blood to patients undergoing arthroplasty. I. Proliferative T-cell responses and the balance of helper and suppressor T cells. Transfusion. 1999 Oct;39(10):1089-96.





Blood Transfusion Increases Risk of Postoperative Bacterial Infection

- 20 peer-reviewed studies, 1986-2000
- 13,152 patients
 - 5215 transfused
 - 7937 not transfused
- Association of Transfusion to Infection
 - OR 3.45 (range 1.43-15.15)
 - 17 of 20 studies with $p < 0.05$

Hill GE1, Frawley WH, Griffith KE, Forestner JE, Minei JP. Allogeneic blood transfusion increases the risk of postoperative bacterial infection: a meta-analysis. J Trauma. 2003 May;54(5):908-14.



Predictors and Complications of Blood Transfusion in Total Hip and Knee Arthroplasty

- Henry Ford Hospital
- Jan 2011 to Dec 2012
- 1573 patients
- 5x higher infection rate in transfused patients
- Factors associated with transfusion
 - Age
 - Female gender
 - BMI
 - Pre-op anemia

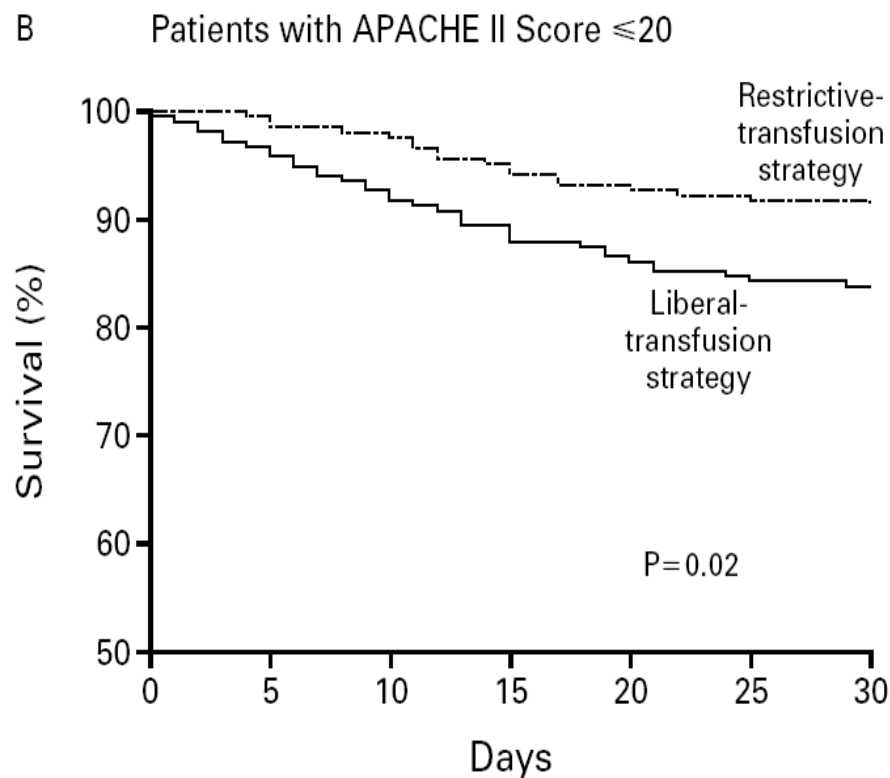
Frisch, et al. AAHKS 11/2013

Frisch NB, et al. Predictors and Complications of Blood Transfusion in Total Hip and Knee Arthroplasty. The Journal of Arthroplasty, 29 Suppl. 2 (2014) 189–192.

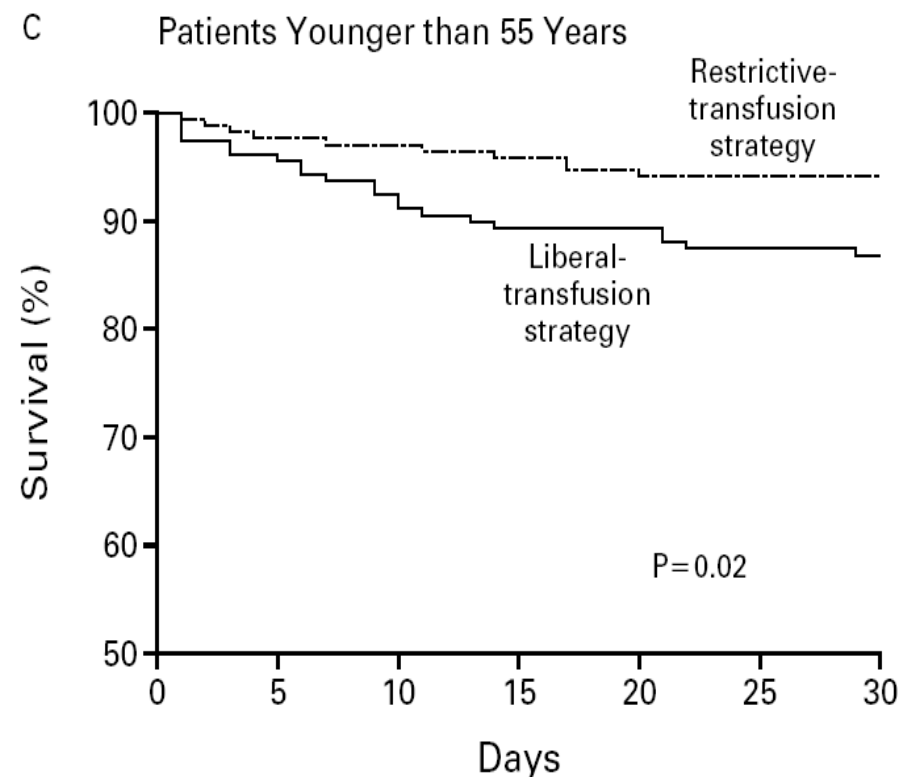
The TRICC Study

- 838 patients ICU patients
- Placed into one of two groups
 - **Restrictive group:**
 - Transfuse if Hb < 7
 - Maintain between 7 and 9
 - **Liberal group:**
 - Transfuse if Hb < 10
 - Maintain between 10 and 12
- The primary outcome measure was death from all causes in the 30 days after randomization

Hébert PC1, Wells G, Blajchman MA, Marshall J, Martin C, Pagliarello G, Tweeddale M, Schweitzer I, Yetisir E. A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. Transfusion Requirements in Critical Care Investigators, Canadian Critical Care Trials Group. N Engl J Med. 1999 Feb 11;340(6):409-17



8.7% vs 16.1%



5.7% vs 13.0%

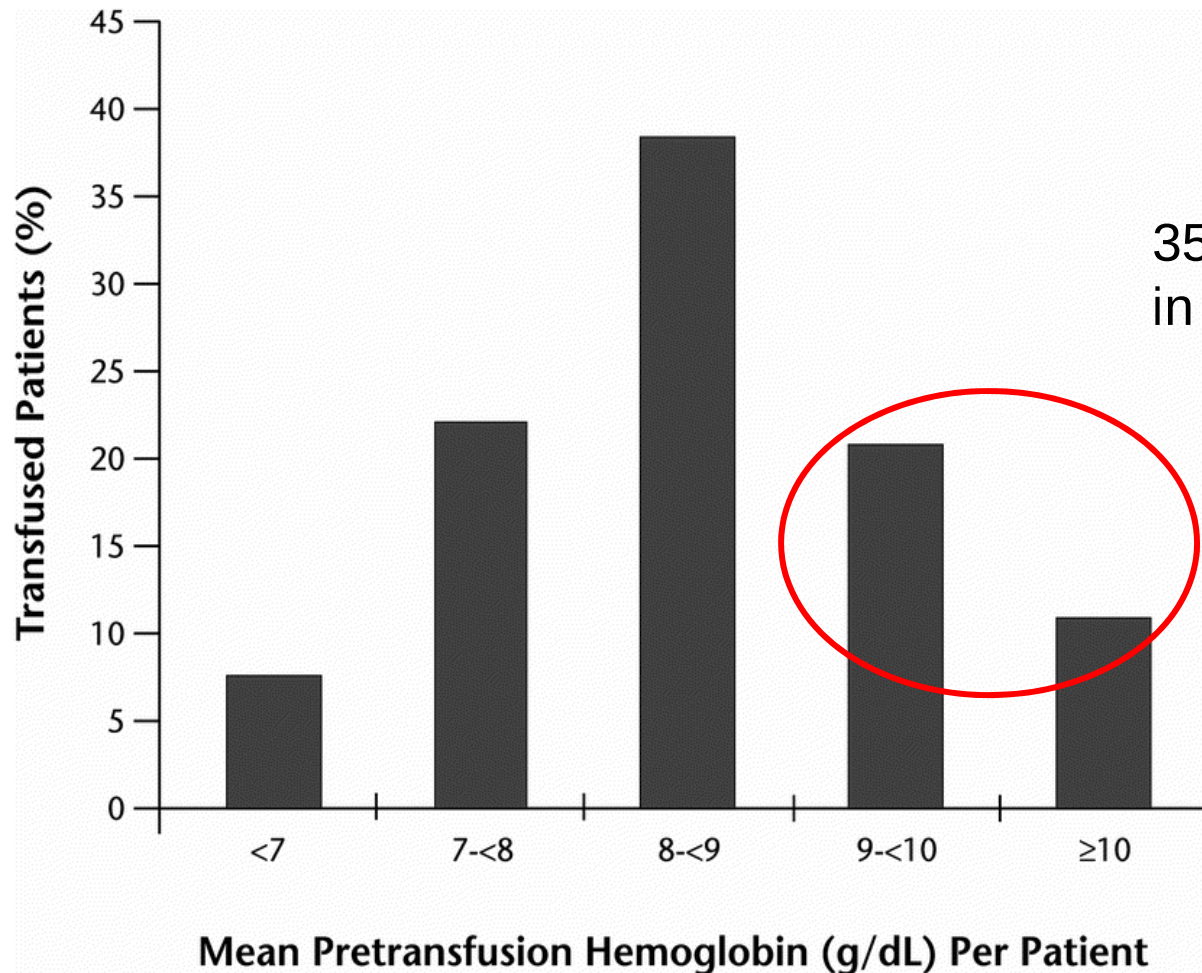
Hébert PC1, Wells G, Blajchman MA, Marshall J, Martin C, Pagliarello G, Tweeddale M, Schweitzer I, Yetisir E. A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. Transfusion Requirements in Critical Care Investigators, Canadian Critical Care Trials Group. N Engl J Med. 1999 Feb 11;340(6):409-17

CRIT Study

- 4,892 ICU patients in the US
- Prospective, multiple center, observational cohort
- Examine the relationship of
 - Anemia
 - RBC transfusion
 - Clinical outcomes

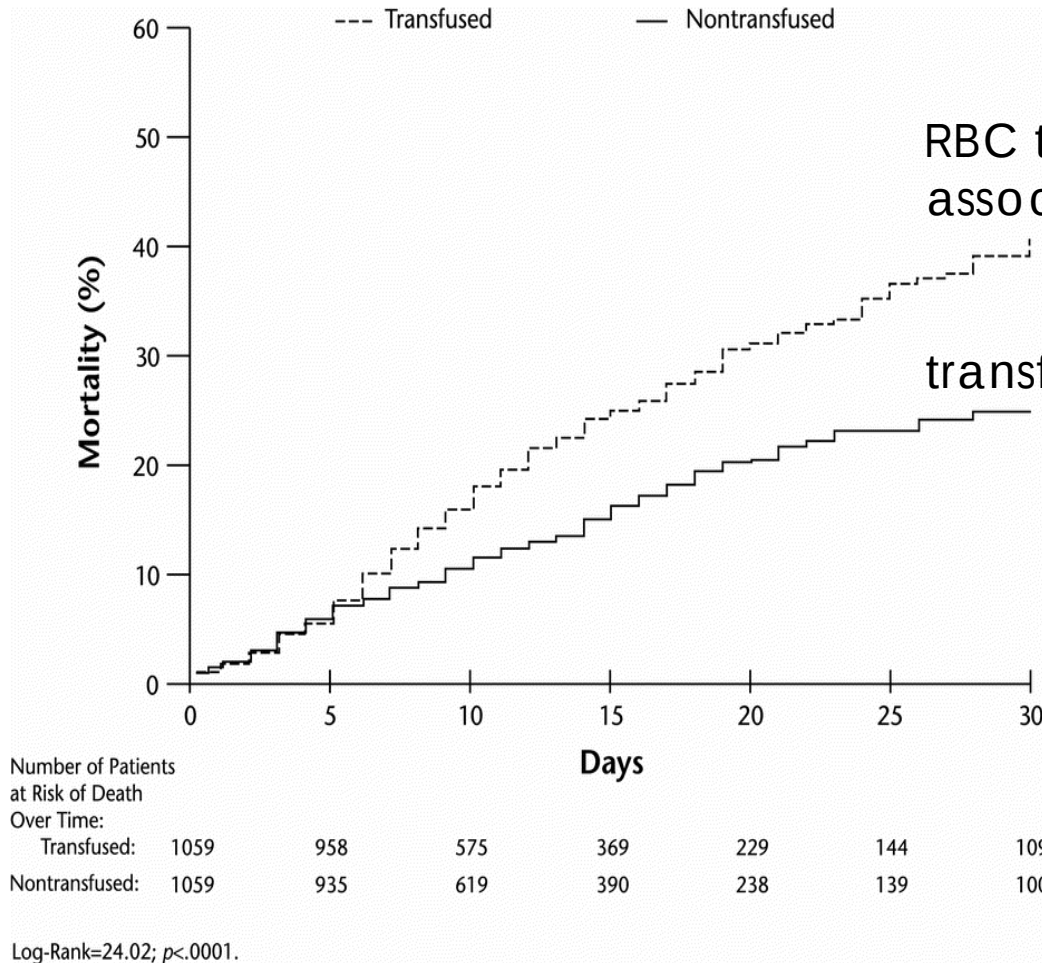
Corwin HL, Gettinger A, Pearl RG, Fink MP, Levy MM, Abraham E, MacIntyre NR, Shabot MM, Duh MS, Shapiro MJ. The CRIT Study: Anemia and blood transfusion in the critically ill--current clinical practice in the United States. Crit Care Med. 2004 Jan;32(1):39-52.

CRIT Results



Corwin HL, Gettinger A, Pearl RG, Fink MP, Levy MM, Abraham E, MacIntyre NR, Shabot MM, Duh MS, Shapiro MJ. The CRIT Study: Anemia and blood transfusion in the critically ill--current clinical practice in the United States. Crit Care Med. 2004 Jan;32(1):39-52.

CRIT Results



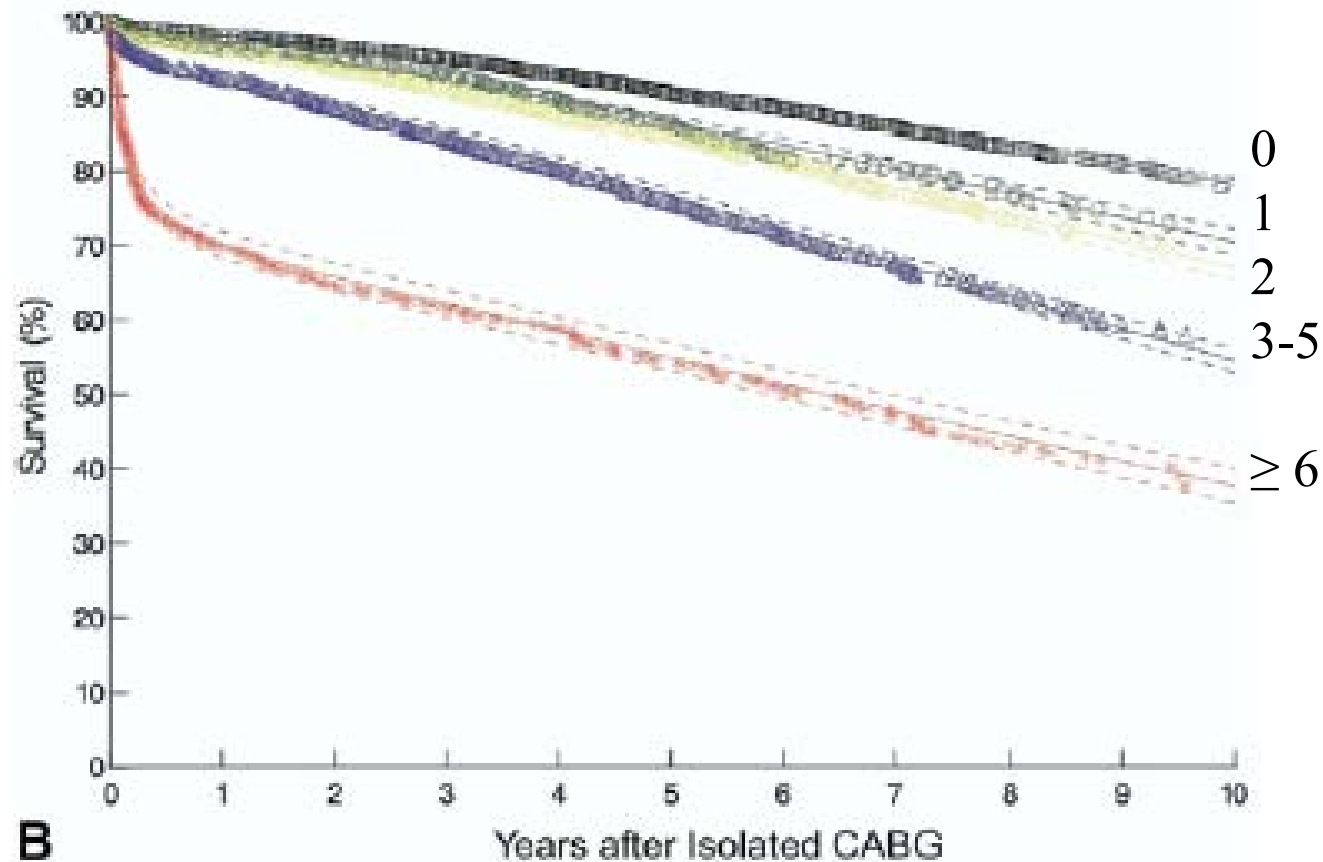
RBC transfusion was independently associated with higher mortality
 OR 1.65 (CI 1.35-2.03)
 OR 2.62 if 3-4 units transfused

Corwin HL, Gettinger A, Pearl RG, Fink MP, Levy MM, Abraham E, MacIntyre NR, Shabot MM, Duh MS, Shapiro MJ. The CRIT Study: Anemia and blood transfusion in the critically ill--current clinical practice in the United States. Crit Care Med. 2004 Jan;32(1):39-52.

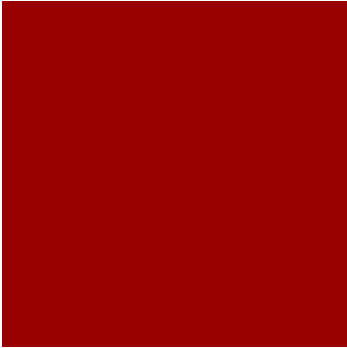
Transfusion in Coronary Artery Bypass Grafting is Associated with Reduced Long-Term Survival

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



Koch CG1, Li L, Duncan AI, Mihaljevic T, Loop FD, Starr NJ, Blackstone EH. Transfusion in coronary artery bypass grafting is associated with reduced long-term survival. Ann Thorac Surg. 2006 May;81(5):1650-7.



FOCUS Trial

- Inclusion criteria:
 - Undergo surgery for hip fracture
 - Have a history of cardiovascular disease
 - Have a postoperative Hgb < 10 g/dL
- Randomized to keep Hgb > 10 g/dL or not
- Primary outcome
 - Ability to walk 10 feet without assistance at 60 days
- Negative outcomes
 - Postoperative unstable angina
 - Myocardial infarction
 - Death

The NEW ENGLAND JOURNAL *of* MEDICINE

ESTABLISHED IN 1812

DECEMBER 29, 2011

VOL. 365 NO. 26

Liberal or Restrictive Transfusion in High-Risk Patients after Hip Surgery

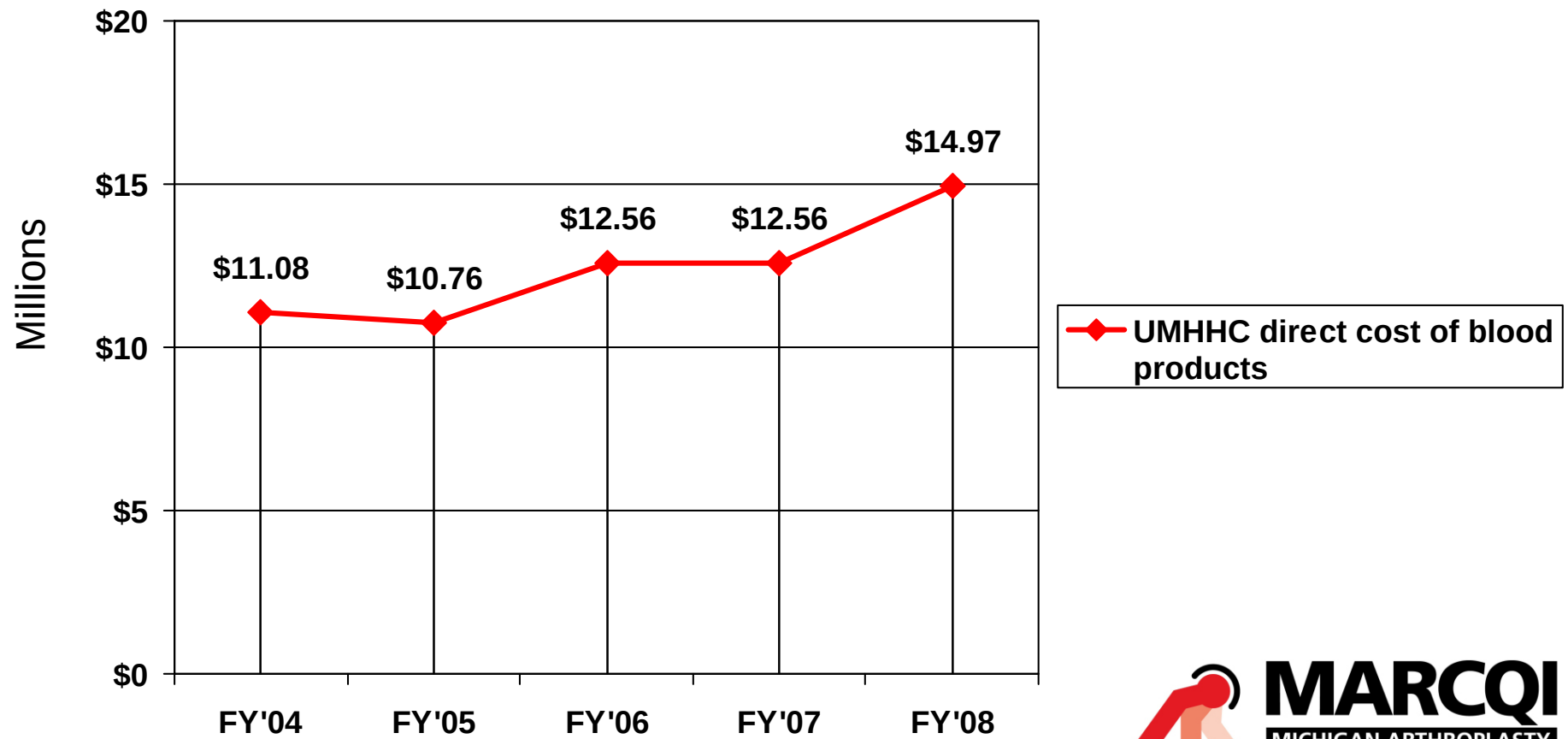
Jeffrey L. Carson, M.D., Michael L. Terrin, M.D., M.P.H., Helaine Noveck, M.P.H., David W. Sanders, M.D., Bernard R. Chaitman, M.D., George G. Rhoads, M.D., M.P.H., George Nemo, Ph.D., Karen Dragert, R.N., Lauren Beaupre, P.T., Ph.D., Kevin Hildebrand, M.D., William Macaulay, M.D., Courtland Lewis, M.D., Donald Richard Cook, B.M.Sc., M.D., Gwendolyn Dobbin, C.C.R.P., Khwaja J. Zakriya, M.D., Fred S. Apple, Ph.D., Rebecca A. Horney, B.A., and Jay Magaziner, Ph.D., M.S.Hyg., for the FOCUS Investigators*

CONCLUSIONS

A liberal transfusion strategy, as compared with a restrictive strategy, did not reduce rates of death or inability to walk independently on 60-day follow-up or reduce in-hospital morbidity in elderly patients at high cardiovascular risk. (Funded by the National Heart, Lung, and Blood Institute; FOCUS ClinicalTrials.gov number, NCT00071032.)

N Engl J Med 2011;365:2453-62.

Financial Burden





Allogenic Transfusion

- Risks
 - Disease transmission
 - Increased complication rates
 - Increased readmissions (MARCQI data)
 - Increased mortality



MARCQI Transfusion Data

In 2013:

- 9.8% of MARCQI patients were transfused
 - 14.2% of hips
 - 7% of knees
 - 23% of bilateral knees
- Only 1.5% of patients had a nadir Hgb < 7 g/dL
- 4.6% receive TXA



MARCQI Sites: 2013 Transfusion Protocols

- Wide range of transfusion triggers
 - Asymptomatic patient
 - Hgb < 7 g/dL to Hgb < 9 g/dL
 - Symptomatic patients
 - Hgb < 7 g/dL to Hgb < 11 g/dL
- Some had no protocol



U of M Transfusion Guidelines

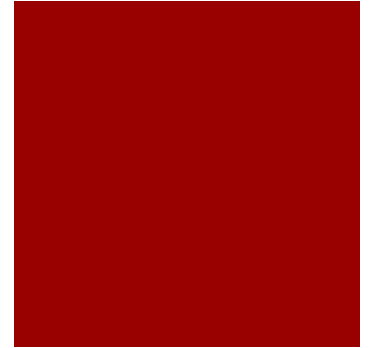
- Hgb < 6 g/dL in asymptomatic patient
- Hgb < 7 g/dL in post-op or ill patient
- Hgb < 10 g/dL acute coronary syndrome



Restrictive Transfusion Protocols

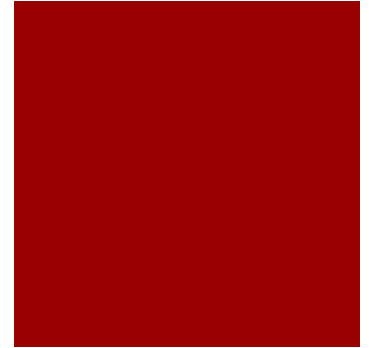
- Are safe
- Recommended by:
 - American Red Cross (ARC)
 - American Association of Blood Banks (AABB)
 - Cochrane Collaboration Review

Summary



- Transfusion may benefit patients during acute coronary syndromes if **Hgb < 8-10 g/dL**
- There is very rarely an indication to transfuse **ANY** patient with a **Hgb $\geq$ 10 g/dL**
- **Each** unit incrementally increases risk
- Decreasing transfusion may
 - reduce risk of infection and readmission
 - reduce mortality
 - decrease cost

Guidelines for Blood Transfusion: PRBCs

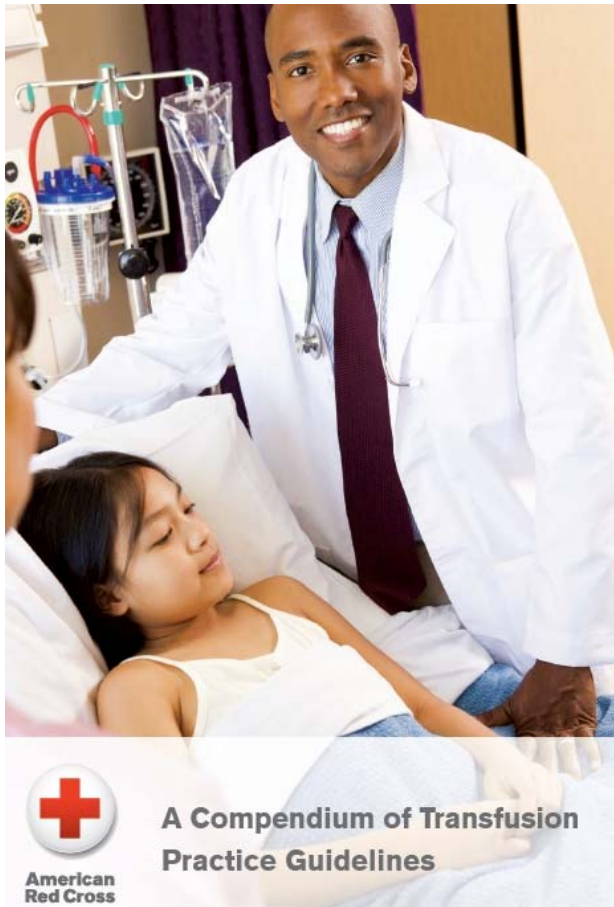


- These guidelines are intended to ensure that the most appropriate, efficient and safe use of the blood supply is achieved
- To establish evidence-based criteria for the transfusion of blood components
- Every indication for the use of blood products cannot be anticipated
- These guidelines are **not** intended to override physician judgement

Guidelines for Blood Transfusion: PRBCs

- Administered as **single units** except for ongoing blood loss with hemodynamic instability.
- Transfusion decisions are clinical judgments that should **not** be based on laboratory parameters alone.

MARCQI Transfusion Guidelines: Presented November 2013



- Red Cross Transfusion Guidelines
 - Post-operative patients
 - Indications for allogenic transfusion
 - Threshold of Hgb < 8 g/dL
 - Clinically significant symptoms of anemia
 - Unresponsive to fluid resuscitation
 - Clinical judgement in patients with Hgb < 10 g/dL and increased risk factors



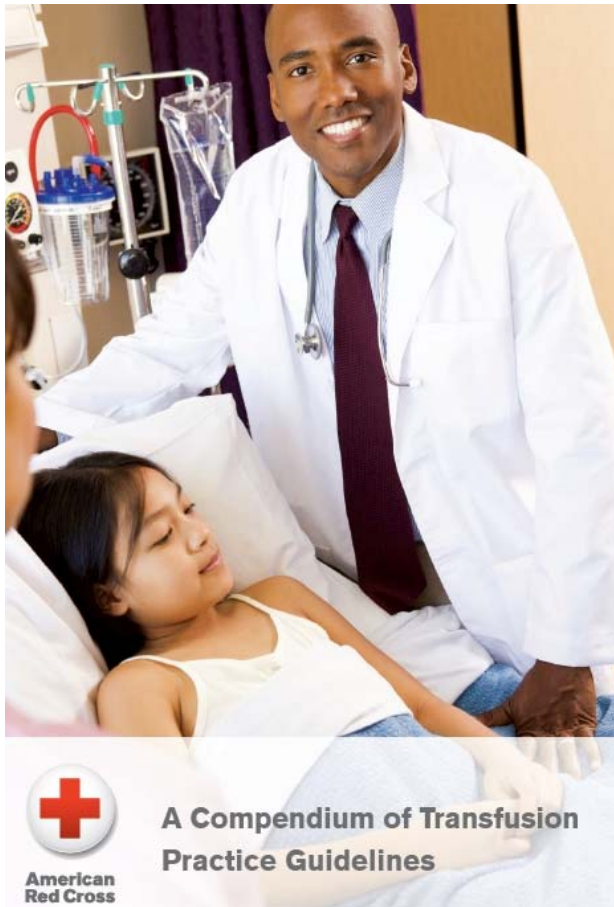
American
Red Cross

A Compendium of Transfusion
Practice Guidelines



MARCQI
MICHIGAN ARTHROPLASTY
REGISTRY
COLLABORATIVE QUALITY INITIATIVE

2013: MARCQI recommendation



- Encourage adoption of the Red Cross Guidelines or similar protocols at your institution and in your practice
- Transfuse one unit at a time
- Encourage these practices with your colleagues



Tranexamic Acid in MARCQI

- Associated with reduced:
 - Transfusion after THA and TKA
 - Readmissions after THA
 - Venous thromboembolism (VTE) after TKA
- **No** increase in risk of:
 - VTE
 - Cardiovascular events
 - Stroke

This is an FDA off-label use of TXA

Hallstrom BR, Singal B, Cowen M, Roberts K, Hughes R. The Michigan experience with safety and effectiveness of tranexamic acid use in hip and knee arthroplasty. *JBJS J Bone Jt Surg -American Bone Jt Surg [Am]*. 2016;98(19):1646-1655. <http://dx.doi.org/10.2106/JBJS.15.01010>.





TXA Analysis for TKA

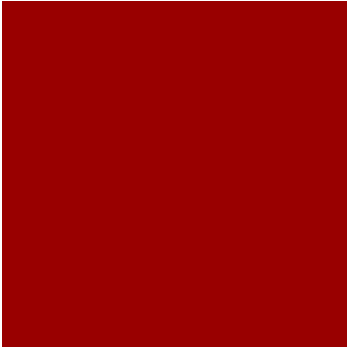


- TXA administration associated with
 - Lower drop in hgb
 - $\frac{1}{4}$ the odds of transfusion
 - OR = 0.26 (95% CI = 0.21 to 0.31; $p < 0.0001$)
 - **Lower risk of VTE**
 - HR = 0.56 (95% CI = 0.42 to 0.73; $p < 0.0001$)
 - No increase in readmissions

This is an FDA off-label use of TXA

Hallstrom BR, Singal B, Cowen M, Roberts K, Hughes R. The Michigan experience with safety and effectiveness of tranexamic acid use in hip and knee arthroplasty. *JBJS J Bone Jt Surg -American Bone Jt Surg [Am]*. 2016;98(19):1646-1655. <http://dx.doi.org/10.2106/JBJS.15.01010>.





TXA Analysis for THA



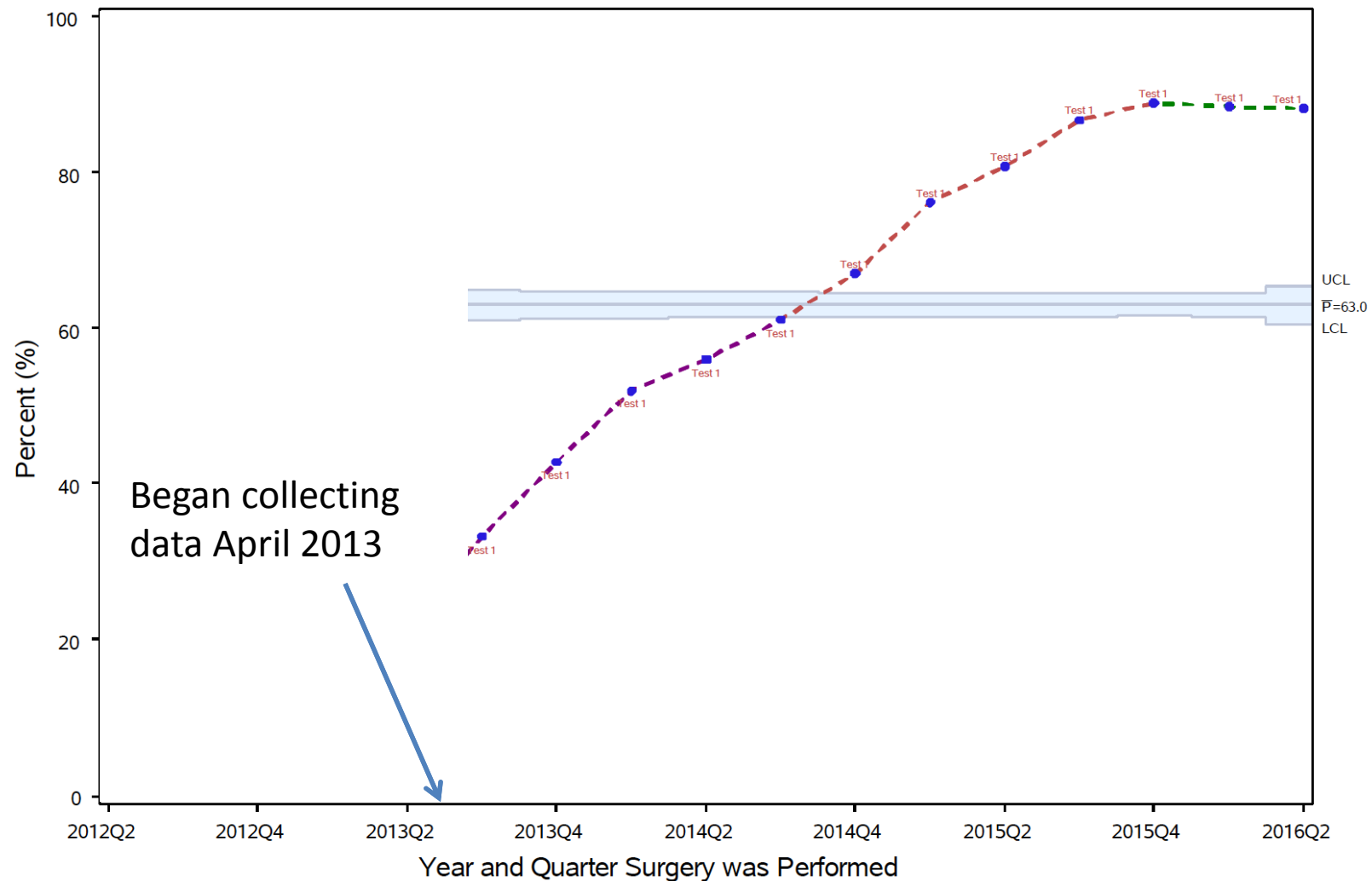
- TXA administration associated with
 - Lower drop in hgb
 - $\frac{3}{4}$ the odds of transfusion
 - OR = 0.72 (95% CI = 0.60 to 0.86; p = 0.0004)
 - No difference in VTE
 - **Decreased odds of readmission**
 - OR = 0.77 (95% CI = 0.64 to 0.93; p = 0.0080)

This is an FDA off-label use of TXA

Hallstrom BR, Singal B, Cowen M, Roberts K, Hughes R. The Michigan experience with safety and effectiveness of tranexamic acid use in hip and knee arthroplasty. *JBJS J Bone Jt Surg -American Bone Jt Surg [Am]*. 2016;98(19):1646-1655. <http://dx.doi.org/10.2106/JBJS.15.01010>.

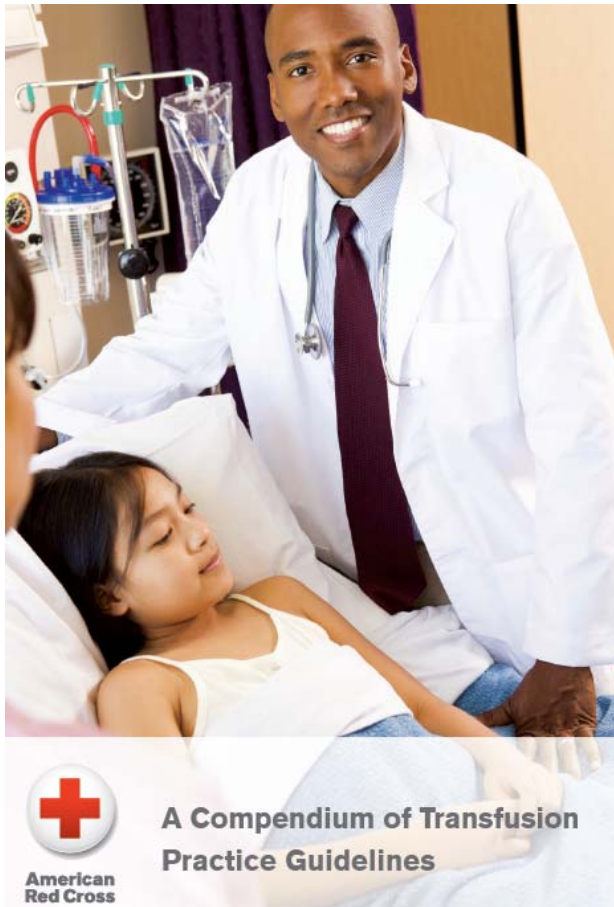
Tranexamic Acid

Hospitalizations Where Tranexamic Acid was Administered, Primaries, All Joints



MARCQI Transfusion Reduction Program

1. Screen for and treat preoperative anemia
2. Adopt intraoperative techniques for limiting blood loss
 - Use TXA in patients without contraindications
3. Adopt transfusion guidelines such as AARC Guidelines at your institution and in your practice
4. Transfuse only one unit at a time



This is an FDA off-label use of TXA

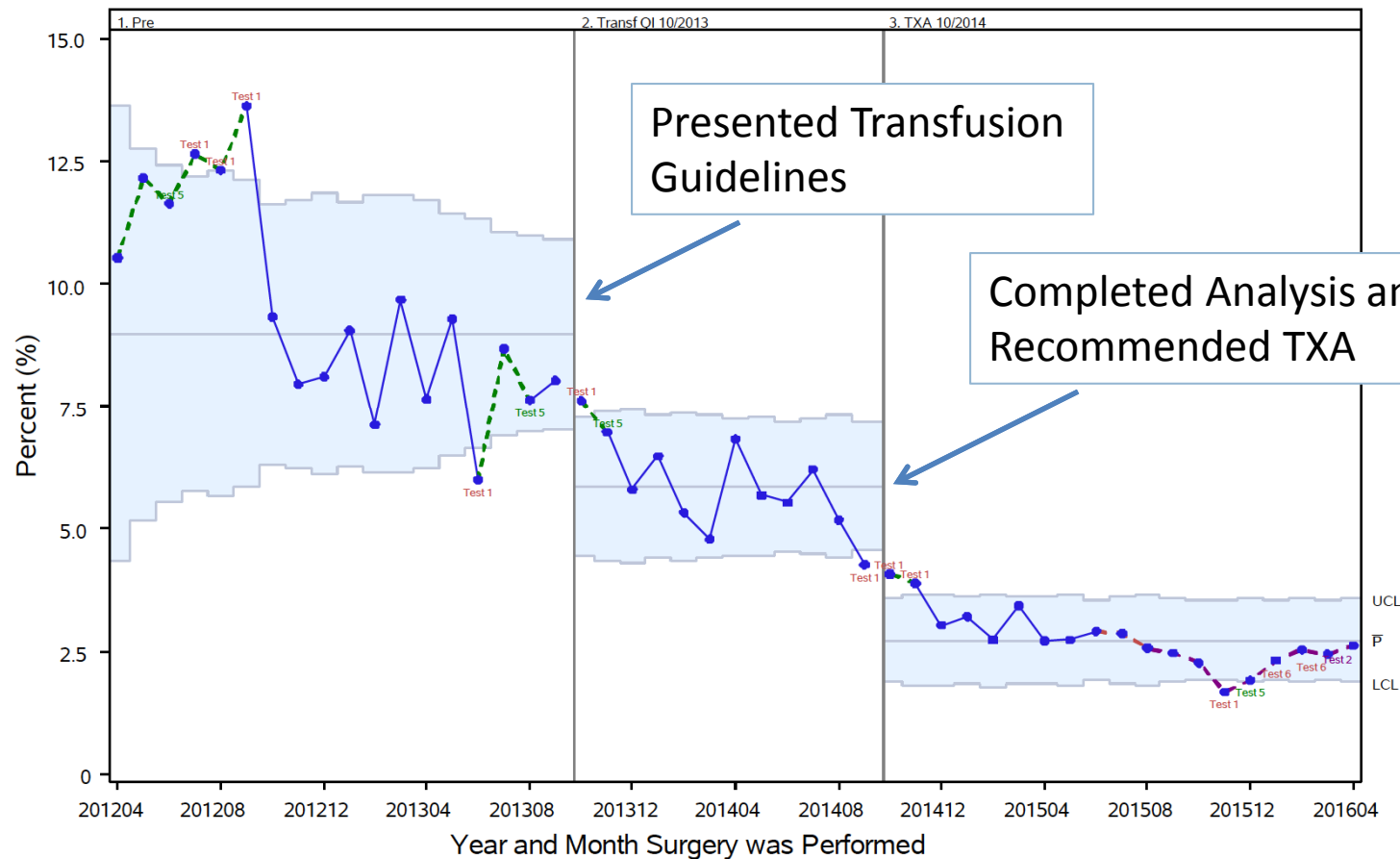


MARCQI
MICHIGAN ARTHROPLASTY
REGISTRY
COLLABORATIVE QUALITY INITIATIVE

MARCQI Transfusion

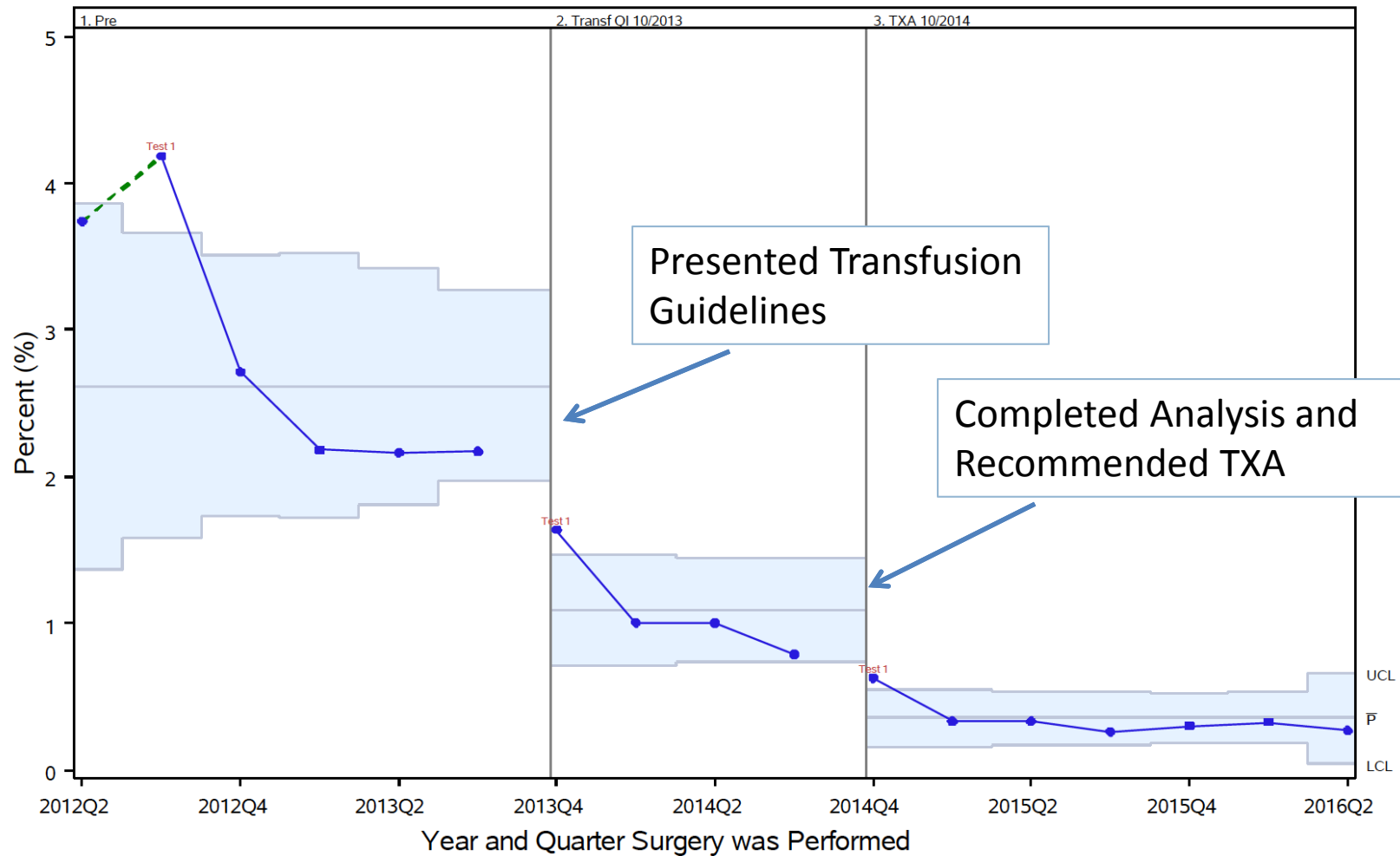
- Estimated 1600 fewer transfusions in 2015

Hospitalizations Having a Blood Transfusion, Primaries, All Joints



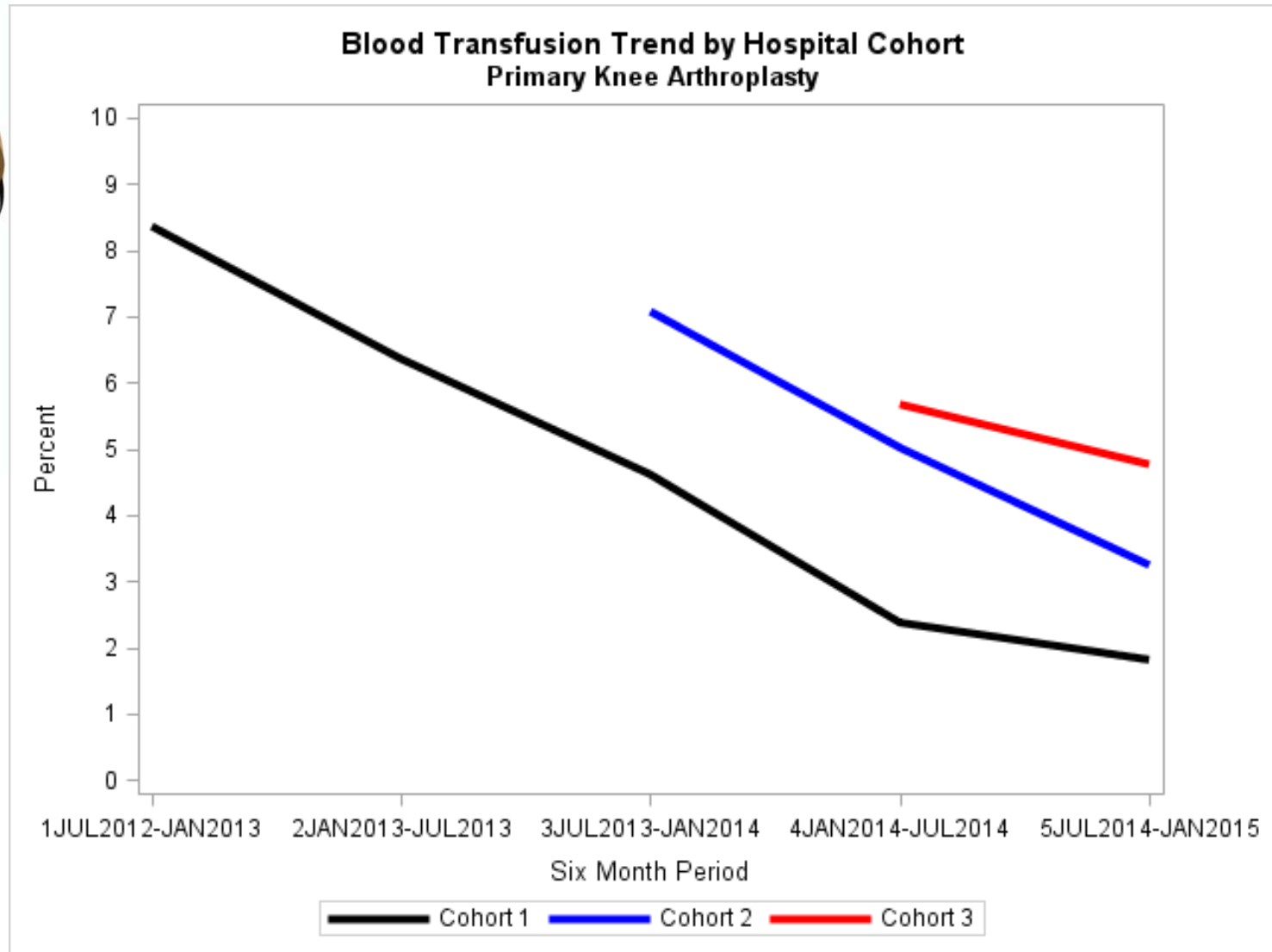
Eliminating Unnecessary Transfusions

Hospitalizations Having both a Blood Transfusion and an HGB Post > 8, Primaries, All Joints



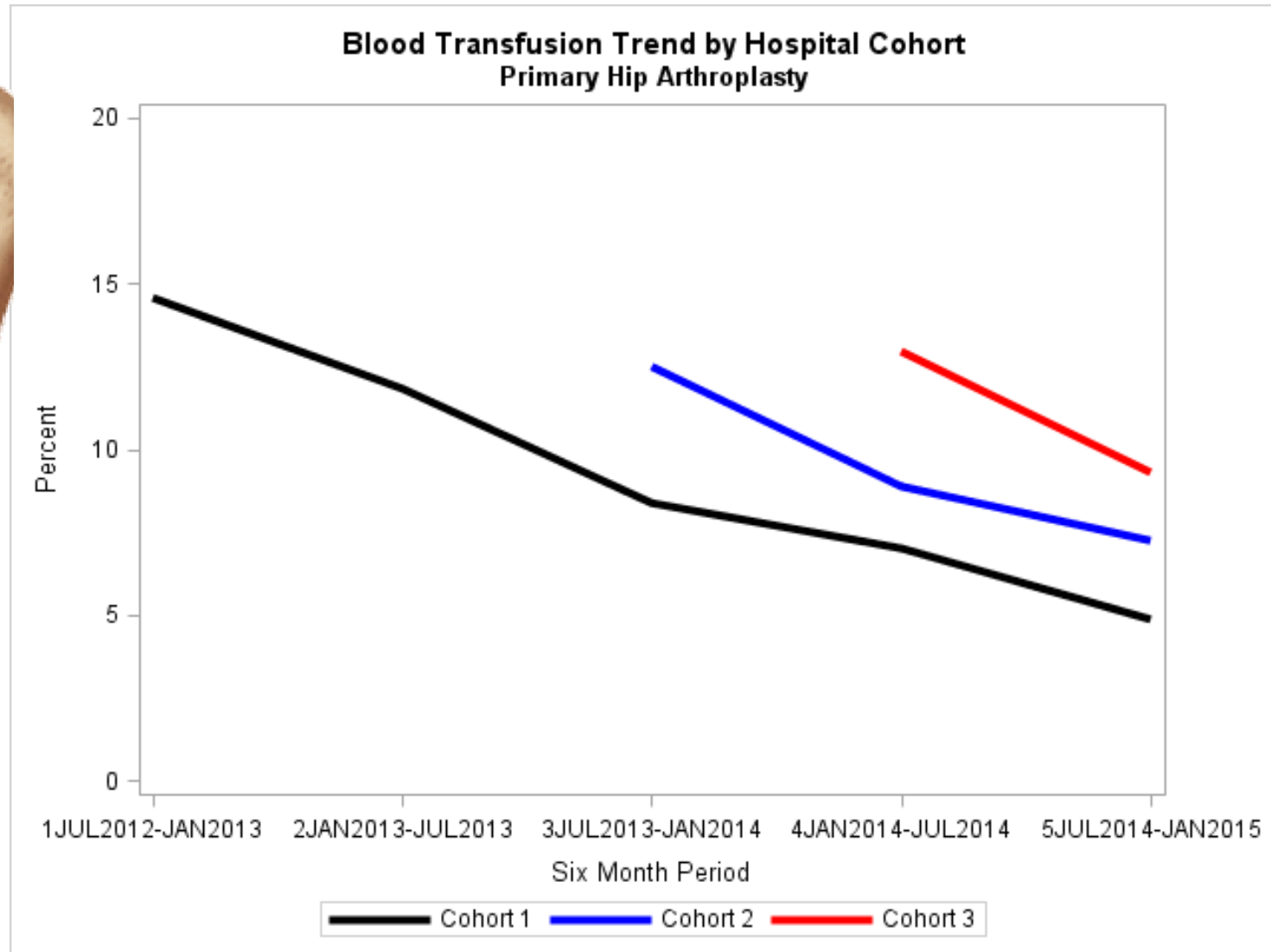
Subgroup Sizes: Min n = 1471 Max n = 10545

Each Cohort that joined MARCQI made improvement.

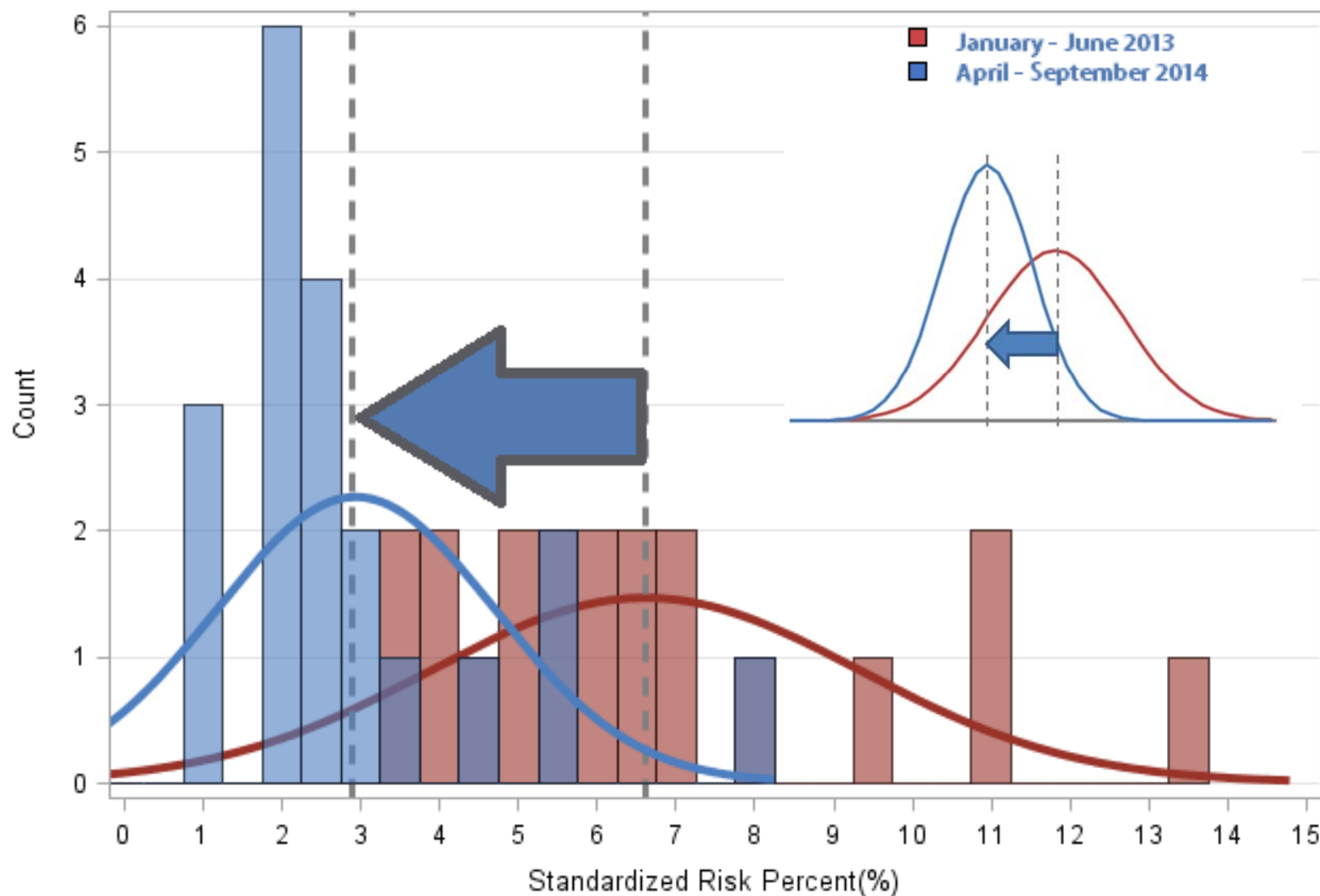




Each Cohort that joined MARCQI made improvement.



Change in Variation in Blood Transfusion after Knee Arthroplasty For Hospitals in MARCQI Since January, 2013



In addition to reduced transfusion rates, variation between hospitals decreased.

Blood Transfusion in MARCQI

- Transfusion in Michigan in 2013
 - 9.5% of patients received at least one transfusion
- Transfusion rate in Michigan now
 - 2.4%
- Drop of 75%
- National rate 11-14% after TKA
 - NSQIP and Premier

Thank You

