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# Blood Management 2016

**2016 AAHKS Annual Meeting  
Orthopaedic Team Member Course**

*Harpal S. Khanuja, MD  
Associate Professor  
Chief of Adult Reconstruction  
Johns Hopkins University  
Chair, Johns Hopkins Bayview*



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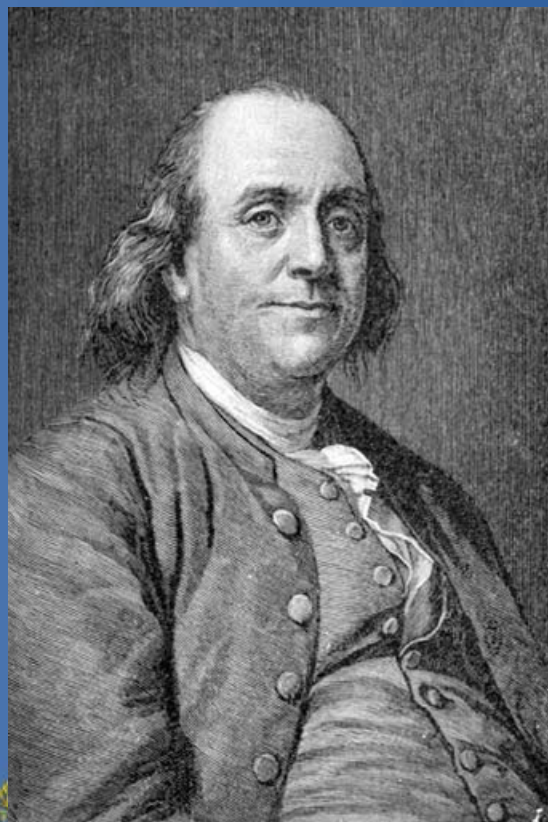
# Objective

- **Managing blood loss**
- **Minimize postoperative anemia**
- **Avoiding Blood Transfusions**
- **Not compromising recovery or outcomes**





# Preoperative Management



“An ounce of prevention is worth a pound of cure.”

-Benjamin Franklin





# Preoperative Management

- Identifying High Risk Patients
  - *Optimize medical condition*
- Stopping anti-platelet / anti-coagulant medications
  - Resumption of these medications
  - Discuss with prescribing physicians





# Preoperative Management

- Nutritional Supplements
  - *Gingko biloba*
  - *Garlic Ginseng*
  - *Fish oils (omega-3 fatty acids)*
  - *Dong Quai*
  - *Feverfew*
  - *Vitamin E*

Anesthet Sur J. 2009 Mar-Apr;29(2):150-7





# Preoperative Management

- Anemia evaluation
  - Preop Hgb > 15g/dL => transfusion is rare
  - 
  - Preop Hgb < 11g/dL => 100% transfusion

J Bone Joint Surg Am. 2002 Feb;84-A(2):216-20





# Preoperative Anemia

- Hgb < 13 requires evaluation and work up supplementation
- Done in conjunction with Medicine

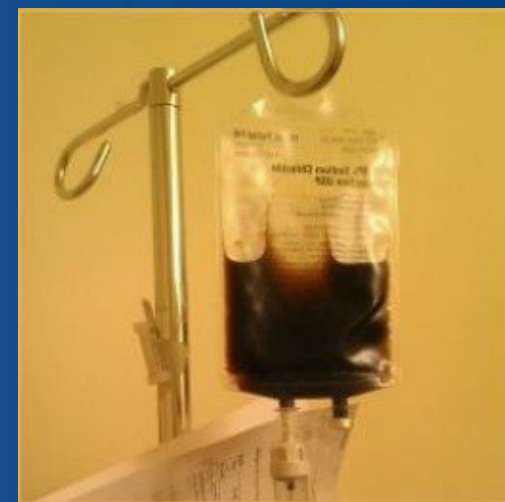






# EPO and IRON

- Effective preoperative tools to increase Hgb
- Iron deficiency is common 35% arthroplasty patients
- IV Iron playing an increasing role
  - *Further studies needed*





# Preoperative autologous blood donation



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- May have lower allogenic transfusion rates
- Forgie et. al. meta-analysis - OR 0.17 for need for allogenic blood



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# Preoperative autologous blood donation



Reported costs vary:

*\$489-\$507.20 for autologous*

*\$68 greater than allogenic blood*

>50% wasted and disposal costs  
can be ~\$175





# Multimodal Approach Peri-op

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- Hypotensive anesthesia with spinals
- Tranexamic acid
- Hemostasis
- Adequate volume resuscitation with crystalloid and colloid
- No use of drains



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# Hypotensive Anesthesia

- Reduce intra-op blood loss, allow for more precise hemostasis
- Independent factor in transfusion reduction
- Decrease DVT rate
- Dry field for visualization and implant fixation

(Juelsgaard et al. Regional Anesthesia and Pain Medicine 2001, Sculco et al. AAOS Instructional Course Lectures 2005, Sharrock et al. Anesthesia & Analgesia 1993)



# Cell Salvage in Hip and Knee Arthroplasty

A Meta-Analysis of Randomized Controlled Trials

- 2015 meta-analysis including Cochrane plus studies to January 2013
- Newer studies tended to have better study design with more restrictive transfusion thresholds and decreased use of closed suction drainage



# New Meta-Analysis Results

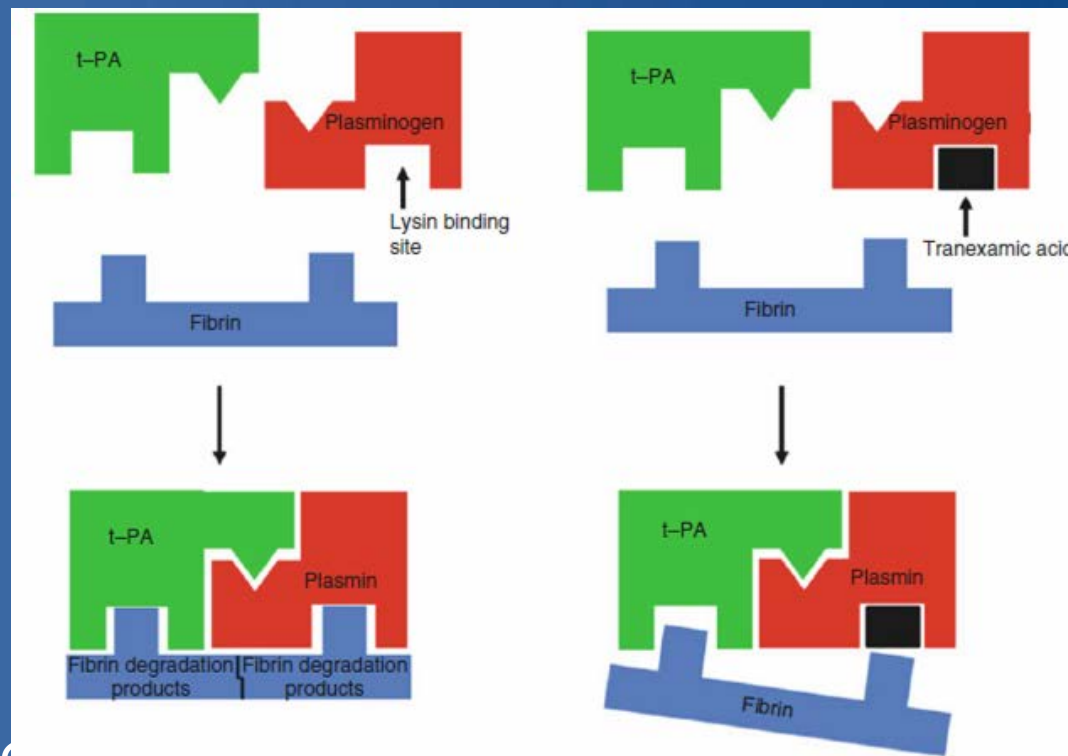
- Traditional transfusion ( $>8$  g/dl):
  - *THA* - RR 0.57 (95% CI: 0.36-0.89)
  - *TKA* - RR 0.54 (95% CI: 0.40-0.73)
- Restrictive transfusion ( $<8$  g/dl):
  - *THA* - RR 0.72 (95% CI: 0.58-0.91)
  - *TKA* - RR 0.54 (95% CI: 0.25-1.18)





# Tranexamic Acid

- Inhibits degradation of fibrin through competitive binding at lysine binding site of plasminogen and plasmin





RESEARCH ARTICLE

Open Access

# Tranexamic acid and the reduction of blood loss in total knee and hip arthroplasty: a meta-analysis

Rajiv Gandhi<sup>1\*</sup>, Heather MK Evans<sup>2</sup>, Safiyah R Mahomed<sup>3</sup> and Nizar N Mahomed<sup>4</sup>

- Meta-analysis of RCTs for primary THA and TKA from 1995-July 2012
- Delivery: 29 IV, 3 intraarticular, 1 oral, and 1 topical





# Results: Blood Loss in TKA

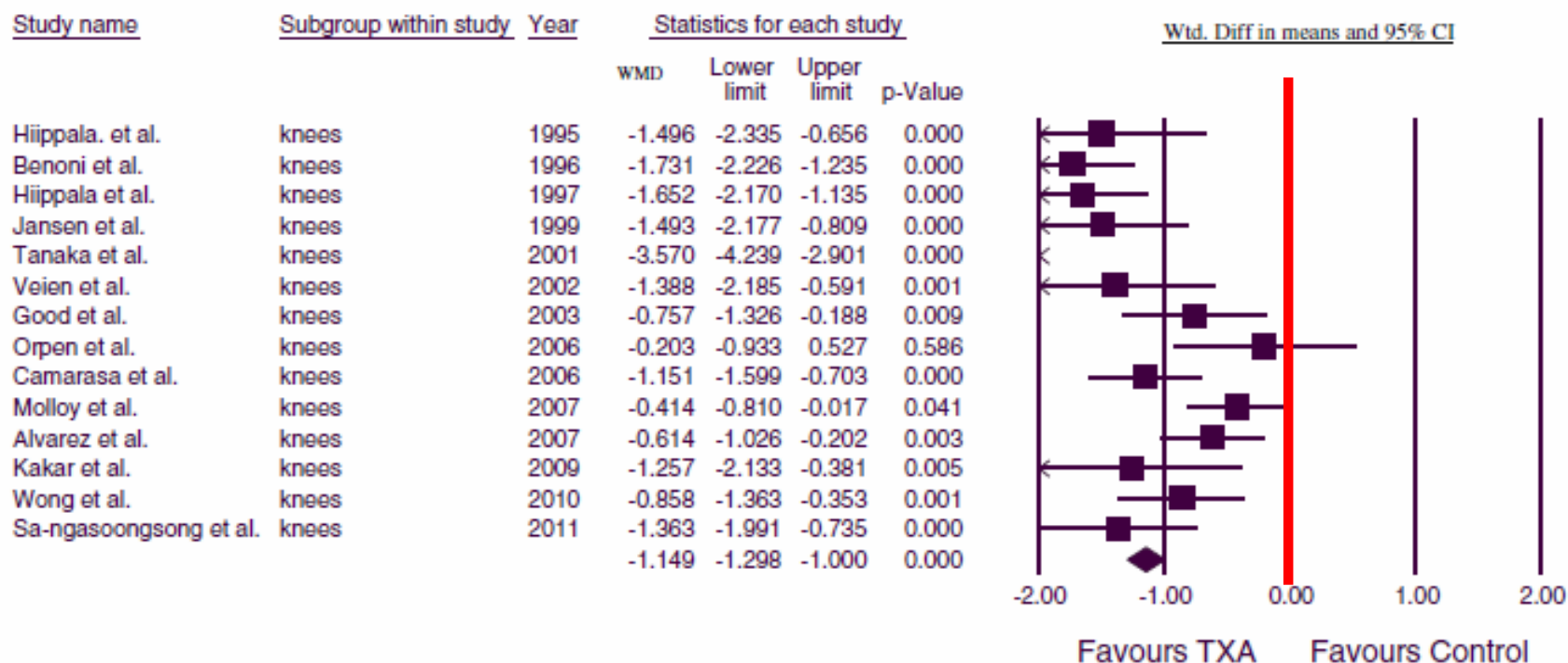


Figure 3 Forest plot of combined WMD values for total blood loss in knee arthroplasty.





# Results: Blood Loss in THA

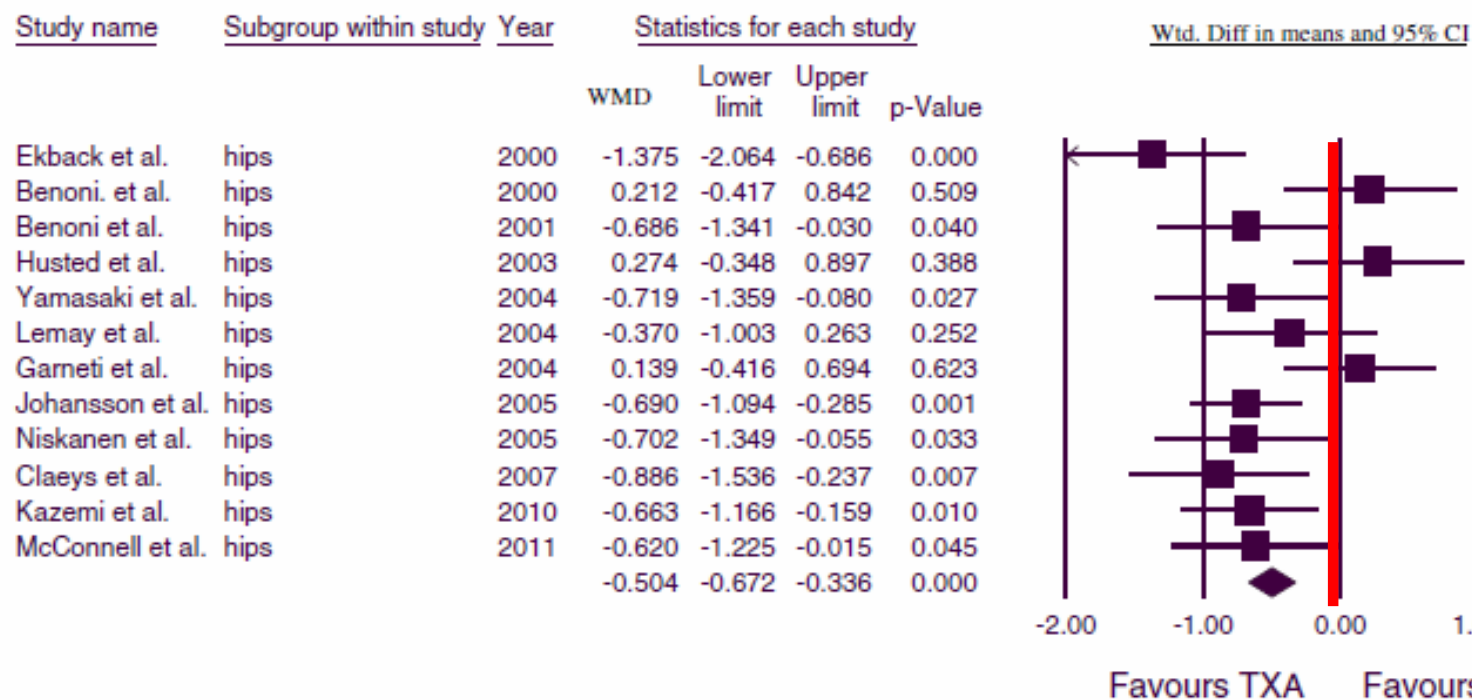


Figure 4 Forest plot of combined WMD values for total blood loss in hip arthroplasty.





# Results: Transfusions in TKA

Study name	Subgroup within study	Time point	Statistics for each study				Odds ratio and 95% CI
			Odds ratio	Lower limit	Upper limit	p-Value	
Hiippala. et al.	knees	1995	0.167	0.017	1.671	0.128	
Benoni et al.	knees	1996	0.181	0.068	0.480	0.001	
Hiippala et al.	knees	1997	0.091	0.027	0.306	0.000	
Jansen et al.	knees	1999	0.065	0.012	0.355	0.002	
Tanaka et al.	knees	2001	0.020	0.001	0.366	0.008	
Engel et al.	knees	2001	0.109	0.005	2.365	0.158	
Ellis et al.	knees	2001	0.048	0.004	0.563	0.016	
Veien et al.	knees	2002	0.174	0.008	3.956	0.273	
Good et al.	knees	2003	0.089	0.021	0.380	0.001	
Zohar et al.	knees	2004	0.074	0.013	0.411	0.003	
Orpen et al.	knees	2006	0.262	0.024	2.878	0.273	
Molloy et al.	knees	2007	0.394	0.126	1.233	0.109	
Wong et al.	knees	2010	0.550	0.047	6.379	0.633	
Ishida et al.	knees	2011	0.327	0.013	8.215	0.497	
Sa-ngasoongsong et al.	knees	2011	0.087	0.010	0.765	0.028	
Roy et al.	knees	2012	0.224	0.041	1.210	0.082	
			0.145	0.094	0.223	0.000	

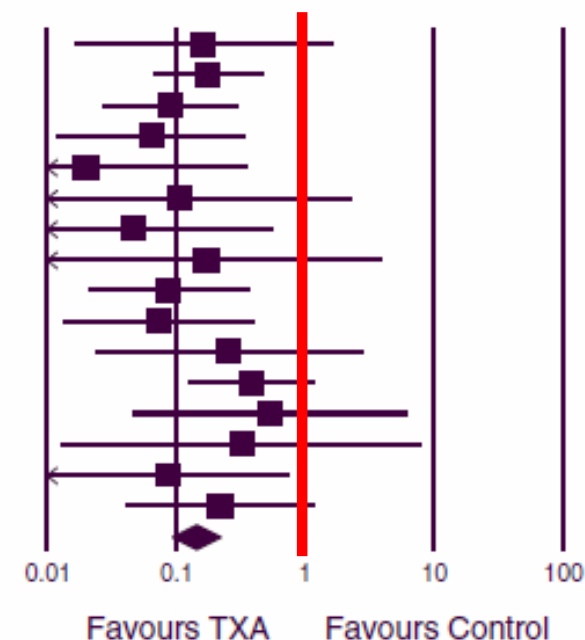


Figure 5 Forest plot of combined OR values for the number of patients requiring allogeneic transfusions in knee arthroplasty studies.





# Results: Transfusions in THA

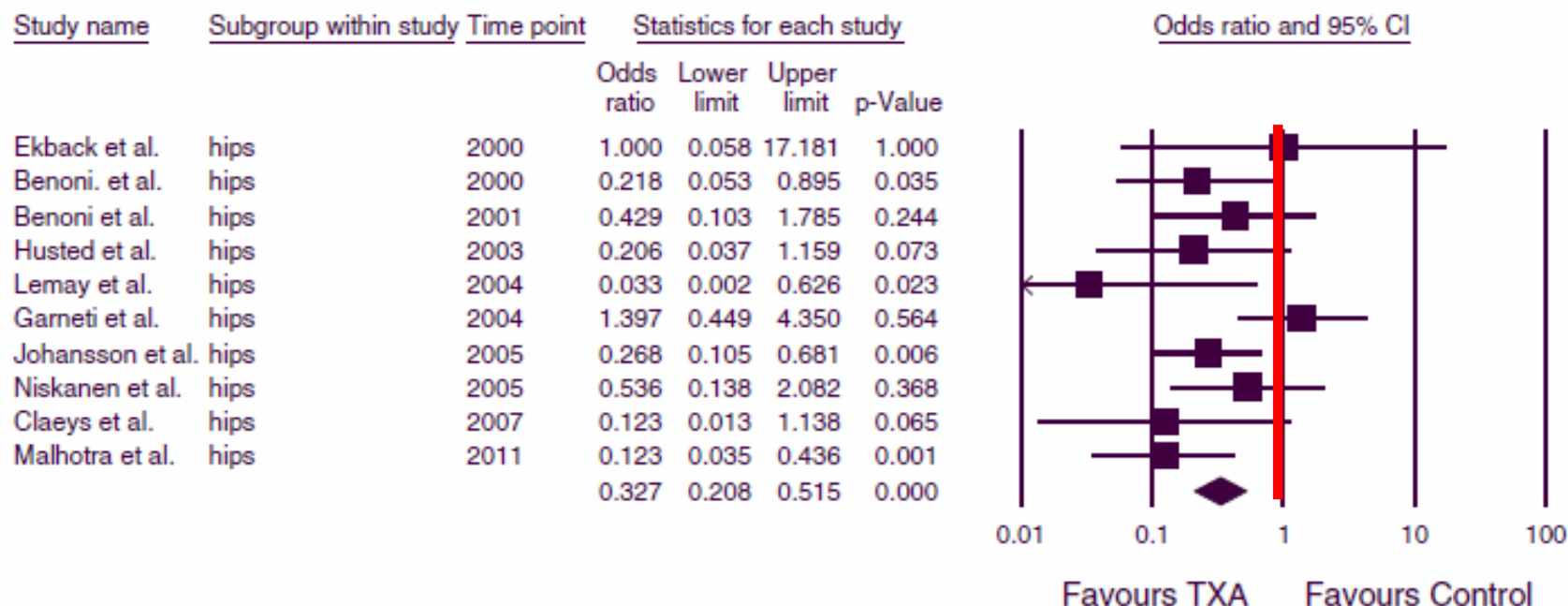


Figure 6 Forest plot of combined OR values for the number of patients requiring allogeneic transfusions in hip arthroplasty studies.





# Results: DVT in TKA

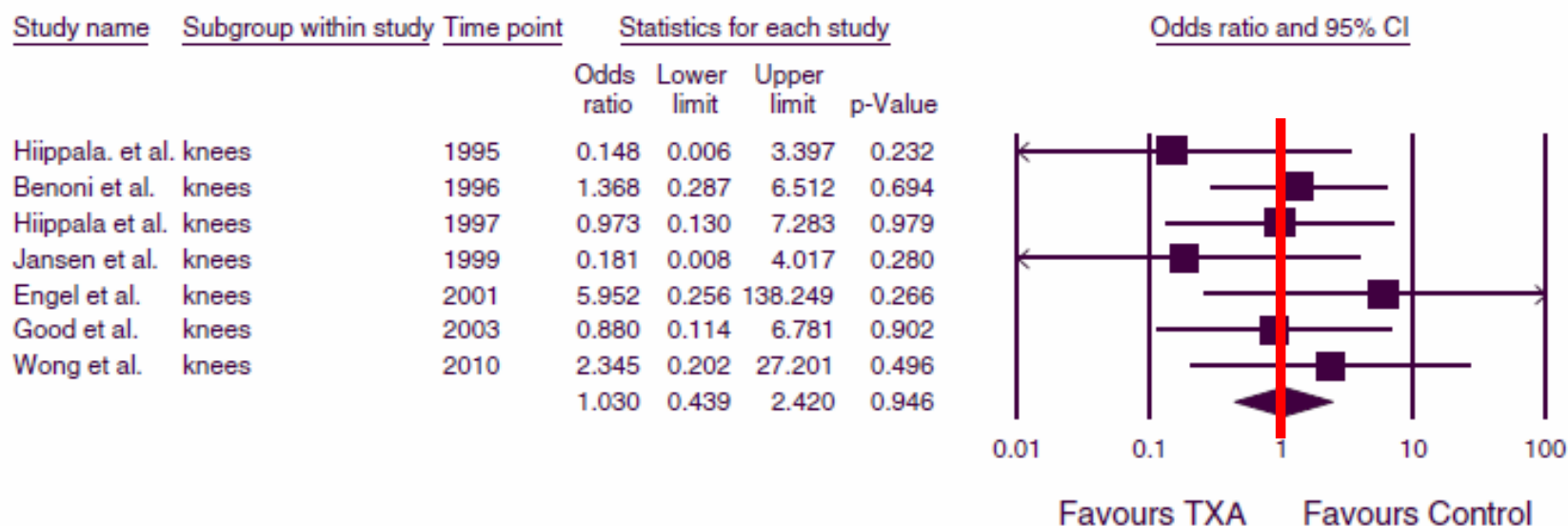


Figure 7 Forest plot of combined OR values for the number of patients who developed a DVT in knee arthroplasty studies.







# Results: DVT in THA

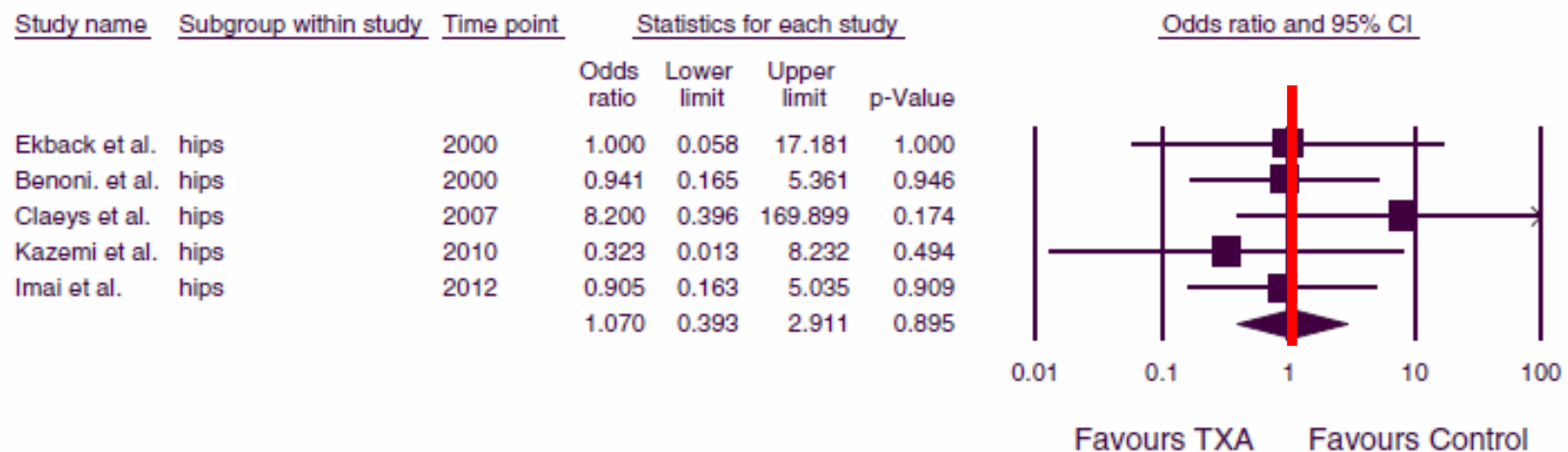


Figure 8 Forest plot of combined OR values for the number of patients who developed a DVT in hip arthroplasty studies.







# Tranexamic Acid

- Contraindications?:
  - *Renal insufficiency, decrease dose*
  - *thromboembolic event*
    - no evidence in literature for increased rate of future events
  - *Cerebrovascular and cardiac disease*
    - no evidence for increased complication rates





# Tranexamic Acid

- Contraindications?:
  - *Known TXA allergy, anaphylaxis reported*
  - *History of VTE and Stents*
    - Use Topical





# Drain Use

- Used to decrease swelling, hematoma, and wound issues
- Shown to increase blood loss and transfusion requirement



- 2008 meta-analysis of randomized studies
  - No difference in incidence of wound infection, hematoma, dehiscence, or reoperation
  - Blood transfusion more frequent in those who received drains





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# POST-OPERATIVE

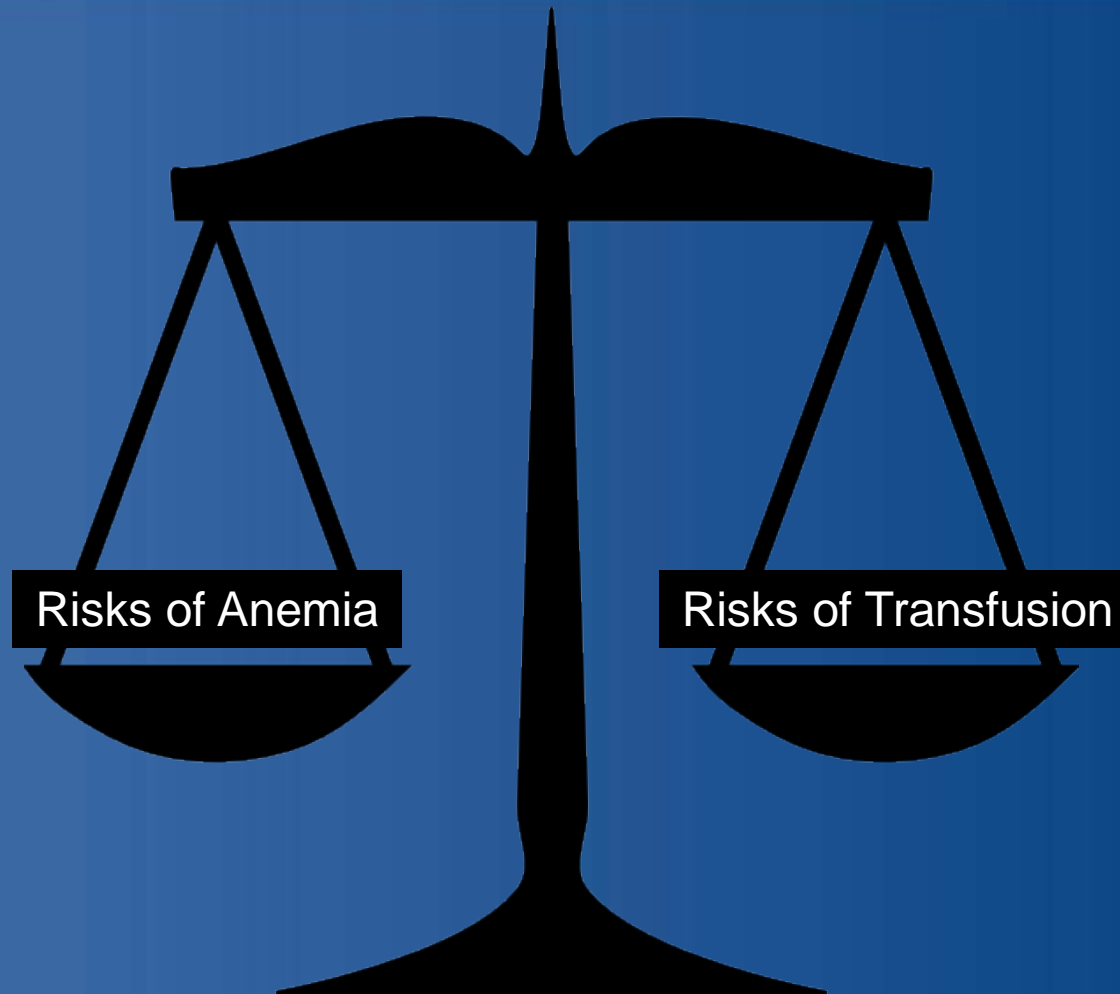


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# Balance



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Risks of Anemia

Risks of Transfusion



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# Transfusion Complications

- Allergic reactions (up to 15%)
- Transfusion-related acute lung injury (0.08% to 15%)
- Transfusion-associated circulatory overload (1% to 11%)
- Graft-versus-host disease (< 1%)



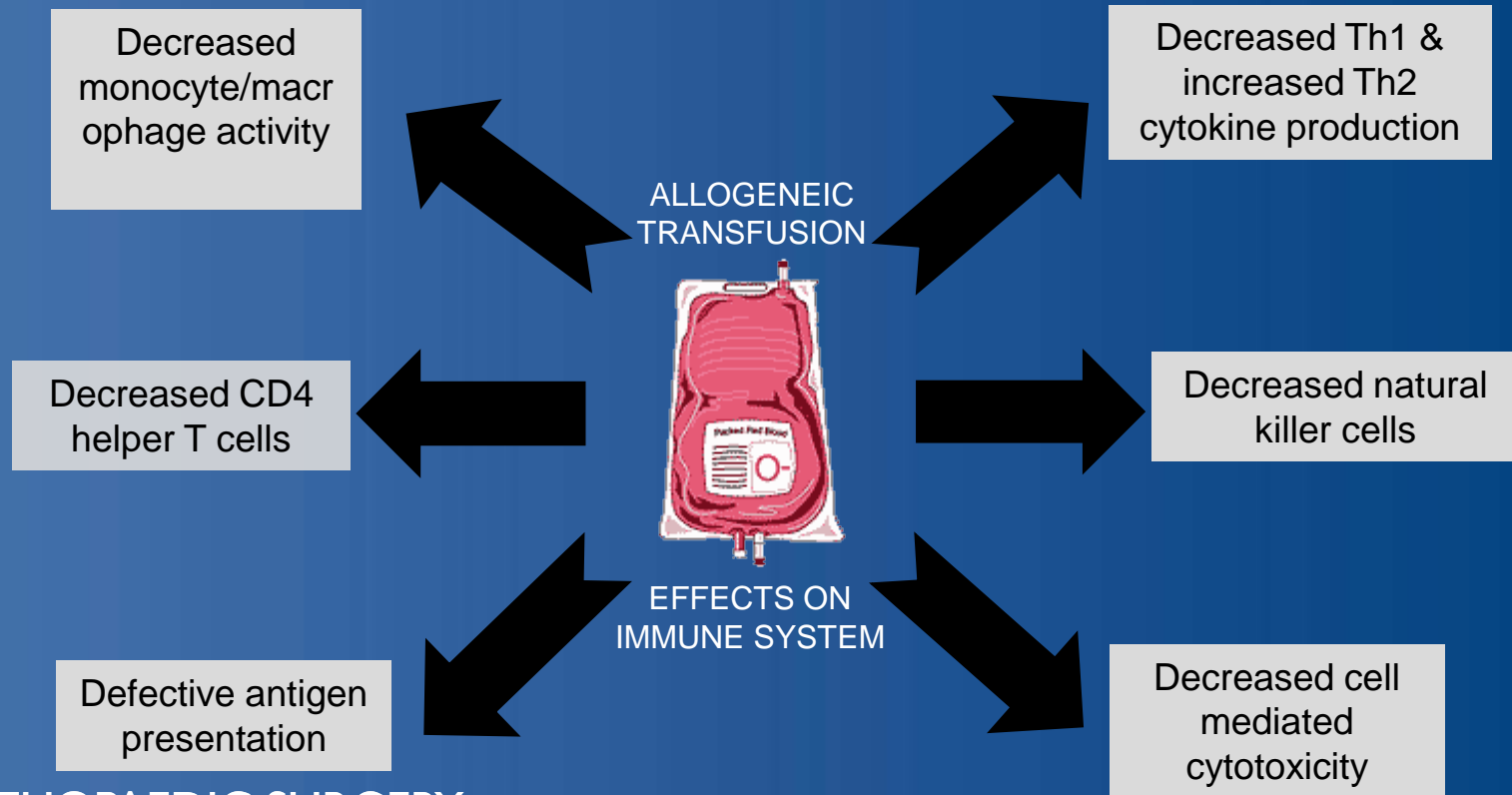


# Transfusion Immunomodulation (TRIM)



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- *TRIM = transient depression of immune system following transfusion*
- *Recipients exposed to large amount of foreign antigens, leads to modulation of recipients immune system*



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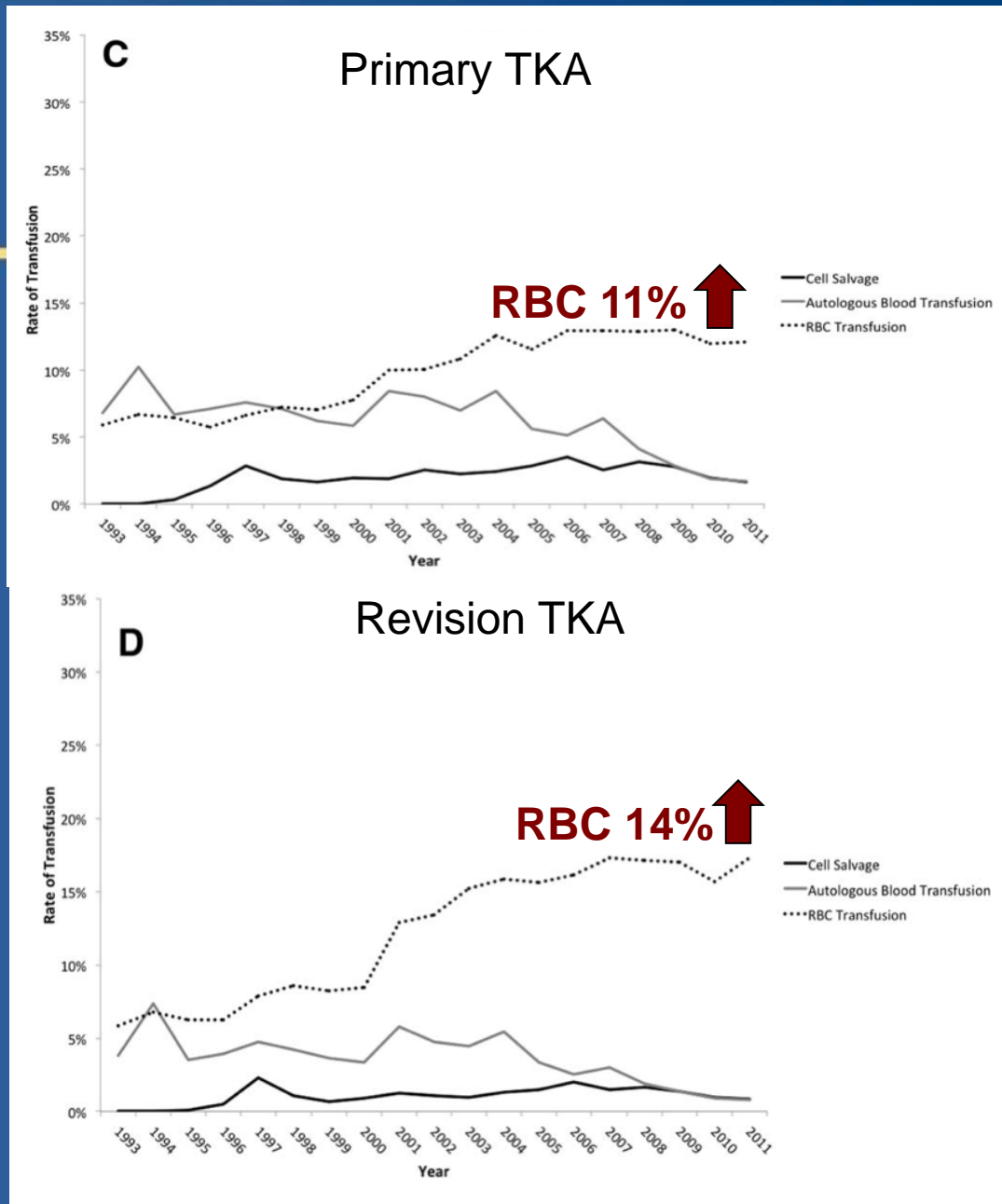
# Studies Show Little Benefit

- Allogeneic transfusions have not shown to improve TJA outcomes:
  - Monsef and Boettner, HSS 2014
    - *Allogeneic blood assoc. w/ increased LOS after THA*
    - *No transfusion (3.3 days), autologous (3.5 days), allogeneic (4.0 days), Auto+Allo (4.2 days)*
  - Newman et al. JBJS 2014
    - *Allogeneic transfusion assoc. w/ higher rates of reoperations for suspected infection in TJA (1.7% vs 0.7%)*
  - Friedman et al. JBJS 2014
    - *Rates of all infections including lung and wound infection were greater for allogeneic transfusion vs autologous or no transfusion in TKA/THA (9.9% vs 7.9%)*
  - Frisch et al. J Arthroplasty 2014
    - *Greater rate of deep surgical site infections (2.4% vs 0.5%)*



# Transfusion Rates

- Allogeneic transfusion independent predictor of in-hospital mortality
  - (Odds ratio 1.5, 95% CI 1.4-1.7)



(Rasouli et al. Transfusion 2016)



# Transfusion Triggers

- Wide range – 6 to 12 g/dL
- Restrictive triggers do not compromise patient outcomes
- Clinical evidence does not justify transfusion thresholds of > 8g/dL in the absence of symptoms



# FOCUS Trial



## The NEW ENGLAND JOURNAL of MEDICINE

### 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  
N Engl J Med 2011; 365:2453-2462 | December 29, 2011 | DOI: 10.1056/NEJMoa1012452

- FOCUS (*Transfusion Trigger Trial for Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Repair*)
  - RCT of 2016 patients, age 50 year or older
  - All pts had risk factors for cardiovascular disease
  - All pts had Hgb of <10g/dL after hip fracture surgery



# Clinical Guidelines



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	Recommendations
NIH Consensus Conference, <sup>42</sup> 1988	<70 g/L (acute)
American College of Physicians, <sup>43</sup> 1992	No number
American Society of Anesthesiologists, <sup>44</sup> 1996	<60 g/L (acute)
American Society of Anesthesiologists, <sup>45</sup> 2006	No number
Canadian Medical Association, <sup>46</sup> 1997	No number
Canadian Medical Association, <sup>46</sup> 1998	No number
College of American Pathologists, <sup>47</sup> 1998	60 g/L (acute)
British Committee for Standards in Haematology, <sup>48</sup> 2001	No number
British Committee for Standards in Haematology, <sup>49</sup> 2012	70 g/L*
Australasian Society of Blood Transfusion, <sup>50</sup> 2001	70 g/L
Society for Thoracic Surgeons, Society of Cardiovascular Anesthesiology, <sup>51</sup> 2007	70 g/L
Society for Thoracic Surgeons, Society of Cardiovascular Anesthesiology, <sup>52</sup> 2011	80 g/L*
American College of Critical Care Medicine, Society of Critical Care Medicine, <sup>53</sup> 2009	70 g/L
American College of Critical Care Medicine, Society of Critical Care Medicine, <sup>54</sup> 2009	70 g/L
Society for the Advancement of Blood Management, <sup>55</sup> 2011	80 g/L
National Blood Authority, Australia, <sup>53</sup> 2012	No number
AABB, <sup>56</sup> 2012	70-80 g/L or 80 g/L†
Kidney Disease: Improving Global Outcomes, <sup>57</sup> 2012	No number
National Cancer Center Network, <sup>58</sup> 2012	70 g/L

\*For patients with acute blood loss. †For patients with symptoms of end-organ ischaemia.

**Table 3: Medical society clinical practice guidelines for red blood cell transfusion**

(Goodnough et al. Lancet 2013)



# THE COCHRANE COLLABORATION®



- 2015 meta-analysis
- Inclusion: RCT studies from 1946-2014 of different transfusion thresholds for hip fracture surgery
- 6 studies (2722 pts) comparing a liberal (usually Hgb > 10) vs restrictive (symptomatic anemia or Hgb < 8)







# Results

- Transfusion Rates:
  - 74-100% in liberal group
  - 11-45% in restrictive group
- No difference (liberal vs restrictive)
  - *30 day mortality (RR 0.92, 0.67-1.26)*
  - *60 day mortality (RR 1.08, 0.80-1.44)*



# Keys to Avoiding Postoperative Hypovolemia

- Pre-op hydration
- Maintaining intraoperative volume
- Minimizing blood loss
- Adequate hydration



# Blood Management Protocol



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## TRANSFUSION

*Transfusion*. 2016 Jan 8. doi: 10.1111/trf.13468. [Epub ahead of print]

**Implementing a blood management protocol during the entire perioperative period allows a reduction in transfusion rate in major orthopedic surgery: a before-after study.**

Rineau E<sup>1</sup>, Chaudet A<sup>1</sup>, Chassier C<sup>1</sup>, Bizot P<sup>2</sup>, Lasocki S<sup>1</sup>.

- Patients undergoing THA/TKA
- Introduction of blood management protocol
  - *restrictive trigger (7g/dL)*
  - *preop EPO*
  - *postop IV iron and TXA*
- Led to reductions in perioperative transfusions and total number of patients with Hgb of <10g/dL at discharge

*“Standardized protocol is key”*



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(Rineau et al. *Transfusion* 2016)



# Our Approach

- First line for hypotension
  - *volume resuscitation with crystalloid or colloid*
- Do not transfuse above Hgb of 7g/dL
  - *unless patient is symptomatic despite administration of fluids*
- Patients with CAD kept at a target Hgb of 8g/dL
- One Unit at a time!





# Summary

- Multimodal approach is key
- Consistent protocols
- Early identification and treatment of pre-op anemia
  - *IV iron and Epo stimulate RBC development*





# Summary

- Tranexamic acid decreases transfusion rate
- Limit drain usage
- Maintain volume status with crystalloid
- Transfusion trigger Hgb  $<7$  g/dL is reasonable





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