Introduction to Blood Management

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What is Blood Management?

- **Preventing** a blood transfusion to the patient who doesn't need one

- **Right** blood product, at the **right** time, in the **right** dose, to the **right** patient who does

Why Blood Management?

- Improves patient outcomes
- Conserves limited blood resource
- Reduces cost of care
- Satisfies regulatory requirements

Principles of RBC transfusion

- Red blood cells transport oxygen and carbon dioxide
- The red cell allows oxygen delivery (and CO_2 removal) at the microcirculatory level
- The indication for red cell transfusion is:
  - "Treatment of symptomatic or critical deficit of oxygen-carrying capacity" (Circular of Information)
- Clinicians should use clinical parameters rather than a "Transfusion Trigger"
  - Oxygen Content
  - Oxygen Delivery
  - Oxygen Uptake

Dzik WH. Transfusion 2011: 51;676-85

The RBC Transfusion Paradox

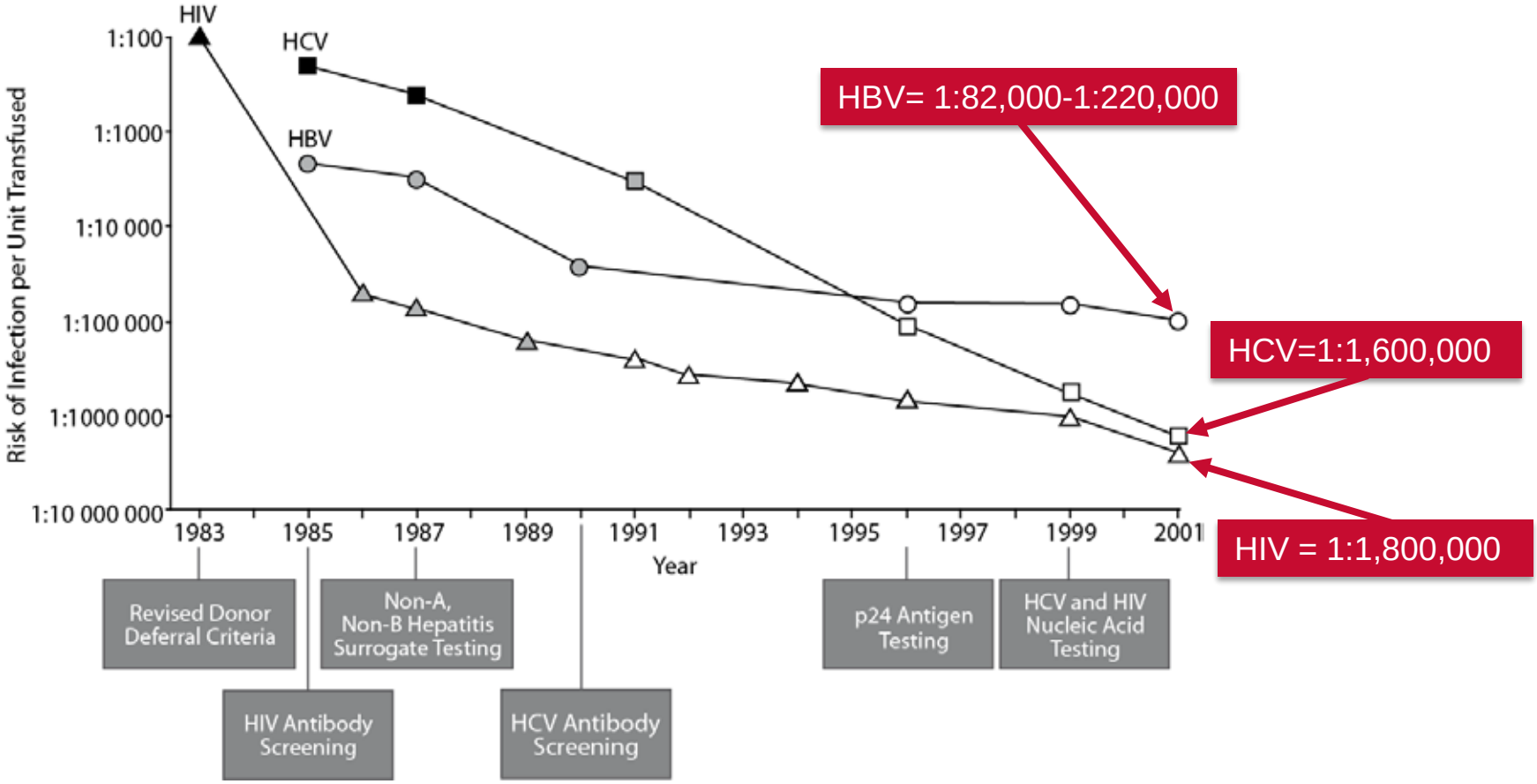
- Anemia is associated with poorer outcomes
- RBC transfusion “corrects” anemia
- However
  - Transfusion dose not necessarily correct the adverse effects of anemia
  - In fact, transfusion often makes the problem even worse

Wu WC, et al. *N Engl J Med* 2001; 345:1230-6

Risks of Blood Transfusion

- Mistransfusion – Human Error
- Reactions – Acute and Delayed
- Transfusion Transmitted Disease
- TRALI – Transfusion Related Acute Lung Injury
- TACO – Transfusion Associated Circulatory Overload
- TRIM – Transfusion Related Immune Modulation
- Blood Storage Lesion

Decline in Human Immunodeficiency Virus and Hepatitis B and Hepatitis C Risks of Transmission Through Transfusion



Busch MP, et al. JAMA 2003; 289:959-962

Transfusion-related Immune modulation (TRIM)

- Transfusion of allogeneic blood results in the infusion of large amounts of foreign cells, antigens, and non-leukocyte derived biological response modifiers
- Leads to at temporary suppression of the immune system
- Dose - response relationship
  - Increased risk of infection
  - Increased risk of mortality
  - Increased length of stay

1,360 cadaver-donor kidney transplants

Graft survival (transfusions vs. no transfusions)

1 year	71.5% vs. 42.2%	p<0.0001
4 years	65.5% vs. 30.3%	p<0.000001

Opelz G, Terasaki PI. N Engl J Med 1978; 299:799-803

Blood Storage Lesion –

Biochemical, Structural, Enzymatic, Morphological and Functional Deterioration

- RBC age rapidly outside the body despite refrigeration
- ATP declines, loss of membrane lipid
- RBC shape changes ® stiffer, poor deformability
- 2, 3-DPG is undetectable at 1 week ® 12-24 hours to regenerate after transfusion
  - 2, 3-DPG enhances the ability of hemoglobin to offload oxygen to the tissues – transfused stored blood can bind O_2 but does not offload it well
- Free hemoglobin scavenges NO – leads to microcirculatory vasoconstriction

Dzik W. Fresh blood for everyone? Balancing availability and quality of stored RBCs.Transfusion Medicine 2008; 18:260-5
Barshtein G, et al.Circulatory risk in transfused red blood cells with impaired flow properties induced by blood banking.Transfusion Medicine Reviews 2011;25:24-35

Morphologic Changes Associated with Blood Storage

- Capillary diameter is ⅓ to ½ the size of an RBC making deformability crucial to the ability of the RBC to traverse the capillary and offload O_2
- Depletion of ATP, 2,3DPG, loss of membrane phospholipids, protein rearrangement and lipid oxidation result in:
  - Alterations is corpuscle shape, deformability, osmotic fragility, aggregablilty and intracellular viscosity
- Limits the clinical benefit of RBC transfusion
- More difficult for RBC to deliver O_2 to tissues
- Applies to PAD as well as banked blood

Hovav T, et al. Transfusion 1999; 39:277-81
Kor DJ, et al. Bosn J Basic Med Sci 2009; 9:S21-S27

Duration of red cell storage and complications after cardiac surgery

Cardiac surgery patients - June 30, 1998 to January 30, 2006
2,872 patients received 8,802 units of blood stored 14 days or less
3,130 patients received 10,782 units of blood stored 15 days or more

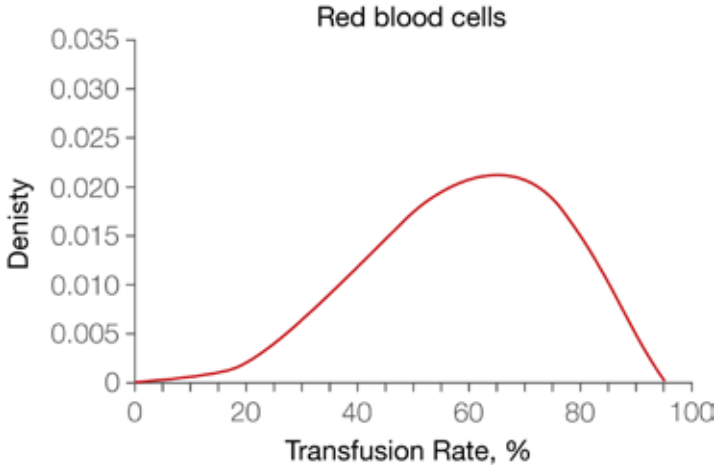
	£ 14 Days	³ 15 Days	p
In-hospital mortality	1.7%	2.8%	0.0004
Prolonged ventilation	5.6%	9.7%	0.001
Renal failure	1.6%	2.7%	0.003
1 year mortality	7%	11%	0.001

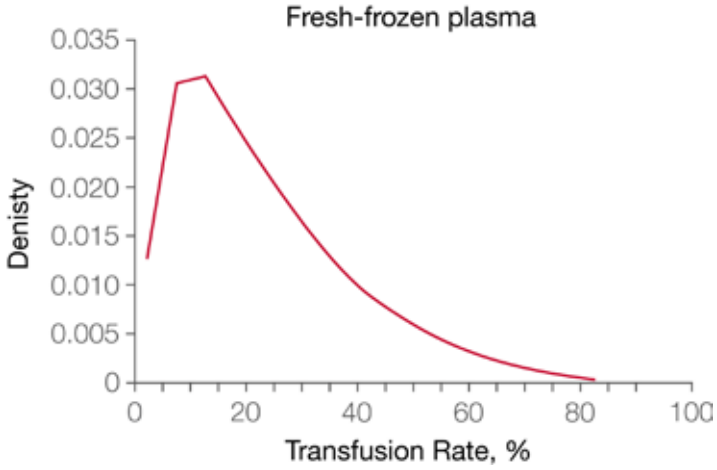
Koch CG, et al. *N Engl J Med* 2008;358:1229-39

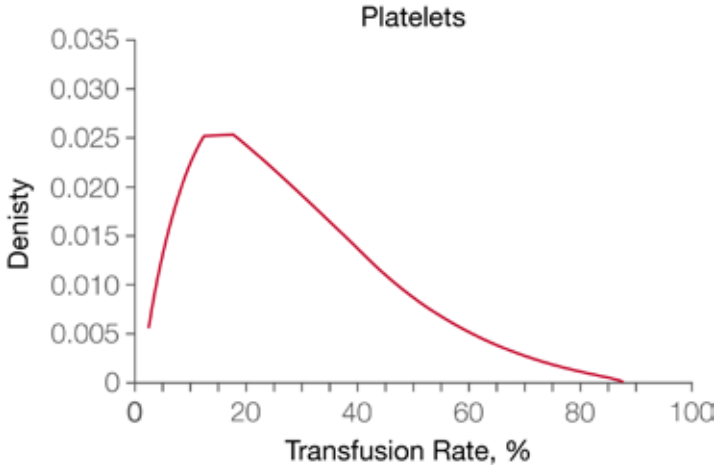
Incidence of RBC transfusion is highly variable

- Transfusion decisions are rarely “evidence-based”

Observed Variation in Hospital-Specific Transfusion Rates for Primary Isolated CABG Surgery With Cardiopulmonary Bypass During 2008 (N = 798 Sites)







Bennett-Guerrero, et al. JAMA 2010; 304:1568-75

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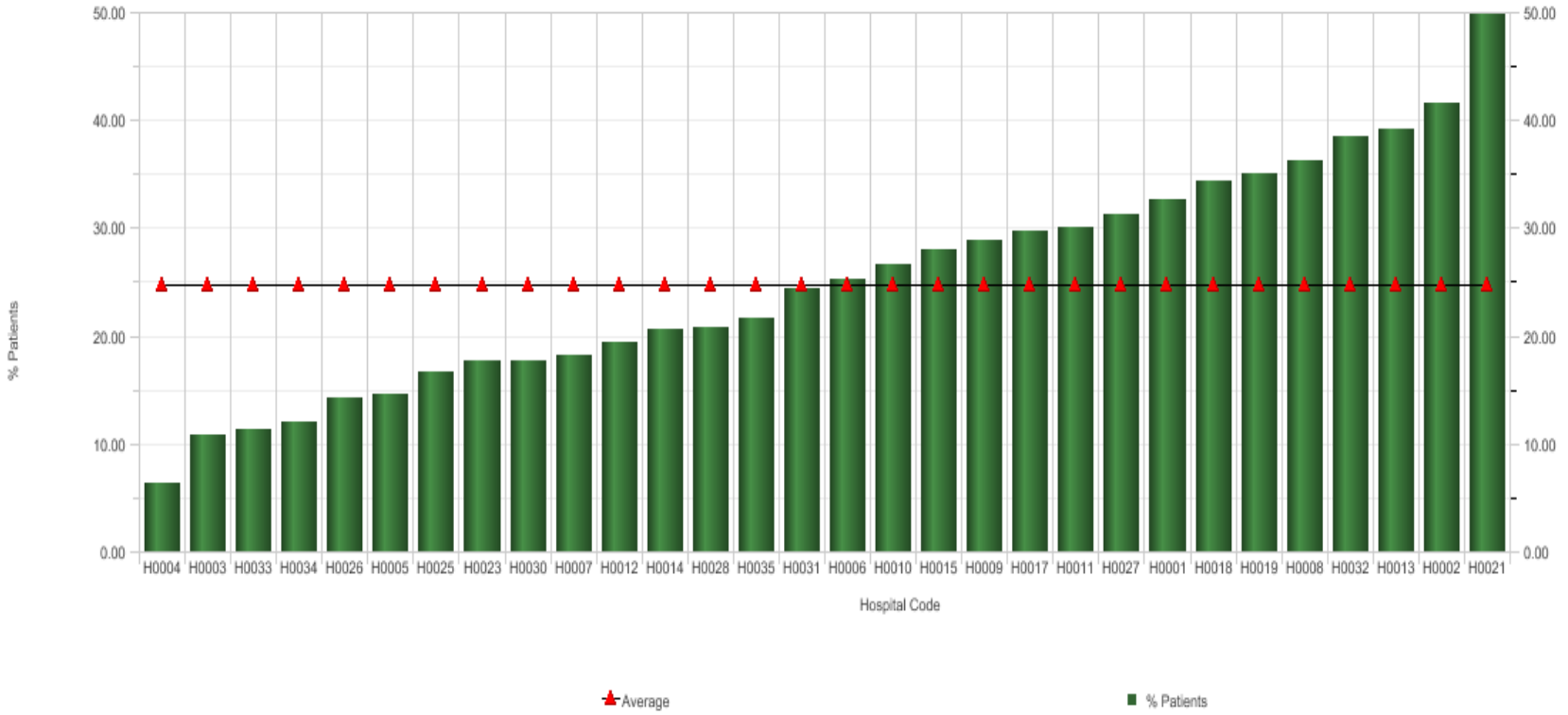
Comparison Allogeneic Transfusion Rates
Joint Replacement - 30 Hospitals, 58,690 procedures



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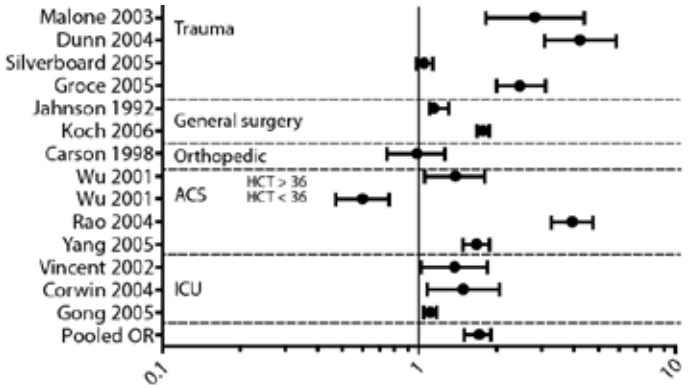
Outcomes of Blood Transfusion

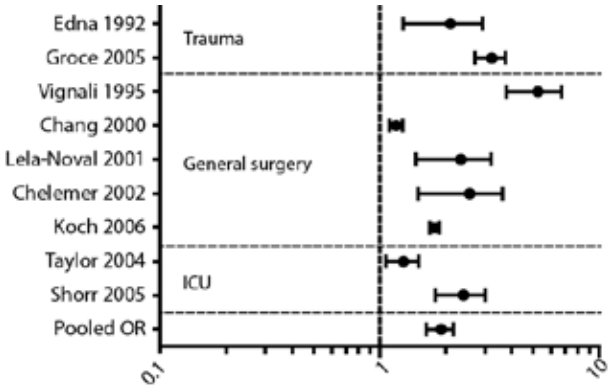
- Transfusions are associated with
  - Increased mortality
  - Increased risk of infection
  - Increased risk of respiratory distress

Efficacy of red cell transfusion in the critically ill; A systemic review of the literature

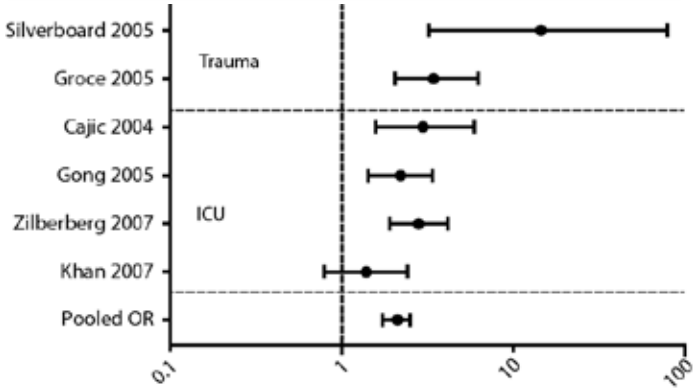
Death



Infectious Complications



ARDS



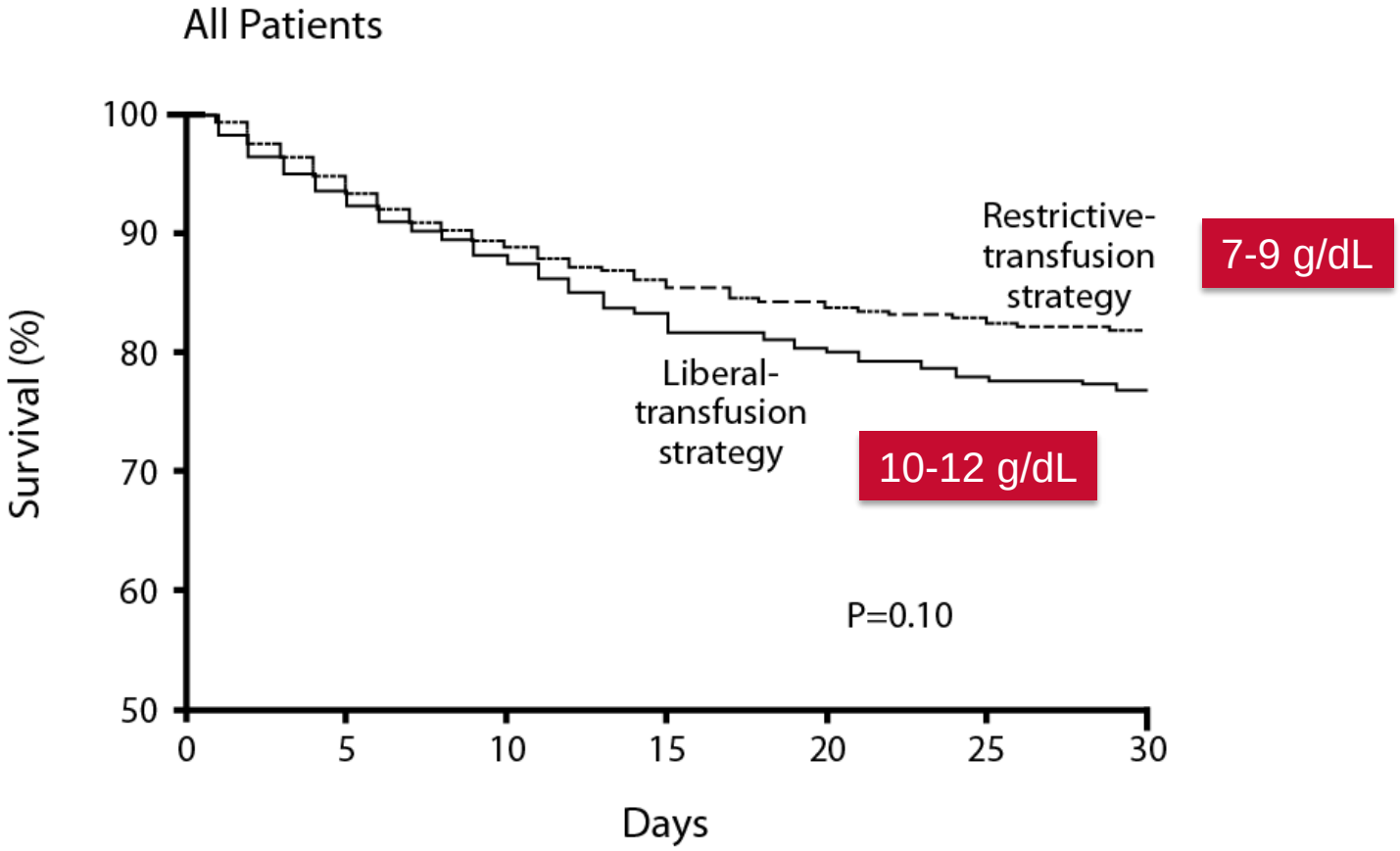
Marik PE, Corwin HL. Crit Care Med 2008; 36:2667-74

Is there a “correct” transfusion trigger? What about Hgb >6g/dL, <10g/dL?

- The use of allogeneic transfusion is variable
- Few randomized clinical trials (only 10 met criteria for Cochrane Review)
- Carson JL, et al. Transfusion Triggers: A Systematic Review of the Literature. *Transfusion Medicine Reviews* 2002; 16:187-189
  - Restrictive practice
    - Reduced the probability of receiving RBC by 48%
    - Reduced the volume of RBC received by 0.93 units
    - Hct values were 5.6% lower
    - Mortality, cardiac events, morbidity and LOS were not affected

TRICC Study

Kaplan-Meier Estimates of Survival in the 30 Days after Admission to the Intensive Care Unit in the Restrictive-Strategy and Liberal-Strategy Groups



Hebert P, et al. N Engl J Med 1999; 340:409-17

Functional **O**utcomes in **C**ardiovascular patients **U**ndergoing **S**urgical hip fracture repair (FOCUS)

- 2,016 patients having surgery for hip fracture
  - ≥ 50 years old
  - Postop anemia (Hgb < 10 g/dL)
- Randomized
  - Transfusion threshold of 10g/dL
  - Transfusion for symptoms and Hgb < 8 g/dL
- Mean age = 81.8 ± 8.8 years
- 75.7% female

Units transfused

- 1,866 vs. 652

No difference between the groups

- Death
- Cardiac events
- Inability to walk without assistance

Carson JL. American Heart Association 2009 Scientific Sessions; November 16, 2009; Orlando, FL.

Sanders D, et al. American Association of Orthopaedic Surgeons 2011 Annual Meeting; February, 2011; San Diego, CA.

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Transfusion Decision

- History - cardiac, anemia, hematologic disorders
- Meds - antiplatelet, anticoagulants
- Symptoms - dyspnea, angina
- Oxygen delivery/consumption
  - Oxygen saturation
  - Oxygen extraction
  - Serum lactate
  - Base deficit
- Procedure/Estimated blood loss
- Potential for continuing blood loss

Anesthetized patients

- Increase in cardiac output mostly from increase in stroke volume

Awake patients

- Increase in cardiac output from increases in both heart rate and stroke volume

Alternatives to Allogeneic Blood

- Preoperative interventions
  - Diagnose and treat anemia
  - Preoperative Autologous Blood Donation (PAD)
- Intraoperative
  - Intraoperative cell salvage
  - Acute Normovolemic Hemodilution (ANH)
  - Hypotensive anesthesia
  - Pharmacologic agents to decrease blood loss
- Postoperative
  - Postoperative blood salvage
  - Tolerate normovolemic anemia

Thank you.

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