



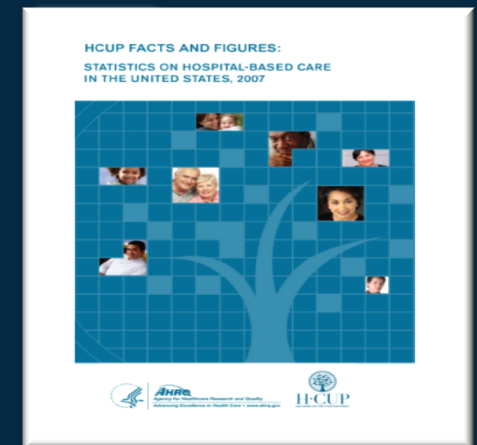
SABM[®]
SOCIETY FOR THE ADVANCEMENT
OF BLOOD MANAGEMENT

BEST TRANSFUSION PRACTICES

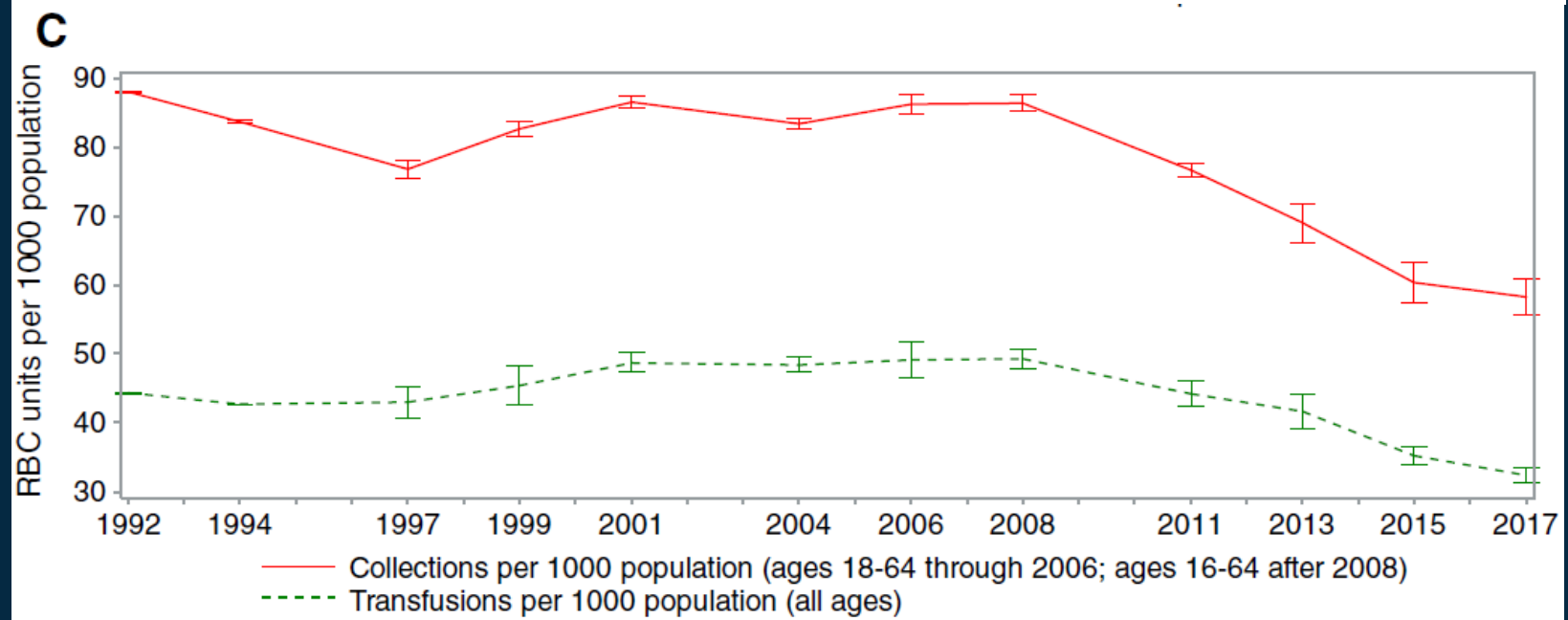
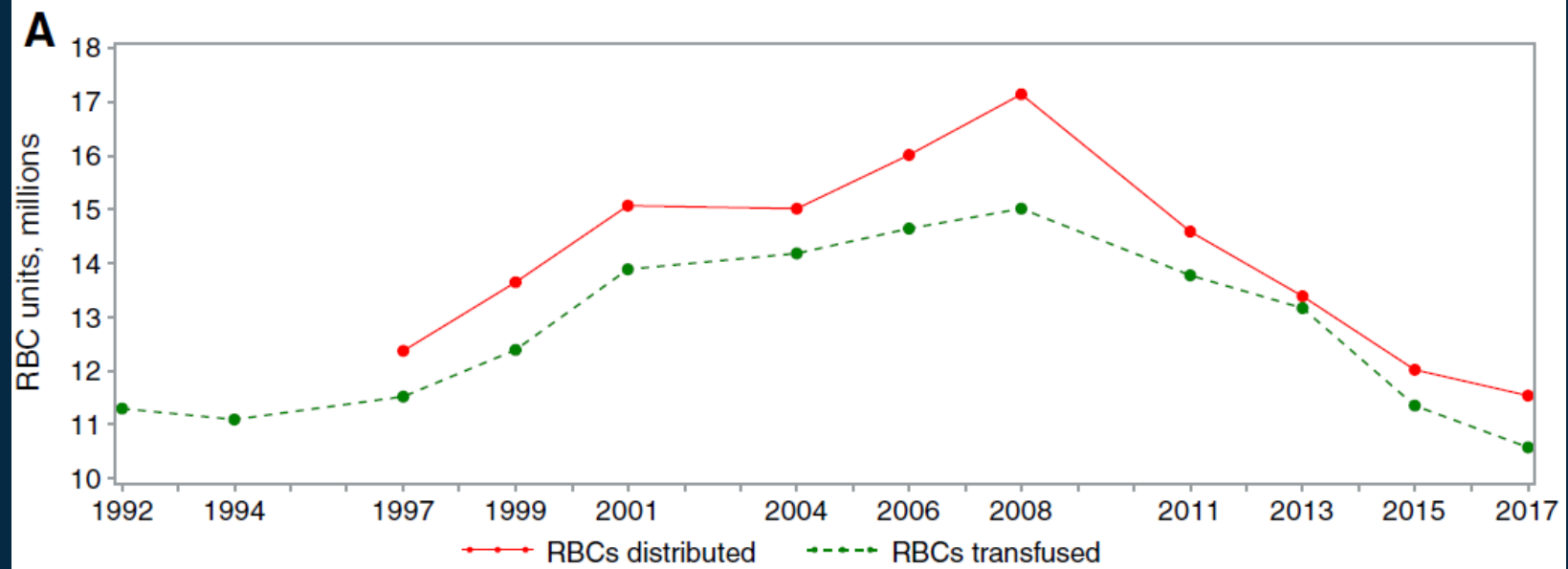
Role of Transfusion in the Management of Anemia

STATUS QUO

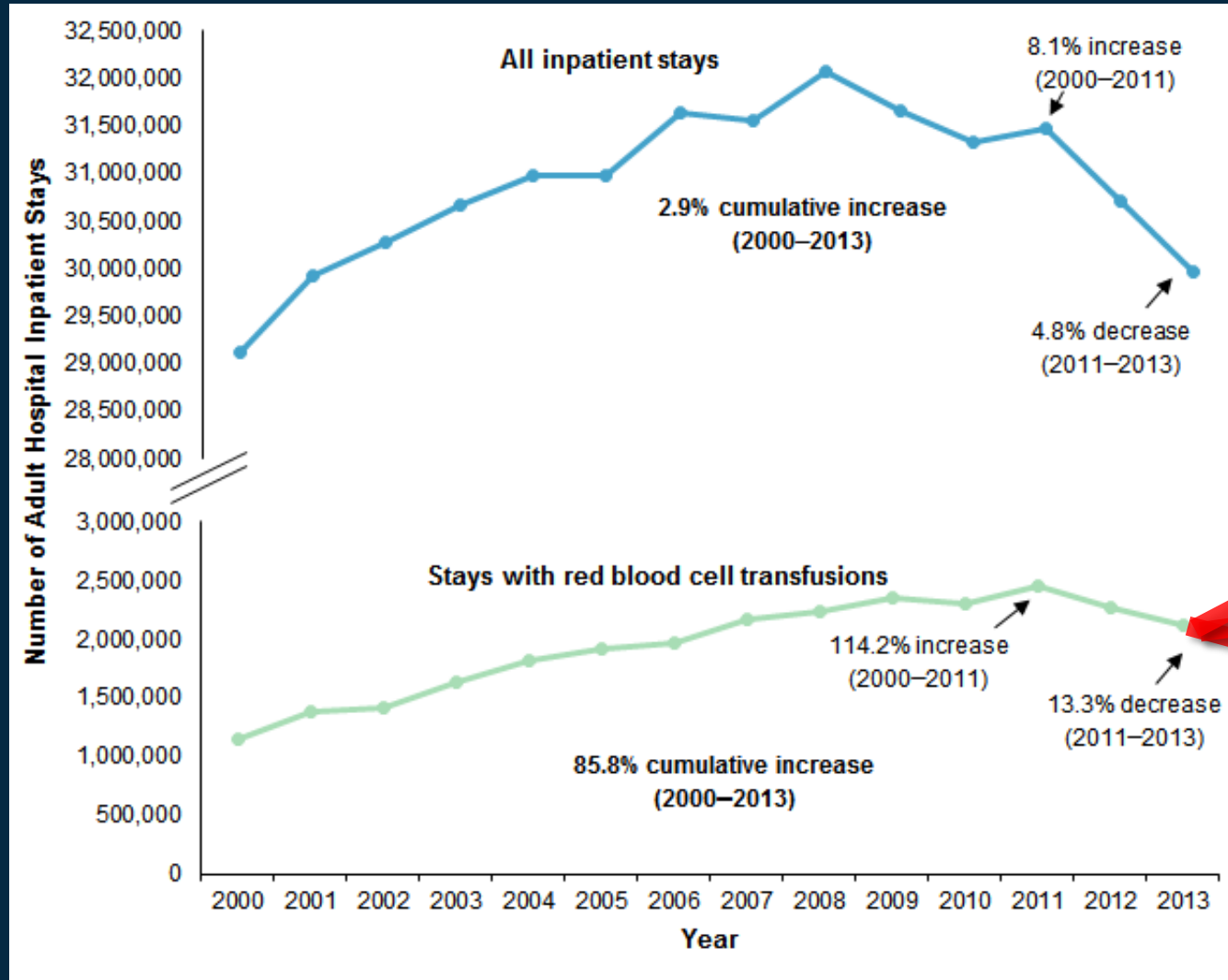
- The National Blood Collection & Utilization Survey (NBCUS):
 - 11.6% decline in RBC collection and 13.9% decline in RBC transfusion during 2013-2015 in the U.S.
 - In 2017: 12,211,000 RBC units collected and 10,654,000 units transfused (3.0% and 6.1% decline compared with 2015)
 - A continued slowing decline in RBC utilization
- AHRQ H-CUP project:
 - The number of hospital stays with an RBC transfusion increased from 1.1 million in 2000 to 2.1 million in 2013.
 - Stays with an RBC transfusion as a percentage of total inpatient stays increased from 3.9 percent in 2000 to 7.1 percent in 2013.



STATUS QUO



STATUS QUO INTO FUTURE



CURRENT TRANSFUSION PRACTICES

- First edition of these slides in 2010:
 - “For years, transfusion practices have been characterized by substantial variations between and within institutions.”
 - Maddux et al (Am J Med Qual, 2009): Institutional intraop transfusion rate in CABG ranged from **0%-85.7%**.
- 10 years later, some improvements have been achieved, but great variation still remains:
 - Fitzgerald et al (J Thorac Cardiovasc Surg, 2020): Of 22,272 adults undergoing isolated CABG using CPB, 32.5% received at least 1U allogeneic RBCs (**range 10.9%-59.9%**).
 - “Variation in center-level RBC transfusion cannot be explained by patient and procedural factors alone.”

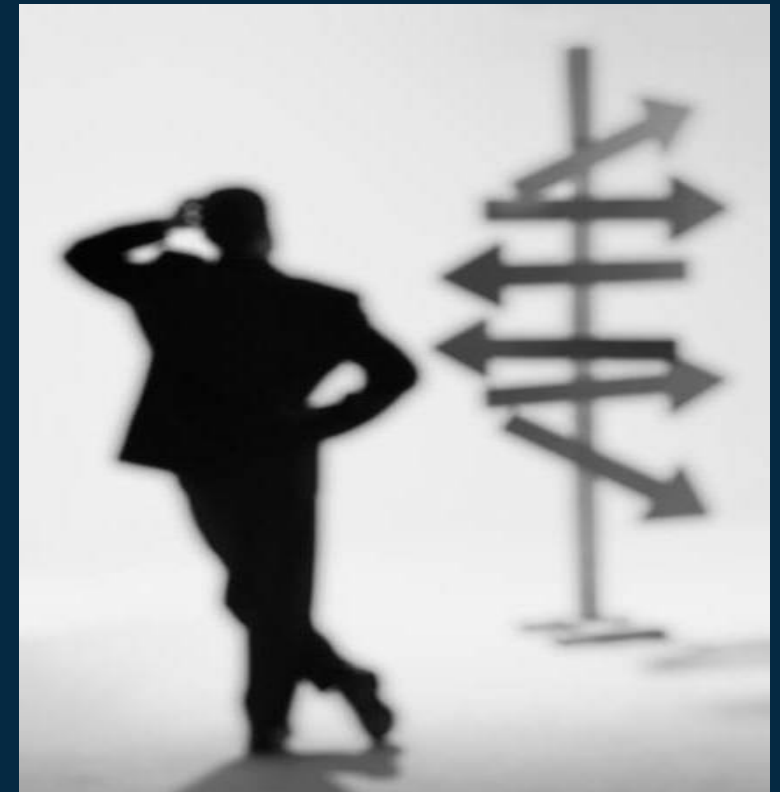
WHY IT MATTERS?

- Transfusions are risky
 - A host of infectious and non-infectious risks
 - Association with worse patient outcomes
- Transfusions are costly
 - A complex process (more tests & processing on the way)
 - True cost likely to be significantly higher than what hospitals pay to blood centers
- Blood supply is limited
 - NBCUS report: 12,211,000 units collected & 666,000 units rejected, leaving 11,545,000 units available vs. 10,654,000 units transfused (2017).
 - Marginal supply likely to worsen:
 - Aging population with more comorbidities (less donation; more demand)
 - Emerging challenges: COVID-19



BEST (BETTER) TRANSFUSION PRACTICE

- Despite widespread use, blood transfusion remains one of the most complex medical decisions
 - Lack of training
 - Lack of data
 - Non-clinical endpoints (treating a patient vs. a lab value)
- Not a decision to be taken lightly (remember the risks, costs, and supply)



SAFETY AND EFFICACY

- Standard approach to new therapeutics:
 - Perform preclinical and clinical (phase 0-III) studies to establish safety and efficacy in the target population for the intended indication
- Case for blood transfusion:
 - Been in use for over a century → “grandfathered” to our time
 - No pivotal RCT done; none likely to ever be done
 - Benefits largely assumed not proven
 - “If blood saved lives of trauma patients who used to bleed to death, it must be good for many other (largely non-bleeding) patients as well.”
 - Several lines of evidence from observational studies suggest otherwise

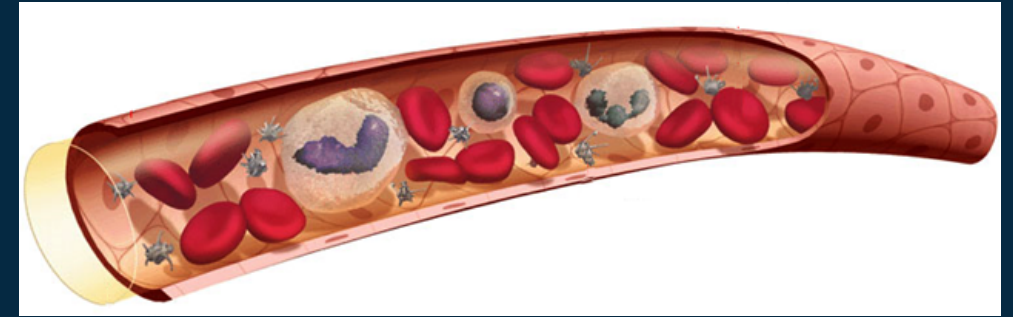
EFFICACY OF BLOOD

Main Aspects

- Blood as a volume expander
 - Helpful in massive bleeding & shock
 - Better options available for many (crystalloids/colloids)
 - Harmful in some (TACO)

- Blood as a viscosity maintainer
 - Minimum viscosity needed to maintain micro-vascular circulation
 - Not likely to be an issue with low to moderate hemodilution in microcirculation (the Fahraeus-Lindqvist effect)
 - High viscosity may be harmful in some situations (triple-H therapy)

- Blood as an oxygen carrier
 - May not increase O₂ delivery as much as hoped



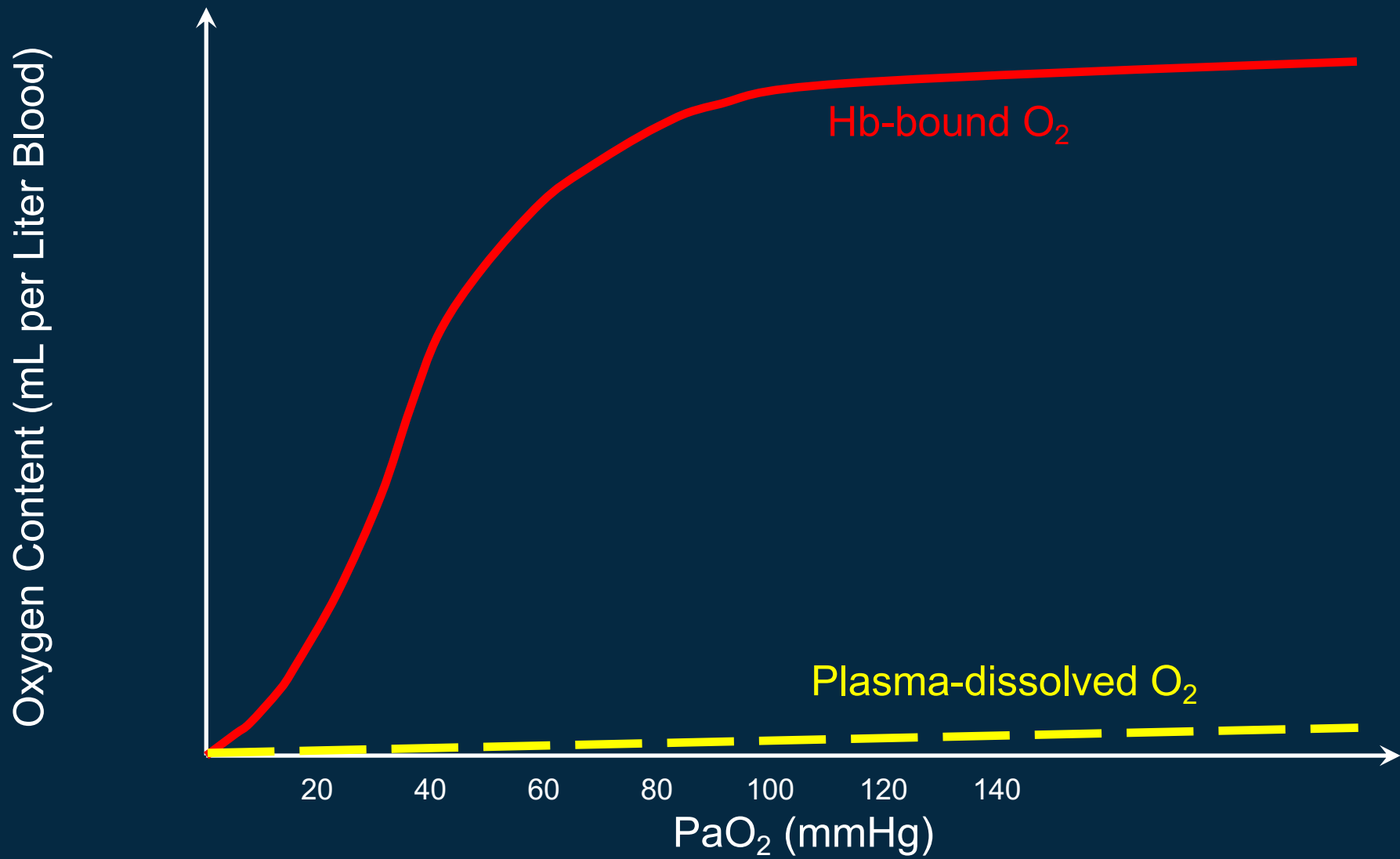
PHYSIOLOGY OF O₂ TRANSPORT

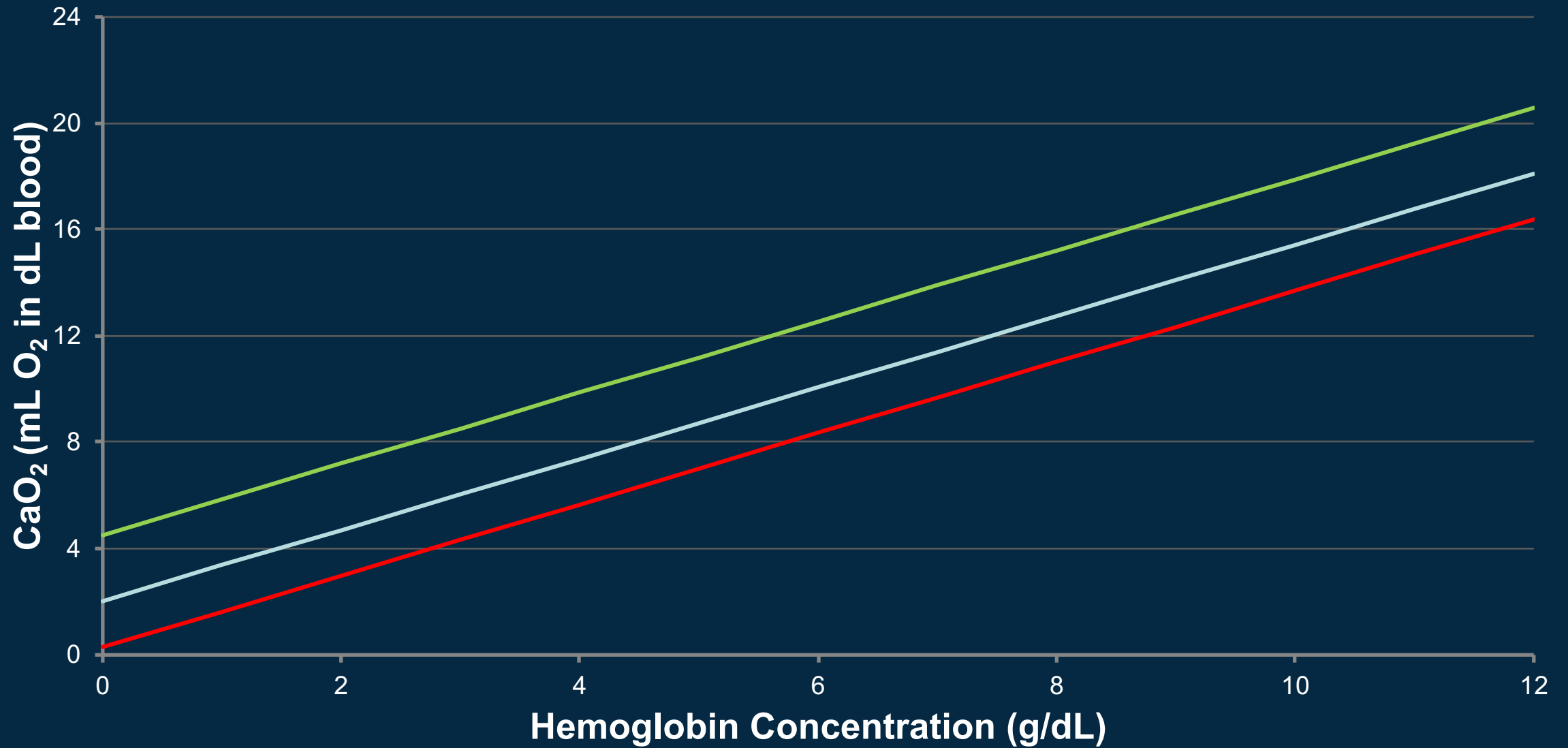
Global O₂ delivery (DO₂):

$$DO_2 = \text{Cardiac Output (CO)} \times \text{Arterial O}_2 \text{ content (CaO}_2\text{)}$$

$$CaO_2 = (\text{SaO}_2 \times 1.34 \times [\text{Hb}]) + (0.003 \times PaO_2)$$

Hb-bound O₂ Plasma-dissolved O₂





— PaO₂=100 mmHg
(Normal air)

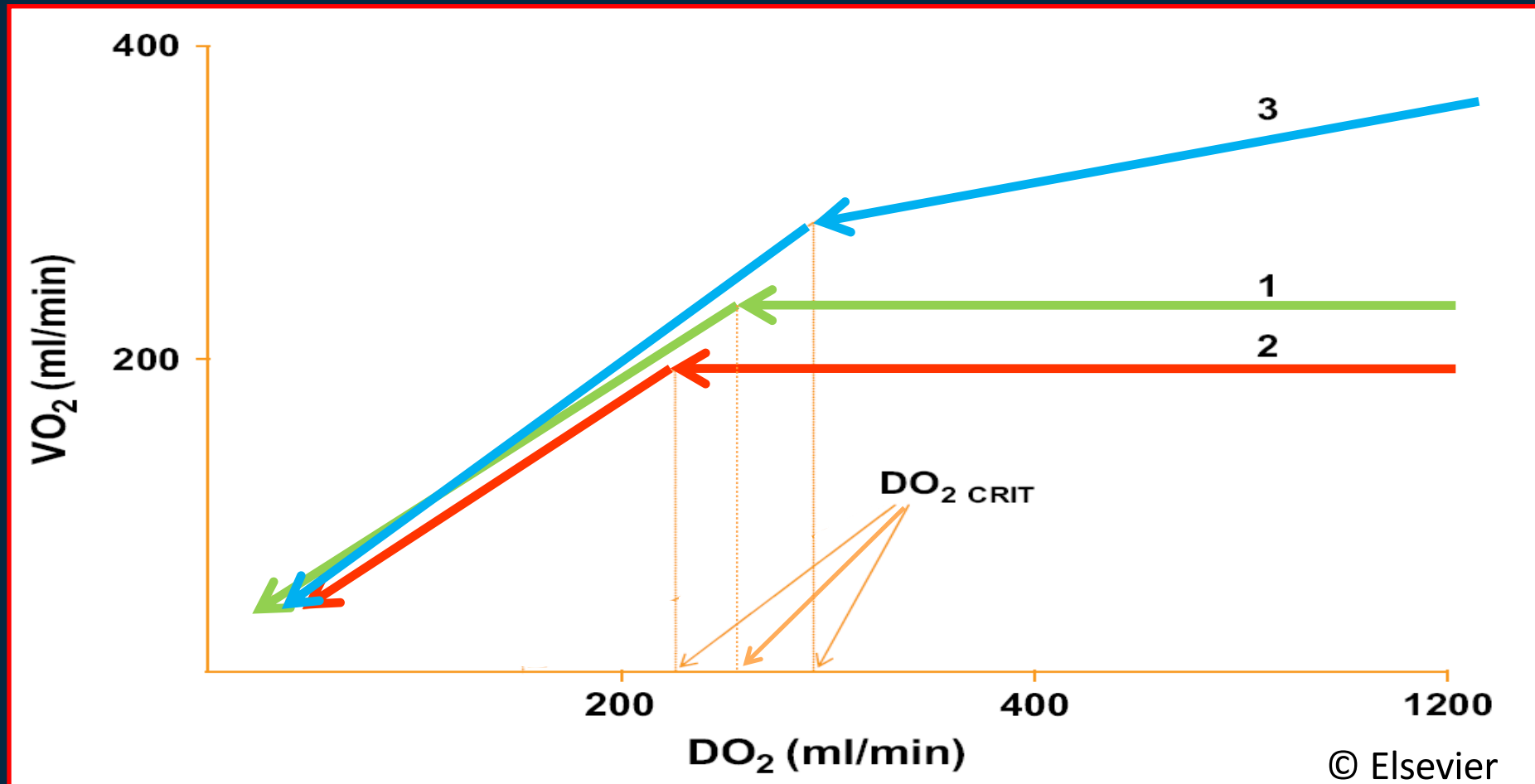
— PaO₂=673 mmHg
(Pure oxygen)

— PaO₂=1500 mmHg
(Hyperbaric oxygen)

O₂ DELIVERY VS. CONSUMPTION

- Global O₂ consumption (VO₂)
 - O₂ consumed by the whole body per min
- O₂ extraction ratio (O₂ER) = VO₂ / DO₂
 - Normally around 20-30%
 - No ischemia as long as VO₂ < DO₂ (by a significant margin)
 - VO₂ ≈ DO₂ → DO₂ CRIT → Ischemia

- VO_2 - DO_2 relationship & DO_2 CRIT



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Modified from: Madjdpour & Spahn. Best Pract Res Clin Anaesthesiol 2007

O₂ DELIVERY VS. CONSUMPTION

- For the majority of the patients (cases #1 & 2), even with severe anemia, VO₂ is unaffected
 - DO₂ independency
 - Important exception: “Supply dependency” as seen in critical illness (case #3)
- What if a patient is reaching O₂ CRIT (ischemia)?
 - Change VO₂ or DO₂
- Two common ways to manipulate DO₂ in clinic:
 - PaO₂ → Hyperbaric O₂
 - Hb → Blood transfusion

IMPACT OF TRANSFUSION

Classic premise:

- The patient is anemic
- Anemia \rightarrow $DO_2\downarrow$ \rightarrow $VO_2\uparrow$ \rightarrow Risk of ischemia \uparrow
- Transfuse the patient:
 - Transfusion \rightarrow $Hb\uparrow$ \rightarrow $DO_2\uparrow$ \rightarrow $VO_2\uparrow$ \rightarrow Ischemia \downarrow

What happens in reality?

Author (year)	Population	n	Blood Transfused	↑Hb	↑DO ₂	↑VO ₂	↓Lactate
Shah et al (1982)	Posttrauma critically ill patients	8	1 or 2 units	Yes	No	No	?
Kahn et al (1986)	Acute respiratory failure	15	7–10 mL/kg	Yes	No	No	?
Gilbert et al (1986)	Septic adults	54	Δ 20 g/L	Yes	Yes	No	No
Dietrich et al (1990)	Medical shock (septic/cardiac)	32	577 mL	Yes	Yes	No	No
Conrad et al (1990)	Septic shock	19	Δ 3 g/dL	Yes	Yes	No	No
Ronco et al (1990)	PCP pneumonia	5	1.5 units	Yes	Yes	Yes	?
Fenwick et al (1990)	ARDS	24	1.5 units	Yes	Yes	No	No
Mink et al (1990)	Septic shock 2 mo–6 yrs	8	8–10 mL/kg × 1–2 hrs	Yes	Yes	No	?
Lucking et al (1990)	Septic shock 4 mos–15 yrs	7	10–15 mL/kg × 1–3 hrs	Yes	Yes	Yes	?
Ronco et al (1991)	ARDS	17	1.5 units	Yes	Yes	No	?
Steffes et al (1991)	Postoperative and posttrauma	21	1–2 units	Yes	Yes	Yes	?

Author (year)	Population	n	Blood Transfused	↑Hb	↑DO ₂	↑VO ₂	↓Lactate
Babineau et al (1992)	Postoperative	31	328 ± 9 mL	Yes	Yes	No	No
Silverman et al (1992)	Septic shock 21–88 yrs	21	2 units	Yes	Yes	No	No
Marik et al (1993)	Septic adults	23	3 units	Yes	Yes	No	No
Lorente et al (1993)	Septic adults	16	2 units	Yes	Yes	No	?
Gramm et al (1996)	Septic shock 46 ± 3 yrs	19	2 units	Yes	No	No	?
Casutt et al (1999)	Postoperative 32–81 yrs	67	368 ± 10 mL	Yes	Yes	No	?
Fernandes et al (2001)	Septic shock 18–80 yrs	10	1 units	Yes	No	No	No
Walsh et al (2004)	Euvolemic anemic critically ill patients	22	2 units	Yes	?	?	No
Suttner et al (2004)	Volume-res mechanically ventilated patients	51	1 or 2 units vs. 100% FIO ₂	Yes	Yes	No	?
Mazza et al (2005)	SIRS/Sepsis	29	1–3 units	Yes	?	?	No

IMPACT OF TRANSFUSION

- Following transfusion:
 - In all of the studies, Hb increased
 - In 79% of the studies, DO_2 increased
 - In 16% of the studies, VO_2 increased
 - In none of the studies, ischemia (as measured by lactate level) improved
 - Missing column: Impact on patient outcome?
 - Observational studies

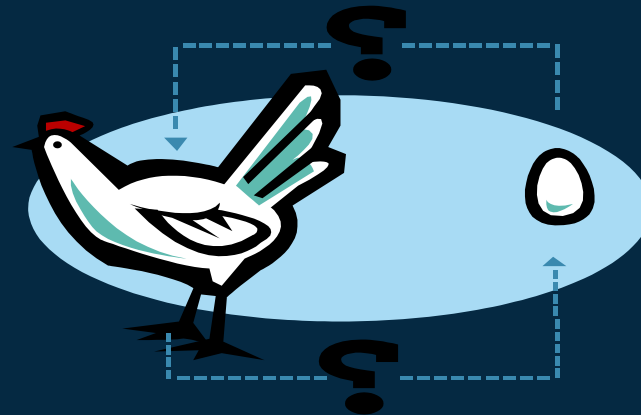
Author (year)	Population	n	Impact of Blood Transfusion
Leal-Novel et al (2001)	Cardiac surgery	738	- Higher mortality rate - Longer ICU stay
Wu et al (2001)	Elderly with MI	78,974	- Lower 30-day mortality (if admission Hct<33*) - Higher 30-day mortality (if admission Hct>36)
Engoren et al (2002)	Cardiac surgery	1,915	- Higher 5-year mortality rate
Vincent et al (2002)	Critically ill	3,534	- Higher 14- and 28-day mortality rate
Malone et al (2003)	Trauma	15,534	- Higher mortality rate - More ICU admission - Longer ICU/hospital stay
Corwin et al (2004)	Critically ill	4,892	- Higher mortality rate - Longer length of stay - More number of complications
Dunne et al (2004)	Trauma	9,539	- Higher mortality rate - More ICU admission - More SIRS
Innerhofer et al (2005)	Orthopedic surgery	308	- More infections
Weber et al (2005)	Orthopedic surgery	695	- Longer time to ambulation - Longer length of stay
Koch et al (2006)	Cardiac surgery	5,841	- More AF

Author (year)	Population	n	Impact of Blood Transfusion
Koch et al (2005)	Cardiac surgery	11,963	- Higher postop mortality rate - Higher postop morbidity rate (RF, prolonged ventilatory support, serious infection, cardiac complications, & neurologic events)
Murphy et al (2007)	Cardiac surgery	8,598	- Higher mortality rate - More ischemic complications - More infectious complications
Surgenor et al (2009)	Cardiac surgery	3,254	- Decreased survival after cardiac surgery
Pedersen et al (2009)	Total hip replacement	4,508	- Higher mortality rate - More pneumonia
Nikolsky et al (2009)	PCI after MI	2,060	- Higher 30-day and 1-year mortality rate
van Straten et al (2010)	Cardiac surgery	10,435	- Worse early survival
D'Ayala et al (2010)	Lower extremity amputation	300	- More postop adverse events - Longer ICU/hospital stay
O'Keefe et al (2010)	Lower extremity revascularization	8,799	- Higher mortality rate - More pulmonary complications - More infectious complications
Veenith et al (2010)	Elderly undergoing cardiac surgery	874	- Higher mortality rate - Longer ICU/hospital stay

Author (year)	Population	n	Impact of Blood Transfusion
Obi et al (2015)	Vascular Surgery	2,946	- Increased 30-d morbidity and mortality
Elsamadicy et al (2017)	Elective Spine Surgery	160	- Increased postop complications - Higher 30-d readmission - Longer hospital stay
Valentijnet al (2015)	Vascular Surgery	1,041	- Increased 30-d risk of cardiovascular events - Higher 30-d mortality
Goel et al (2018)	Surgery	750,937	- Increased risk of VTE
Osborne et al (2018)	Vascular Surgery	24,131	- Higher mortality - Increased risk of postop MI
Kaserer et al (2020)	Severely burnt	413	- Higher infection rate - Increased thromboembolic morbidity - Longer hospital stay
Kang et al (2020)	Nephrectomy for RCC	1,019	- Reduced recurrence-free & and cancer-specific survival
Nilsson et al (2020)	Septic critically ill	474	- Increased mortality & morbidity
Yuan et al (2020)	Surgery	1,896,584	- Increased risk of wound and nosocomial infections - Higher in-hospital mortality - Longer hospital stay
Shin et al (2020)	Elderly femoral fracture surgery	225	- Higher 1-y mortality
Jang et al (2020)	Elderly hip fracture	14,744	- Higher mortality rate within 30-d, 90-d & 180-d
Roh et al (2020)	ICH hospitalizations	597,046	- Higher in-hospital mortality

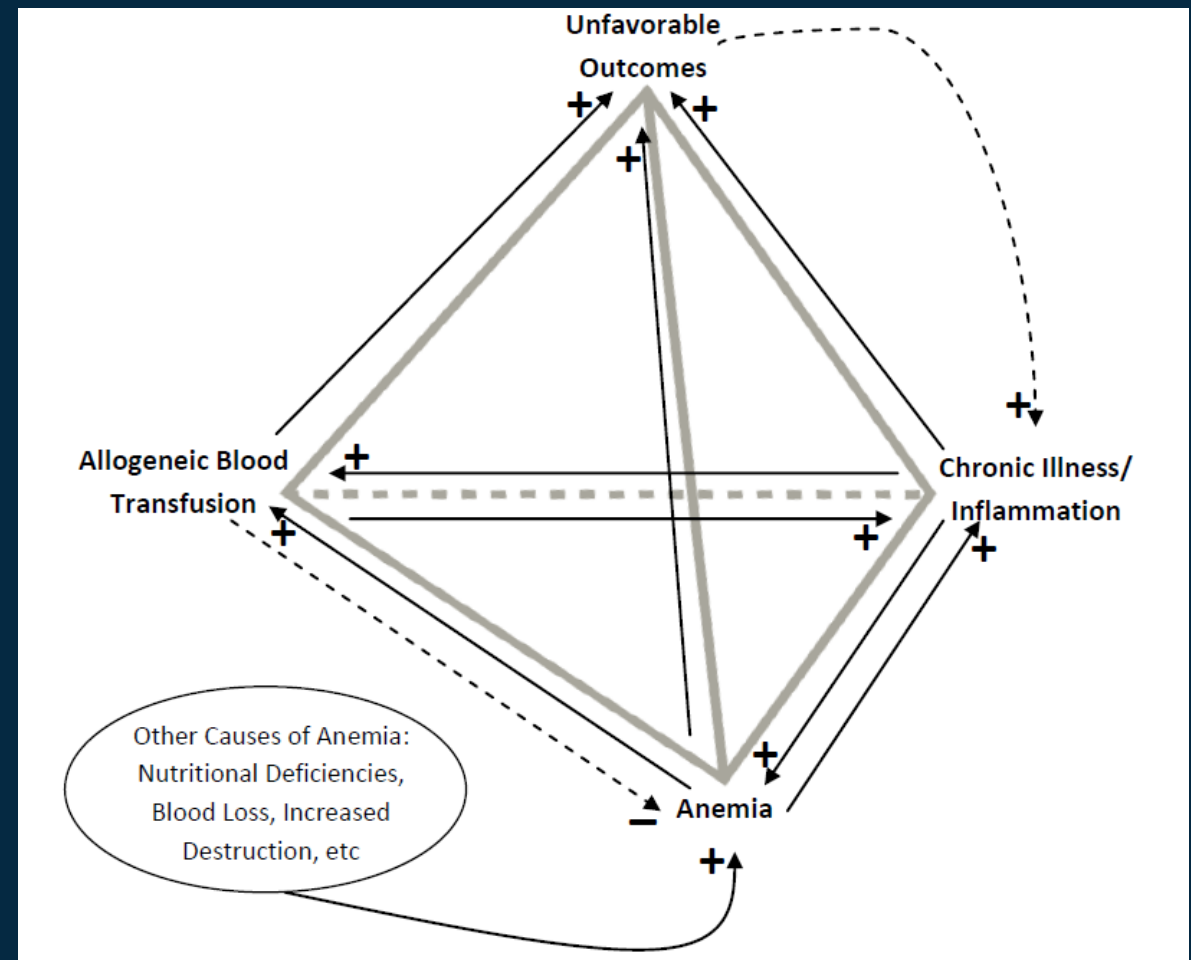
IMPACT OF TRANSFUSION

- Studies comparing blood transfusion with no transfusion are uncontrolled/observational
 - Transfusion causing worse outcome vs. transfusion making sicker patients?
 - Statistical methods to adjust for confounders → transfusion usually remains an independent factor associated with worse outcome



IMPACT OF TRANSFUSION

- Worsening of outcomes:
 - An interplay of transfusions, anemia, and comorbidities



IMPACT OF TRANSFUSION - RCTS

- RCTs: “Restrictive” (usually Hb 7-8) vs. “liberal” (usually Hb 9-10) transfusion
 - Hébert et al, TRICC trial (NEJM 1999):
 - Critically ill patients (n=838). Overall mortality rates similar; **Mortality lower in restrictive patients with lower APACHE II score or those younger than 55 yrs old**
 - Hébert et al, TRICC trial (CCM 2001):
 - Critically ill patients with cardiovascular disease (n=357). Overall mortality rates similar; **Mortality rate in restrictive patients with severe IHD higher but not statistically significant; Less MOF in restrictive group**
 - Hébert et al, TRICC trial (Chest 2001):
 - Critically ill patients under mechanical ventilation (n=713). No difference in duration of requiring respiratory support

IMPACT OF TRANSFUSION - RCTS

- McIntyre et al, TRICC trial (J Trauma 2004):
 - Critically ill trauma patients (n=203). Similar mortality, ICU/hospital length of stay and MOF
- Grover et al (Vox Sang 2006):
 - Elective hip & knee replacement (n=260). Similar incidence of silent myocardial ischemia & length of stay
- McIntyre et al, TRICC trial (Neurocrit Care 2006):
 - Critically ill trauma patient with moderate to severe head injury (n=67). No difference in mortality, length of stay, or MOF
- Foss et al (Transfusion 2009):
 - Elderly with hip fracture surgery (n=120). Similar postop rehabilitation scores and length of stay; **Higher cardiovascular complications and mortality in the restrictive group**

IMPACT OF TRANSFUSION - RCTS

- Hajjar et al, TRACS trial (JAMA 2010):
 - Patients undergoing cardiac surgery with CPB (n=502). Non-inferior rates of the combined outcome of 30-day all-cause mortality and severe morbidity.
- Carson et al, FOCUS trial (NEJM 2011):
 - Patients ≥ 50 years with CVD history/risk factors and Hb <10 g/dL after hip-fracture surgery (n=2016). Liberal transfusion did not reduce rates of death or inability to walk independently.
- Villanueva et al (NEJM 2013)
 - Patients with severe acute upper GI bleeding (n=921). **Restrictive strategy significantly improved outcomes.**

IMPACT OF TRANSFUSION - RCTS

- Murphy et al, TITRe2 trial (NEJM 2015):
 - Patients undergoing nonemergency cardiac surgery with postop Hb<9 g/dL (n=2007). Restrictive transfusion was not superior with respect to morbidity or health care costs.
- Palmieri et al, TRIBE trial (Ann Surg 2017):
 - Patients with 20% or more TBSA burn (n=345). Restrictive transfusion strategy halved blood product utilization with no negative impact on blood infection, mortality, or organ dysfunction.
- Mazer et al, TRICS III trial (NEJM 2017):
 - Patients undergoing cardiac surgery at moderate-to-high risk for death according to EuroSCORE I ≥ 6 (n=5243). Restrictive strategy was non-inferior to a liberal strategy with respect to the composite outcome of death, MI, stroke, or new-onset renal failure, with less blood transfused.

IMPACT OF TRANSFUSION - RCTS

- NB: These results are based on average of populations, not individual patient
 - Challenge: To identify the patient who is likely to benefit from transfusion
 - Prevent/reduce tissue ischemia
 - Improve patient outcome
 - Answer: Transfusion criteria other than reflex transfusion based on arbitrary Hb/Hct thresholds alone
 - i.e. better transfusion practices

BETTER TRANSFUSION PRACTICES

- Key guidelines
 - STS → Cardiac surgery
 - Perioperative Blood Transfusion and Blood Conservation in Cardiac Surgery (ATS, 2007)
 - SCCM → Critically ill
 - Clinical practice guideline: Red blood cell transfusion in adult trauma and critical care (CCM, 2009)
 - SIMTI → Periop
 - Recommendations for the transfusion management of patients in the peri-operative period (Blood Transfus, 2011)
 - BCSH → Critically ill
 - Guidelines on the management of anemia and red cell transfusion in adult critically ill patients (Br J Haematol, 2013)
 - ATS/AACN/ACCP/SCCM Choosing Wisely → Critically ill
 - An official ATS/AACC/ACCP/SCCM policy statement: the Choosing Wisely® Top 5 list (Am J Respir Crit Care Med, 2014)
 - ASA → Periop
 - Practice Guidelines for Perioperative Blood Management. An Updated Report by the ASA (Anesthesiology, 2015)
 - NICE → General
 - Blood Transfusion. National Clinical Guideline Centre. London: National Institute for Health and Care Excellence (UK), 2015
 - AAGBI → General hospitalized
 - AAGBI guidelines: the use of blood components and their alternatives 2016 (Anaesthesia, 2016)
 - AABB → General hospitalized
 - Clinical Practice Guidelines From the AABB: Red Blood Cell Transfusion Thresholds and Storage (JAMA, 2016)



AABB GUIDELINES

- Target settings:
 - Hospitalized adult patients who are hemodynamically stable
- Recommendations:
 - A restrictive RBC transfusion threshold of 7 g/dL in hospitalized hemodynamically stable adult patients, including critical care patients
 - For patients undergoing orthopedic surgery and cardiac surgery and those with existing cardiovascular disease, a restrictive RBC transfusion threshold of 8 g/dL
 - The threshold of 7 g/dL is likely comparable to 8 g/dL, but evidence is not available for all patient categories.
 - Conditions in which evidence is judged to be insufficient for any recommendation:
 - Acute coronary syndrome
 - Severe thrombocytopenia in hematology/oncology patients at risk of bleeding,
 - Chronic transfusion-dependent anemia.

AAGBI GUIDELINES



- Target settings:
 - Hospitalized
- Recommendations:
 - Hb measured in all patients before scheduling for major elective surgery. If anemic (WHO criteria), anemia should be investigated and treated and elective non-urgent surgery delayed.
 - RBC units transfused 1 unit at a time, and Hb should be checked before each unit transfused (except ongoing bleeding or a large deficit)

AAGBI GUIDELINES

- Recommendations (cont.):
 - A general Hb threshold of 7 g/dL should apply as a guide for RBC transfusion.
 - Same Hb threshold can be applied to critically ill patients (unless patient has cardiac disease).
 - The same principle of restrictive use of RBCs (70–80 g/dL) also applies for patients admitted to ICU with hematological malignancies.
 - Uncertainty remains for patients with ischemic heart disease, including acute coronary syndrome and after cardiac surgery and higher thresholds (8 g/dL) may be more appropriate in such circumstances.

NICE GUIDELINES



- Target settings: General
- Recommendations:
 - Use restrictive RBC transfusion thresholds for patients who need transfusions and who do not:
 - have major hemorrhage or
 - have acute coronary syndrome or
 - need regular blood transfusions for chronic anemia
 - When using a restrictive RBC transfusion threshold, consider a Hb threshold of 7 g/dL and an Hb target of 7-9 g/dL after transfusion.

NICE GUIDELINES

- Recommendations (cont.):
 - Consider RBC transfusion threshold of 8 g/dL and Hb target of 8-10 g/dL after transfusion for patients with acute coronary syndrome.
 - Consider setting individual thresholds and Hb concentration targets for each patient who needs regular blood transfusions for chronic anemia.
 - Consider single-unit RBC cell transfusions for adults (or equivalent volumes calculated based on body weight for children or adults with low body weight) who do not have active bleeding.
 - After each single-unit RBC transfusion , clinically reassess and check Hb levels, and give further transfusions if needed.

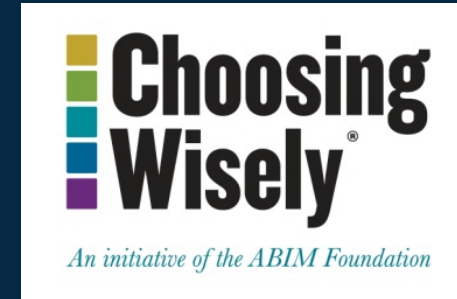


American Society of
Anesthesiologists[™]

ASA GUIDELINES

- Target setting: Perioperative
- Recommendations:
 - A restrictive RBC transfusion strategy (usually Hb <8 g/dL or Hct <25%) may be safely used to reduce transfusion administration.
 - Determination of whether Hb between 6-10 g/dL justifies RBC transfusion should be based on potential or actual ongoing bleeding (rate and magnitude), intravascular volume status, signs of organ ischemia, and adequacy of cardiopulmonary reserve.
 - RBCs should be administered unit-by-unit, when possible, with interval reevaluation.

ATS/AACC/ACCP/SCCM CHOOSING WISELY



- Target setting: Critically ill
- Recommendations:
 - Do not transfuse RBCs in hemodynamically stable, non-bleeding ICU patients with an Hb >7 mg/dL.
 - It is possible that different thresholds may be appropriate in patients with acute coronary syndromes, although most observational studies suggest harms of aggressive transfusion even among such patients.

BCSH GUIDELINES

BRITISH COMMITTEE FOR
STANDARDS IN HAEMATOLOGY

- Target setting: Critically ill
- Recommendations - General Intensive Care:
 - A transfusion Hb threshold ≤ 7 g/dL, with a target Hb range of 7–9 g/dL should be the default for all critically ill patients, unless specific co-morbidities or acute illness-related factors modify clinical decision-making.
 - Transfusion triggers should not exceed 9 g/dL in most critically ill patients.

BCSH GUIDELINES

- Recommendations - Sepsis:
 - In the early resuscitation of patients with severe sepsis, if there is clear evidence of inadequate DO_2 , transfusion of RBCs to a target Hb of 9-10 g/dL should be considered.
 - During the later stages of severe sepsis, a restrictive approach to transfusion should be followed with a target Hb of 7–9 g/dL.
- Recommendations – Neurocritical Care:
 - In patients with TBI the target Hb should be 7-9 g/dL.
 - In patients with TBI and evidence of cerebral ischemia, the target Hb should be >9 g/dL.
 - In patients with SAH, the target Hb should be 8-10 g/dL.
 - In patients presenting to the ICU with an acute ischemic stroke, the Hb should be maintained above 9 g/dL.

BCSH GUIDELINES

- Recommendations – Ischemic heart disease:
 - In patients suffering from ACS, the Hb should be maintained at >8 g/dL.
 - Anemic critically ill patients with stable angina should have Hb maintained >7 g/dL.
- Recommendations – Weaning:
 - RBC transfusion should not be used as a strategy to assist weaning from mechanical ventilation when the Hb is >7 g/dL.

SIMTI GUIDELINES



- Target setting: Perioperative
- Recommendations:
 - The decision to transfuse RBC depends on Hb level, the amount and speed of the blood loss, and the clinical condition of the patient (signs and symptoms of reduced local or general oxygenation).
 - Blood loss RBC transfusion decision criteria in acute anemia:
 - Loss of <15% of blood volume or <750 mL blood: Non necessary, if no pre-existing anemia
 - Loss of 15-30% of blood volume or 750-1500 mL blood: Non necessary, unless pre-existing anemia and/or cardiopulmonary disease
 - Loss of 30-40% of blood volume or 1500-2000 mL blood: Probably necessary
 - Loss of >40% of blood volume or >2000 mL blood: Necessary

SIMTI GUIDELINES

- Recommendations (cont.):
 - Hb transfusion decision criteria in acute anemia:
 - Hb > 10 g/dL: Transfusion therapy extremely rarely required
 - Hb 8-10 g/dL: Transfusion only in presence of symptoms indicative of hypoxia (tachycardia, hypotension, ECG signs of ischemia, lactic acidosis, etc.)
 - Hb 6-8 g/dL: Transfusion not needed if no risk factors or no signs of hypoxia. Transfusion is needed in presence of risk factors (coronary artery disease, heart failure, cerebrovascular disease/limited mechanisms of compensation) or signs of hypoxia (tachycardia, hypotension, ECG signs of ischemia, lactic acidosis)
 - Hb < 6 g/dL: Transfusion almost always necessary
 - Note: Patients with acute hemorrhage can have normal/raised Htc and Hb until the plasma volume is restored

SCCM GUIDELINES



- Target setting: Critically ill
- RBC transfusion in general critically ill patients:
 - Indicated for patients with evidence of hemorrhagic shock
 - May be indicated for patients with evidence of acute hemorrhage and hemodynamic instability or inadequate oxygen delivery
 - A “restrictive” strategy (transfuse when Hb <7 g/dL) is as effective as a “liberal” transfusion strategy (transfusion when Hb <10 g/dL) in hemodynamically stable patients
 - Except possibly in patients with acute myocardial ischemia
 - Use of Hb level alone as a “trigger” for transfusion should be avoided
 - Decision should be based on patient’s intravascular volume status, evidence of shock, duration/extent of anemia, & cardiopulmonary physiologic parameters

SCCM GUIDELINES

- RBC transfusion in general critically ill patients (cont.):
 - In the absence of acute hemorrhage, RBC should be given as single units
 - Consider RBC if Hb <7 g/dL in patients requiring mechanical ventilation
 - Consider RBC if Hb <7 g/dL in resuscitated critically ill trauma patients
 - Consider RBC if Hb <7 g/dL in patients with stable cardiac disease
 - RBC transfusion should not be considered as an absolute method to improve VO_2
 - RBC transfusion may be beneficial in patients with acute coronary syndrome with Hb ≤ 8 g/dL on hospital admission

SCCM GUIDELINES

- RBC transfusion in sepsis:
 - Each case must be assessed individually since optimal transfusion triggers in sepsis patients are not known
- RBC transfusion in patients with (or at risk for) ALI/ARDS:
 - All efforts should be made to avoid transfusion
 - RBC should not be considered as a method to facilitate weaning from ventilator
- RBC transfusion in patients with neurologic injury/disease
 - No benefit of a “liberal” transfusion strategy (Hb >10 g/dL) in patients with moderate/severe TBI
 - Patients with SAH must be assessed individually since optimal transfusion triggers are not known

STS GUIDELINES



- Target setting: Cardiac surgery
- RBC transfusion in general cardiac surgery patients:
 - Reasonable if Hb <6 g/dL
 - Reasonable in most postop patients if Hb <7 g/dL (no high-level evidence available though)
 - Not unreasonable in certain patients with critical noncardiac end-organ ischemia (e.g. CNS, GI) with Hb \leq 10 g/dL (more evidence needed)
 - Unlikely to improve O₂ transport and not recommended if Hb >10 g/dL

STS GUIDELINES

- RBC transfusion during CPB:
 - Reasonable with Hb ≤ 6 g/dL
 - In patients with Hb >6 g/dL, consider:
 - Patient factors (age, severity of illness, cardiac function, risk of critical end-organ ischemia)
 - Clinical setting (massive or active blood loss)
 - Paraclinic parameters (Hb/Hct, SVO₂, evidence of myocardial ischemia on ECG/echo, etc)
 - Reasonable with higher Hb levels in patients at risk of decreased cerebral O₂ delivery (e.g. history of CVA, diabetes, carotid stenosis)
 - Not unreasonable to keep Hb ≥ 7 g/dL in patients with risk of critical end-organ ischemia/injury

COMMON THEMES

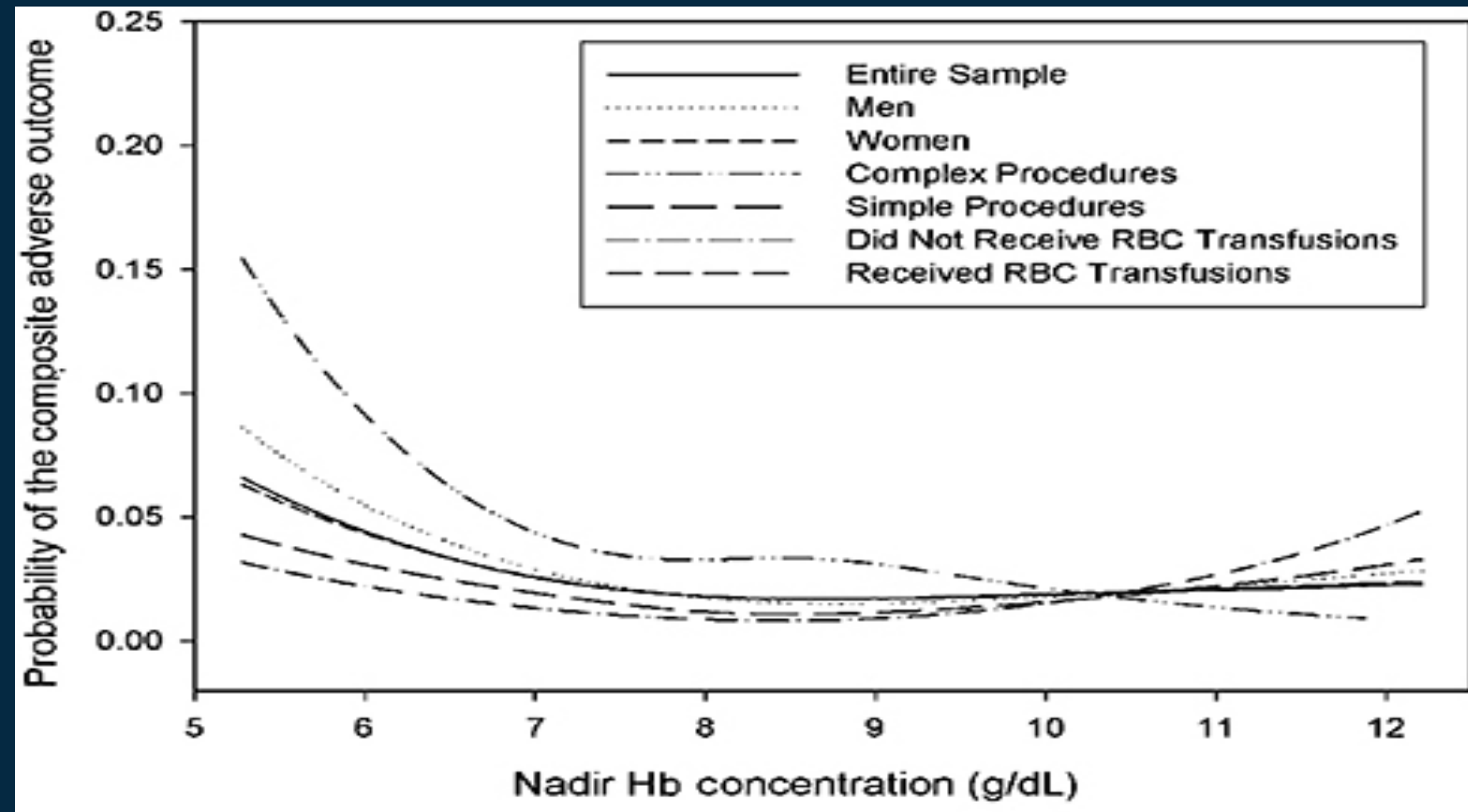
- Hb alone is usually not a very informative parameter to use as basis for transfusion decisions:
 - Blood usually indicated if Hb <6 g/dL
 - Blood rarely indicated if Hb >10 g/dL
 - Look at other factors particularly if Hb 6-10 g/dL
- Ultimate goal of transfusion is not achieving/maintaining an arbitrary Hb level, but avoiding ischemia and improving outcomes
- Other potentially important factors to consider:
 - Patient factors (age, comorbidities, etc)
 - Extent and rate of blood loss
 - Evidence of ischemia (Physiologic transfusion criteria)
- Single-unit transfusions (esp. if no active massive blood loss)
- Limited high-quality evidence available

PHYSIOLOGIC TRIGGERS

Parameter	Intraop/ ICU	Postop/ Inpatient Unit
MAP	<70-80% of baseline or <60 mmHg	
HR	>120-130% of baseline or >110-130 p/min	
ECG	New ST-segment depression >0.1 mV	
ECG	New ST-segment elevation >0.2 mV	
Trans-esophageal/-thoracic echocardiography	New wall motion abnormality	
PvO ₂	<32 mmHg	Not applicable
O ₂ extraction rate	>40%	Not applicable
SvO ₂	<60%	Not applicable
Decrease in VO ₂	>10%	Not applicable

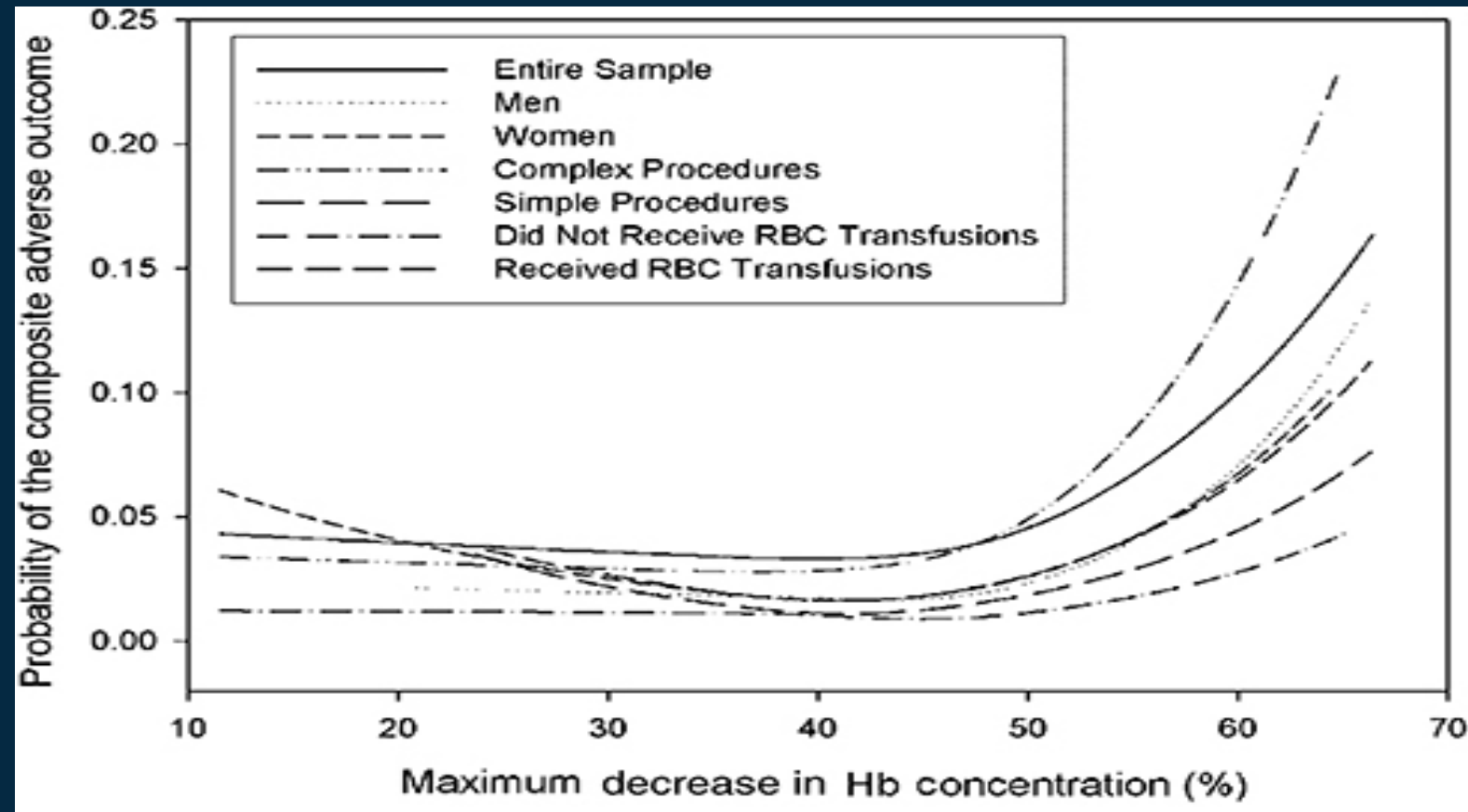
OTHER CONSIDERATIONS

- Hb decrease: absolute drop vs. % drop from the baseline
 - Study of 10,179 patients with normal baseline Hb undergoing on-pump cardiac surgery
 - Composite outcome of death, stroke or renal failure
 - Apparent increase in risk with nadir Hb below 7 g/dL, but not significant when adjusted for confounders



OTHER CONSIDERATIONS

- Hb decrease: absolute drop vs. % drop from the baseline
 - Study of 10,179 patients with normal baseline Hb undergoing on-pump cardiac surgery
 - Composite outcome of death, stroke or renal failure
 - Conversely, increased risk independently associated with >50% drop in Hb (OR 1.53, 95% CI 1.12-2.08, p=0.008)



OTHER CONSIDERATIONS

- Before giving transfusion:
 - Optimize hemodynamics and oxygenation
 - Don't forget obtaining informed consent from the patient
- Age of blood:
 - Some cohort studies have suggested detrimental effect associated with aged blood
 - Not supported in RCTs
- Leukoreduction:
 - Mixed results from the studies
 - Does not seem to be an unreasonable approach
- Other strategies to avoid or minimize RBC transfusion → Patient Blood Management (That's another story!)

BETTER TXN PRACTICES IN ACTION

- Englewood Health RBC order set → Check one box:

1) Acute Anemia

(Before considering txn, all efforts should be made to control active bleeding)

- Acute blood loss & Symptomatic
(>30% of EBV with Hb <7; Tachycardia or hypotension not corrected by fluids alone, or mixed venous O₂ sat <55%)
- Evidence of ACTIVE ischemia
(new EKG changes ANG symptomatic)



BETTER TXN PRACTICES IN ACTION

- Englewood Health RBC order set → Check one box (cont.):

2) Chronic Anemia

(Treatable causes of anemia should be ruled out first: Fe/Folate/B₁₂ deficiencies; Consider using ESAs)

- Patient is symptomatic
(Tachycardia or hypotension not corrected by fluids alone, or mixed venous O₂ sat <55%)
- Patient is undergoing active treatment anticipated to cause significant anemia

Remember: Treat patients not numbers...



THANK YOU!

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