ISBT Webinar – Ask the Expert:

Evidence-based Transfusion Practice and Blood Management Programs

Steven M. Frank, M.D.

Professor
Director, Johns Hopkins Health System Blood Management Program
Director, Center for Bloodless Medicine and Surgery
Department of Anesthesiology/Critical Care Medicine
The Johns Hopkins Medical Institutions

Disclosures

Haemonetics

Potential Bias in My Talk:

I had a life saving transfusion in 1988

1988

3rd yr resident

Bicycle vs. Car

6 Units blood

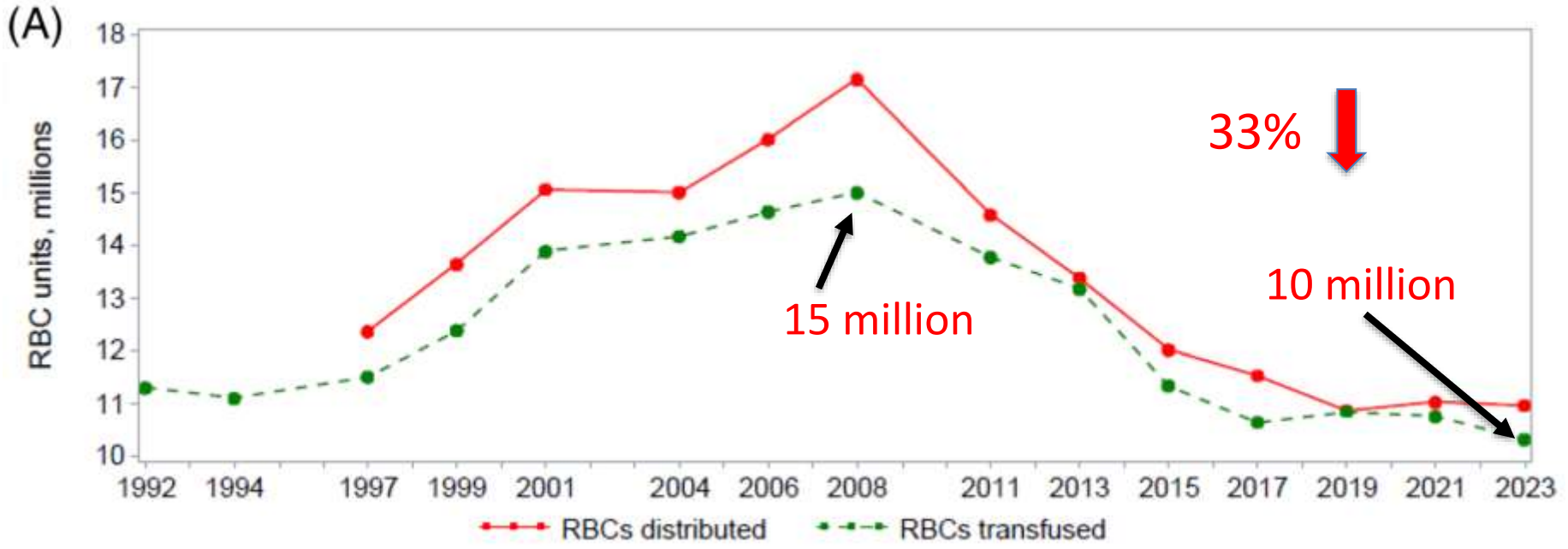
Hb 7.0 leaving hospital

GIVE BLOOD
SAVE LIFE

Have we reached a new baseline for blood collection and transfusion in the United States? National Blood Collection and Utilization Survey, 2023

TRANSFUSION, January 2025

Kelsey McDavid[1] | Rebecca Lien[1,2] | Joel Chavez Ortiz[1,3] | Tatiana Bradley[1,4] | Angelina Luciano[1,4] | Isabel Griffin[1] | James Berger[5] | Sridhar V. Basavaraju[1] | Ian Kracalik[1]



Joint Commission Overuse Summit

(October, 2012)

Blood transfusion targeted at the Overuse Summit.

- **Blood transfusion is the most commonly performed procedure in US hospitals**

Five most overused procedures:

1. Blood transfusions
2. Heart vessel stents
3. Ear tubes (tympanostomy tubes)
4. Antibiotics for the common cold (viral upper respiratory infections)
5. Early scheduled births (early induction) without medical need

Blood Management –

One of the few areas in medicine where all three of these can be achieved at the same time:

- **Reduce Risk**
- **Save Cost**
- **Improve Outcomes**

Three Categories of Risks / Adverse Effects from Blood Transfusion

Clinical Event		Risk / Unit
Allergic/Urticaria		1 in 100
RBC Alloimmunization		1 in 100
TACO		1 in 100
TRALI		1 in 5,000
Hemolytic Rxn		1 in 6,000
Wrong Unit Given		1 in 15,000
Hepatitis B		1 in 400,000
Hepatitis C		1 in 2,000,000
HIV 1 and HIV 2		1 in 2,000,000

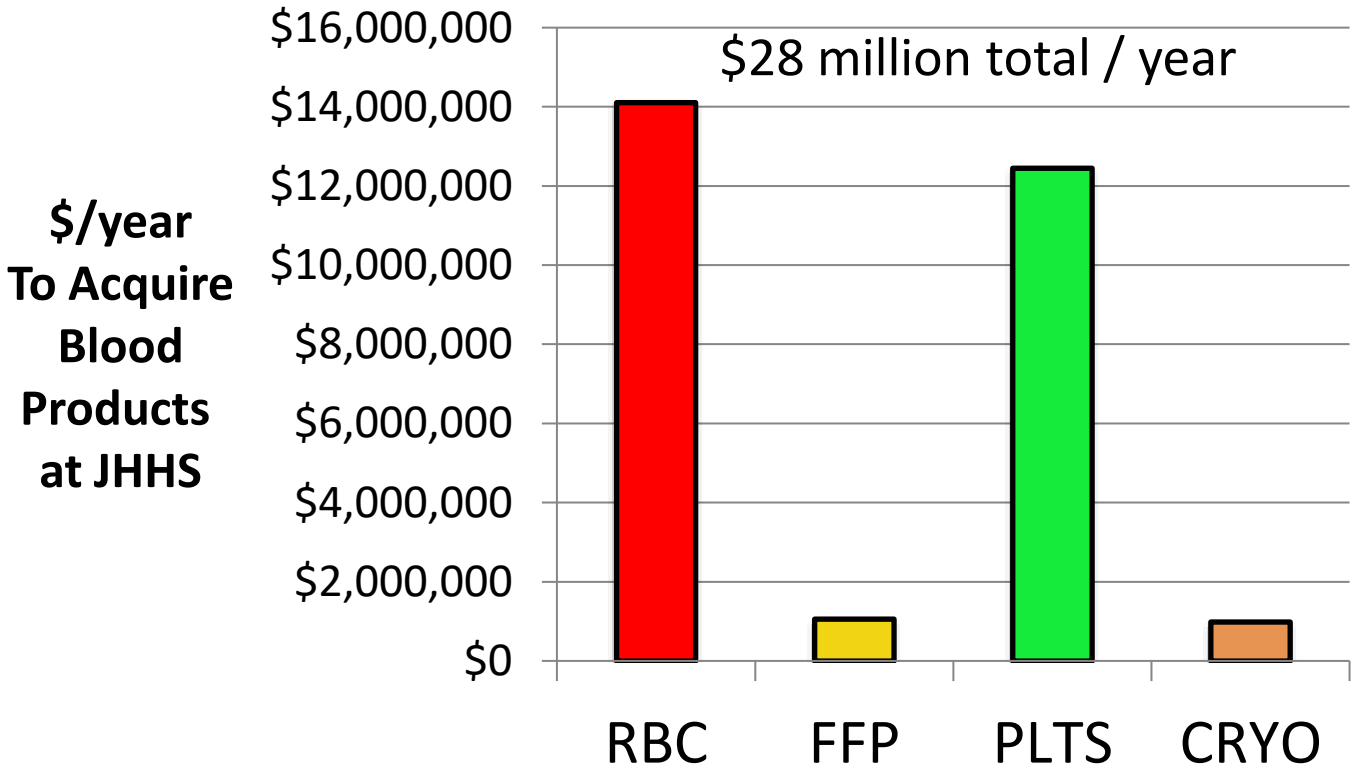
} Common

} Not so Rare

} Rare

5% less blood products = $1.4 million cost reduction/year

10% less blood products = $2.8 million cost reduction/year



Twelve Landmark Randomized Clinical Trials Supporting Hb Triggers of 7-8 g/dL (Less is More)

Randomized Trials:

– all supporting Hb triggers of 7 or 8 g/dL

		Higher Triggers (9-10 g/dL)
7	•Hebert PC, et al: NEJM 1999 – Critically ill MICU pts.	- Same/Worse
7	•Lacroix J, et al: NEJM 2007 – Critically ill PICU pts.	- Same
7	•Villanueva C, et al: NEJM 2013 – Severe GI Bleeding	- Worse
7	•Holst LB, et al: NEJM 2014 – Septic Shock	- Same
7	•Robertson CS. et al: JAMA 2014 – Traumatic Brain Injury	- Same/Worse
8	•Carson JL, et al: NEJM 2011 – Elderly orthopedic Surg.	- Same
8	•Hajjar LA, et al: JAMA 2010 – Cardiac surgery pts.	- Same
7.5	•Murphy GJ, et al: NEJM 2015 – Cardiac surgery pts.	- Same
7.5	•Mazer CD, et al: NEJM 2017 – Cardiac surgery pts.	- Same/Worse (age > 75)
8	•Kirpalani H, et al: NEJM 2020 – Premat. Neonates	- Same
7-8	•Franz AR, et al: JAMA 2020 – Premat. Neonates	- Same
8	•Ducrocq G, et al: JAMA 2021 – Acute MI	- Same

LESS IS MORE !

Until 2024 ?

Three New Randomized Trials Supporting Hb Triggers of 9-10 g/dL (More is More?)

		Higher Triggers (9-10 g/dL)
7-8	•Carson JL, et al. *NEJM* 2024 - Acute MI (MINT)	- ? Better
7	•Turgeon AF, et al. *NEJM* 2024 - Traumatic Brain Injury (HEMOTION)	- ? Better
7	•Taccone FS, et al. *JAMA* 2024 – Acute TBI, SAH, IPH (TRAIN)	- Better
8	•English SW, et al. *NEJM* 2024 – SAH (SAHARA)	- Same

2024 Update

Ischemic or injured heart and brain *may* benefit from Hb triggers of 9-10 g/dL as opposed to 7-8 g/dL.

More is More?

Frank SM, et al. Variability in blood and blood component utilization as assessed by an anesthesia information management system. Anesthesiology 2012;117:99-106

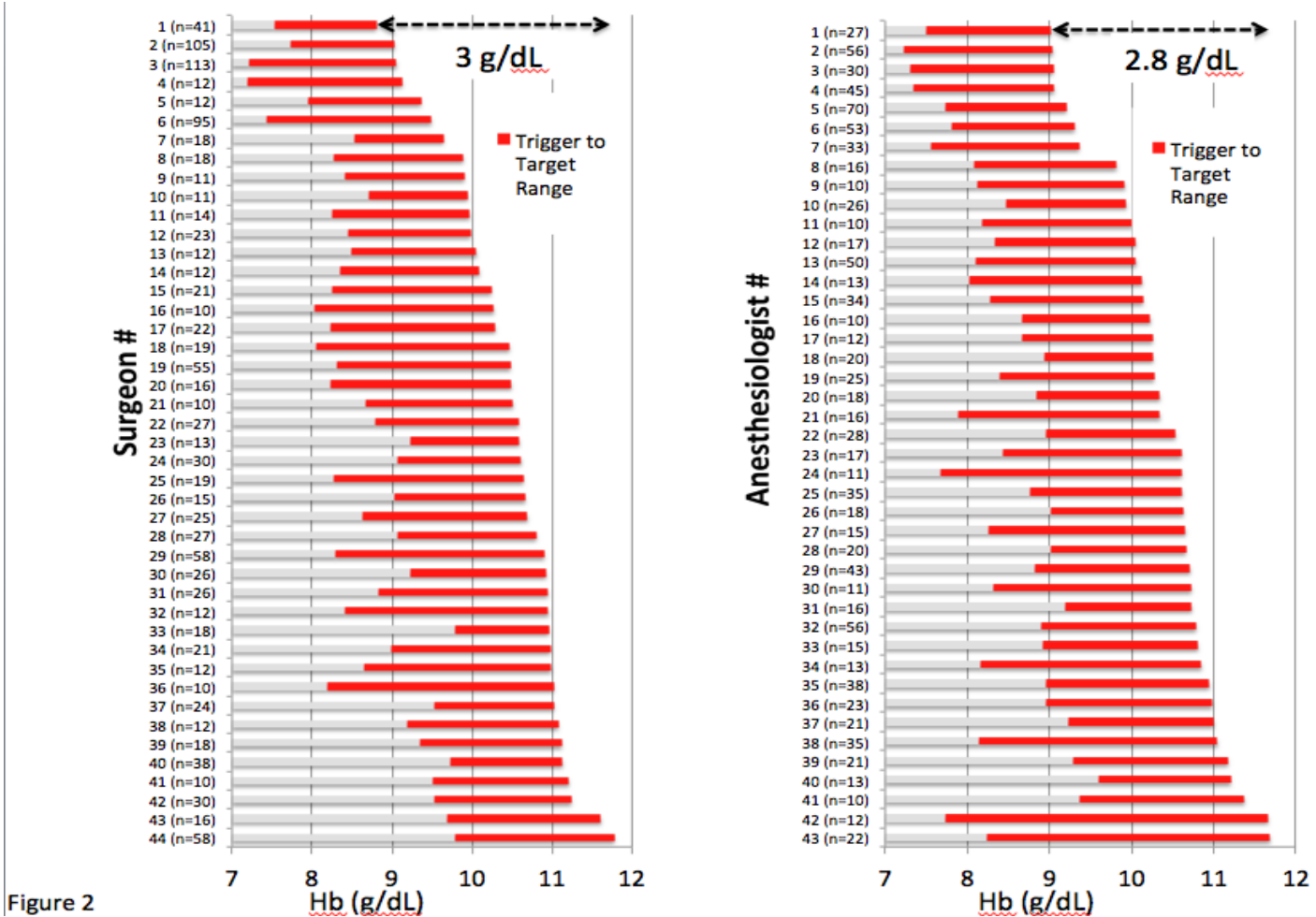


Figure 2

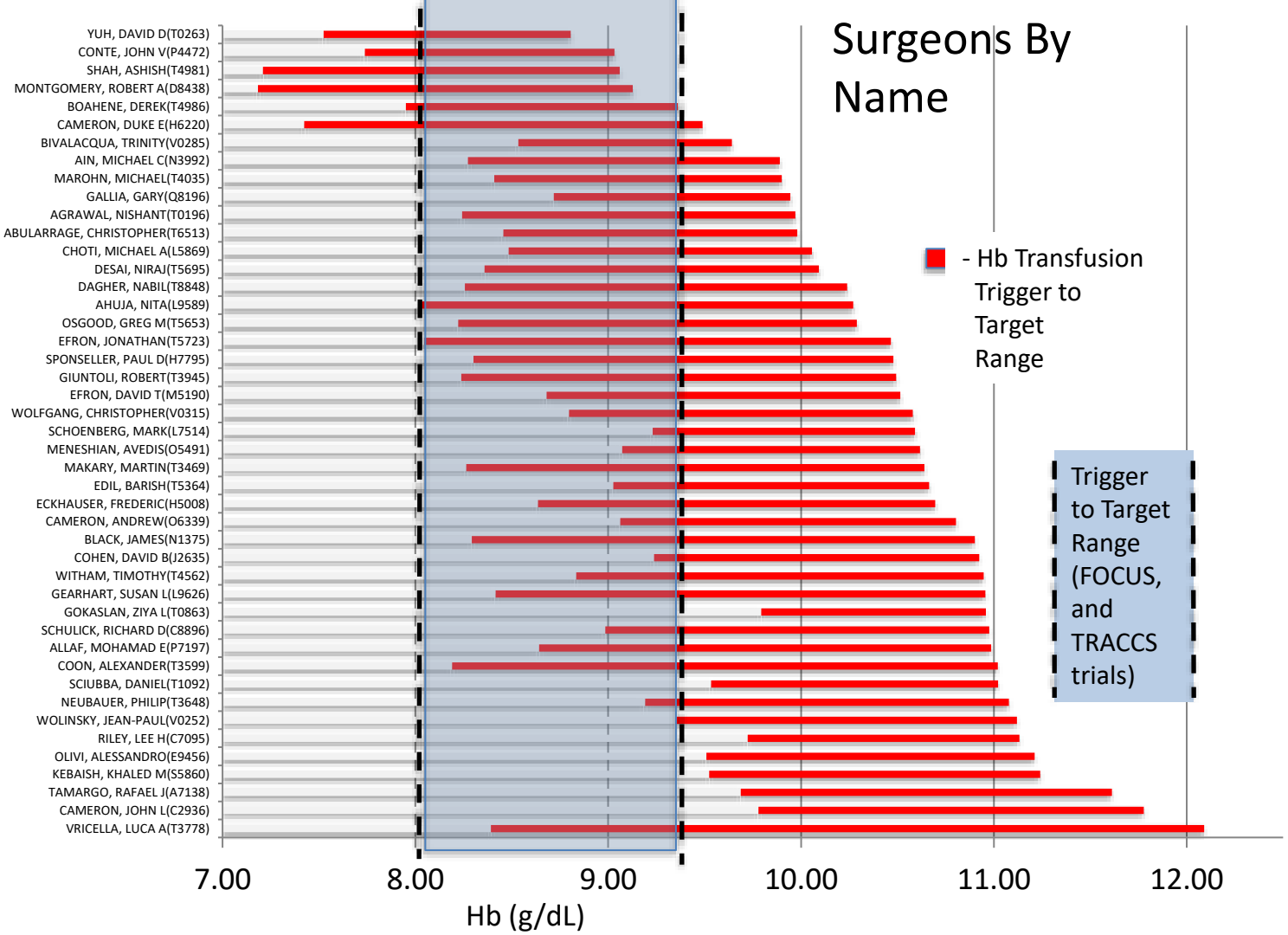
Frank SM, et al. Variability in blood and blood component utilization as assessed by an anesthesia information management system. Anesthesiology 2012;117:99-106

The New York Times
Tuesday, September 11, 2012

New Study Reveals Wide Variation in Blood Transfusion Practices During Surgery

Published: July 26, 2012

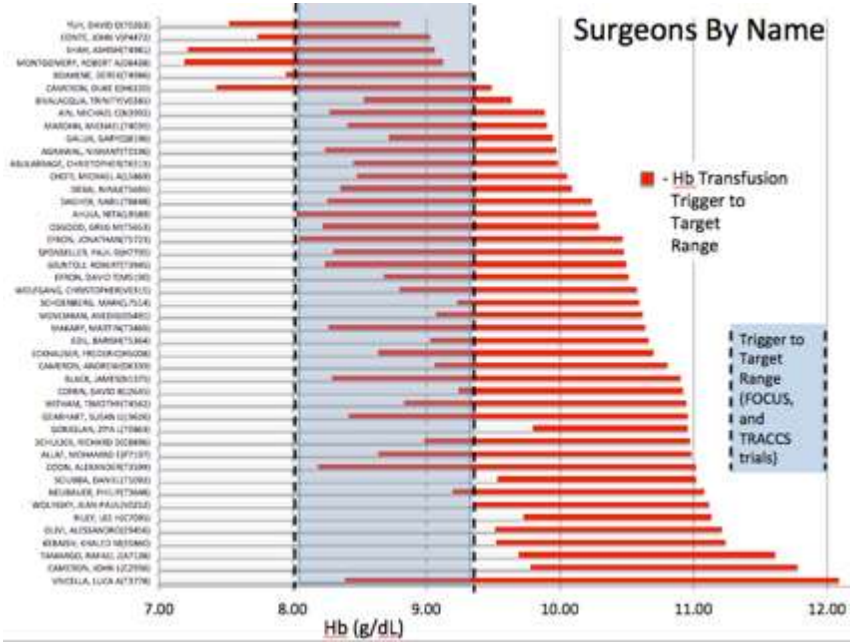
IRVINE, Calif., July 26, 2012 /PRNewswire/ -- According to a new study in the July 2012 print edition of *Anesthesiology*, blood transfusion, the most common procedure performed in U.S. hospitals[1], has wide variation in frequency by surgical procedure and physician as well as wide variation in the hemoglobin trigger used to help decide whether to transfuse.[2] The study also showed a significant number of transfusion decisions are made without laboratory hemoglobin measurements. The research adds to the growing clinical evidence highlighting the need for improved blood-management strategies. It also underscores the opportunity for noninvasive and continuous total


Surgeons By Name
YUH, DAVID D(T0263)
CONTE, JOHN V(P4472)
SHAH, ASHISH(T4981)
MONTGOMERY, ROBERT A(D8438)
BOAHENE, DEREK(T4986)
CAMERON, DUKE E(H6220)
BIVALACQUA, TRINITY(V0285)
AIN, MICHAEL C(N3992)
MAROHN, MICHAEL(T4035)
GALLIA, GARY(Q8196)
AGRAWAL, NISHANT(T0196)
ABULARRAGE, CHRISTOPHER(T6513)
CHOTI, MICHAEL A(L5869)
DESAI, NIRAJ(T5695)
DAGHER, NABIL(T8848)
AHUJA, NITA(L9589)
OSGOOD, GREG M(T5653)
EFRON, JONATHAN(T5723)
SPONSELLER, PAUL D(H7795)
GIUNTOLI, ROBERT(T3945)
EFRON, DAVID T(M5190)
WOLFGANG, CHRISTOPHER(V0315)
SCHOENBERG, MARK(L7514)
MENESHIAN, AVEDIS(O5491)
MAKARY, MARTIN(T3469)
EDIL, BARISH(T5364)
ECKHAUSER, FREDERIC(H5008)
CAMERON, ANDREW(O6339)
BLACK, JAMES(N1375)
COHEN, DAVID B(J2635)
WITHAM, TIMOTHY(T4562)
GEARHART, SUSAN L(L9626)
GOKASLAN, ZIYA L(T0863)
SCHULICK, RICHARD D(C8896)
ALLAF, MOHAMAD E(P7197)
COON, ALEXANDER(T3599)
SCIUBBA, DANIEL(T1092)
NEUBAUER, PHILIP(T3648)
WOLINSKY, JEAN-PAUL(V0252)
RILEY, LEE H(C7095)
OLIVI, ALESSANDRO(E9456)
KEBAISH, KHALED M(S5860)
TAMARGO, RAFAEL J(A7138)
CAMERON, JOHN L(C2936)
VRICELLA, LUCA A(T3778)
- Hb Transfusion Trigger to Target Range
Trigger to Target Range (FOCUS, and TRACCS trials)
7.00
8.00
9.00
10.00
11.00
12.00
Hb (g/dL)

Public Display

Surgeon #44 (with permission)

- Just completed his 2000th Whipple
- Difficult operation – pancreatic cancer
- Sent Surgeon #44 an email on 12/25
- Notified him he has the highest Hb in the hospital



Surgeon #44 (with permission)

- Next week in a Whipple case

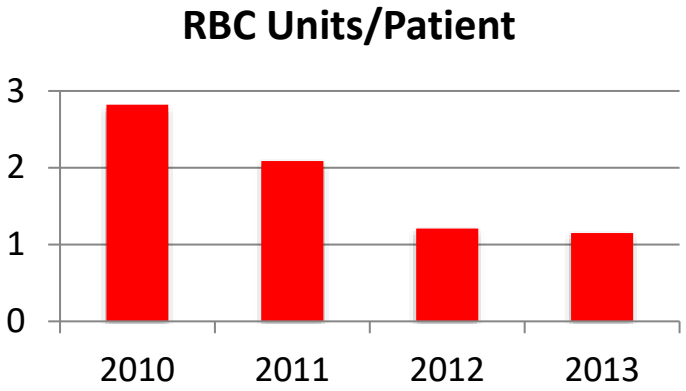
  "If you hang that blood Steve Frank is gonna be all over our case"

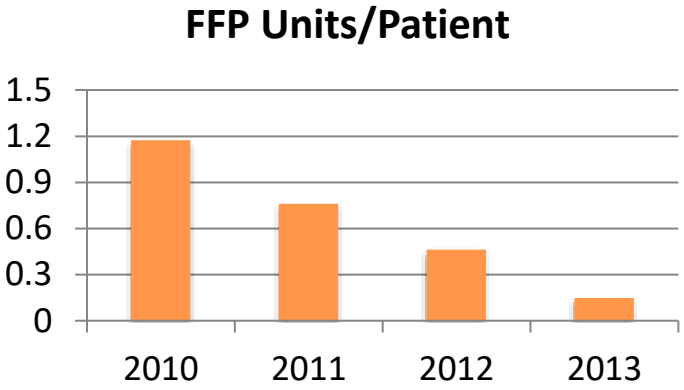
Either:

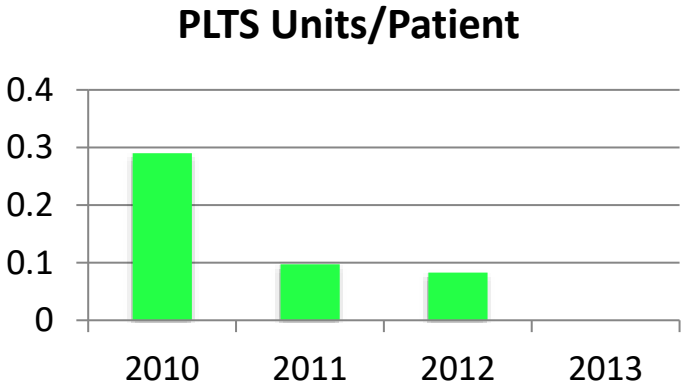
A. He must have heard about the bathroom door

B. He didn't want to be on the edge of the bell-shaped curve

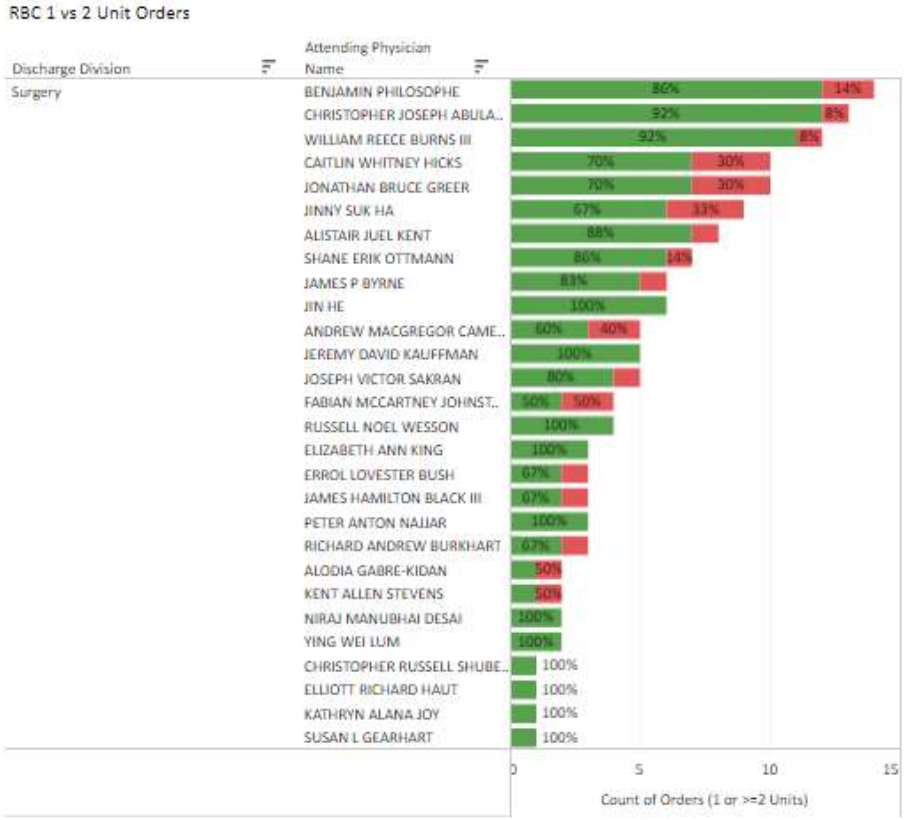
Surgeon #44 (with permission)

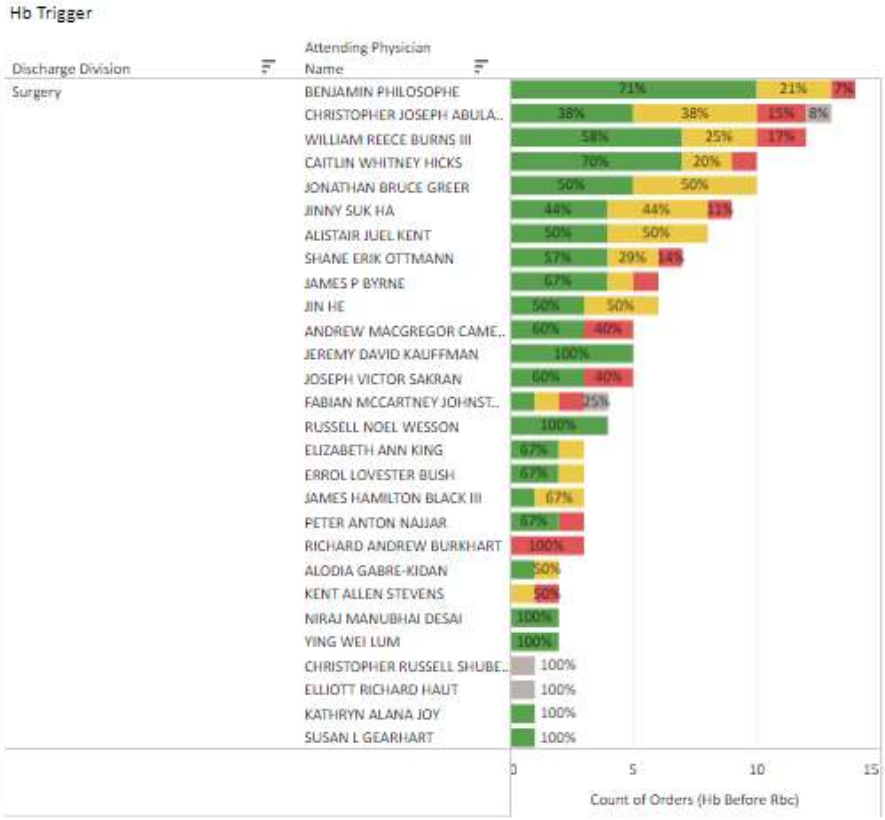






Johns Hopkins Medicine – Johns Hopkins Hospital
Number and % of 1- vs. ≥2-Unit Orders and by Hb Trigger (All Inpatients)
Surgery (April 2023)





Perioperative Patient Blood Management

"Right dose, right product, right patient, right time"

1. Preop anemia treatment –
   A $5 bottle of iron pills beats $500 of blood
   IV iron, EPO as needed – preop and postop
2. Good surgery, less invasive-
   laparoscopic, robotic, endovascular
3. Blood Salvage (Cell Salvage)
   The "Centerpiece" of blood conservation
4. Topical hemostatics and newer cautery devices
5. Minimize phlebotomy
6. CPOE with clinician decision support
7. Antifibrinolytics (Tranexamic acid, Amicar)
8. Point of care testing (TEG, rapid turnaround)
9. Audits with feedback
10. Education

Case scenarios (Case #1)

65 y/o in the Coronary Care Unit with acute myocardial infarction requiring placement of coronary stents in the mid-LAD. Hemoglobin has drifted since admission from 11 down to 8 g/dL and the patient has been slightly tachycardic (HR 100) on a norepinephrine infusion to keep his SBP > 100. The urine output has been less than 0.5 ml/kg/hr. Troponins remain elevated for 3 days since admission.

Would you:

A. Give 1 RBC unit
B. Give 2 RBC units
C. Transfuse until the Hemoglobin is over 10 g/dL
D. It depends

Would you:

A. Give 1 RBC unit
B. Give 2 RBC units
C. Transfuse until the Hemoglobin is over 10 g/dL
D. It depends

The answer here is controversial.

Even though the MINT trial was borderline significant in favor of targeting a Hgb level > 10 g/dL (*P*=0.07) , in this case the benefits of RBCs likely outweigh the risks.

Since this patient has intravascular volume depletion, I would most likely give her RBCs rather than IV crystalloid because giving a liter of normal saline could drop her Hgb concentration even lower (from 8 to 6 g/dL).

Case scenarios (Case #2)

48 y/o in Neuro ICU post bicycle vs car head-on collision (not wearing helmet) w severe head injury and high ICP after drainage of a subdural hematoma. Hemoglobin has drifted since admission from 14 down to 8 g/dL and the patient has a Glasgow score of 6 (out of 3-15).

Would you:

A. Give 1 RBC unit
B. Transfuse until the Hemoglobin is over 10 g/dL
C. It depends

Glasgow Coma Scale

BEHAVIOR	RESPONSE	SCORE
Eye opening response	Spontaneously	4
	To speech	3
	To pain	2
	No response	1
Best verbal response	Oriented to time, place, and person	5
	Confused	4
	Inappropriate words	3
	Incomprehensible sounds	2
	No response	1
Best motor response	Obeys commands	6
	Moves to localized pain	5
	Flexion withdrawal from pain	4
	Abnormal flexion (decorticate)	3
	Abnormal extension (decerebrate)	2
	No response	1
Total score:	*Best response*	15
	Comatose client	8 or less
	Totally unresponsive	3

Would you:

A. Give 1 RBC unit
B. Transfuse until the Hemoglobin is over 10 g/dL
C. It depends

If on pressors, tachycardic, hypotensive and oliguric (signs of decreased intravascular volume) then I would definitely transfuse.

This patient has a 27% chance of death and 75% chance of severe disability – so I will do anything that has any chance of helping this patient.

I will do what the Neurosurgeon says because they call the shots in my hospital, and at the latest Neurosurgery meeting she said they presented new studies showing that more blood was better.

“Blood transfusions are good, and bad,
and sometimes good, and sometimes bad,
and you can give too many, or not enough”

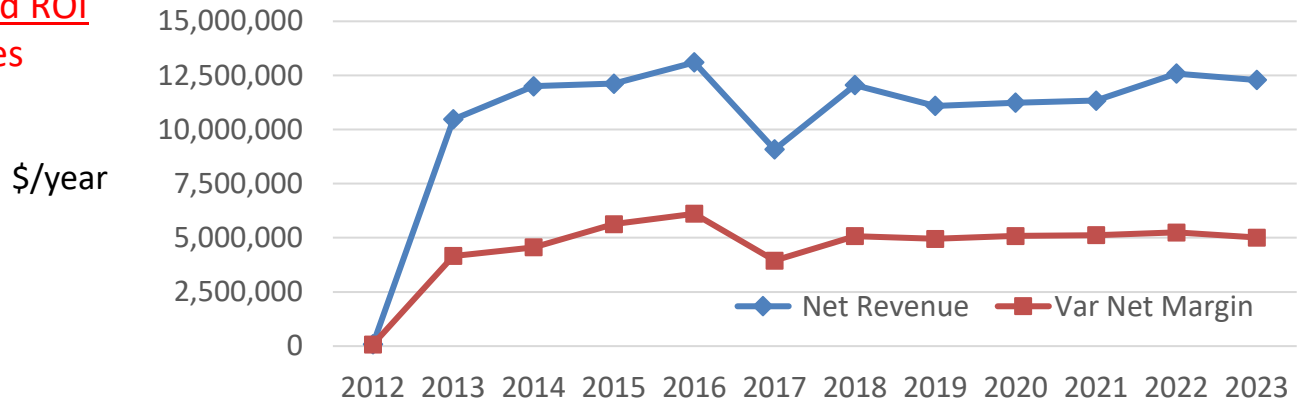
— did I get it right??

Gedge Rosson MD – Johns Hopkins surgeon

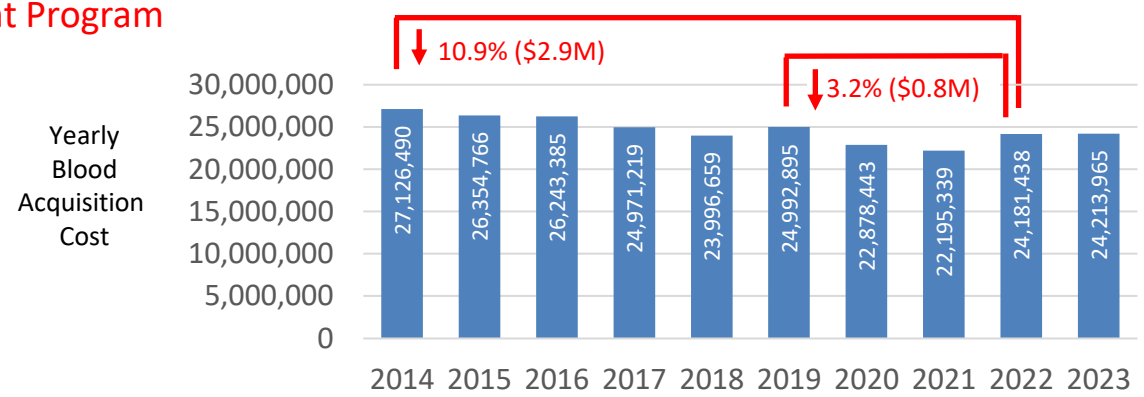
Extra Slides

“Greater than 7-fold Return on Investment for a Comprehensive Patient Blood Management Program with Equivalent or Improved Outcomes”

Johns Hopkins Center for Bloodless Medicine and Surgery
generating 5.0 M/yr = 6.6-fold ROI
with same or better outcomes



Johns Hopkins Patient Blood Management Program
saving $2.9 M/yr = 9.6-fold ROI
with same or better outcomes




EPO

Currently Available Intravenous Iron Preparations in the US

Trade name							
Manufacturer	American Regent	Watson Pharma	sanofi-aventis	American Regent	AMAG Pharmaceuticals	Luitpold Pharmaceuticals	Pharmacosmos
Carbohydrate	High-molecular-weight iron dextran	Low-molecular-weight iron dextran	Ferric gluconate	Iron sucrose	Ferumoxytol	Carboxymaltose	Isomaltoside
Total dose infusion (TDI)	Yes	Yes	No	No	No	Yes	Yes
Test dose required	Yes	Yes	No	No	No	No	No
Black box warning	Yes	Yes	No	No	No	NA	NA

Who benefits from red blood cell salvage?—Utility and value of intraoperative autologous transfusion

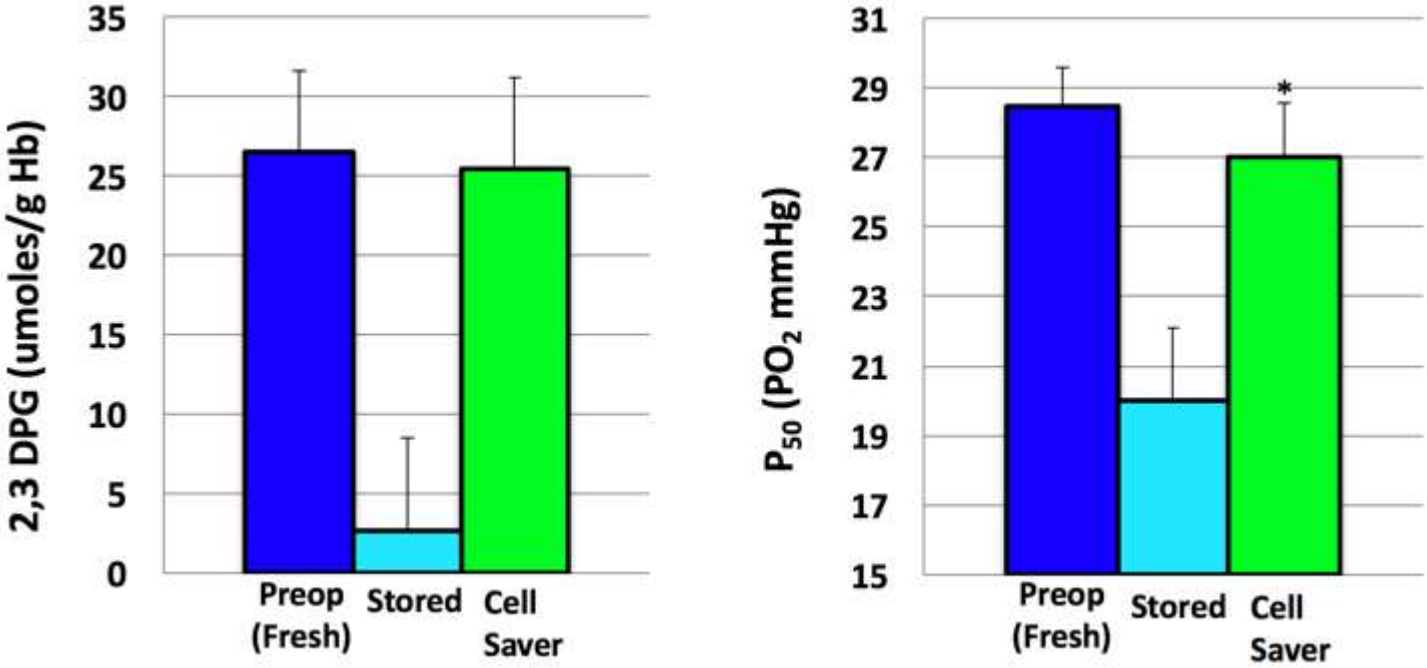
Steven M. Frank, MD
e-mail: sfrank3@jhmi.edu
Perioperative Blood Management Services
Department of Anesthesiology/Critical Care Medicine
The Johns Hopkins Medical Institutions
Baltimore, MD

The centerpiece of blood conservation

Frank SM. *Transfusion*, 2011

2,3-Diphosphoglycerate Concentrations in Autologous Salvaged Versus Stored Red Blood Cells and in Surgical Patients After Transfusion

Andrew V. Scott, BS,* Enika Nagababu, PhD,* Daniel J. Johnson, BS,* Khaled M. Kebaish, MD,†
Joshua A. Lipsitz,* Ian M. Dwyer,* Gabriel S. Zuckerberg,* Viachaslau M. Barodka, MD,*
Dan E. Berkowitz, MD,*‡ and Steven M. Frank, MD*

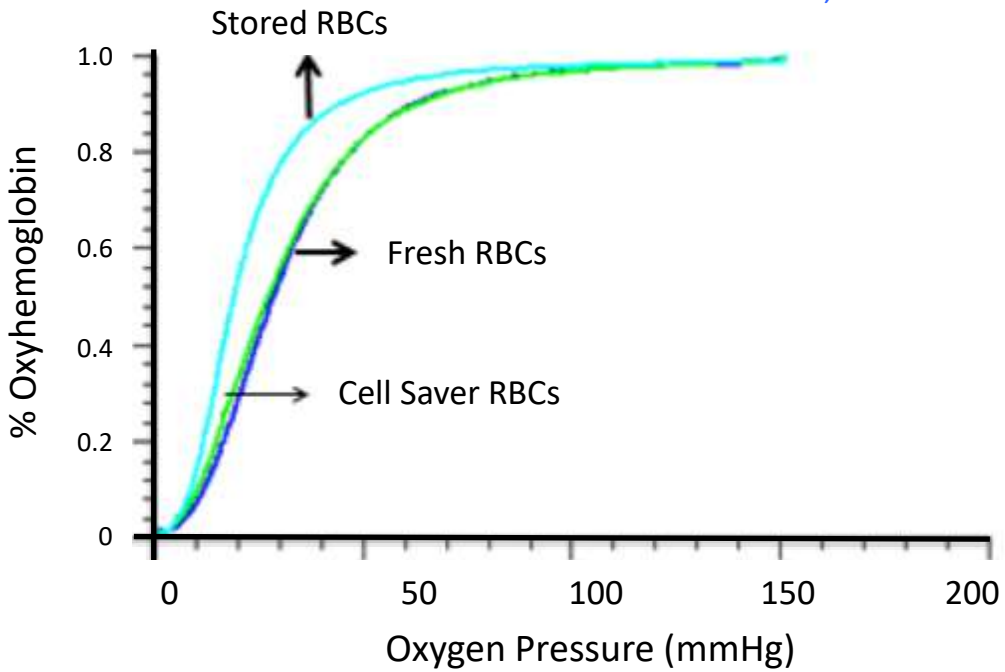


Scott AV, et al. *Anesth Analg*, 2016

2,3-Diphosphoglycerate Concentrations in Autologous Salvaged Versus Stored Red Blood Cells and in Surgical Patients After Transfusion

Andrew V. Scott, BS,* Enika Nagababu, PhD,* Daniel J. Johnson, BS,* Khaled M. Kebaish, MD,†
Joshua A. Lipsitz,* Ian M. Dwyer,* Gabriel S. Zuckerberg,* Viachaslau M. Barodka, MD,*
Dan E. Berkowitz, MD,*‡ and Steven M. Frank, MD*

Scott AV, et al. *Anesth Analg*, 2016



The Washington Post

Recycled blood is better than donated blood for transfusions, Hopkins study finds

BY LENNY BERNSTEIN May 9 at 8:45 am

We recycle a lot of things — paper, plastic, metal, blood.

Yes, blood. During some surgeries, operating room personnel try to capture as much blood as possible and return the red blood cells to your system, instead of, or in addition to, donated blood from a blood bank. They find that patients have better outcomes when transfused with their own blood.

A Johns Hopkins University study, published in the June issue of the journal Anesthesia and Analgesia, explains one reason for that. As banked

ScienceTimes
The New York Times

PROGNOSIS

Reusing a Patient's Own Blood

In heart surgery, a patient's own red blood cells may be a better choice than blood transfusion.

Transfusions of donated blood can be lifesaving, but a number of studies have found it can also increase the risk of infections and other problems. An alternative is collecting and reusing a patient's own blood during the operation.

For the study, published online in Ánesthesia & Analgesia, 12 heart surgery patients were given only their own salvaged red blood cells, while 20 other patients were given their own cells plus varying amounts of stored donated blood.

Over the next three days, the researchers measured the flexibility of the cells' membranes, an indicator of blood cell health.

Those who got their own fresh red blood cells had no changes in flexibility. But getting stored blood was associated with cell membrane stiffening. The more donated blood patients received, the longer it took for their cells to return to normal.

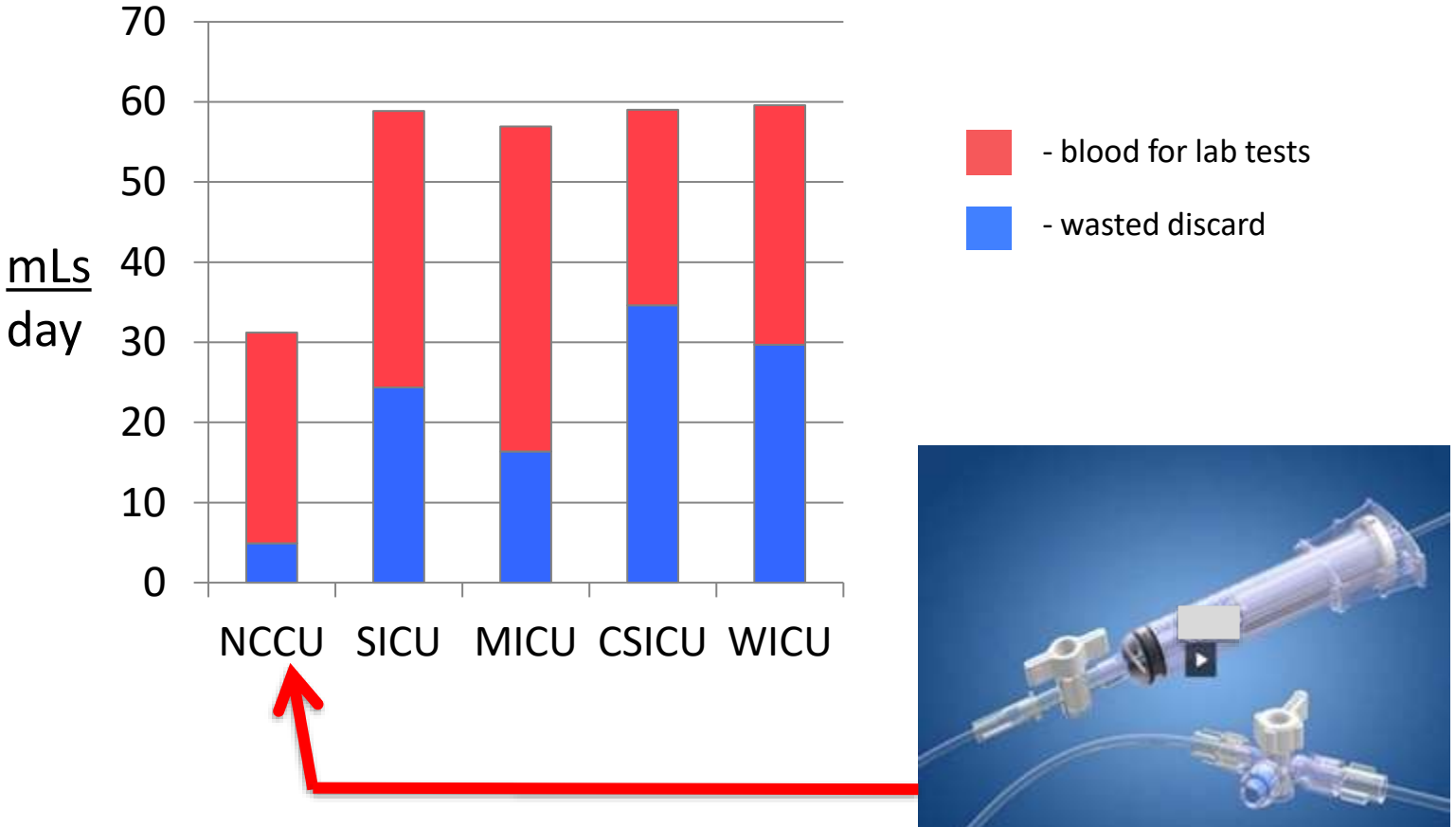
"Most surgeries don't require transfusion," said the senior author, Dr. Steven M. Frank, an associate professor of anesthesiology at Johns Hopkins University. "But for specific types of surgery, it appears that salvaging your own blood results in a higher quality transfusion."

The cell salvage device costs about $35,000, but a single use costs about $120, compared with $240 for a transfusion.

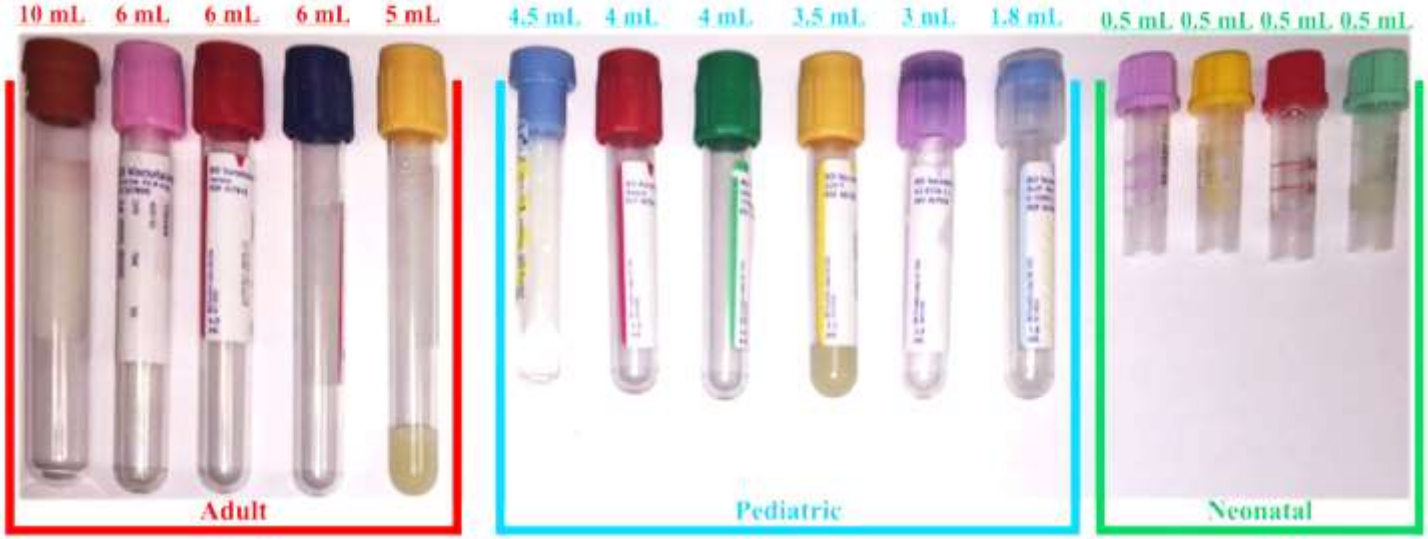
ICU phlebotomy at Johns Hopkins

Over 1% of blood volume/day (cancels out erythropoiesis)

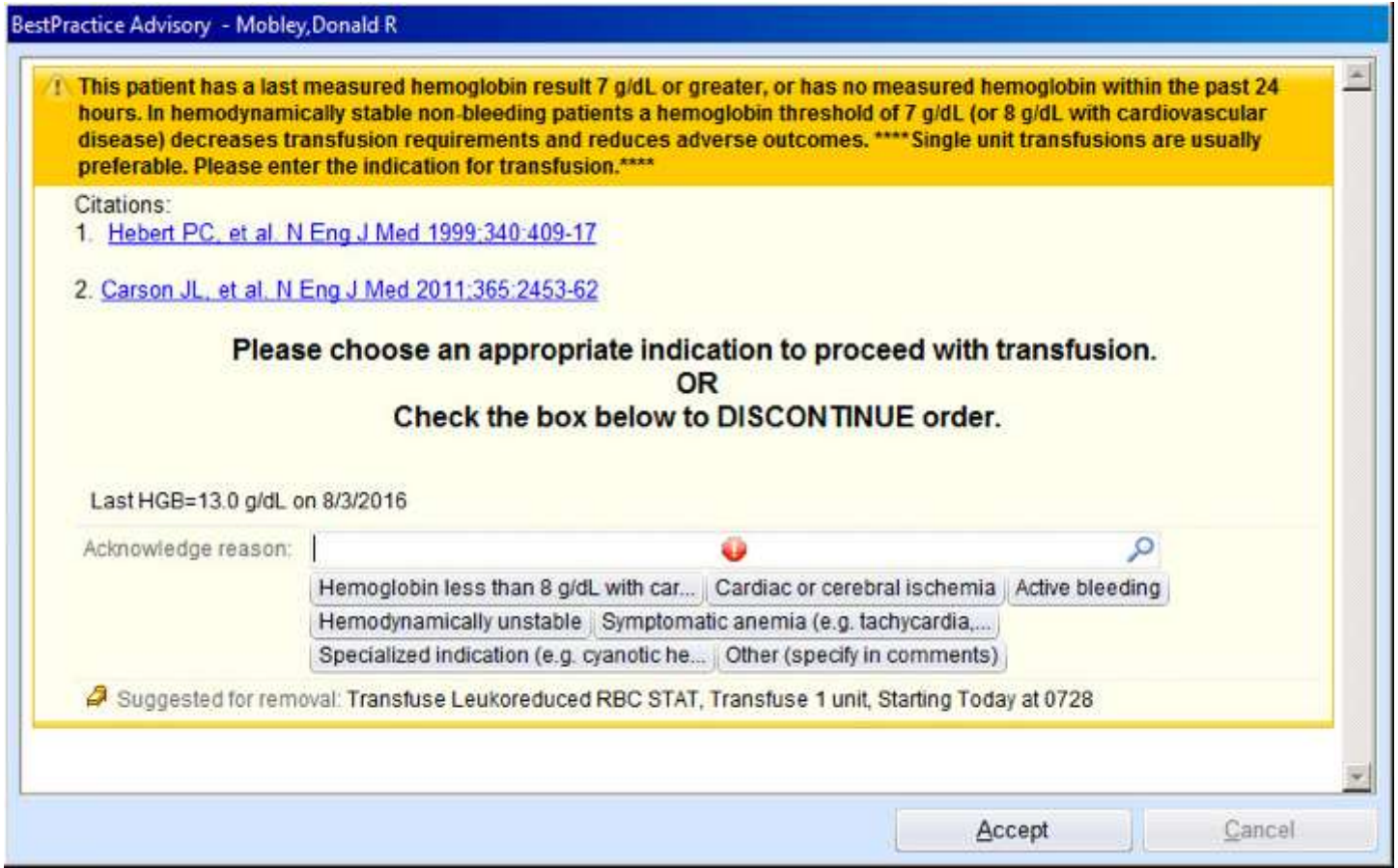
Cut in half using in-line blood draw system ($9.45 cost)



Adult Pediatric Neonatal



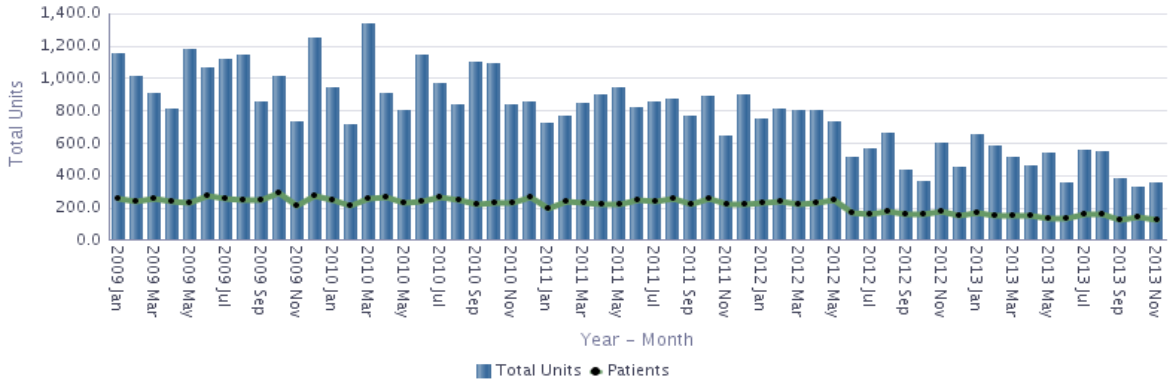
Best Practice Advisory triggered on Hb ≥ 7 g/dL



Zuckerberg GS, et al. *TRANSFUSION*, 2015

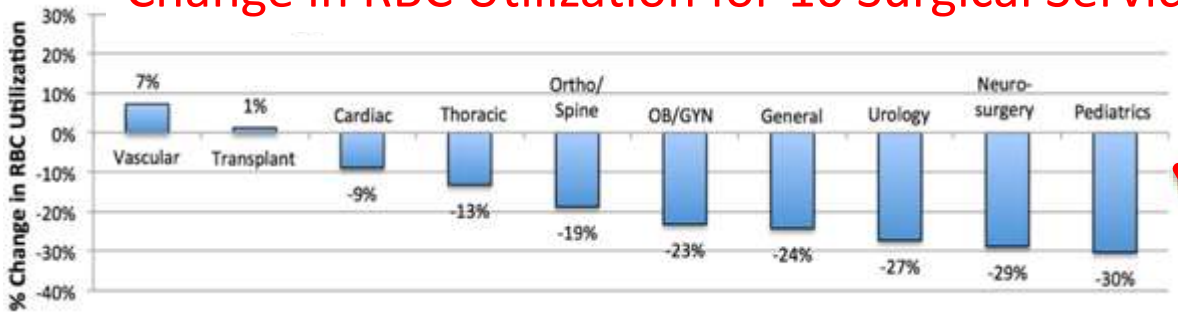
"Efficacy of Education Followed by Computerized Provider Order Entry with Clinician Decision Support to Reduce Red Blood Cell Utilization"

Monthly number of RBC units w/ preceding Hb > 8



↓ 54%

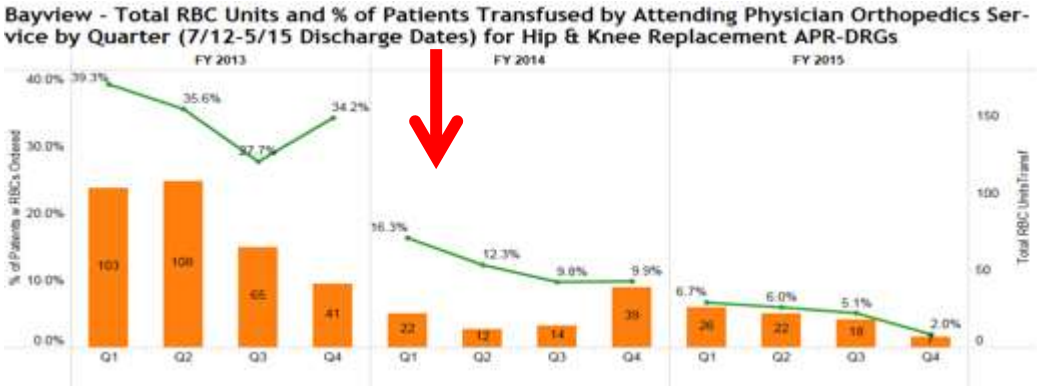
Change in RBC Utilization for 10 Surgical Services

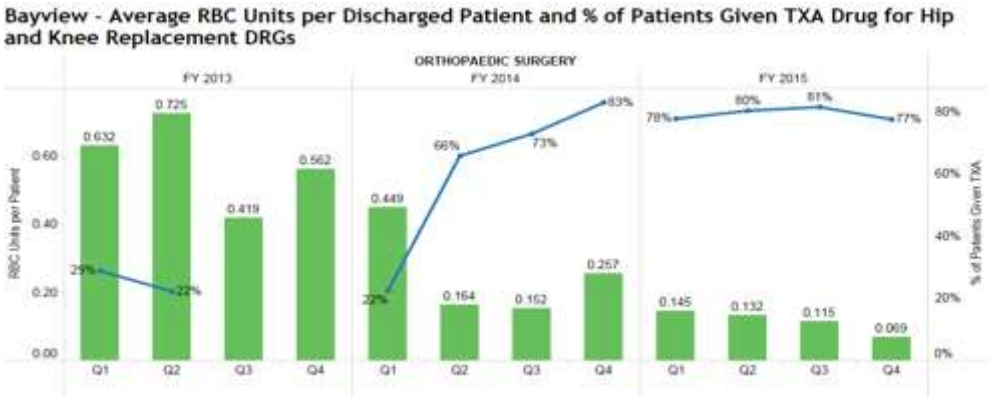


↓ 14.3%

Bayview Hip and Knee Replacement FY13 – FY15
Tranexamic acid - a “game-changer”

TXA began





73% ↓

In RBC U/Pt.

Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial

*CRASH-2 trial collaborators**

CRASH-2

Lancet, 2011

> 20,000 pt. RCT
> 1 gram TXA + 1 gram over 8 hours
> 9% ↓in death
> 15% ↓in hemorrhagic death

Effect of early tranexamic acid administration on mortality, hysterectomy, and other morbidities in women with post-partum haemorrhage (WOMAN): an international, randomised, double-blind, placebo-controlled trial

*WOMAN Trial Collaborators**

WOMAN

Lancet, 2017

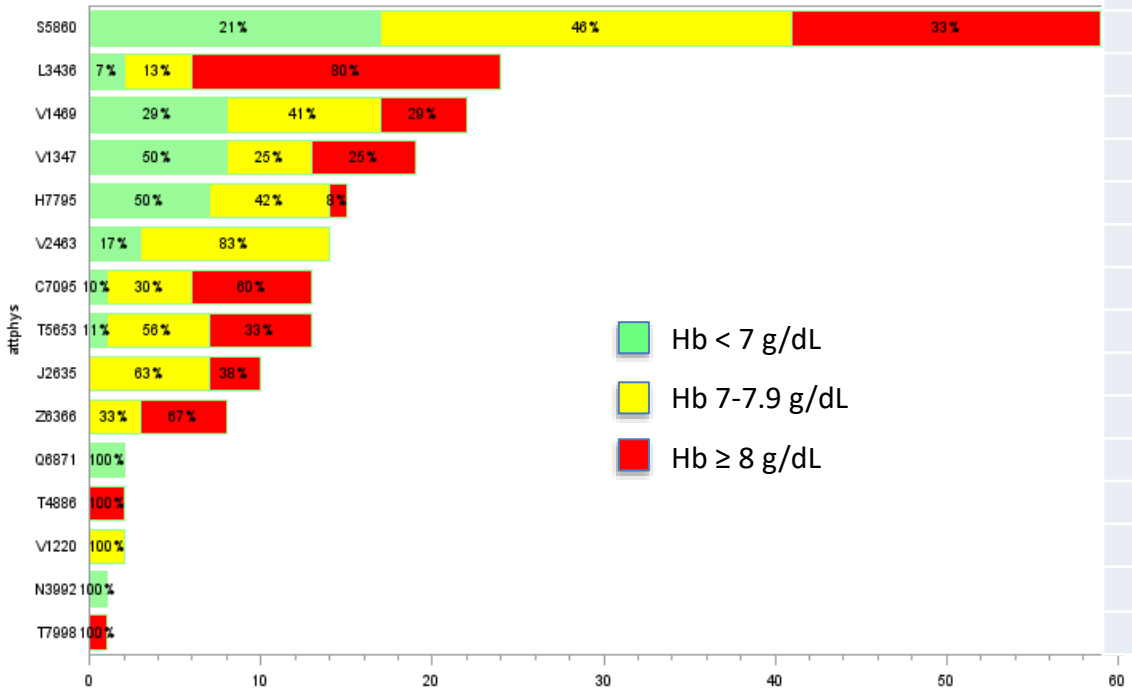
> 20,000 pt. RCT
> 1 gram TXA ± 1 more gram
> 19% ↓ in death from bleeding
> 31% ↓ if TXA given early (<3 hrs)

Interactive dashboards to support a patient blood management program across a multi-institutional healthcare system

Transfusion, 2016

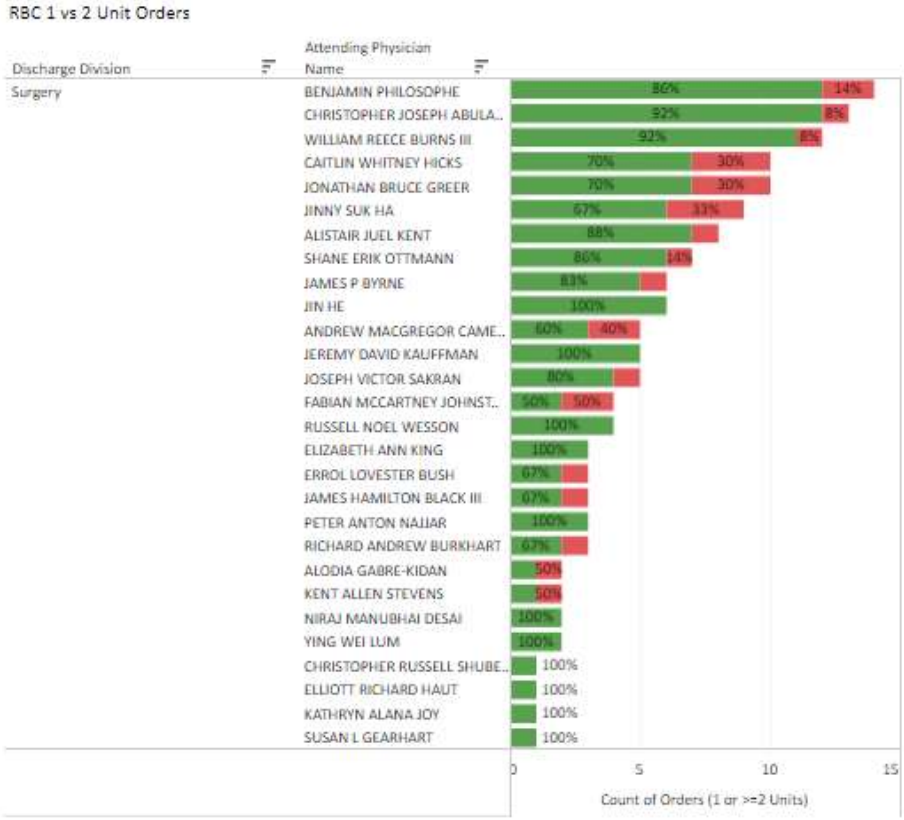
Tyler L. Wintermeyer,[1] Jing Liu,[2] K.H. Ken Lee,[3] Paul M. Ness,[2] Daniel J. Johnson,[4] N. Ann Hoffman,[1] Pat A. Wachter,[3] Renee Demski,[3] and Steven M. Frank[5]

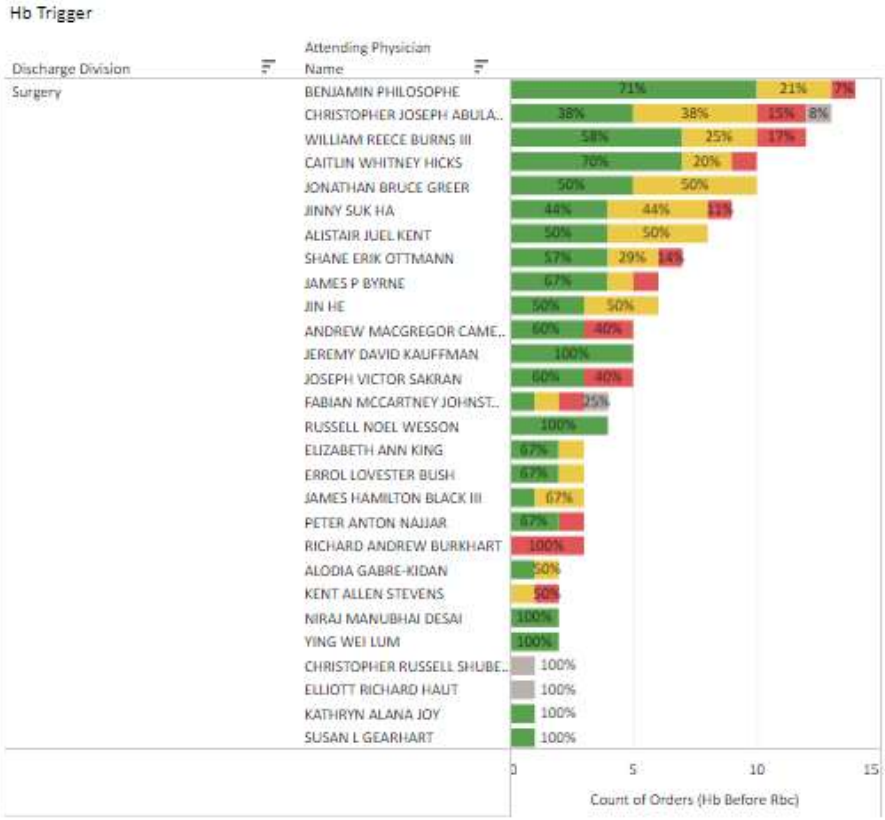
JHH Orthopedics Dept. – Physician Level Reports by Hb Trigger (October 2014)



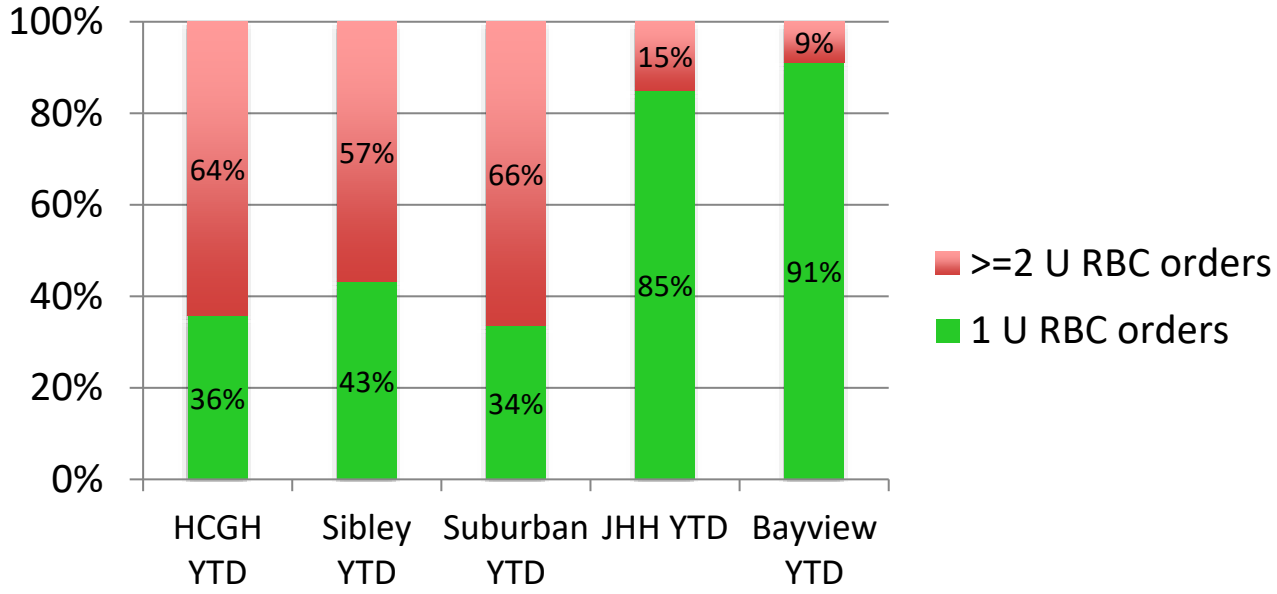
	Number Of Patients	Total Units
S5860	21	59
L3436	12	24
V1469	7	22
V1347	9	19
H7795	11	15
V2463	7	14
C7095	7	13
T5653	6	13
J2635	6	10
Z6366	3	8
Q6871	2	2
T4886	1	2
V1220	1	2
N3992	1	1
T7998	1	1

Johns Hopkins Medicine – Johns Hopkins Hospital
Number and % of 1- vs. ≥2-Unit Orders and by Hb Trigger (All Inpatients)
Surgery (April 2023)





1 unit vs. ≥ 2 unit RBC Orders
All 5 Hopkins Affiliates
July-Dec, 2014

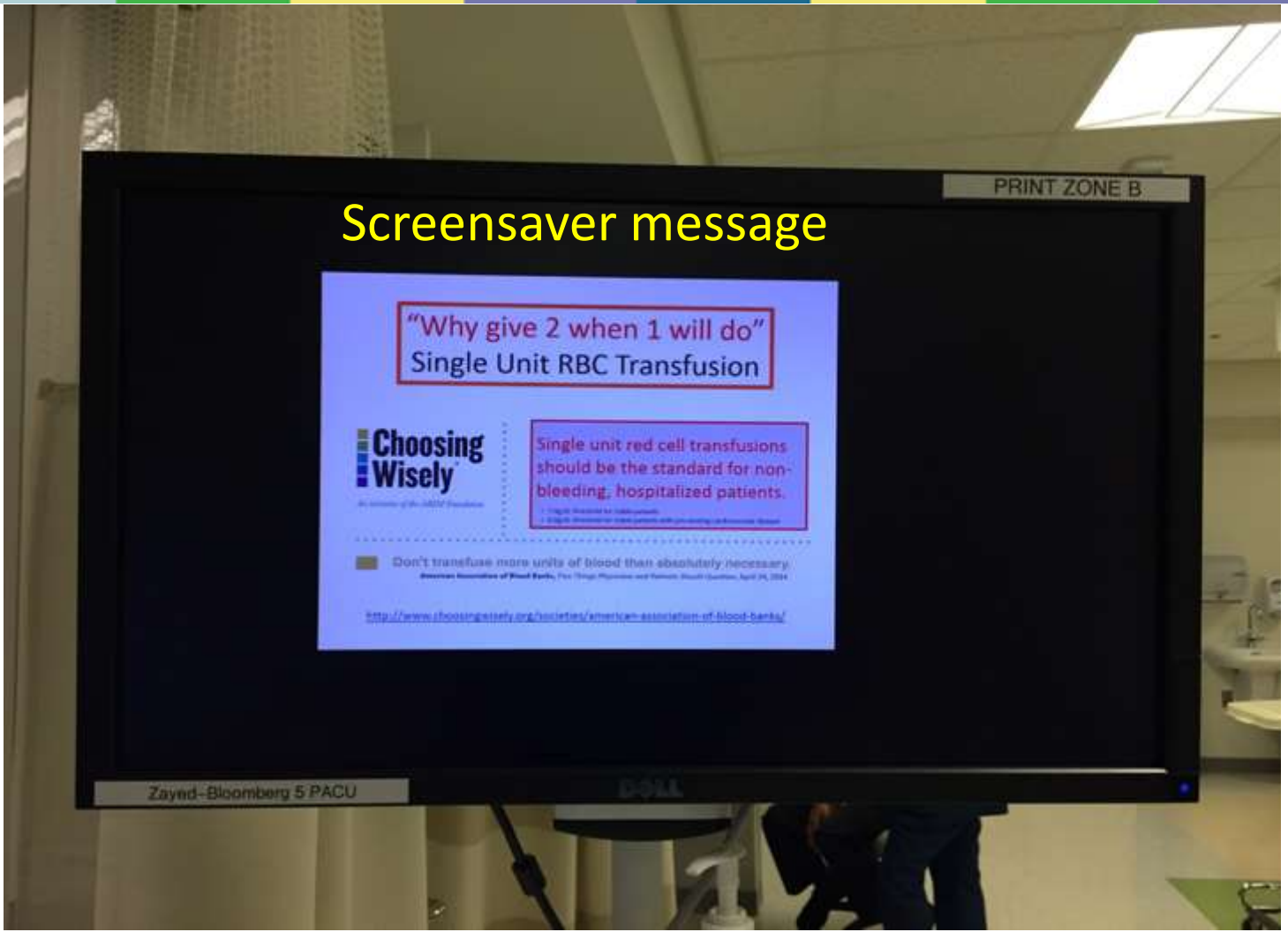


inside Hopkins
JOHNS HOPKINS MEDICINE
April 8, 2015

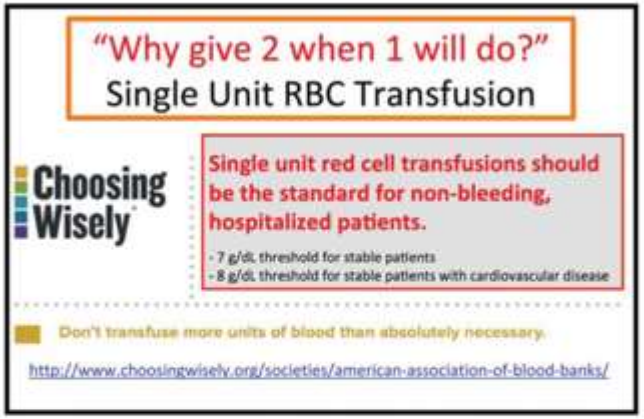
Why Give Two When One Will Do?

That is the question being asked by the Armstrong Institute for Patient Safety and Quality as it relates to unnecessary blood transfusions, one of the top five most overused medical procedures. Cutting back on excessive blood transfusions could save millions across Johns Hopkins Medicine. More »

Screensaver message



A.



B.

Implementing a "Why give 2 when 1 will do?" Choosing Wisely campaign

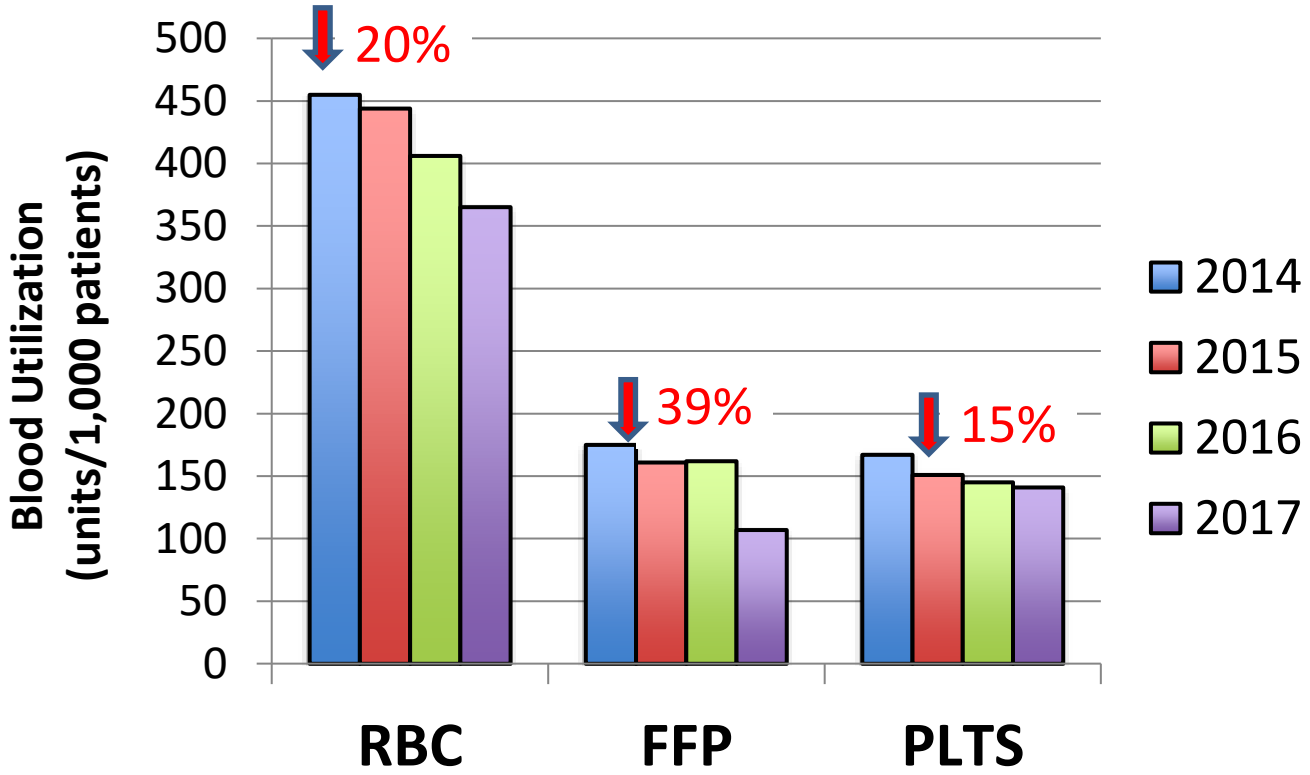
Stanley J. Podlasek,[1] Rajiv N. Thakkar,[2] Leo C. Rotello,[3] Thomas A. Fleury,[1] Renee J. Demski,[4] Paul M. Ness,[1] and Steven M. Frank[5]

Transfusion, Sept., 2016

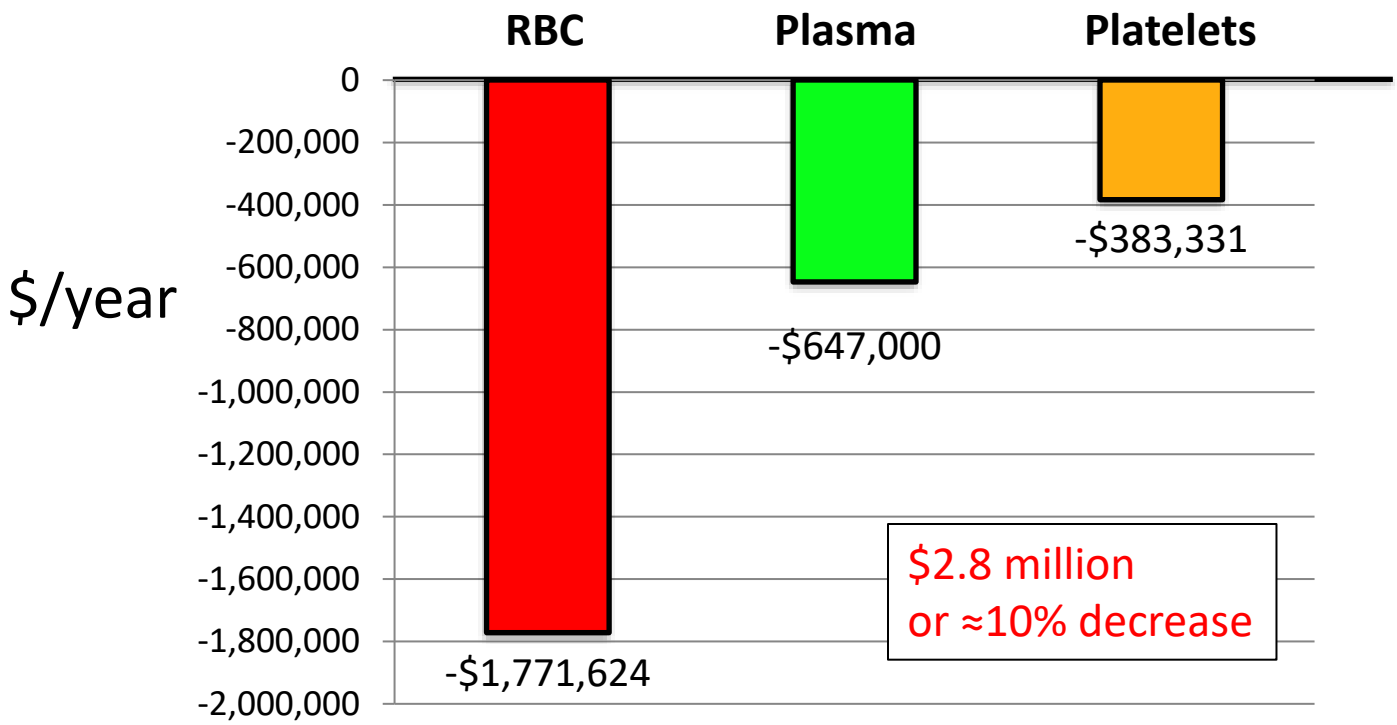
Implementing a Health System–wide Patient Blood Management Program with a Clinical Community Approach

Steven M. Frank, M.D., Rajiv N. Thakkar, M.D., Stanley J. Podlasek, M.D., K. H. Ken Lee, Dr.PH., M.H.S., Tyler L. Wintermeyer, M.S., Will W. Yang, B.S., Jing Liu, Ph.D., Leo C. Rotello, M.D., Thomas A. Fleury, M.D., Pat A. Wachter, M.A., Lisa E. Ishii, M.D., Renee Demski, M.S.W., M.B.A., Peter J. Pronovost, M.D., Ph.D., Paul M. Ness, M.D.

Frank, SM et al, *Anesthesiology*, October, 2017



JHHS Cost Savings: FY17 vs. FY14



Outcomes at the Extremes of Transfusion

- Bloodless patients who do not accept transfusion
  (extreme blood management)

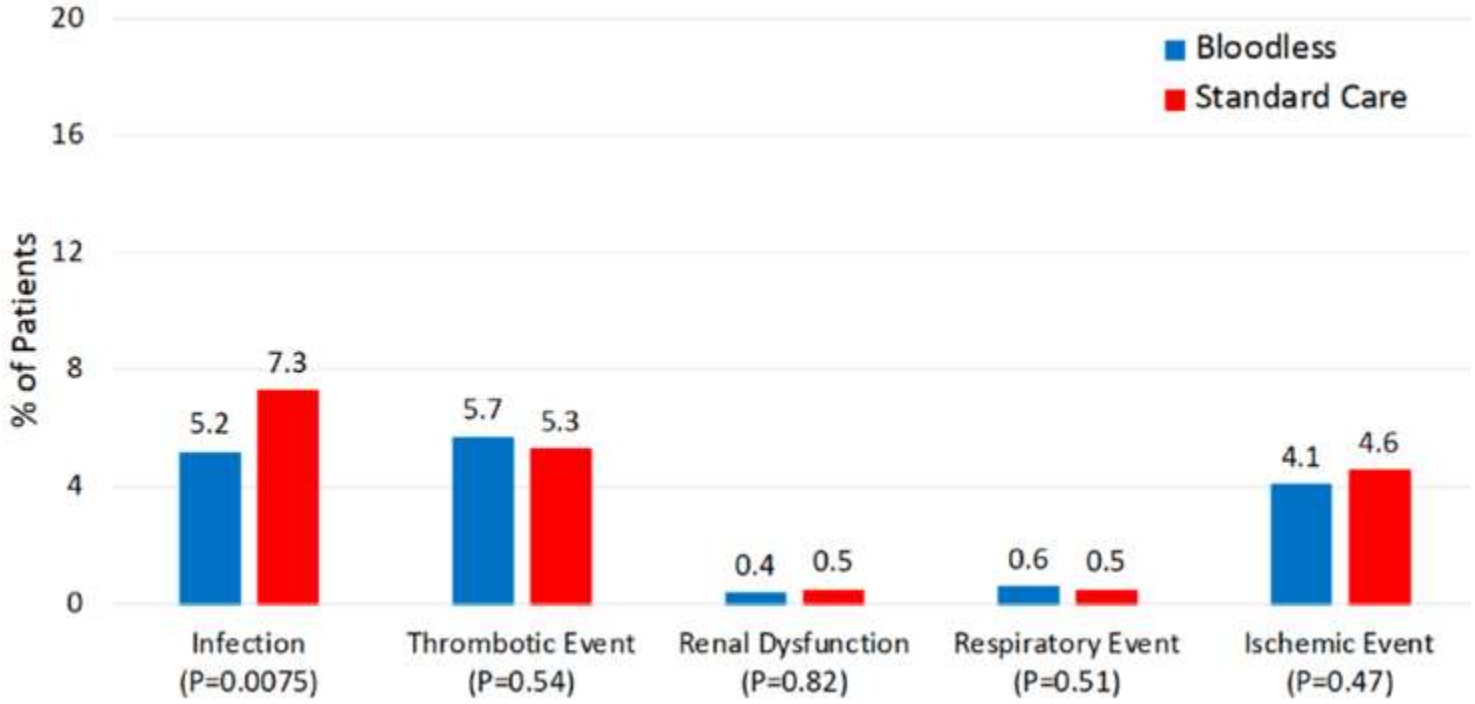
- Massively transfused patients
  (coolers of blood)

ORIGINAL CLINICAL RESEARCH REPORT

Methods of Bloodless Care, Clinical Outcomes, and Costs for Adult Patients Who Decline Allogeneic Transfusions

Steven M. Frank, MD,* Andrew Pippa, BS,† Ish'shah Sherd, RN, Andrew V. Scott, MD,† Brian D. Lo, MD,† Nicolas C. Cruz, BA,† Elizabeth A. Hendricks, MSN, ACNP,†† Paul M. Ness, MD,‡ Shruti Chaturvedi, MBBS,‡ and Linda M. S. Resar, MD§

Cost per case – 8.7% lower w/Bloodless Care



Anesth Analg, 2022

ORIGINAL CLINICAL RESEARCH REPORT

Clinical Outcomes, Blood Utilization, and Ethical Considerations for Pediatric Patients in a Bloodless Medicine and Surgery Program

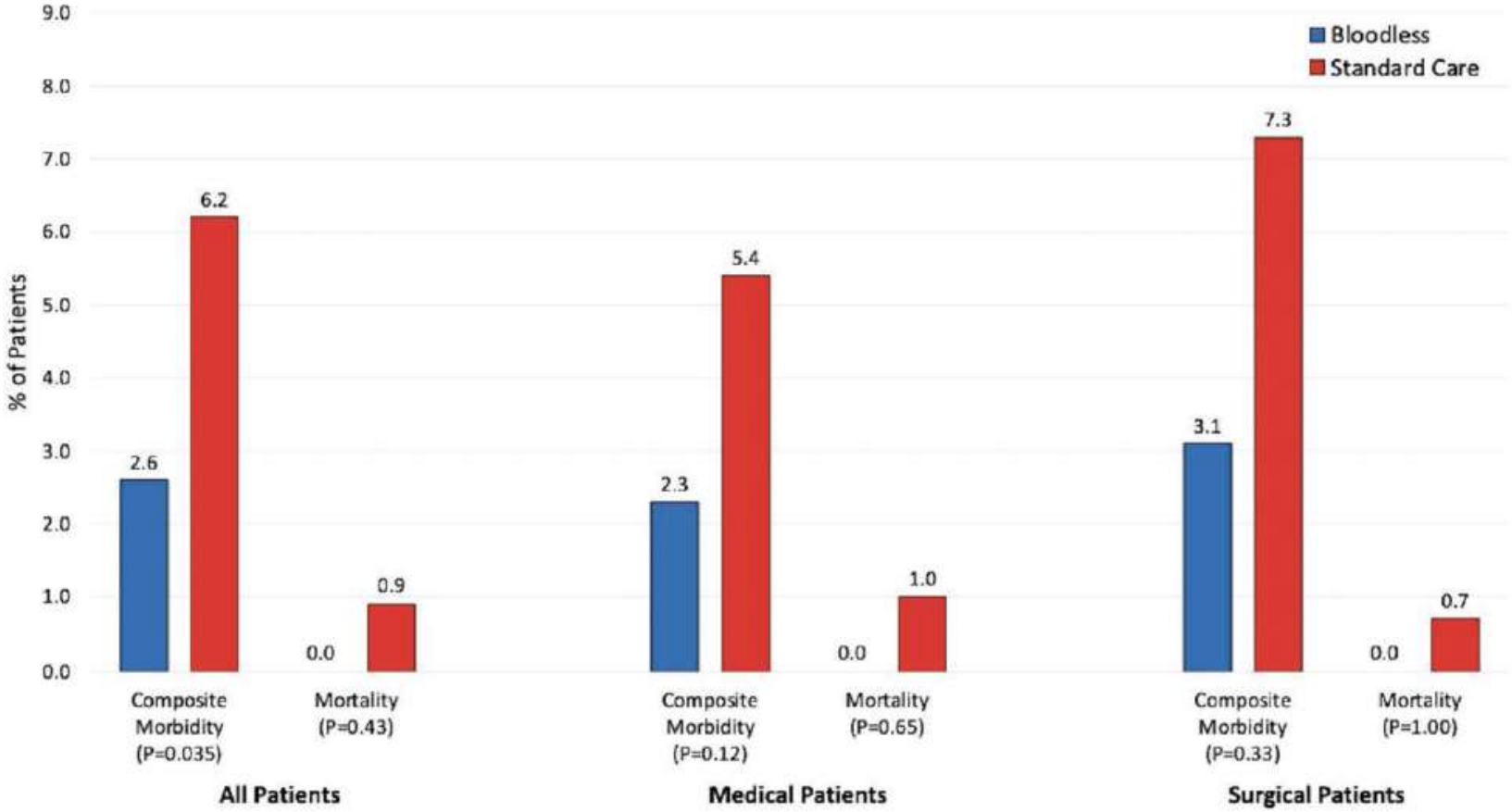
Brian D. Lo, MD,* Andrew Pippa, BS,† Ish'shah Sherd, RN,† Andrew V. Scott, MD,† Ananda J. Thomas, BS,†
Elizabeth A. Hendricks, MSN, ACNP,† Paul M. Ness, MD,‡ Shruti Chaturvedi, MBBS,§
Linda M. S. Resar, MD,‖ and Steven M. Frank, MD¶

196 Pediatric patients with JW parents

KEY POINTS

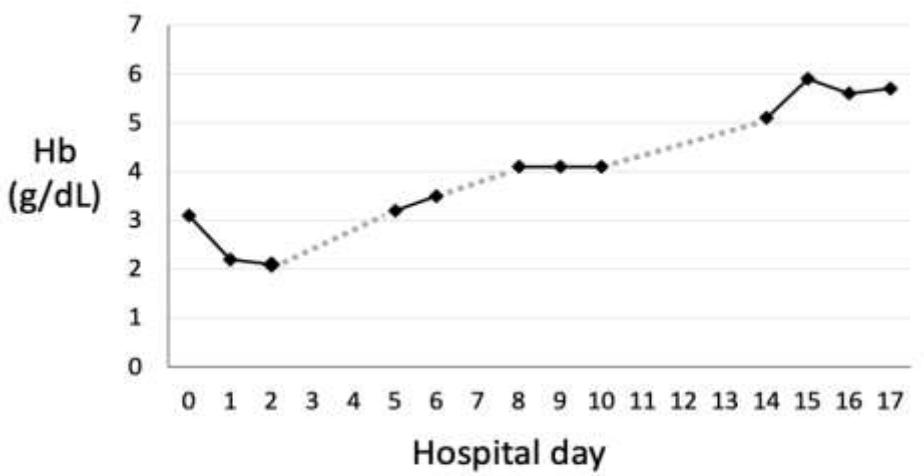
- **Question:** As parents cannot legally refuse lifesaving interventions for their children, what are the clinical outcomes, ethical considerations, and blood utilization rates when pediatric patients request bloodless care?
- **Findings:** Pediatric patients receiving bloodless care exhibited similar rates of adverse outcomes when compared to standard care patients, with no mortalities. Although ~6% of pediatric patients in our study cohort ultimately received an allogeneic transfusion, none were administered under a court order.
- **Meaning:** When delivered in a collaborative and patient-centered manner, bloodless care can be safely provided to pediatric patients, thereby reducing the associated risks and costs of allogeneic blood transfusions.

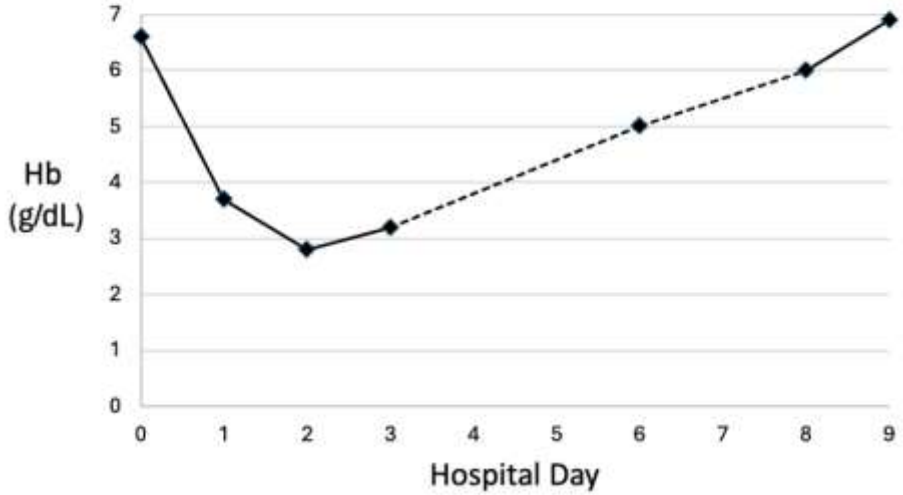
196 Pediatric patients with JW parents



Gastrointestinal Bleeding and Survival after a Nadir Hemoglobin < 3.0 g/dL in Two Jehovah's Witness Patients

In press





13 bloodless medicine publications over the past 10 years from our group

Gastrointestinal Bleeding and Survival After a Nadir Hemoglobin <3.0 g/dL in 2 Jehovah's Witness Patients: A Case Report.
Sklar MB, Kajstura TJ, Vogt SL, Gray C, Ulatowski JA, Resar LMS, **Frank SM.**
A A Pract. 2024 Aug 13;18(8):e01837. doi: 10.1213/XAA.0000000000001837. eCollection 2024 Aug

Management and clinical outcomes for patients with gastrointestinal bleeding who decline transfusion.
Asiedu JO, Thomas AJ, Cruz NC, Nicholson R, Resar LMS, Khashab M, **Frank SM.**
PLoS One. 2023 Aug 25;18(8):e0290351. doi: 10.1371/journal.pone.0290351. eCollection 2023.

A novel algorithm to calculate target preoperative hemoglobin for patients declining allogeneic transfusion.
Cruz NC, Guinn NR, Adegboye J, Hsiao J, Thomas AJ, Lo BD, Chaturvedi S, Resar LMS, **Frank SM.**
J Clin Anesth. 2023 Aug;87:111070. doi: 10.1016/j.jclinane.2023.111070. Epub 2023 Feb 27.

Methods of Bloodless Care, Clinical Outcomes, and Costs for Adult Patients Who Decline Allogeneic Transfusions
Frank, Steven M.; Pippa, Andrew; Sherd, Ish'shah; Scott, Andrew V.; Lo, Brian D.; Cruz, Nicolas C.; Hendricks, Elizabeth A.; Ness, Paul M.; Chaturvedi, Shruti; Resar, Linda M. S. Less
Anesthesia & Analgesia. 135(3):576-585, September 2022.

Perioperative Management of Patients for Whom Transfusion Is Not an Option.
Guinn NR, Resar LMS, **Frank SM.**
Anesthesiology. 2021 Jun 1;134(6):939-948. doi: 10.1097/ALN.0000000000003763.
PMID: 33857295 Free article. Review. No abstract available.

Preoperative treatment of anemia and outcomes in surgical Jehovah's Witness patients.
Chaturvedi S, Koo M, Dackiw L, Koo G, **Frank SM**, Resar LMS.
Am J Hematol. 2019 Feb;94(2):E55-E58. doi: 10.1002/ajh.25359. Epub 2018 Dec 18.
PMID: 30474135 Free article. No abstract available.

Bloodless medicine: current strategies and emerging treatment paradigms.
Resar LM, Wick EC, Almasri TN, Dackiw EA, Ness PM, **Frank SM.**
Transfusion. 2016 Oct;56(10):2637-2647. doi: 10.1111/trf.13736. Epub 2016 Jul 29.
PMID: 27473810 Review.

Clinical Outcomes, Blood Utilization, and Ethical Considerations for Pediatric Patients in a Bloodless Medicine and Surgery Program.
Lo BD, Pippa A, Sherd I, Scott AV, Thomas AJ, Hendricks EA, Ness PM, Chaturvedi S, Resar LMS, **Frank SM.**
Anesth Analg. 2024 Jan 2. doi: 10.1213/ANE.0000000000006776. Online ahead of print.

Methods of Bloodless Care, Clinical Outcomes, and Costs for Adult Patients Who Decline Allogeneic Transfusions.
Frank SM, Pippa A, Sherd I, Scott AV, Lo BD, Cruz NC, Hendricks EA, Ness PM, Chaturvedi S, Resar LMS.
Anesth Analg. 2022 Sep 1;135(3):576-585. doi: 10.1213/ANE.0000000000006114. Epub 2022 Aug 17.

Approaches to Bloodless Surgery for Oncology Patients.
Frank SM, Chaturvedi S, Goel R, Resar LMS.
Hematol Oncol Clin North Am. 2019 Oct;33(5):857-871. doi: 10.1016/j.hoc.2019.05.009. Epub 2019 Jul 31.
PMID: 31466609 Review.

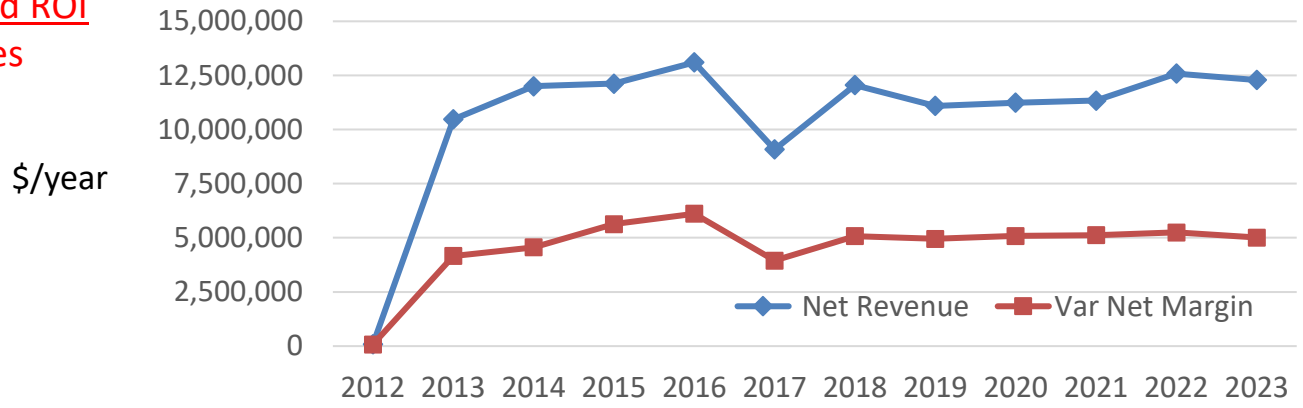
Proceedings From the Society for Advancement of Blood Management Annual Meeting 2017: Management Dilemmas of the Surgical Patient-When Blood Is Not an Option.
Tan GM, Guinn NR, **Frank SM**, Shander A.
Anesth Analg. 2019 Jan;128(1):144-151. doi: 10.1213/ANE.0000000000003478.
PMID: 29958216

Bloodless medicine: what to do when you can't transfuse.
Resar LM, **Frank SM.**
Hematology Am Soc Hematol Educ Program. 2014 Dec 5;2014(1):553-8. doi: 10.1182/asheducation-2014.1.553. Epub 2014 Nov 18.
PMID: 25696910 Review.

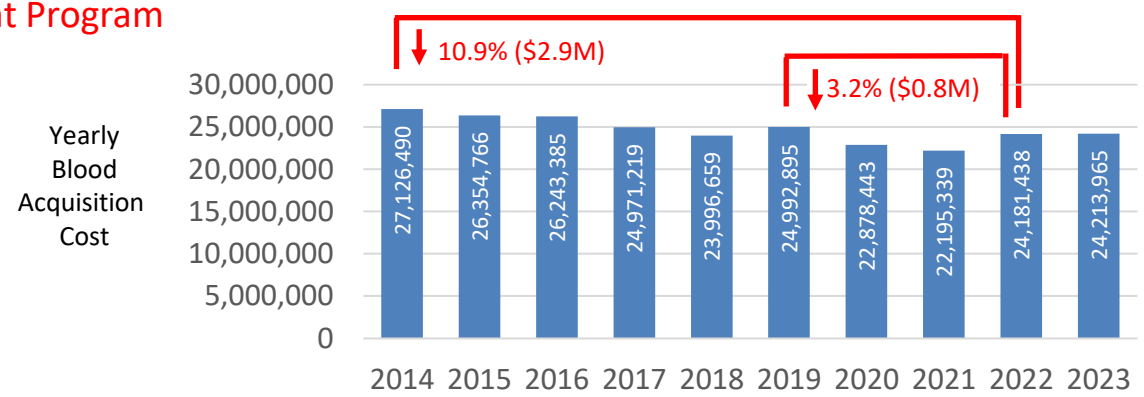
Risk-adjusted clinical outcomes in patients enrolled in a bloodless program.
Frank SM, Wick EC, Dezern AE, Ness PM, Wasey JO, Pippa AC, Dackiw E, Resar LM.
Transfusion. 2014 Oct;54(10 Pt 2):2668-77. doi: 10.1111/trf.12752. Epub 2014 Jun 18.
PMID: 24942198 Free PMC article.

“Greater than 7-fold Return on Investment for a Comprehensive Patient Blood Management Program with Equivalent or Improved Outcomes”

Johns Hopkins Center for Bloodless Medicine and Surgery
generating 5.0 M/yr = 6.6-fold ROI
with same or better outcomes



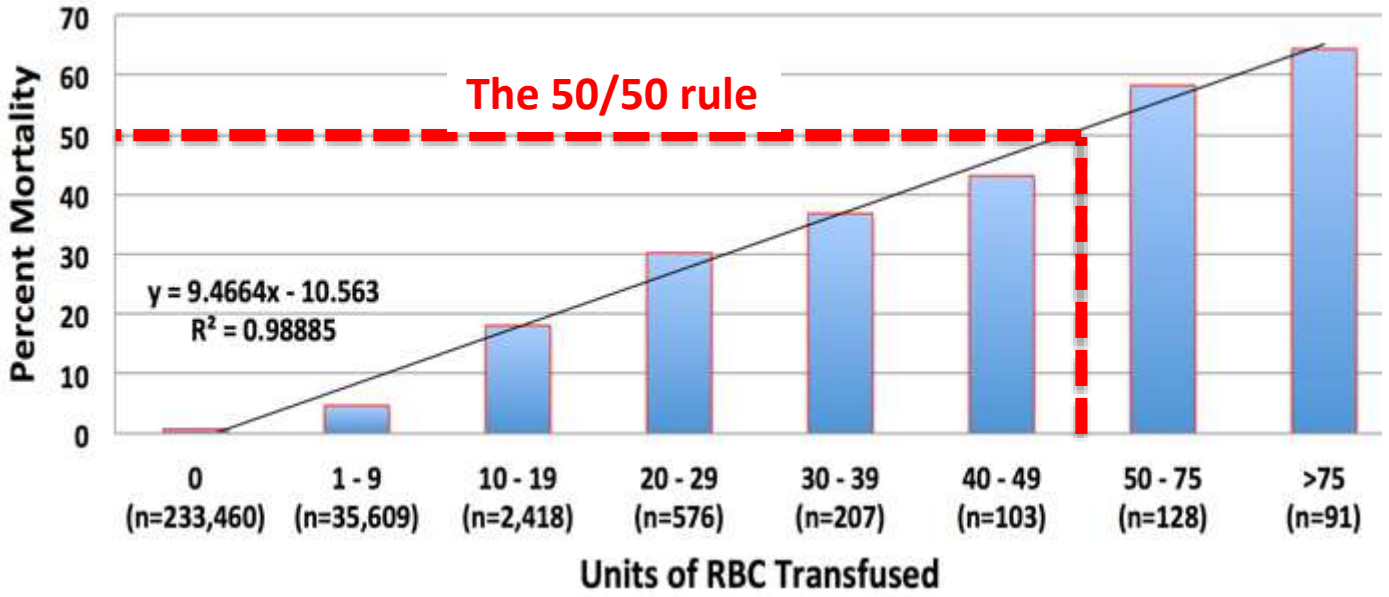
Johns Hopkins Patient Blood Management Program
saving $2.9 M/yr = 9.6-fold ROI
with same or better outcomes

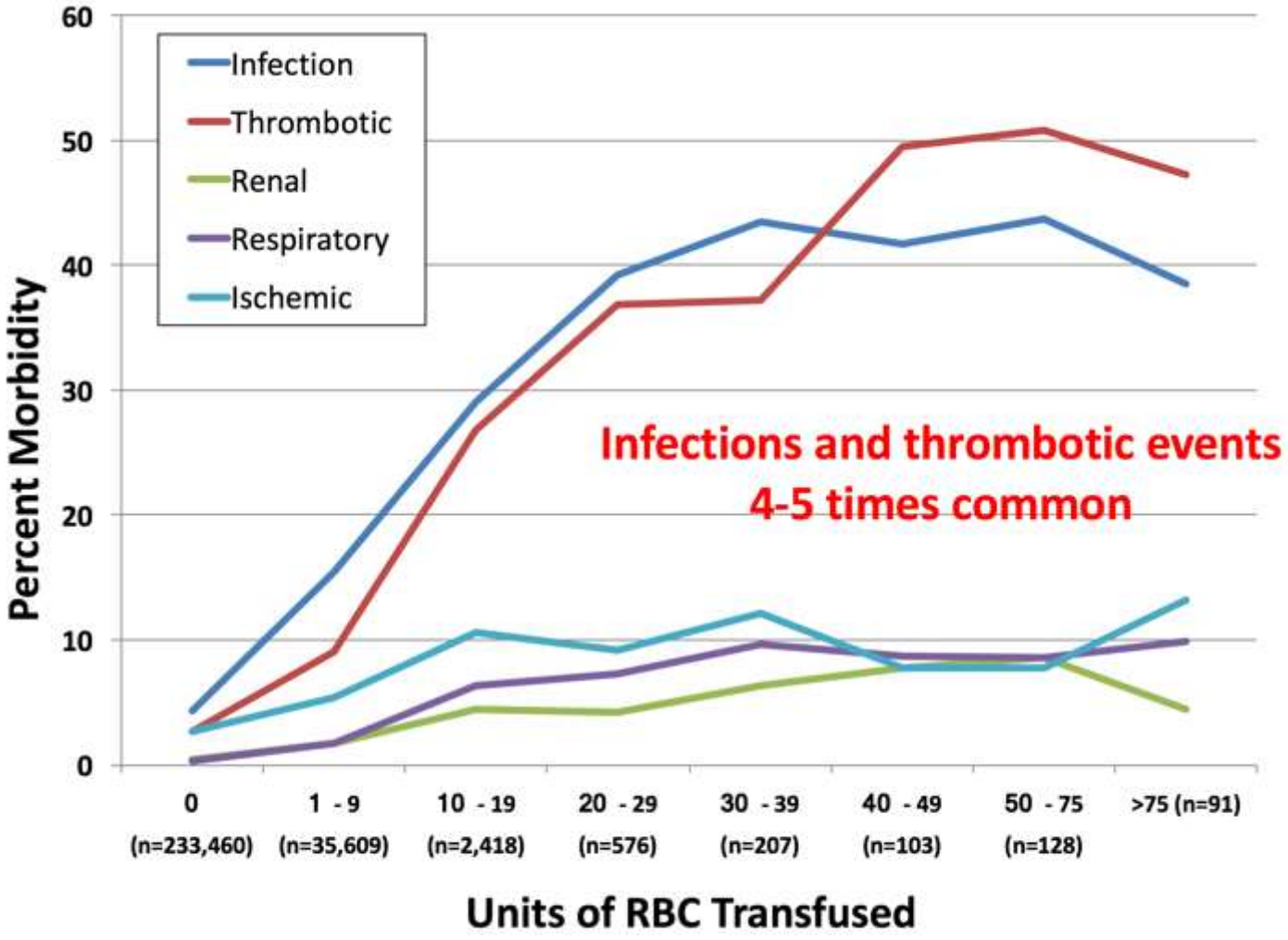


Johnson DJ et al. *Anesthesiology*, 2015

Morbidity and Mortality after High-dose Transfusion

Daniel J. Johnson, B.S., Andrew V. Scott, B.S., Viachaslau M. Barodka, M.D., Sunhee Park, M.D., Jack O. Wasey, B.M., B.Ch., Paul M. Ness, M.D., Tom Gniadek, M.D., Ph.D., Steven M. Frank, M.D.





Johnson DJ et al. *Anesthesiology*, 2015

- Blood saves lives when you need it

- Only increases risks and costs when you don’t

The Six “P”s for surgical bleeding

Pressure
Patience
Prayer
Prolene
Plasma
Platelets