All Things Hemostasis

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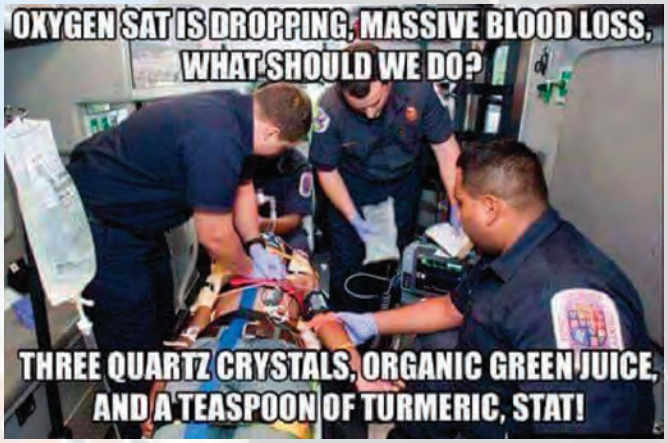
Disclosures

- Nothing to Disclose
- No Conflicts of Interest
- The information contained in this presentation has been compiled by nationwide experts and summarized for your benefit.
- The views expressed are the authors and may not reflect the official policy or position of his employers.

Learner Outcomes

- Identify roles of nurse anesthetists in obtaining and maintaining hemostasis.
- Identify how to incorporate therapeutic advances into current practice.
- Discuss future therapies impacting patients with accidental and surgical trauma.



Preventable Death on the Battlefield: OEF and OIF

- Eastridge 2012 Study:
- 4,596 U.S. deaths
- 87% pre-hospital deaths
- 24% of pre-hospital deaths were potentially **survivable**
- Holcomb, et al, 2007 – US SOF Preventable Deaths = 15% , 2008 – US Military Preventable Deaths = 24%
- Eastridge, et al, 2011, 2012 – US Military Preventable Deaths = 27.6%

- Eastridge BJ, Hardin M, Cantrell J, et al. Died of Wounds on the Battlefield: Causation and Implications for Improving Combat Casualty Care. *The Journal of Trauma: Injury, Infection, and Critical Care*. 2011;71(supplement). doi:10.1097/ta.0b013e318221147b.

Potentially Survivable COD

- 75.7% nonsurvivable
- 24.3% potentially survivable
  - 90.9% hemorrhage
  - 8% airway obstruction
  - 1% tension PTX
- Location
  - 67.3% truncal
  - 19.2% junctional
  - 13.5% extremity

ABC → CAB

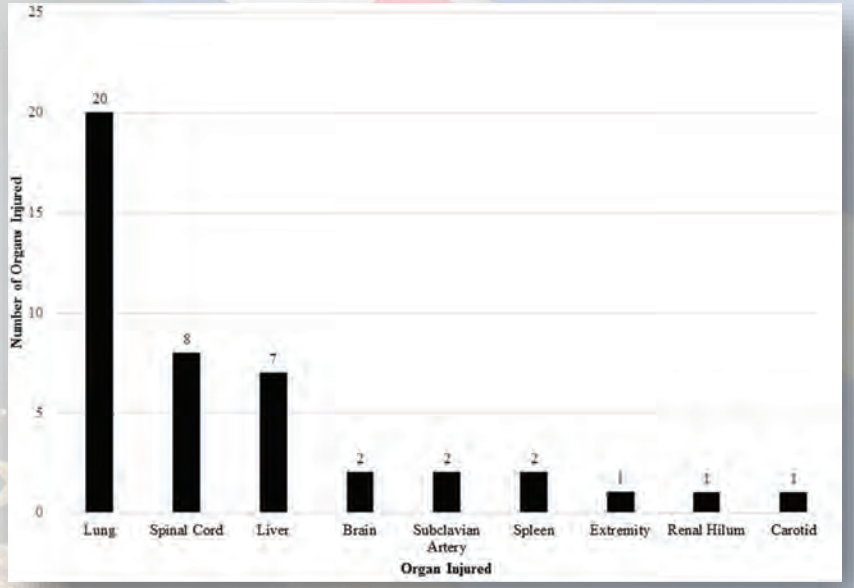
Civilian Trauma Related Injuries

- Trauma 2nd leading cause death
- 30-40% of trauma mortality
- 33-56% prehospital death
- Economic burden $670 Billion

- Kauvar et. al, 2006; Norton & Kobusingye, 2013;

Are civilian injury patterns the same?

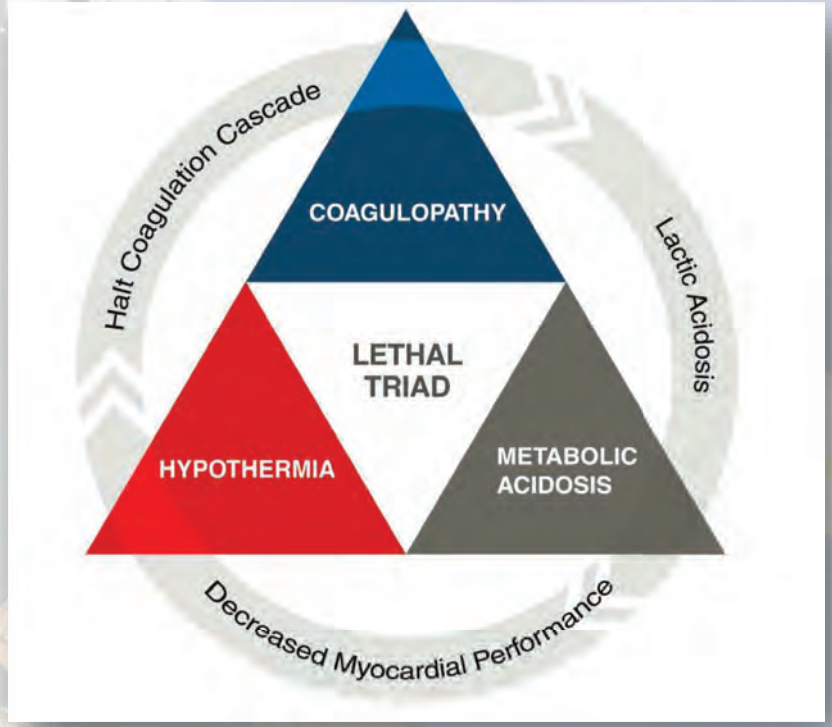
- No Body armor leads to more core injuries
- In mass shootings average of 2.7 gunshots per patient
- Potentially preventable death rate (PPD)7%
- GSW to chest most associated with PPD (89%)



Smith ER, Shapiro G, Sarani B. The profile of wounding in civilian publicmass shooting fatalities. J Trauma Acute Care Surg 2016;81:86e92.

The Hemorrhage Problem

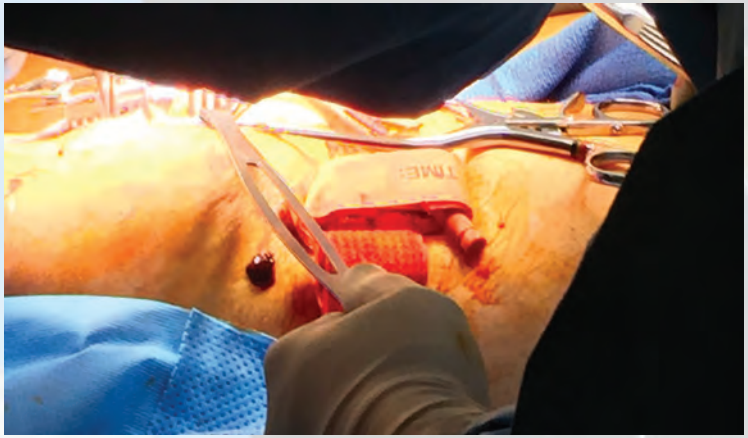
- Bleeding is the leading cause of preventable death in all types of traumatic injuries
- Stopping hemorrhage early is critical to good outcomes
- 25% of trauma patients arriving in the ED have established coagulopathy



The Death of General Albert Sidney Johnston

- Leading Confederate General
- KIA at Shiloh 7 April 1862
- Gen Johnston's Surgeon – Dr. David Yandell – directed that tourniquets be issued
- During the battle, Gen Johnston sustained injury to popliteal artery and bled to death
- Tourniquet was in his pocket


LEF
traUMA



Tourniquets in Extremity Trauma

- Early control of severe hemorrhage is critical
  - Only LIFE-THREATENING bleeds
- Tourniquet placed for total or partial amputations
  - **High** risk of rebleeding
- Wounds with heavy arterial or massive venous bleeding

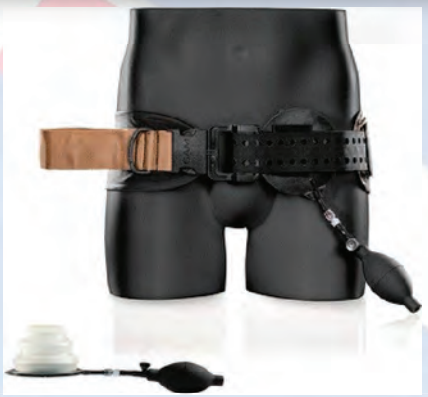
Blackbourne et al. 2013

The TRUTH About Tourniquets

- Fast and easy to apply approximately 30 seconds to stop bleeding completely
- Subsequent bleeding control in other phases of care is aimed at downgrading
- Survival is better if applied prior to onset of shock
- Safety profile Related to time of application Multiple studies show safety if off <2 hours
- Some reviews show 1.5-3% transient nerve palsy
- **Use an approved tourniquet from a reputable supplier, there are a lot of imposters (Mabry, 2006)**

Not just for extremities

- The junctional tourniquet-for those hard to reach places
  - Inguinal
  - Axilla
- Pelvic stabilization
- Recent studies indicate
  - Junctional hemorrhage accounts for up to 20% of preventable deaths in combat. Immediate, effective treatment is necessary for patient survival.
  - 24% of patients with traumatic lower limb amputations from IEDs had associated pelvic fractures



**Death on the battlefield (2001-2011): Implications for the future of combat casualty care. J Trauma Acute Care Surgery. Eastridge et al. Volume 73, Number 6, Supplement 5*

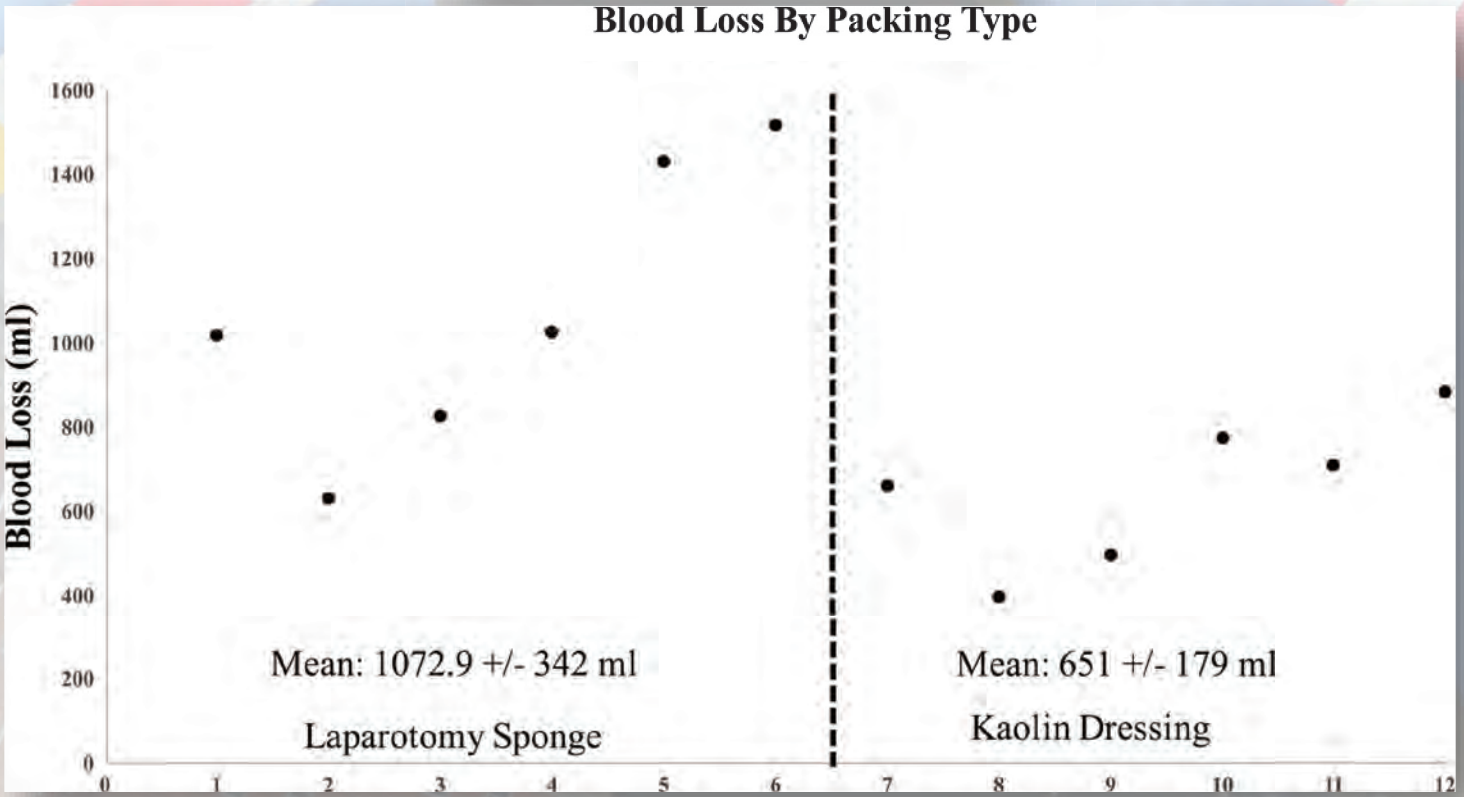
***British Editorial Society of Bone & Joint Surgery (2010): Lower Limb Traumatic Amputations - The importance of pelvic binding for associated pelvic fractures in blast injury. Cross et.al .J Bone Joint Surg Br 2012 vol. 94-B no. SUPP XXI 4*

Hemostatic Gauzes

- QuickClot
  - Rapid absorption H20 content of blood
- Combat Gauze
  - Mineral (kaolin impregnated) hemostatic gauze
  - Activates intrinsic clotting pathway
- Chitosans
  - Celox
  - No hemostatic properties
  - Biodegradable complex carbohydrate
  - Electrostatic interaction between + chitosan and – cell membranes RBCs

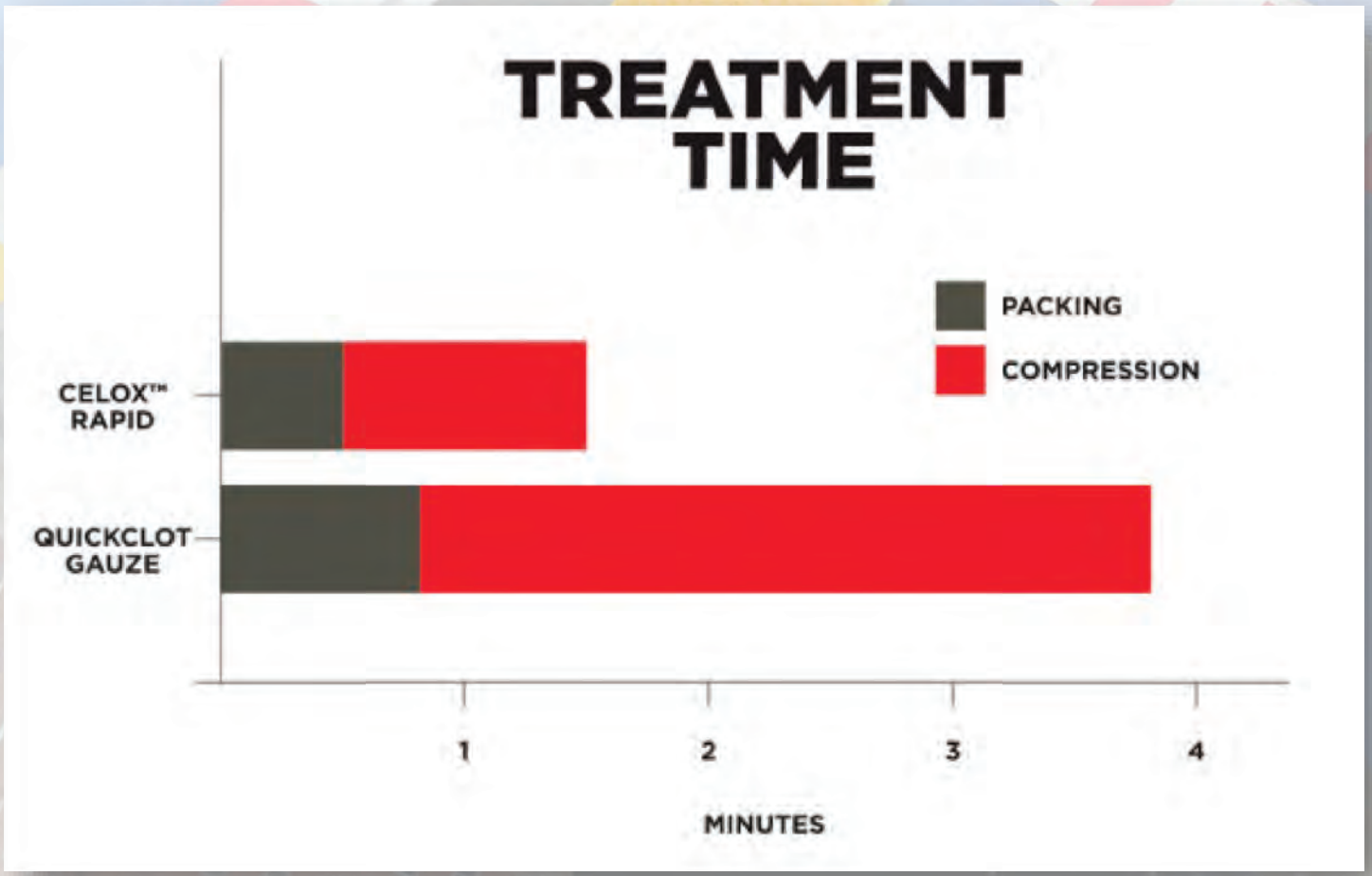
Quikclot


QuikClot
CONTROL+

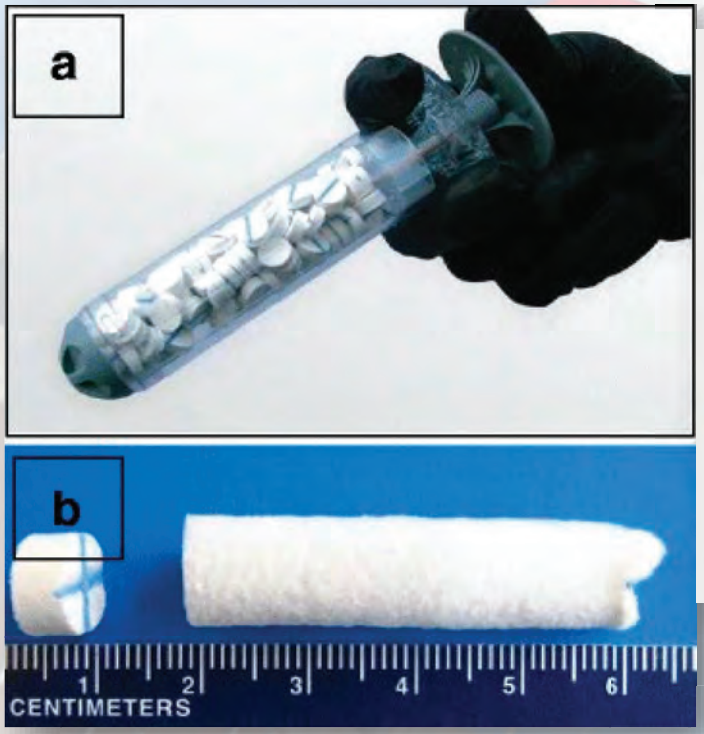

Blood Loss By Packing Type
Blood Loss (ml)
1600
1400
1200
1000
800
600
400
200
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Mean: 1072.9 +/- 342 ml
Laparotomy Sponge
Mean: 651 +/- 179 ml
Kaolin Dressing

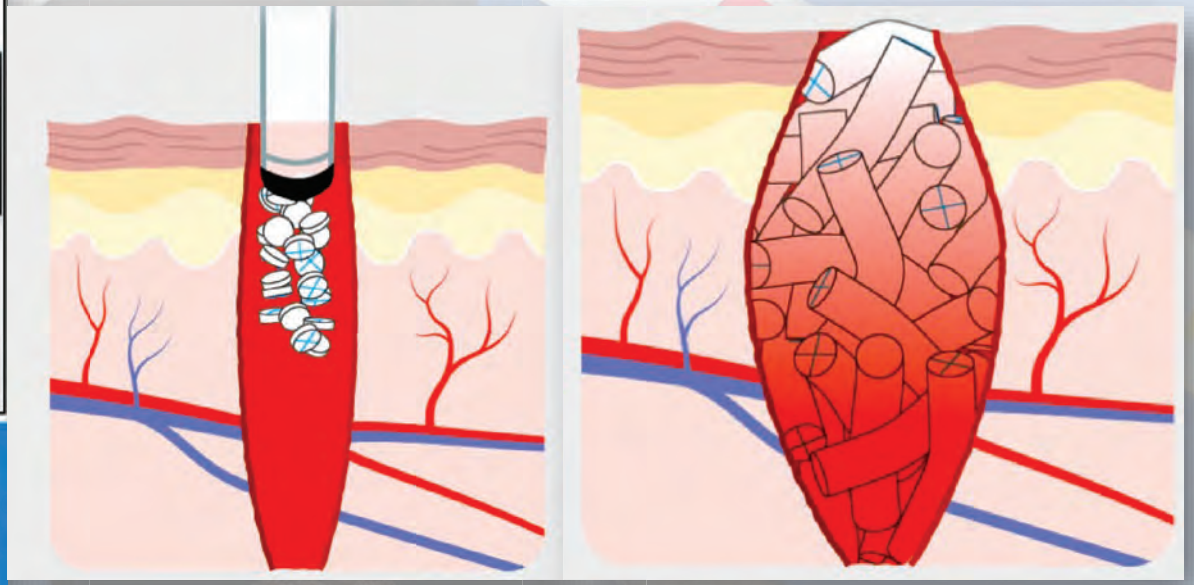
Celox


CEL X RAPID
Hemostatic Z-fold Gauze
Stops Bleeding Fast*


TREATMENT TIME
PACKING
COMPRESSION
CELOX™ RAPID
QUICKCLOT GAUZE
1
2
3
4
MINUTES

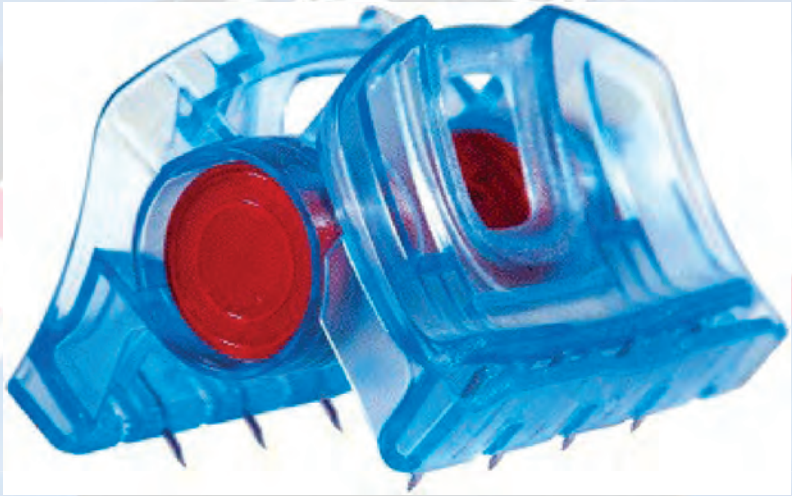
XSTAT

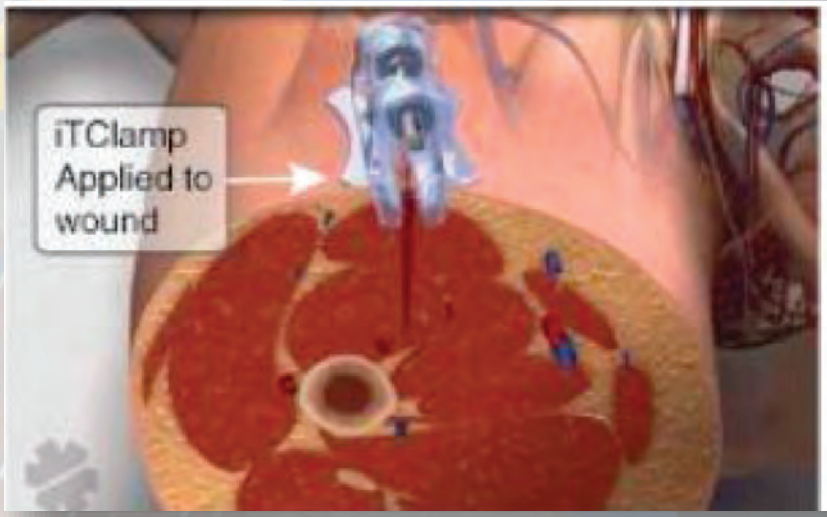


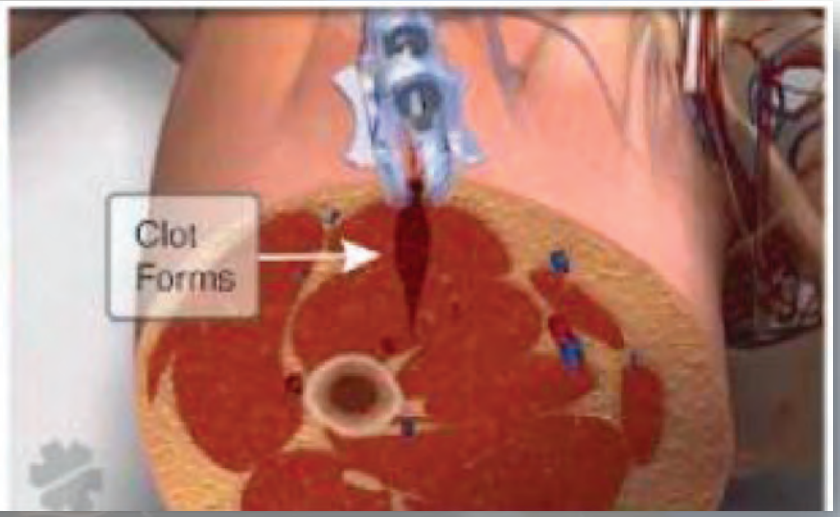


[XSTAT video]

ITClamp







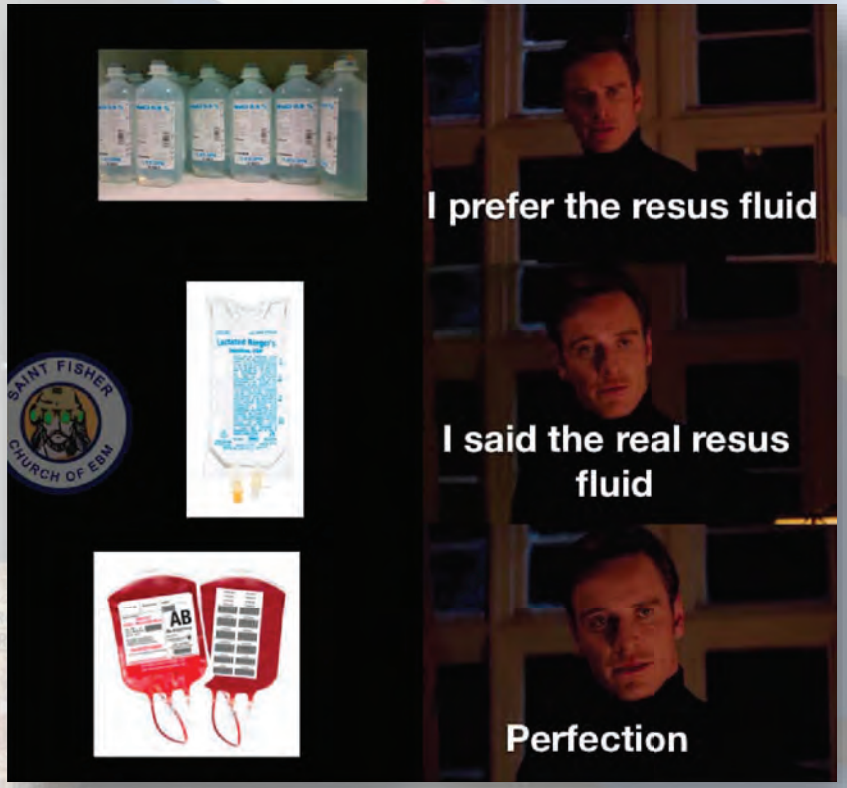
Fluid Resuscitation

- Plasmalyte/Normosol>LR>NS
- Logistically useful small volume fluid
- Albumin (5% or 25%) provides effective and more physiologic volume expansion than other colloids but given alone contributes to hemodilution.
- Hextend or Hespan use should be avoided as these products worsen coagulopathy
- Hypertonic Saline does not improve mortality in hemorrhagic shock and should only be used for patients with Traumatic Brain Injury (TBI) and evidence of raised Intracranial Pressure (ICP).

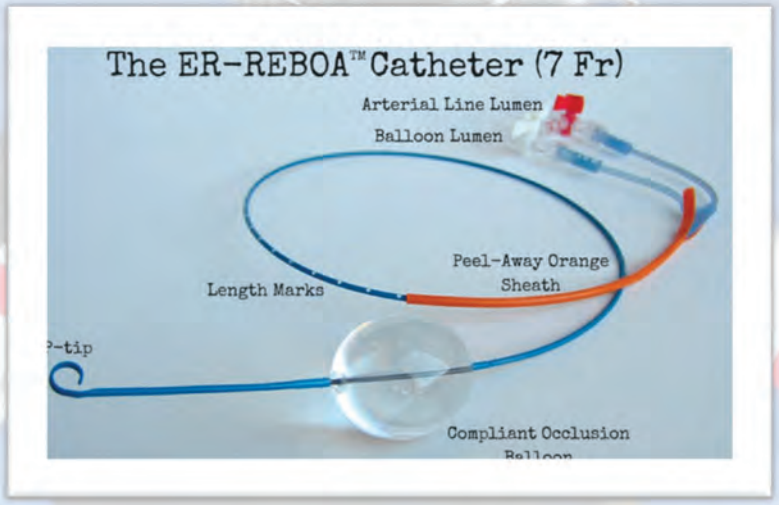
Wise R, Faurie M, Malbrain MLNG, Hodgson E. Strategies for Intravenous Fluid Resuscitation in Trauma Patients. *World J Surg*. 2017;41(5):1170-1183

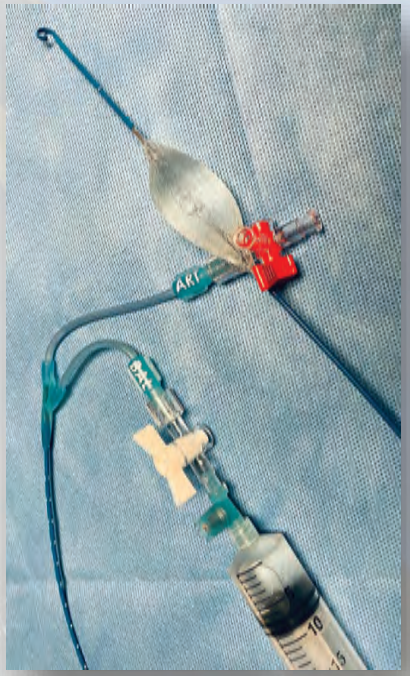
Blood Product Resuscitation=Improved survival

- Balanced better than unbalanced
- Early better than late
- Fewer Blood Products are being given
- Remember to **WARM** everything



Resuscitative Endovascular Balloon Occlusion of the Aorta





SURGERY

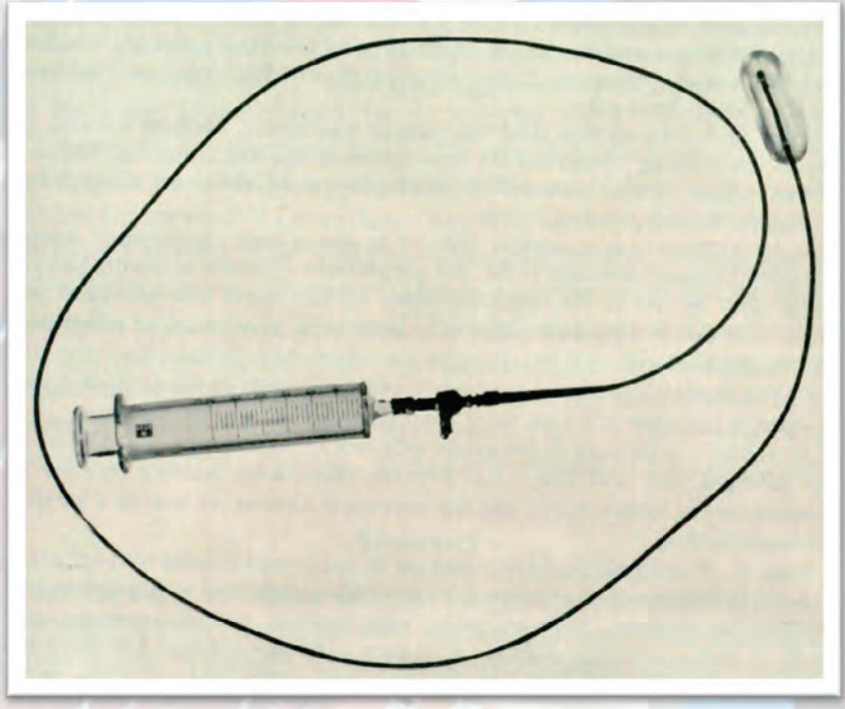
Log in

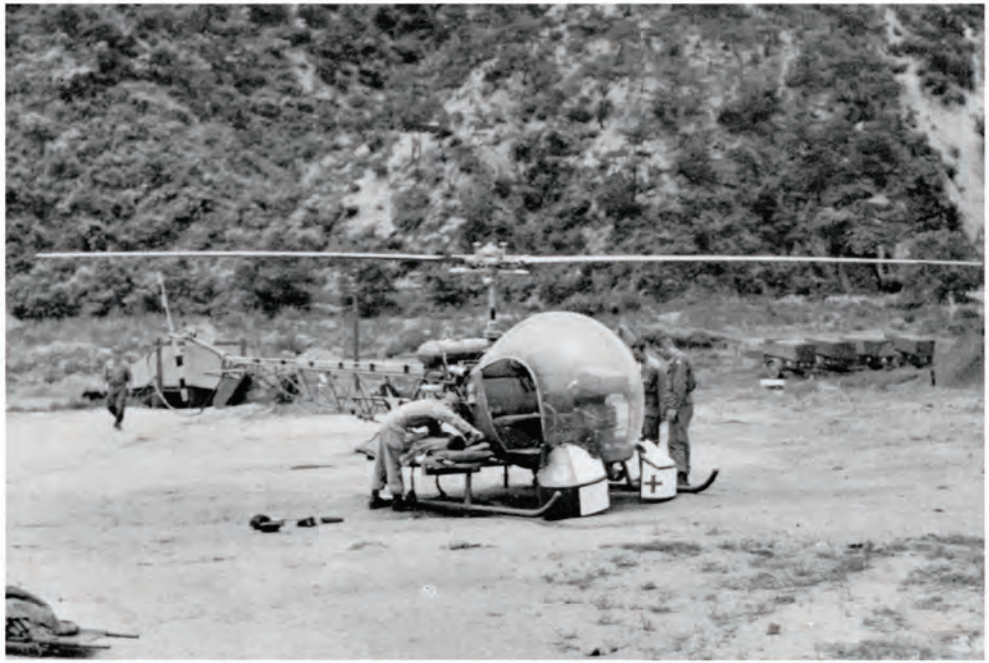
ORIGINAL COMMUNICATION | VOLUME 36, ISSUE 1, P65-68, JULY 01, 1954

Use of an intra-aortic balloon catheter tamponade for controlling intra-abdominal hemorrhage in man

Lieutenant Colonel Carl W. Hughes

DOI: https://doi.org/10.5555/uri:pii:0039606054902664





REBOA

- Support cerebral/myocardial perfusion
- Bridge/adjunct to resuscitation and/or hemostasis
- Less invasive the Emergent thoracotomy
  - No need to repair open chest wound
  - can BE DONE IN ED OR OPERATING ROOM

REBOA

Indications

- Hemorrhage related trauma
- Non-compressible torso injuries
- Pelvic fractures
- Obstetric emergencies

Contraindication

- Injuries above the diaphragm- head, neck, or axilla
- Blunt cardiac/aortic injuries

Zenoli et al., 2018; Howie et al., 2019

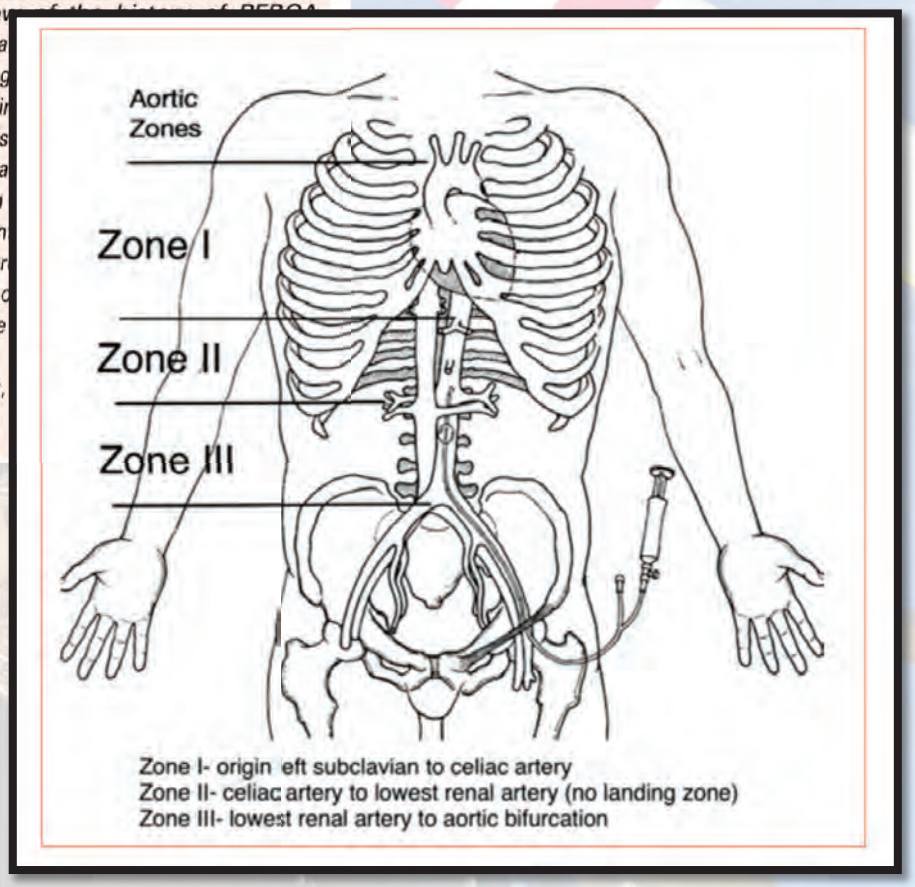
Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) as an Option for Uncontrolled Hemorrhagic Shock: Current Best Practices and Anesthetic Implications

AANA Journal ■ February 2019 ■ Vol. 87, No. 1

William Howie, DNP, CRNA
Michael Broussard, MS, CRNA
Bonjo Batoon, MS, CRNA

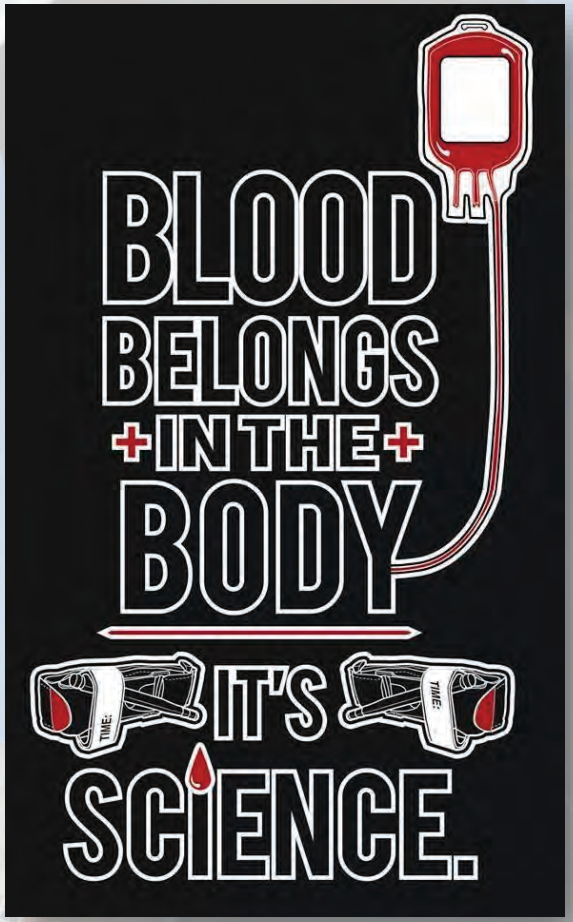
Noncompressible torso hemorrhage is reported to be a leading cause of potentially preventable mortality in both civilian trauma victims and military combat casualties. This hemorrhage may come from venous, arterial, or additional combined sources in the chest, abdomen, pelvis, axilla, or groin regions. Aortic occlusion as an adjunct to strategies for trauma damage control can decrease the amount of bleeding distal to the occluded site and provide a time-sensitive opportunity for resuscitation and definitive hemorrhage control. Recently, resuscitative endovascular balloon occlusion of the aorta (REBOA) has emerged as a temporary hemorrhage control and resuscitation technique that has the advantage of being minimally invasive and may offer improved patient morbidity and mortality compared with the traditional emergency department thoracotomy. An overview of the history of REBOA and indications and contra vided. A placement strateg includes basic suggested i tomical placement sites, is device-related morbidity a Anesthetic implications in reviewed in light of curren dations are given for futur and improving the care o who may require this type

Keywords: Endovascular, control, REBOA, trauma.



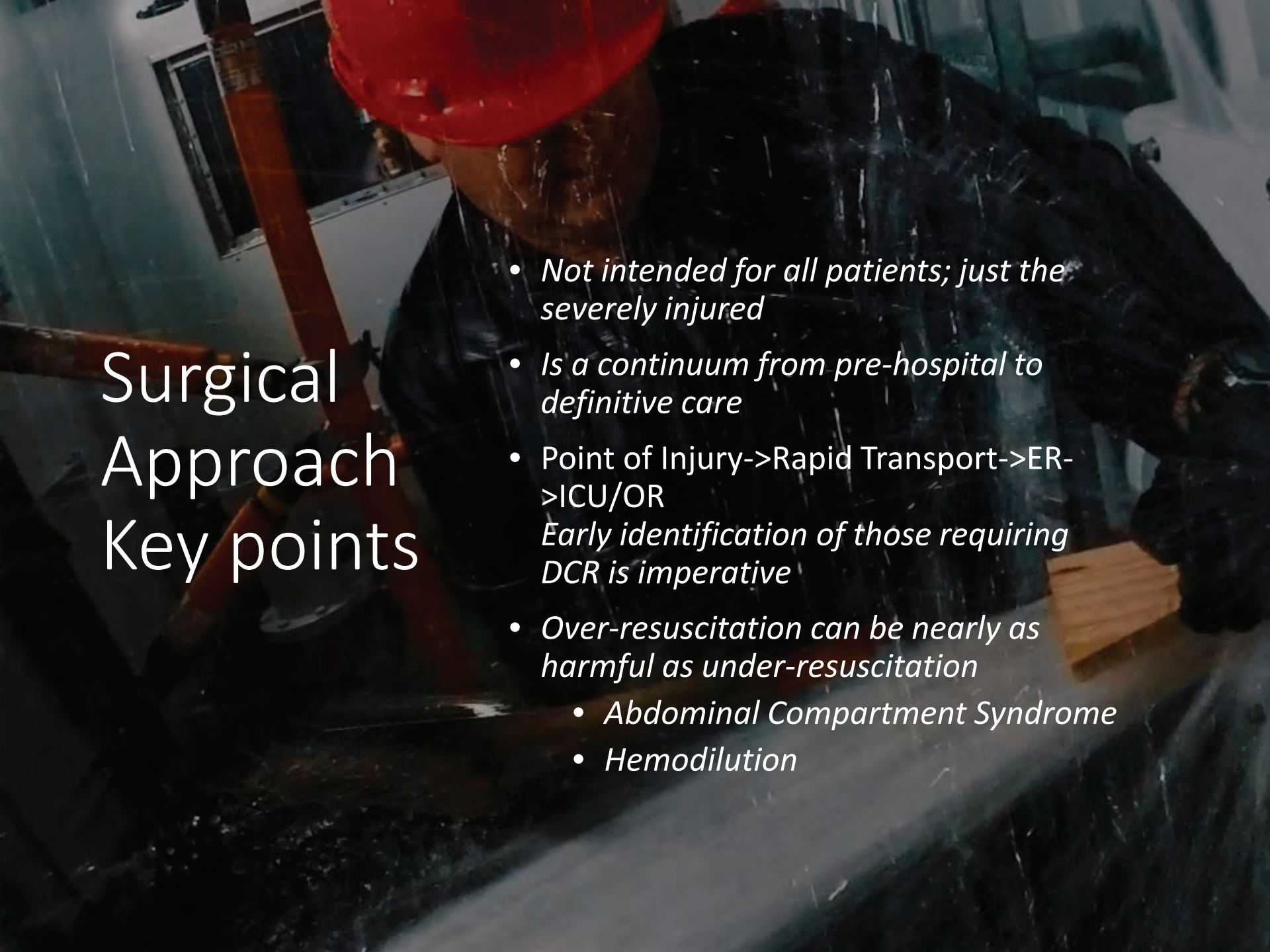
Damage Control Resuscitation

- *For decades, the trauma mantra has been "two large bore IVs and two liters of crystalloid bolus"*



Damage Control Resuscitation

- *Rapid transport to definitive care*
- *Early control of hemorrhage*
- *Limited crystalloids*
- *Early whole blood or ratio-based resuscitation (1:1:1)*
- *Permissive hypotension (excluding TBI/SCI patients)*
- *Judicious and early use of tourniquets, pelvic binders, splints, compressive dressings/direct pressure*
- *Quick peripheral large bore IV*
- *Focusing on and addressing ABC's using available adjuncts (FAST, CXR, Pelvic X-ray)*

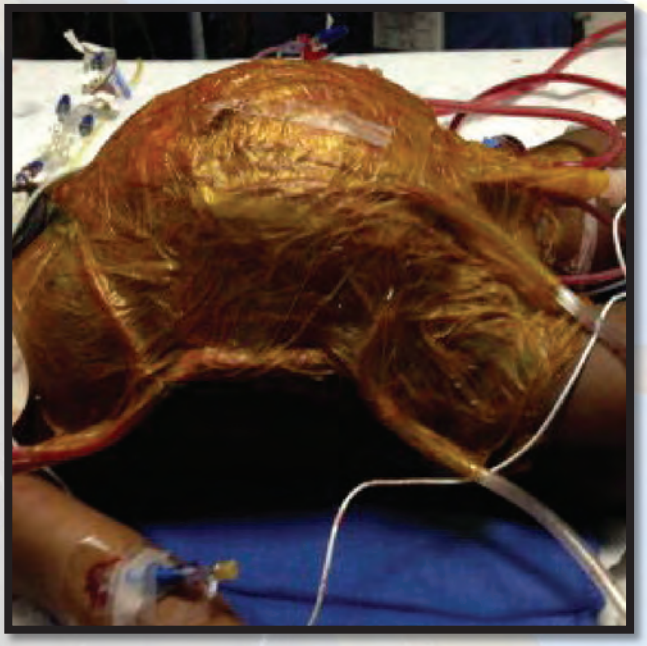


Surgical Approach Key points

- *Not intended for all patients; just the severely injured*
- *Is a continuum from pre-hospital to definitive care*
- Point of Injury->Rapid Transport->ER->ICU/OR
  Early identification of those requiring DCR is imperative
- *Over-resuscitation can be nearly as harmful as under-resuscitation*
  - *Abdominal Compartment Syndrome*
  - *Hemodilution*

Operative Damage Control

- *Abbreviated initial procedure-control hemorrhage*
- *Control contamination*
- *Temporary closure: Continued resuscitation in ICU* — *Ex Fix Wound Vacs*
- *Reverse hypothermia, acidosis, coagulopathy*
- *Definitive repair and closure – return to OR*

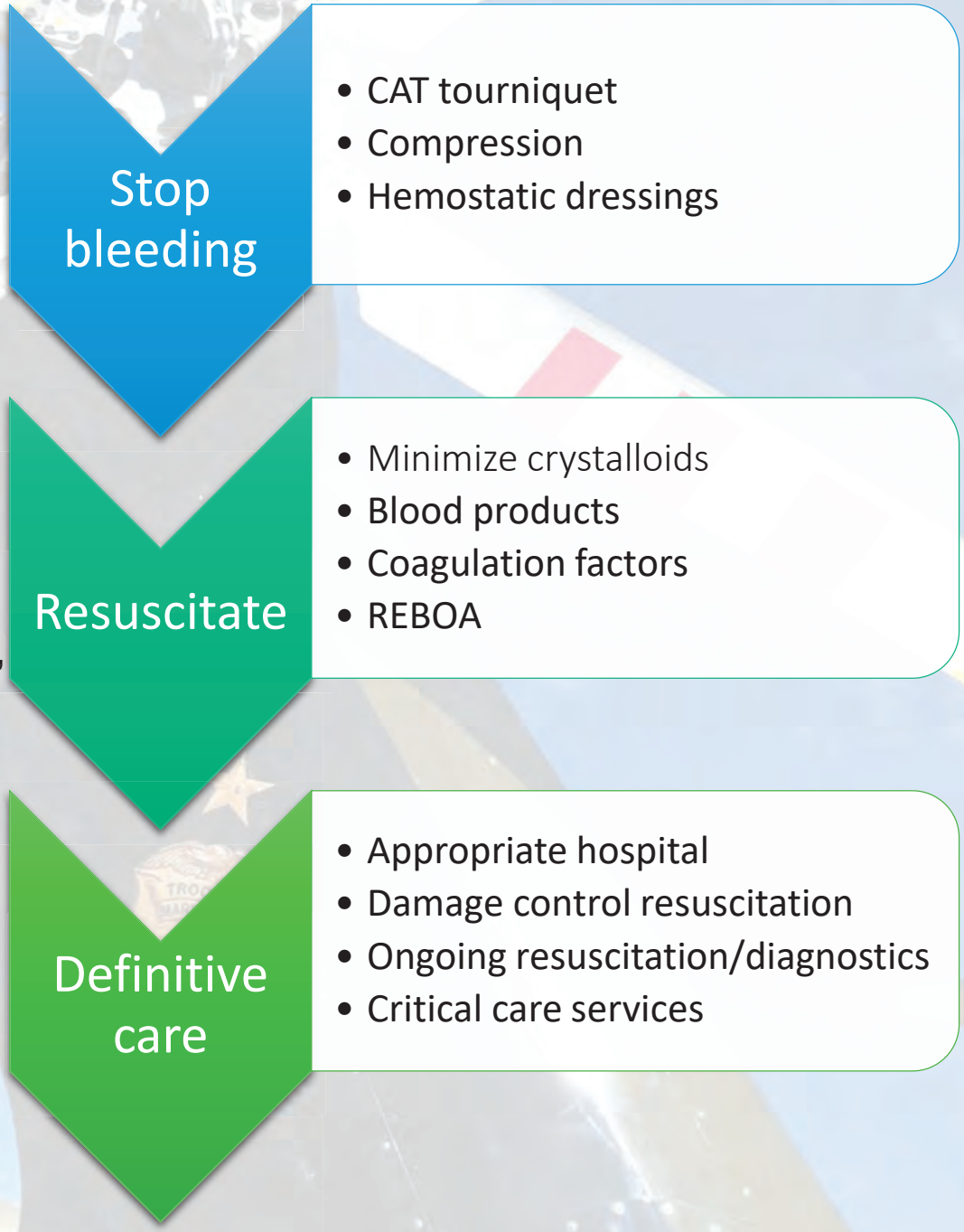


DCR Summary

- Hemorrhage and injury cause **acute blood failure** or **hemovascular dysfunction (leading to the "lethal triad")**.
- **DCR treats drivers of blood failure simultaneously with blood/blood products (and TXA).**
- DCR is most effective if **started immediately: RDCR**.
- Risk/benefit of products should be considered in light of exsanguination mortality.
- Simplicity is a virtue: **LTOWB**.
- Push the *capability* forward to save lives close to POI.

It's Simple right?

- **Stop Bleeding with Devices**
- **Then Resuscitate**
  - **Crystalloid resuscitation increases blood loss, transfusion requirements and death**
  - Balanced blood product resuscitation decreases blood loss, transfusion requirements and improves survival
  - Must have dried/thawed/liquid plasma to really do this well
- **Time is critical**

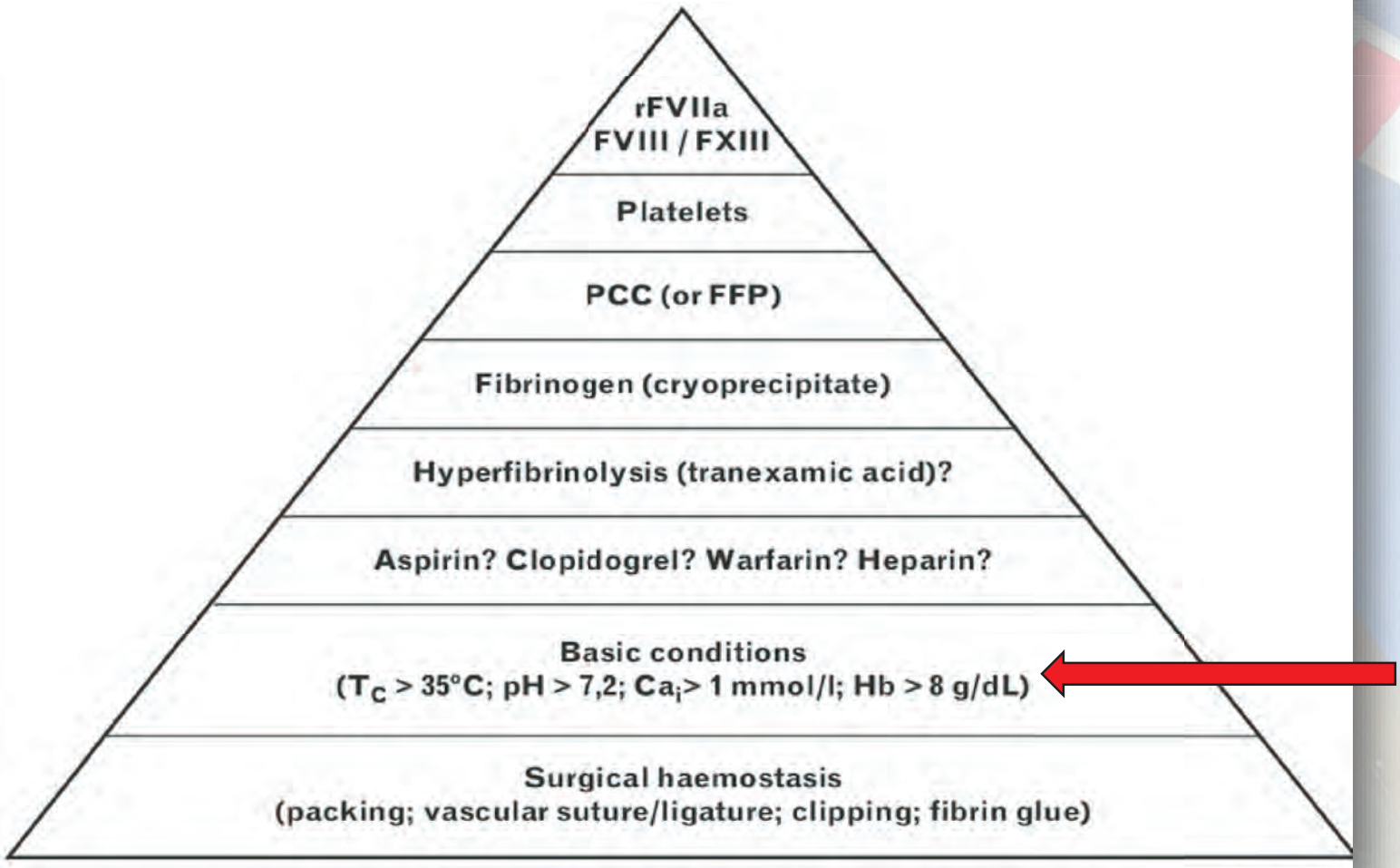


On the Inside

REVIEW

Potential value of transfusion protocols in cardiac surgery

Klaus Görlinger[a], Daniel Dirkmann[a], and Alexander A. Hanke[b]



Treating Coagulopathy in Trauma Patients

Ray Armand and John R. Hess

Whole Blood	Component Therapy
1 unit WB	1 RBC + 1 PLT + 1 FFP + 1 Cryo
RBC: Hct 38-50%	RBC: Hct 29%
PLTs: 150- 400K	PLTs: 80K
Coagulation activity: 100%	Coagulation activity: 65%

Warm fresh whole blood is independently associated with improved survival for patients with combat-related traumatic injuries

Comparative Study > J Trauma. 2009 Apr;66(4 Suppl):S69-76.
doi: 10.1097/TA.0b013e31819d85fb.

Philip C Spinella [1], Jeremy G Perkins, Kurt W Grathwohl, Alec C Beekley, John B Holcomb

Reconstitution w/ Additives & Anti-Coagulants

Whole Blood	Component Therapy
WB 63ml/unit x 6 = 378 ml	RBC 120ml/unit x 6 = 720ml
	FFP 50ml/unit x 6 = 300 ml
	PLT 35ml /unit x 1 = 35ml
Total = 378ml	Total = 1055ml

Whole blood transfusion versus component therapy in trauma resuscitation: a systematic review and meta-analysis

Ellen Crowe BSA, Stacia M. DeSantis PhD, Austin Bonnette BS, Jan O. Jansen MBBS, PhD, Jose-Miguel Yamal PhD, John B. Holcomb MD, Claudia Pedroza PhD, John A. Harvin MD, MS ... See all authors

First published: 29 May 2020 | https://doi.org/10.1002/emp2.12089 | Citations: 8

"...whole blood was not associated with 24-hour or in-hospital mortality".

GUIDELINES

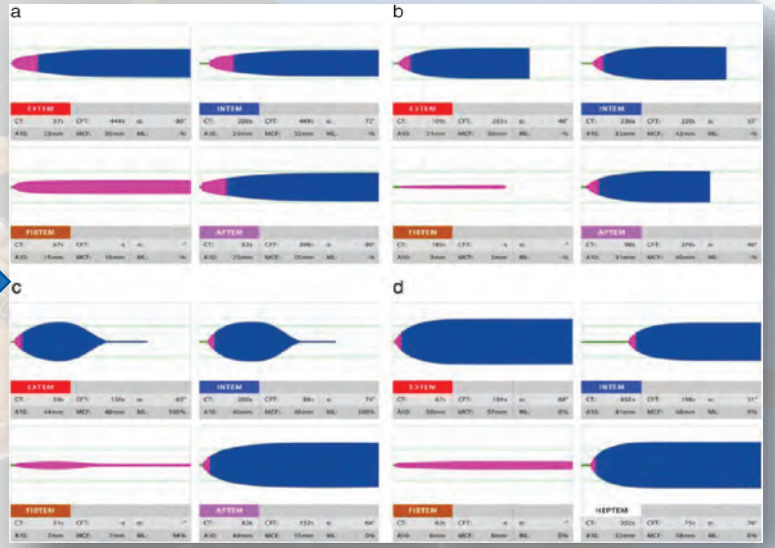
Management of severe perioperative bleeding

guidelines from the European Society of Anaesthesiology
First update 2016

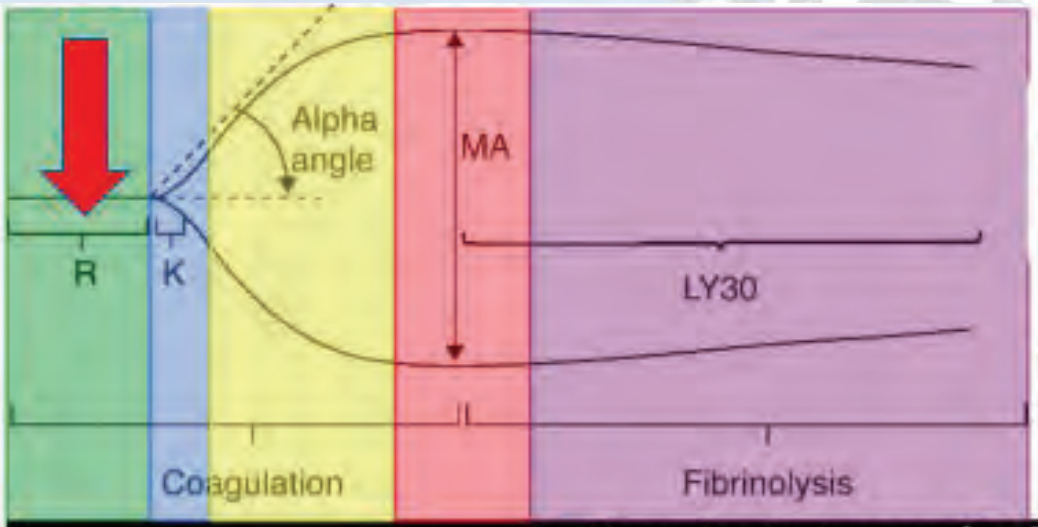
Early ratio-based resuscitation

Goal-directed resuscitation

1 : 1 : 1



Kozek-Langenecker et al. (2017). European Journal of Anaesthesiology
doi: 10.1097/EJA.0000000000000630

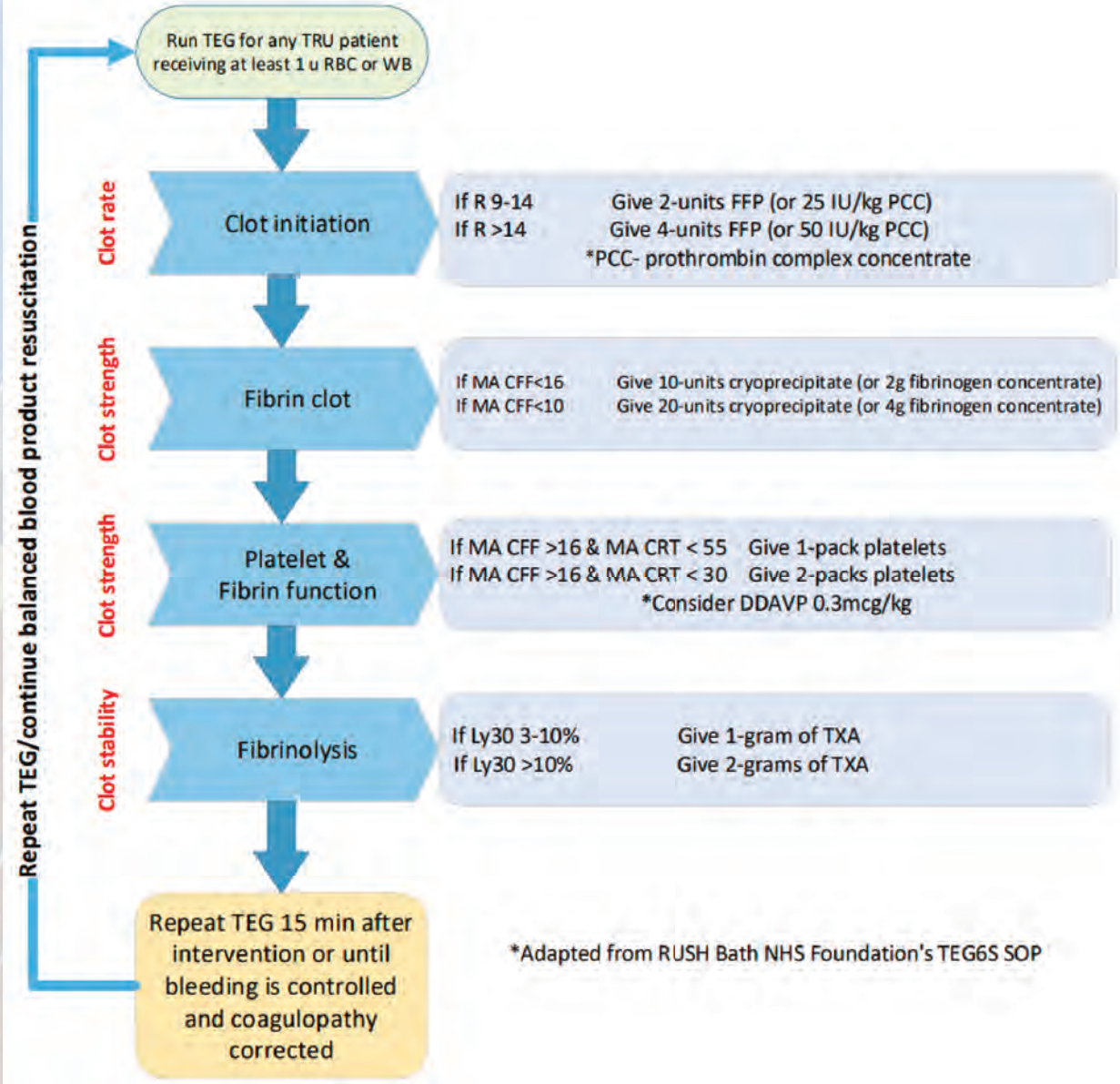


R.E.B.E.L.em

rebelem.com

Thromboelastogram (TEG)

Components	Definition	Normal Values	Problem with...	Treatment
R Time	Time to start forming clot	5 - 10 minutes	Coagulation Factors	FFP PCC
K Time	Time until clot reaches a fixed strength	1 - 3 minutes	Fibrinogen	Cryoprecipitate
Alpha angle	Speed of fibrin accumulation	53 - 72 degrees	Fibrinogen	Cryoprecipitate
Maximum Amplitude (MA)	Highest vertical amplitude of the TEG	50 - 70 mm	Platelets	Platelets and/or DDAVP
Lysis at 30 Minutes (LY30)	Percentage of amplitude reduction 30 minutes after maximum amplitude	0 - 8%	Excess Fibrinolysis	Tranexemic Acid and/or Aminocaproic Acid



*Adapted from RUSH Bath NHS Foundation's TEG6S SOP

CK Reference Ranges

Citrated Blood Parameter	N	Range
R(Min)	157	4.6 – 9.1
K (Min)	157	0.8 – 2.1
Angle (deg)	155	63 – 78
MA (mm)	151	52 – 69
LY30 (%)	132	0.0 – 2.6

CRT Reference Ranges

Citrated Blood Parameter	N	Range
TEG-ACT(sec)	157	82 – 152
R (min)	157	0.3 – 1.1
K (min)	156	0.8 – 2.7
Angle (deg)	154	60 – 78
A10 (mm)	153	44 – 67
MA (mm)	152	52 – 70
LY30 (%)	131	0.0 – 2.2

CKH Reference Ranges

Citrated Blood Parameter	N	Range
R(Min)	155	4.3 – 8.3
K (Min)	157	0.8 – 1.9
Angle (deg)	154	64 – 77
MA (mm)	154	52 – 69

CFF Reference Ranges

Citrated Blood Parameter	N	Range
A10 (mm)	153	15 – 30
MA (mm)	151	15 – 32

DYNAMIC USE OF FIBRINOGEN UNDER VISCOELASTIC ASSESSMENT RESULTS IN REDUCED NEED FOR PLASMA AND DIMINISHED OVERALL TRANSFUSION REQUIREMENTS IN SEVERE TRAUMA

- RETROSPECTIVE ANALYSIS OF SEVERE BLEEDING TRAUMA PATIENTS OVER 11 YEARS. 135 PATIENTS. Median ISS 34.

- TRANSFUSION SRATEGY

2008 — VHA (ROTEM™) IMPLEMENTATION — 2019

TOWARDS A NEW PARADIGM

EMPIRICAL aMTP (PRBC:FFP:PC)	TRANSITION TIME (MTP + VHA)	GDT BASED ON ROTEM™

VHA ALGORITHM STEPS FOR HEMOSTATIC RESUSCITATION

1st ⇨ HYPERFIBRINOLISIS
2nd ⇨ FIBRINOGEN DEFICIT
3rd ⇨ TROMBIN DEFICIT
4th ⇨ PLATELET DEFICIT

- RESULTS: Patients with...

	EMPIRICAL aMTP (PRBC:FFP:PC)	TRANSITION TIME (MTP + VHA)	GDT BASED ON ROTEM™
PLASMA TRANSFUSION	100%	100%	0%
FIBRINOGEN ADMINISTRATION	0%	100%	100%
TRANSFUSION ≥ 7 PRBC	78.57%	75.38%	42.86%
SEVERE BLEEDING MORTALITY	21.43%	26.15%	11.90%

- CONCLUSIONS

VHA based reanimation seems effective in trauma patients.
The result is a plasma-free strategy, and a high use of fibrinogen concentrate, associated with a decrease in blood transfusion and outcomes improvement.

Barquero et al. *Journal of Trauma and Acute Care Surgery*
August 2022
@JTraumAcuteSurg

The Journal of Trauma and Acute Care Surgery®

DELTA
DEVELOPMENT TEAM

SHOCK/SEPSIS/TRAUMA/CRITICAL CARE | VOLUME 202, ISSUE 1, P182-187, MAY 01, 2016

Hypocalcemia in trauma patients receiving massive transfusion

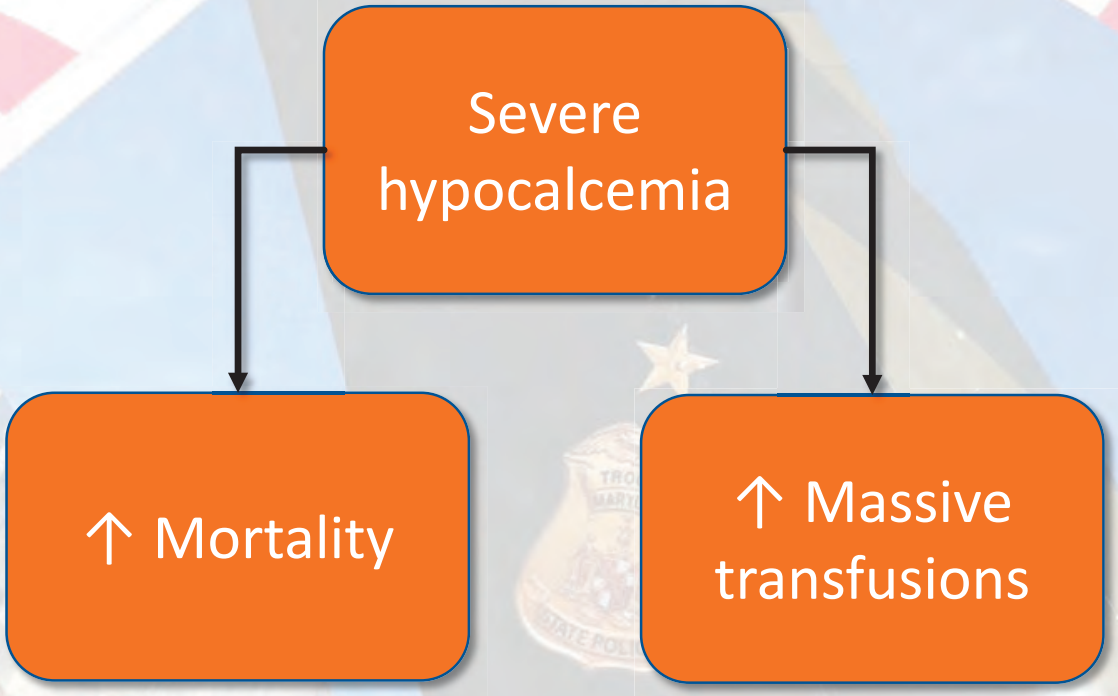
Amanda Giancarelli, PharmD, BCCCP, CNSC • Kara L. Birrer, PharmD, BCPS • Rodrigo F. Alban, MD, FACS [1] • Brandon P. Hobbs, PharmD, BCPS • Xi Liu-DeRyke, PharmD, FCCM [2] • Show footnotes

	Hypocalcemia iCa < 1.12 mmol/L	Severe hypocalcemia iCa < 0.90mmol/L
Prevalence	97%	71%
Mortality*	24%	49%
Blood products*	22 units	34 units
CaCl grams*	3	4

*Statistically significant

FORGOT CALCIUM? ADMISSION IONIZED-CALCIUM IN TWO CIVILIAN RANDOMIZED CONTROLLED TRIALS OF PRE-HOSPITAL PLASMA FOR TRAUMATIC HEMORRHAGIC SHOCK

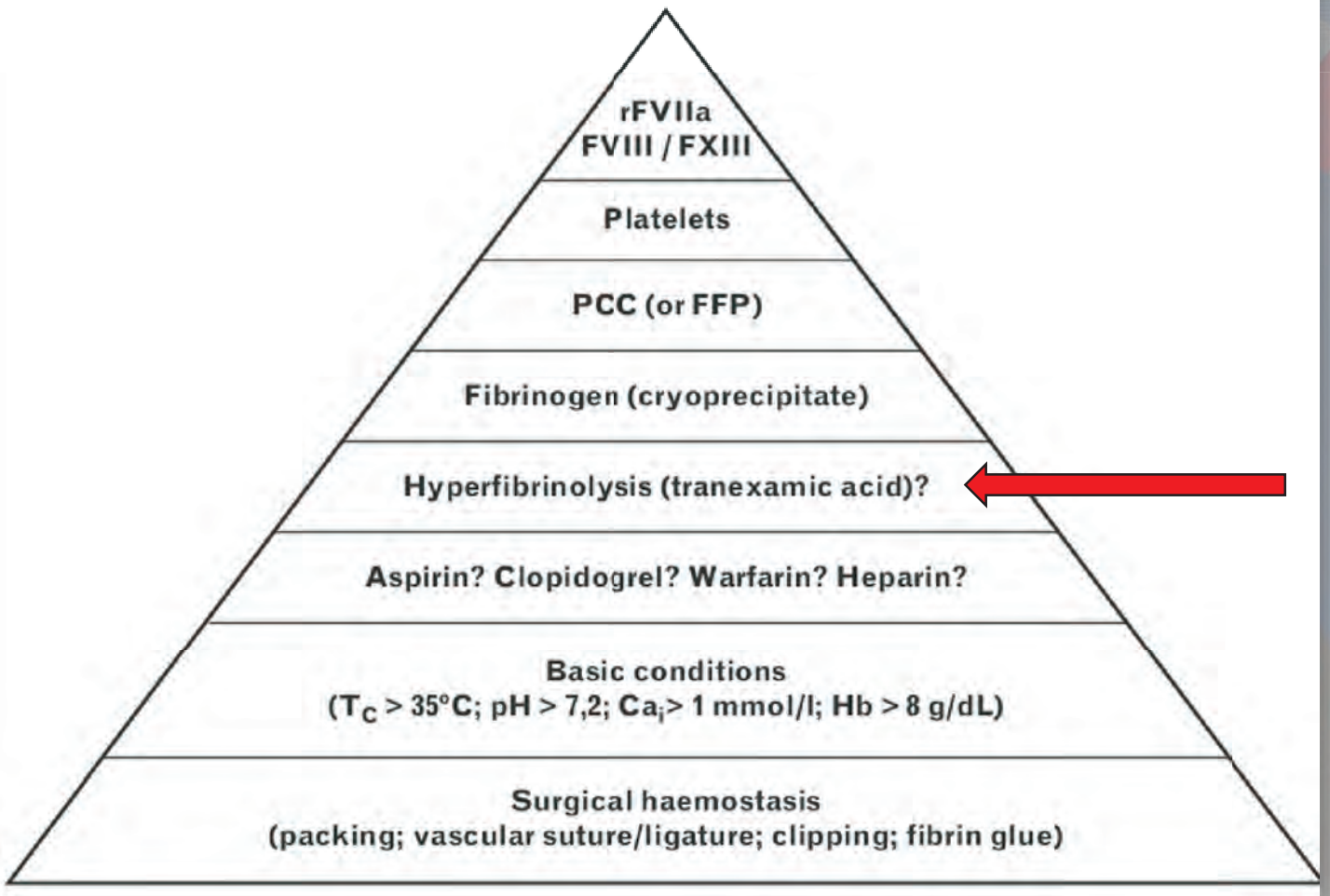
Hypocalcemia prehospital plasma transfusion
53% vs 36% (controls)
(Moore et al., 2020)



REVIEW

Potential value of transfusion protocols in cardiac surgery

Klaus Görlinger[a], *Daniel Dirkmann*[a], *and Alexander A. Hanke*[b]



Tranexamic acid evidence and **controversies**: An illustrated review.

Relke N, Chornenki NLJ, Sholzberg M.

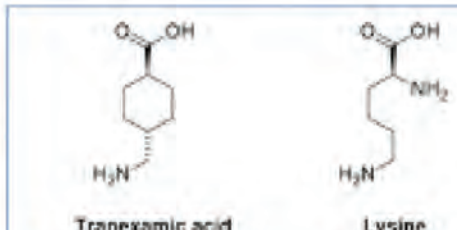
Res Pract Thromb Haemost. 2021 Jul 14;5(5):e12546. doi: 10.1002/rth2.12546. eCollection 2021 Jul.

PMID: 34278187 Free PMC article. Review.

Left: Shosuke Okamoto, Right: Utako Okamoto

Tranexamic Acid: Mechanism of Action

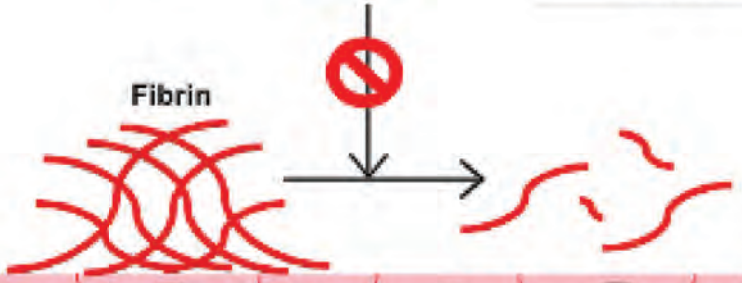
TXA is an **anti-fibrinolytic**



TXA is a synthetic analog of the amino acid **lysine**

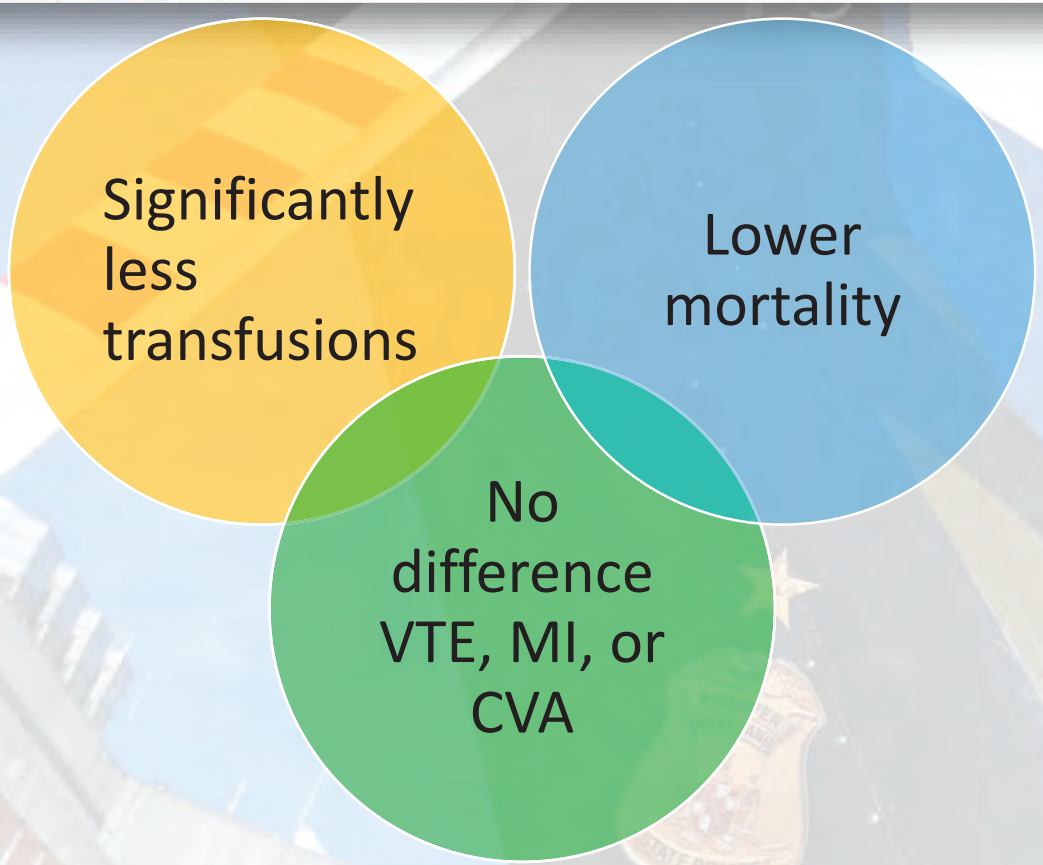
TXA ultimately reduces fibrinolysis and stabilizes the fibrin-rich clot

TXA blocks lysine binding sites on plasminogen which is essential for binding fibrin → preventing activation of plasminogen to plasmin[12]



ORIGINAL ARTICLES

The incidence of venous thromboembolic events in trauma patients after tranexamic acid administration: an EAST multicenter study



"Use of TXA in bleeding, injured patients is not associated with VTE, MI, or CVA but is associated with a lower transfusion need and mortality." (Rivas et al., 2020)

ORIGINAL ARTICLE

ONLINE FIRST

Military Application of Tranexamic Acid in Trauma Emergency Resuscitation (MATTERs) Study

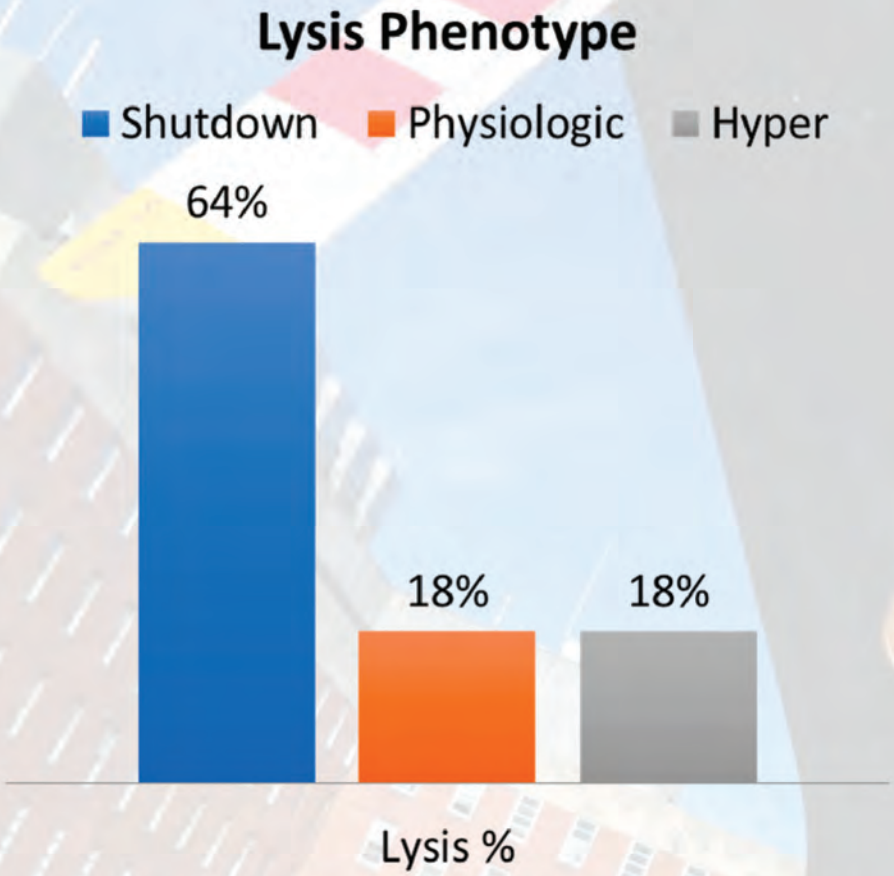
Jonathan J. Morrison, MB ChB, MRCS; Joseph J. Dubose, MD; Todd E. Rasmussen, MD; Mark J. Midwinter, BMedSci, MD, FRCS

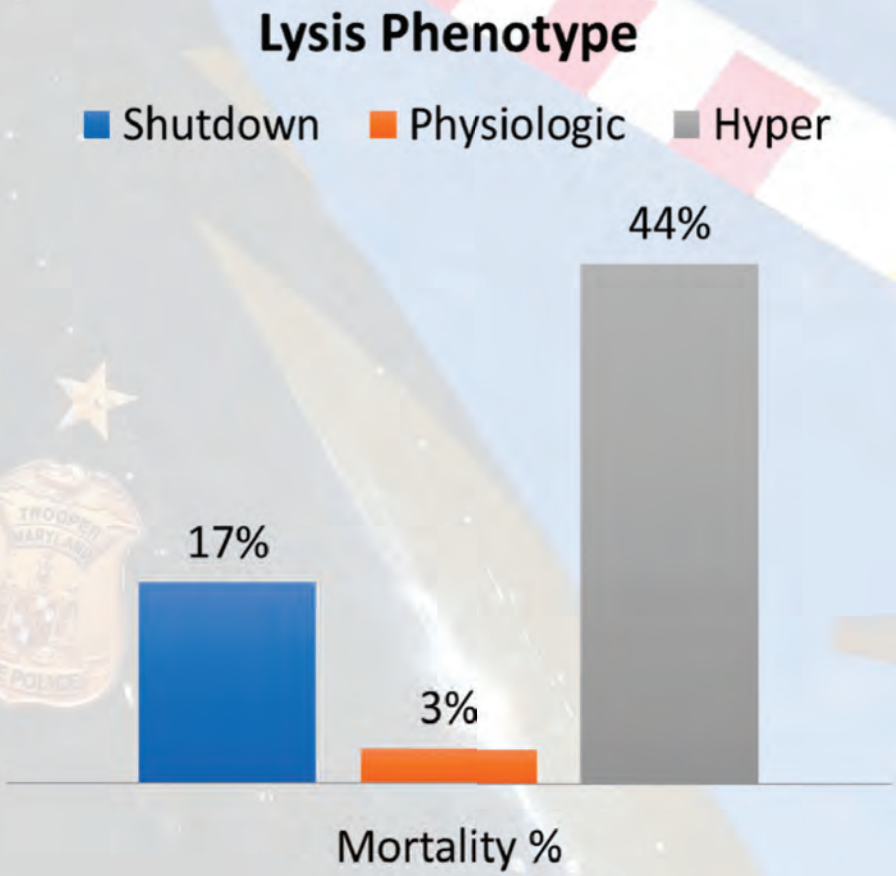
	TXA	⃠ TXA
ISS	25.2	22.5
Mortality	17.4%	23.9%
Mortality MT	14.4%	28.1%

- TXA group less over all coagulopathy

Hyperfibrinolysis, physiologic fibrinolysis, and fibrinolysis shutdown: The spectrum of postinjury fibrinolysis and relevance to antifibrinolytic therapy

Hunter B. Moore, MD, Ernest E. Moore, MD, Eduardo Gonzalez, MD, Michael P. Chapman, MD, Theresa L. Chin, MD, Christopher C. Silliman, MD, PhD, Anirban Banerjee, PhD, and Angela Sauaia, MD, PhD



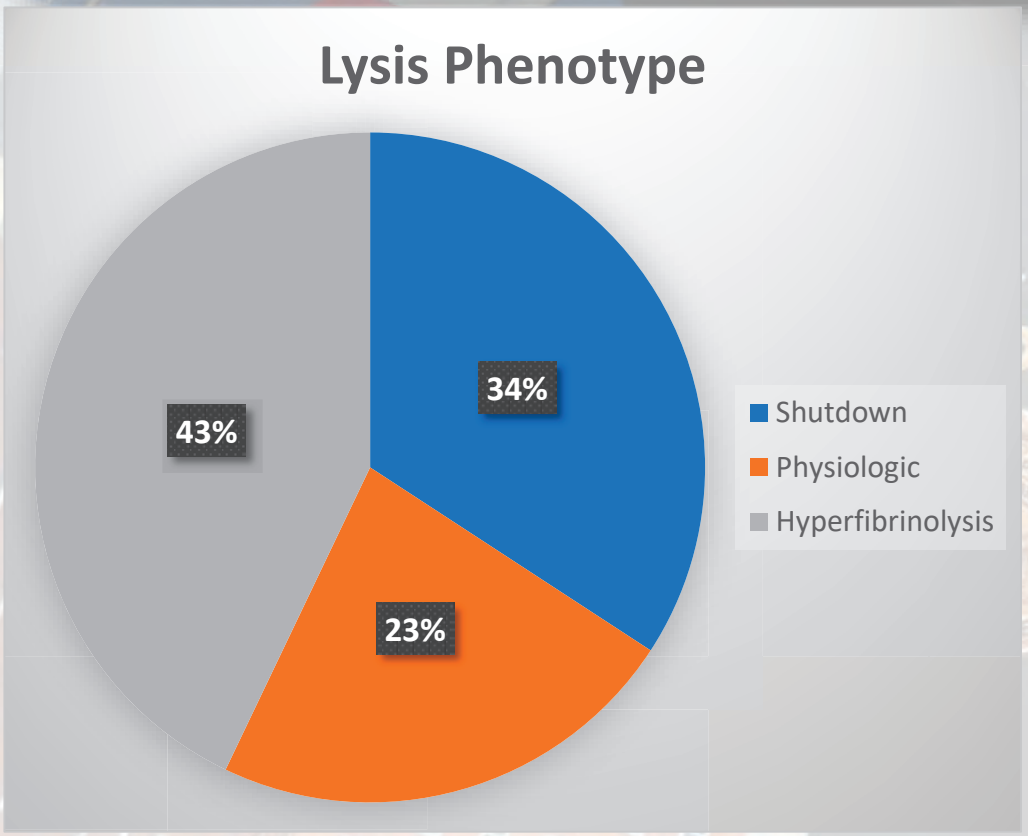


Is Tranexamic Acid Associated With Mortality or Multiple Organ Failure Following Severe Injury?

Richards, Justin E.[*,†,‡]; Fedeles, Benjamin T.[*]; Chow, Jonathan H.[*]; Morrison, Jonathan J.[†,‡]; Renner, Corinne[‡]; Trinh, Anthony T.[‡]; Schlee, Caroline S.[‡]; Koerner, Ken[*,†,‡]; Grissom, Thomas E.[*,†,‡]; Betzold, Richard D.[†,‡]; Scalea, Thomas M.[†,‡]; Kozar, Rosemary A.[†,‡]

Author Information

SHOCK: January 2021 - Volume 55 - Issue 1 - p 55-60
doi: 10.1097/SHK.0000000000001608



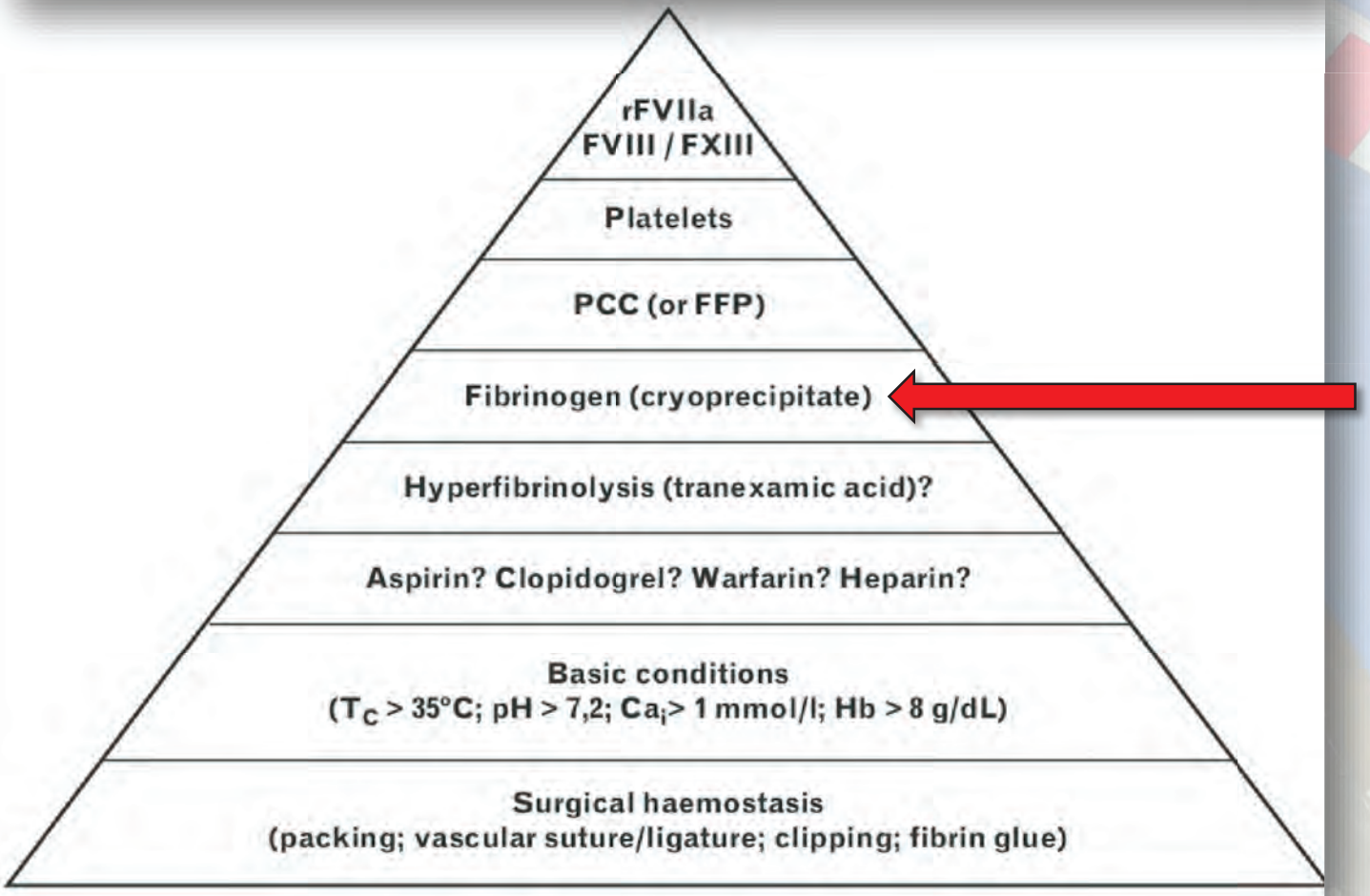
No difference in 28=day mortality ($p = .52$)

TXA was associated 3.2 odds of developing MOF after adjusting for confounding variables

REVIEW

Potential value of transfusion protocols in cardiac surgery

Klaus Görlinger[a], *Daniel Dirkmann*[a], *and Alexander A. Hanke*[b]

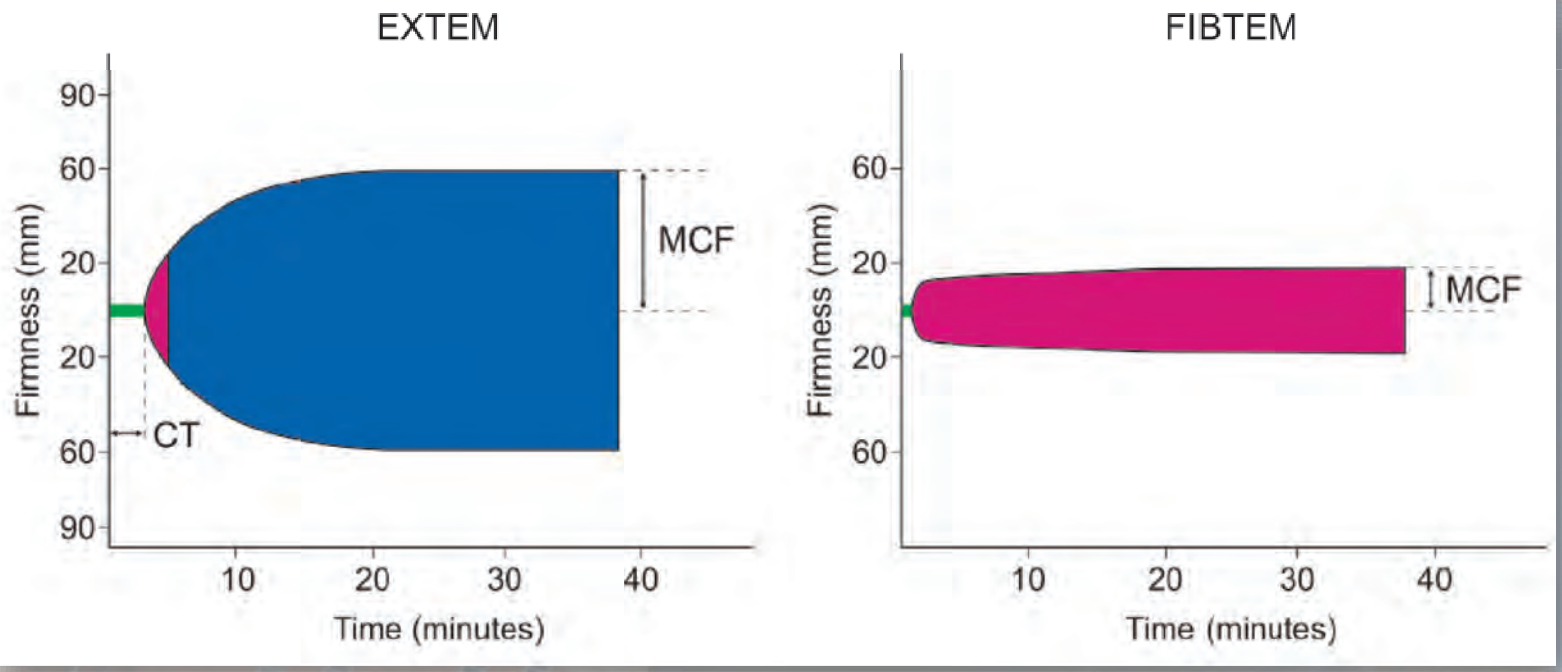


Schöchl *et al. Critical Care* 2010, **14**:R55
http://ccforum.com/content/14/2/R55

CRITICAL CARE

RESEARCH Open Access

Goal-directed coagulation management of major trauma patients using thromboelastometry (ROTEM®)-guided administration of fibrinogen concentrate and prothrombin complex concentrate



Hemostatic Factors and Replacement of Major Blood Loss with Plasma-Poor Red Cell Concentrates

Hiippala, Seppo T. MD; Myllyla, Gunnar J. MD; Vahtera, Elina M. PhD

Author Information

Anesthesia & Analgesia: August 1995 - Volume 81 - Issue 2 - p 360-365

Clotting factor	Critical value	% Blood loss
Platelets	50 x 10^3/mm^3	230
Fibrinogen	1.0 g/L	142
Prothrombin	20	201
Factor V	25	229
Factor VII	20	236

ELSEVIER

Thrombosis Research

Volume 15, Issues 5–6, 1979, Pages 617-629

OPTIMIZATION OF CONDITIONS FOR THE CATALYTIC EFFECT OF THE FACTOR IXa - FACTOR VIII COMPLEX: Probable role of the complex in the amplification of blood coagulation

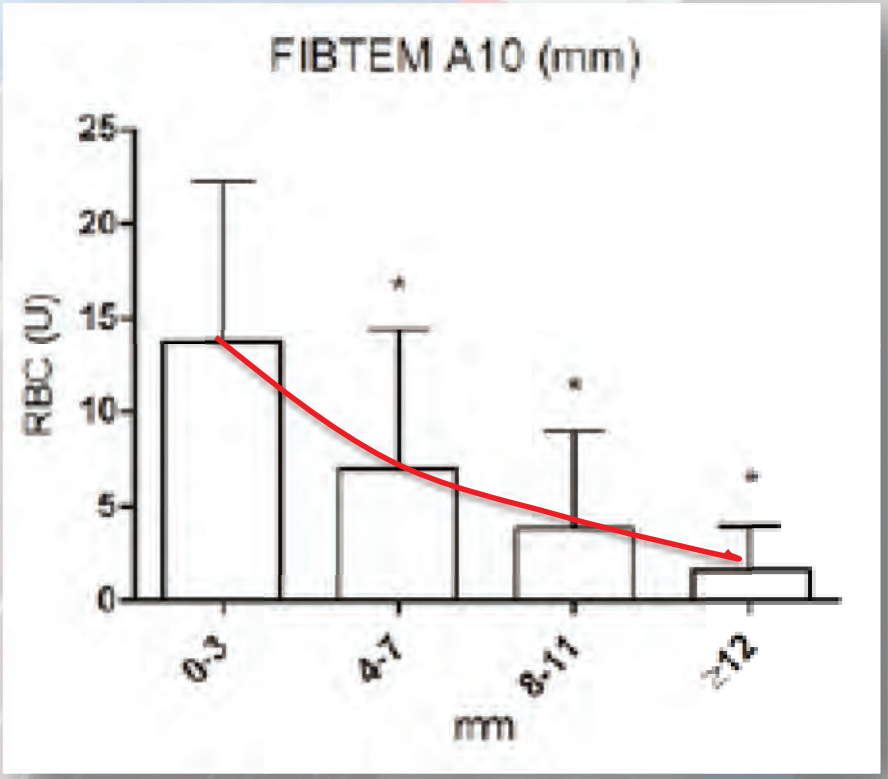
Susan Elődi and Katalin Váradi

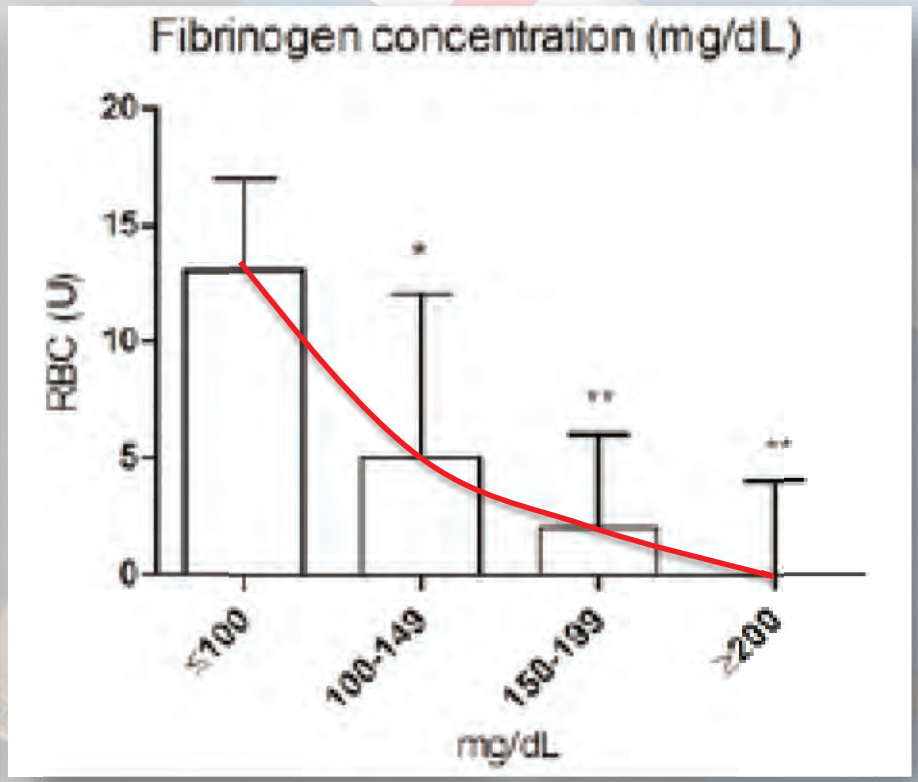
1 molecule thrombin

1680 molecules fibrinogen

FIBTEM provides early prediction of massive transfusion in trauma

Herbert Schöchl[1,2*], Bryan Cotton[3], Kenji Inaba[4], Ulrike Nienaber[5], Henrik Fischer[6], Wolfgang Voelckel[2] and Cristina Solomon[1,7]





Schöchl et al. Critical Care 2011, 15:R265
http://ccforum.com/content/15/6/R265

Sources of Fibrinogen

	FC	CRYO	FFP
Fibrinogen g/L	***20g/L***	10-15 g/L	2-2.5 g/L
ABO compatibility	***No***	Yes	Yes
Viral inactivation	***Yes***	No	Yes
Volume overload	***No***	No	Potentially
Administration time	***Short***	Short	Long

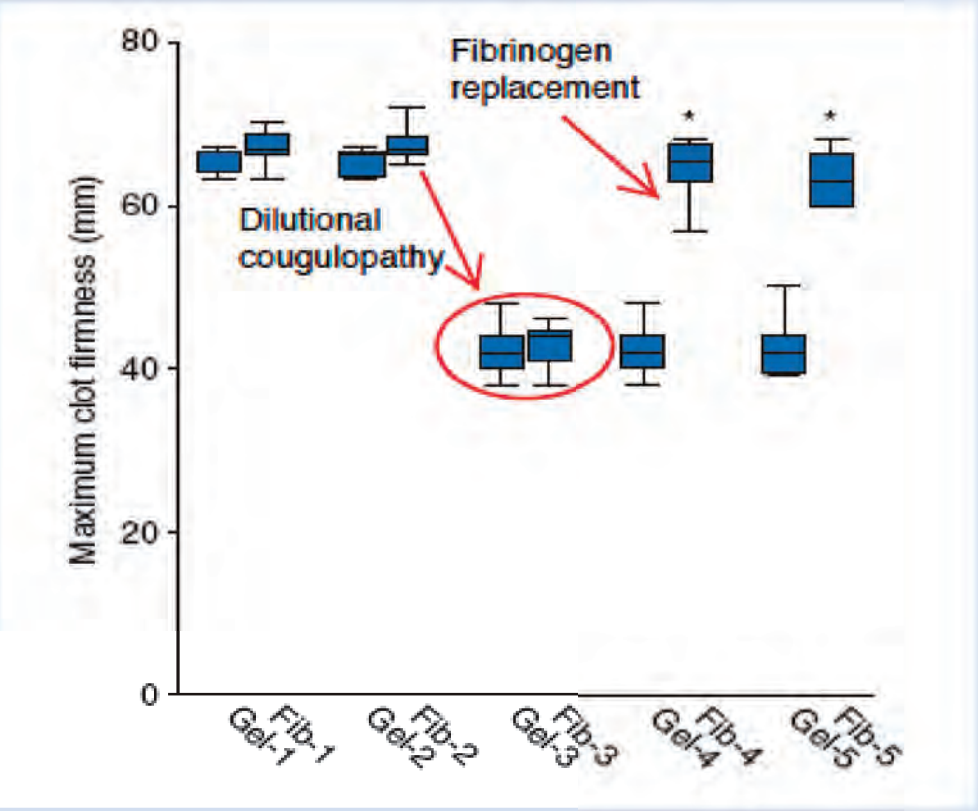


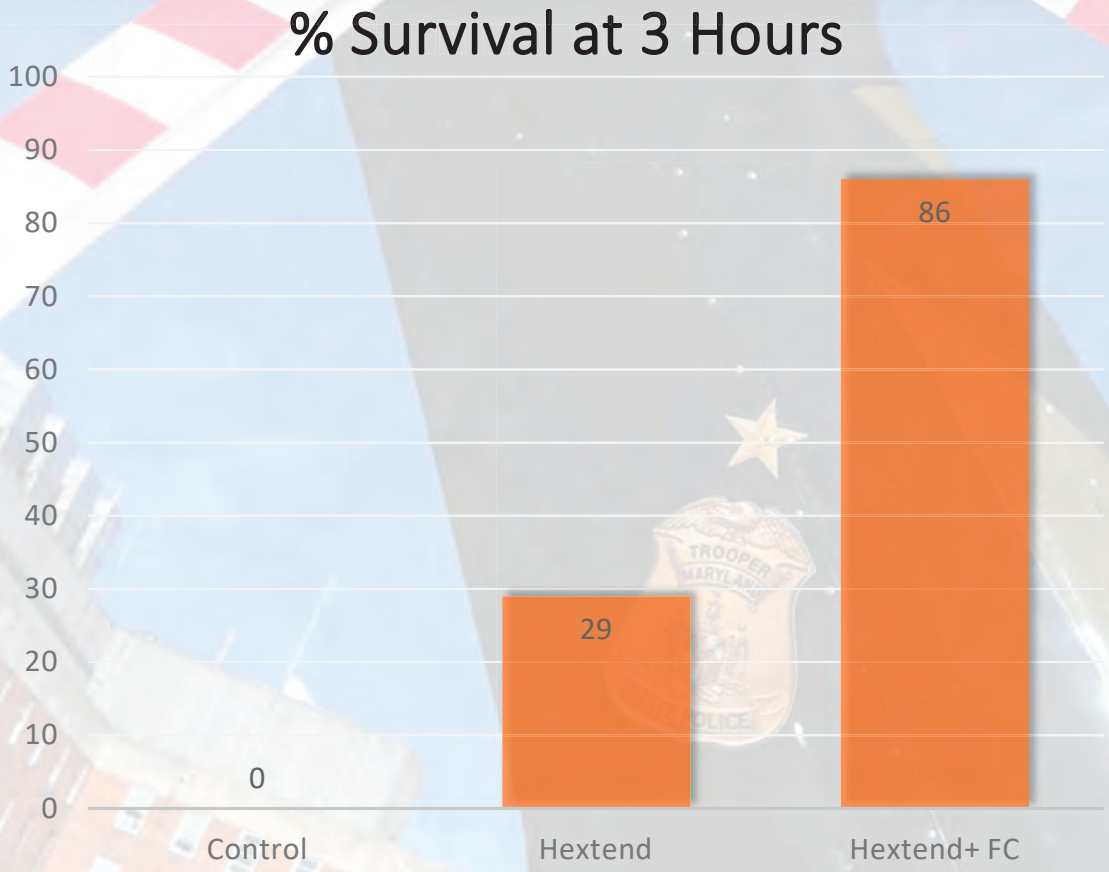
Fig 2 Clot firmness measured with the ROTEM system in an animal model of controlled and uncontrolled haemorrhage: MCF (in mm) at baseline (1), after removal of 65% of the estimated blood volume (2), after colloid administration (3), after substitution of fibrinogen concentrate (Fib) or placebo (Gel) (4), and after an observation period of 2 h (5).[31]

Fries D, Krismer A, Klingler A *et al.* Effect of fibrinogen on reversal of dilutional coagulopathy: a porcine model. *Br J Anaesth* 2005; **95**: 172–7

Published in final edited form as:
Shock. 2014 November ; 42(5): 456–463. doi:10.1097/SHK.0000000000000238.

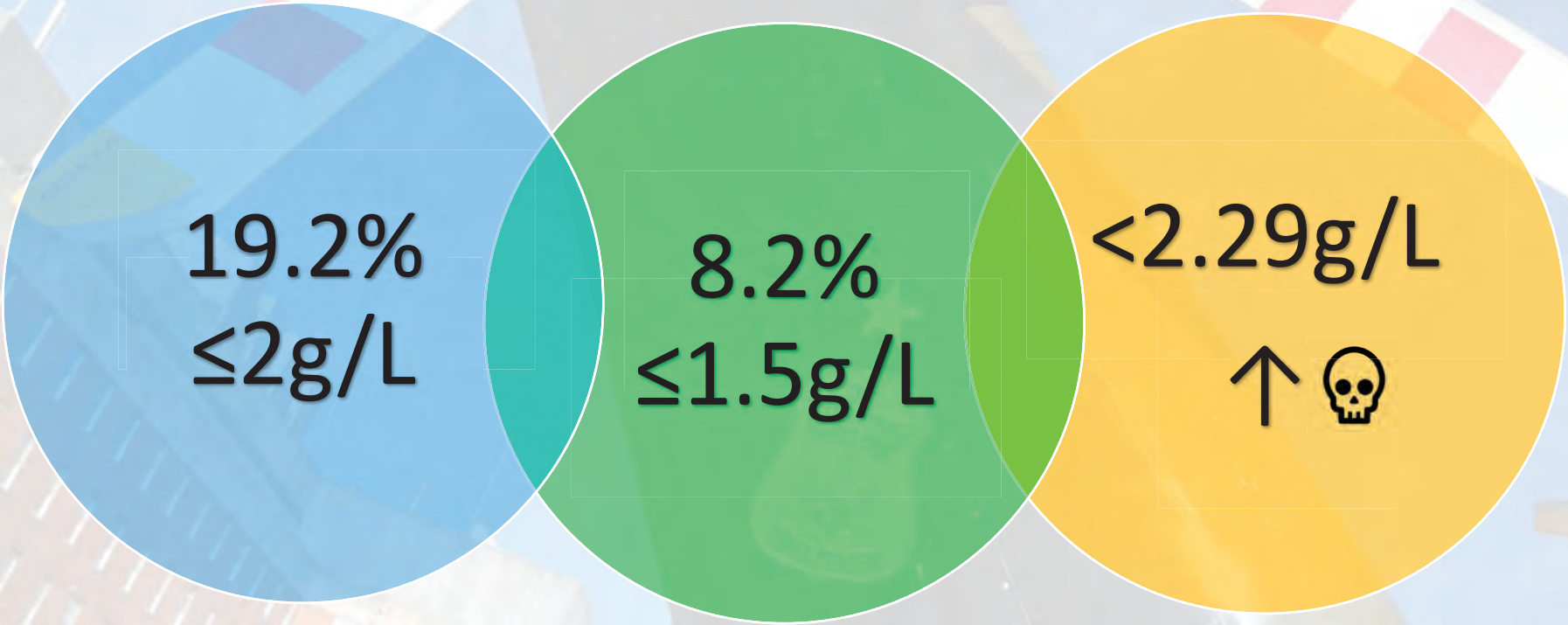
Fibrinogen Concentrate Improves Survival During Limited Resuscitation of Uncontrolled Hemorrhagic Shock in a Swine Model

Nathan J. White[1], Xu Wang[1], W. Conrad Liles[2], and Susan Stern[1]



Prevalence, predictors and outcome of hypofibrinogenaemia in trauma: a multicentre observational study

Jostein S Hagemo[1,2*], Simon Stanworth[3], Nicole P Juffermans[4,5], Karim Brohi[6], Mitchell Jay Cohen[7], Pär I Johansson[8,9], Jo Røislien[1,10], Torsten Eken[11], Paal A Næss[12] and Christine Gaarder[12]



MILITARY MEDICINE, 183, 1/2:e45, 2018

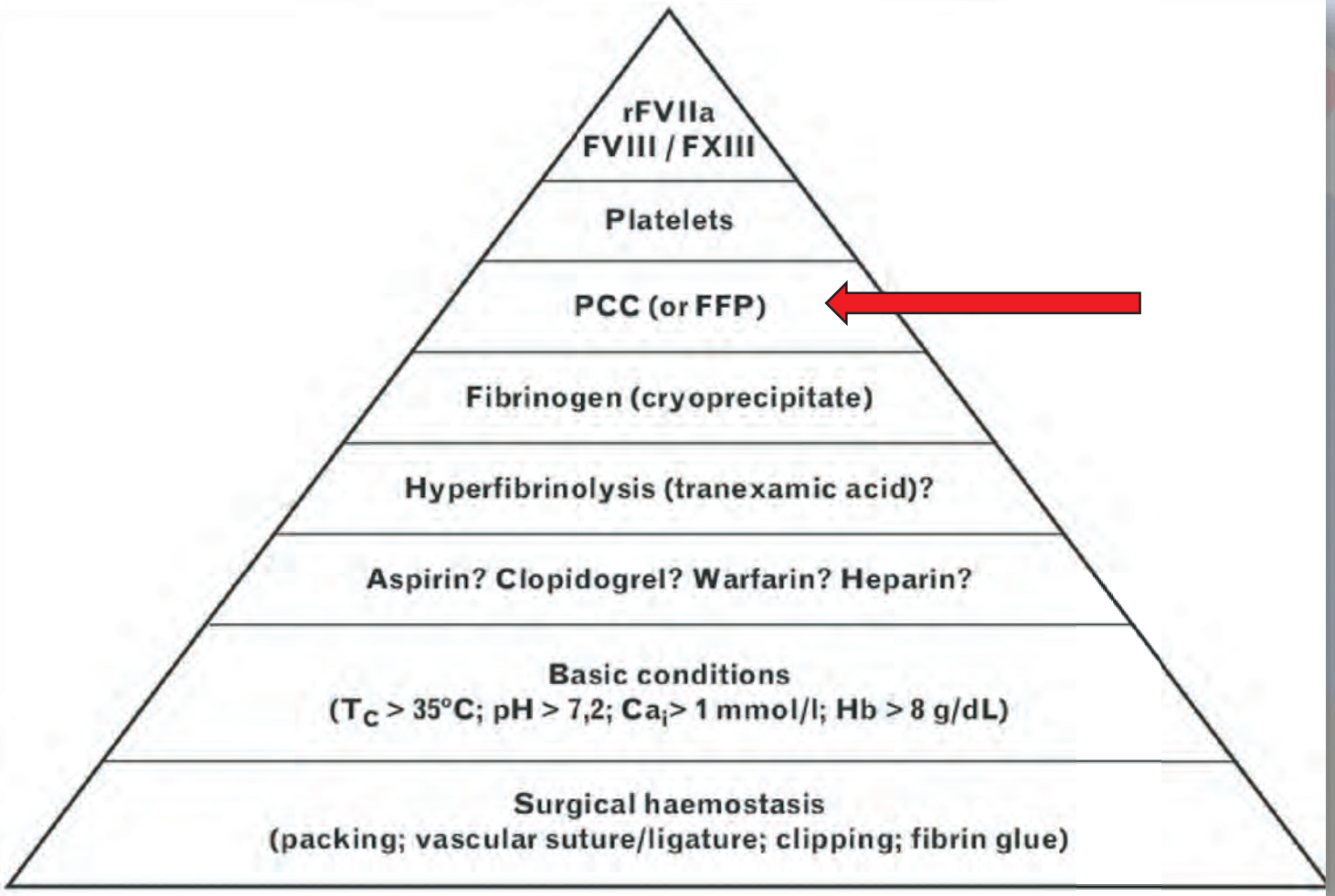
Fibrinogen Concentrate in the Special Operations Forces Environment

Steven Sanders, BSc; COL Homer Tien, MSc, MD, FRCSC†‡; Jeannie Callum, MD, FRCPC‡; Barto Nascimento, MD‡; Henry Peng, PhD§; Chris Funk, MD†; Joanne Schmid, BScN†; Sandro Rizoli, PhD MD, FRCSC‖; Shawn Rhind, PhD‡; LCOL Andrew Beckett, MD, FRCSC*†*

- FC as adjunct to FWB
- No thawing
- No ABO compatibility required
- Excellent safety
- Ease of preparation/transport
- Standard dose
- Long shelf life- 60 months @ 25°C

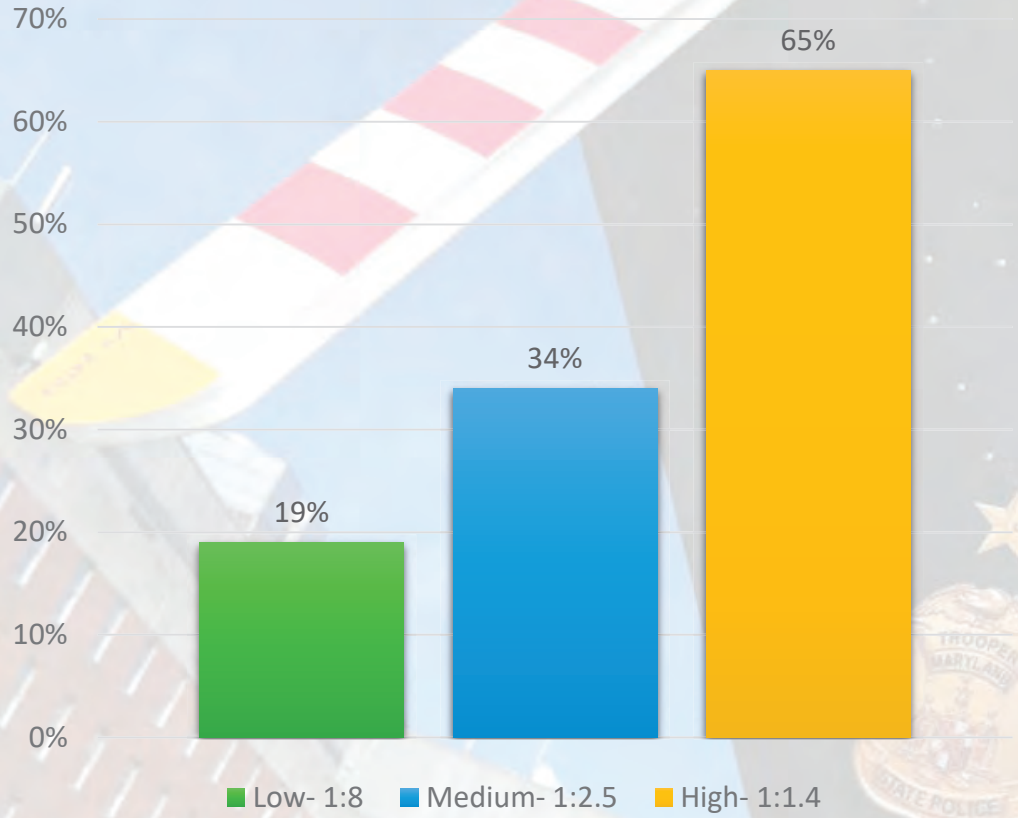
Potential value of transfusion protocols in cardiac surgery

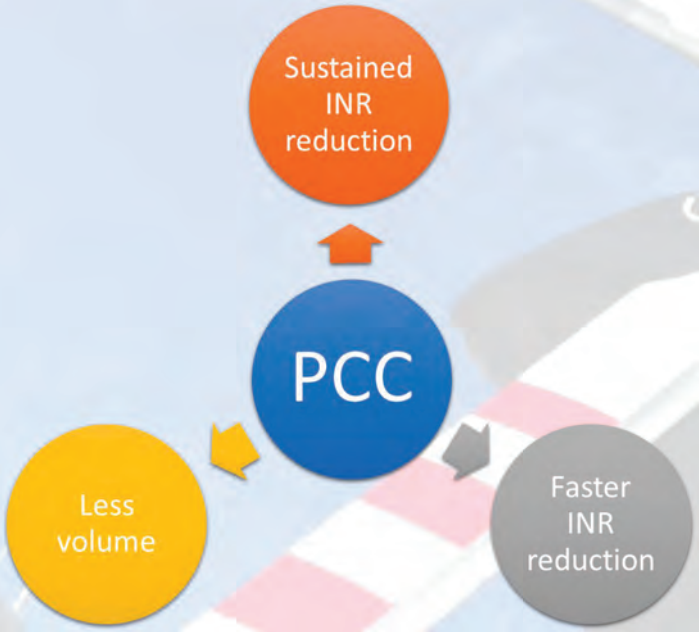
Klaus Görlinger[a], Daniel Dirkmann[a], and Alexander A. Hanke[b]



The Ratio of Blood Products Transfused Affects Mortality in Patients Receiving Massive Transfusions at a Combat Support Hospital

Matthew A. Borgman, MD, Philip C. Spinella, MD, Jeremy G. Perkins, MD, Kurt W. Grathwohl, MD, Thomas Repine, MD, Alec C. Beekley, MD, James Sebesta, MD, Donald Jenkins, MD, Charles E. Wade, PhD, and John B. Holcomb, MD





FASTER ACTING†

- Superior INR reduction at **30 minutes after end of infusion vs plasma**

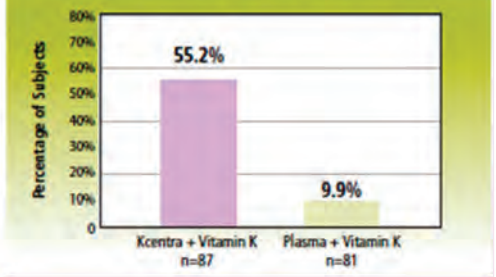
FASTER ADMINISTRATION, LOWER VOLUME

- Mean infusion time is under 25 minutes
- **~85% less volume vs plasma**

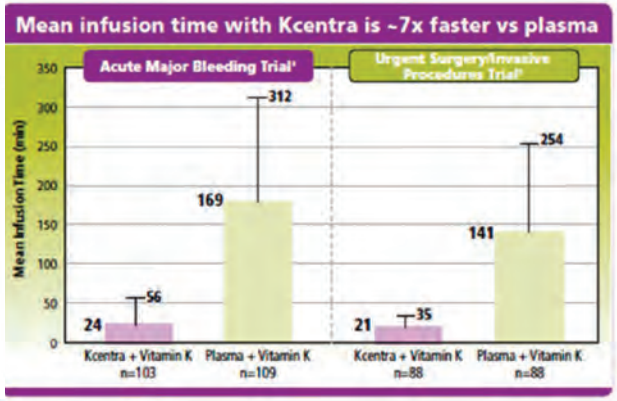
SUSTAINED INR REDUCTION

- Statistically significant INR reduction **sustained ≤1.3 for up to 8 or 12 hours‡ vs plasma**

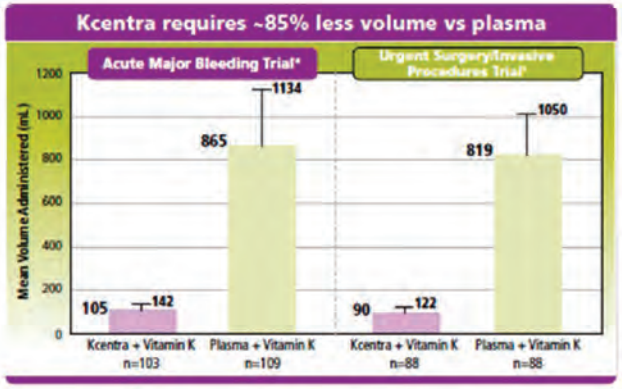
Proportion of subjects experiencing a reduction of INR (≤1.3 at 30 minutes after end of infusion)



Mean infusion time with Kcentra is ~7x faster vs plasma



Kcentra requires ~85% less volume vs plasma



Role of prothrombin complex concentrates in reversing warfarin anticoagulation: A review of the literature

Cindy A. Leissinger,[1]* Philip M. Blatt,[2] W. Keith Hoots,[3] and Bruce Ewenstein[4]

TABLE I. PCCs for Warfarin Reversal: Coagulation Factor Composition

	FII	FVII	FIX	FX	Indication on label
3-Factor PCCs					
Preconativ[a]	84 U	–	100 U	84 U	
Konyne[a]	152 U	16 U	100 U	152 U	
Factor IXa[a]	Unavailable	–	Unavailable	Unavailable	
Prothrombinex HT[b]	100 U	–	100 U	100 U	X
Bebulin[c]	120 U	13 U	100 U	139 U	
Profilnine SD[c]	148 U	11 U	100 U	64 U	
Cofact[d]	~75 U	~25 U	100 U	~75 U	
4-Factor PCCs					
Beriplex P[e]	128 U	68 U	100 U	152 U	
Prothrombinex T[f]	100 U	85 U	100 U	100 U	X
Proplex T[g]	50 U	400 U	100 U	50 U	
Octaplex[d]	44–152 U	36–96 U	100 U	72–120 U	
PPSB-HT[g]	100 U	100 U	100 U	100 U	
Unknown					
Prothromplex[a]	Unavailable	Unavailable	Unavailable	Unavailable	

TABLE III. Current Recommendations for the Use of PCCs for Warfarin Reversal

US 7th ACCP[a] Consensus Conference on Antithrombotic Therapy [35]
- PCCs or rFVIIa for serious or life-threatening bleeding at any INR elevation

UK Guidelines on Oral Anticoagulation [7]
- PCCs (50 IU/kg) for major bleeding

Australian Consensus Guidelines on Warfarin Reversal [14]
- PCCs for clinically significant bleeding, or
- PCCs for INR > 9 without bleeding

Italian Federation of Anticoagulation Clinics [36]
- PCCs for serious bleeding (e.g., CNS, gastrointestinal)

American Journal of Hematology (2008) 83: 137-143

Four-factor prothrombin complex concentrate is associated with improved survival in trauma-related hemorrhage

A nationwide propensity-matched analysis

Zeeshan, Muhammad MD; Hamidi, Mohammad MD; Feinstein, Ara J. MD; Gries, Lynn MD; Jehan, Faisal MD; Sakran, Joseph MD, MPH; Northcutt, Ashley MD; O'Keeffe, Terence MD; Kulvatunyou, Narong MD; Joseph, Bella MD

Journal of Trauma and Acute Care Surgery: August 2019 - Volume 87 - Issue 2 - p 274–281
doi: 10.1097/TA.0000000000002262

	4F-PCC+FFP	FFP
RBC units	6	10
FFP	3	6

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Journal of Trauma and Acute Care Surgery: August 2019 - Volume 87 - Issue 2 - p 274–281
doi: 10.1097/TA.0000000000002262

	FFP alone	PCC + FFP	Sig.
AKI	7.3%	2.1%	.033
ARDS	4.7%	1.3%	.04
DVT	5.5%	3.4%	.11
PE	1.7%	1.3%	.33
Hospital LOS	8 days	5 days	
ICU LOS	1 day	1 day	.21

Comparative Analysis of Prothrombin Complex Concentrate and Fresh Frozen Plasma in Coronary Surgery

↓RBCs

Transfusions 67.2 vs 87.5%

RBCs 2.7 vs 4.9 units

↑AKI

41.4% vs 28.2%

OR 2.3

↓PLTs

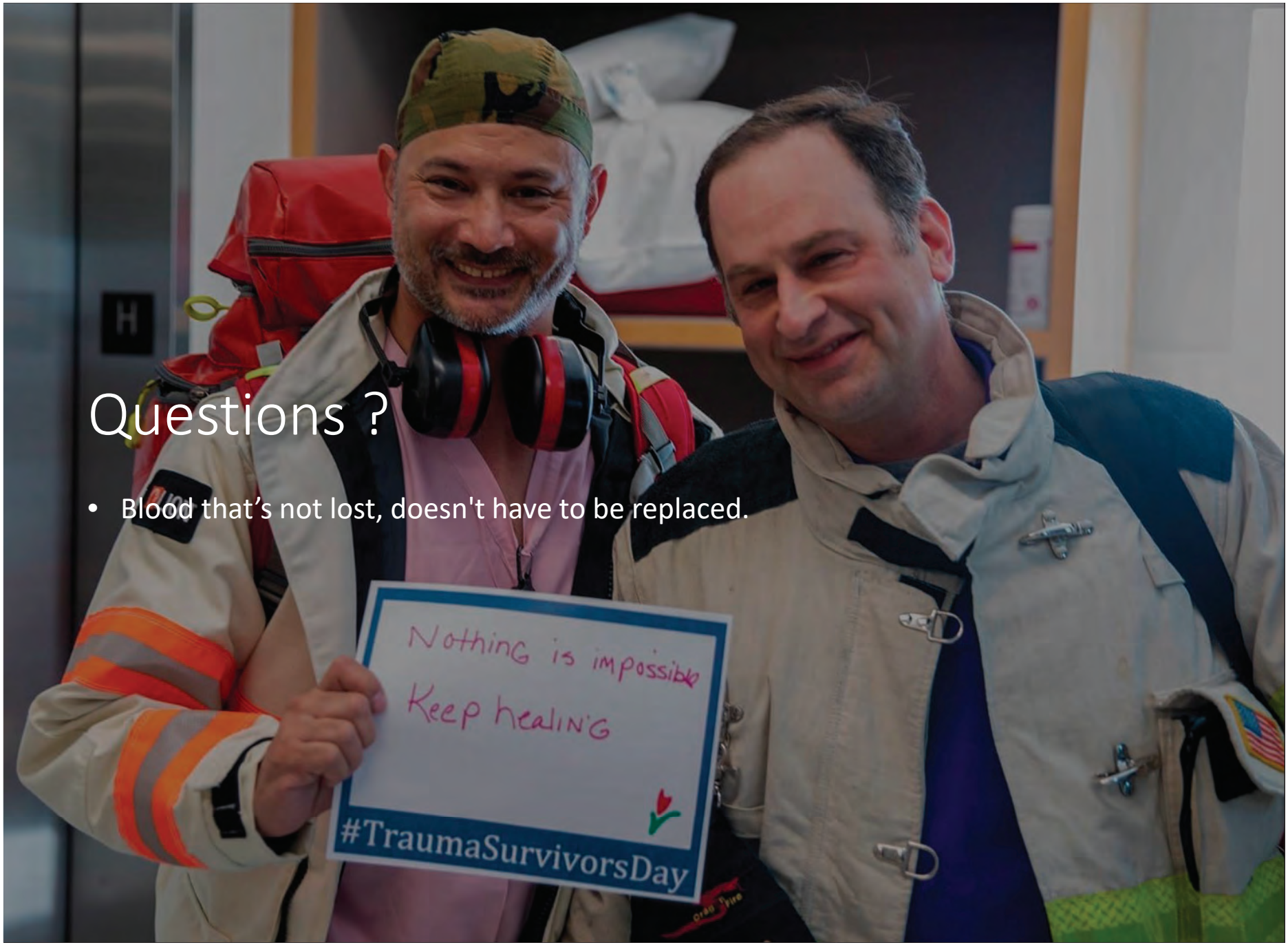
11.8% vs. 45.2%

OR 0.238

Fausto Biancari et al. (2019) *Heart Lung Circ*

Costs of Concentrates

	Cost unit mcg, mg or unit	Cost for 80kg
Fibrinogen concentrate (25-50mg/kg)	$0.85/mg	$1,700-$3,400
PCC (Kcentra) (25-50 units/kg)	$1.39/unit	$2,780-$5,560
APCC (FEIBA) (50-100 units/kg)	$1.58/unit	$6,320-$12,640
rFVIIa (90 mcg/kg)	$1.64/mcg	$ 11,808



Questions ?

- Blood that’s not lost, doesn't have to be replaced.

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