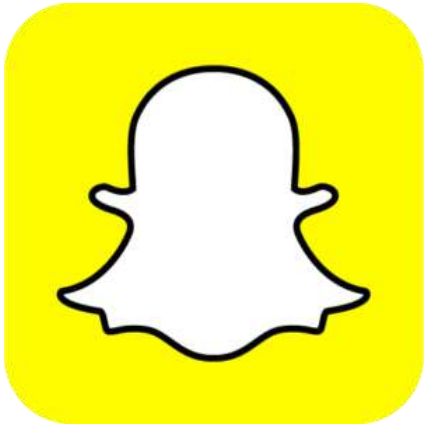
Out of Hospital Hemorrhage Control

Brandon B. Bleess, MD, EMT-T, FAAEM

@BBBleess

PLEASE SHARE!

- #ITLS18
- #FOAMed
- #FOAMems
- #FOANed
- #FOAMpara
- #StopTheBleed



OSF LIFE FLIGHT

EMERGENCY MEDICINE RESIDENCY
PEORIA

DISCLOSURES

- Nothing to disclose
- Will discuss commercially available devices- not an endorsement of any particular product
- Opinions expressed are my own

OBJECTIVES

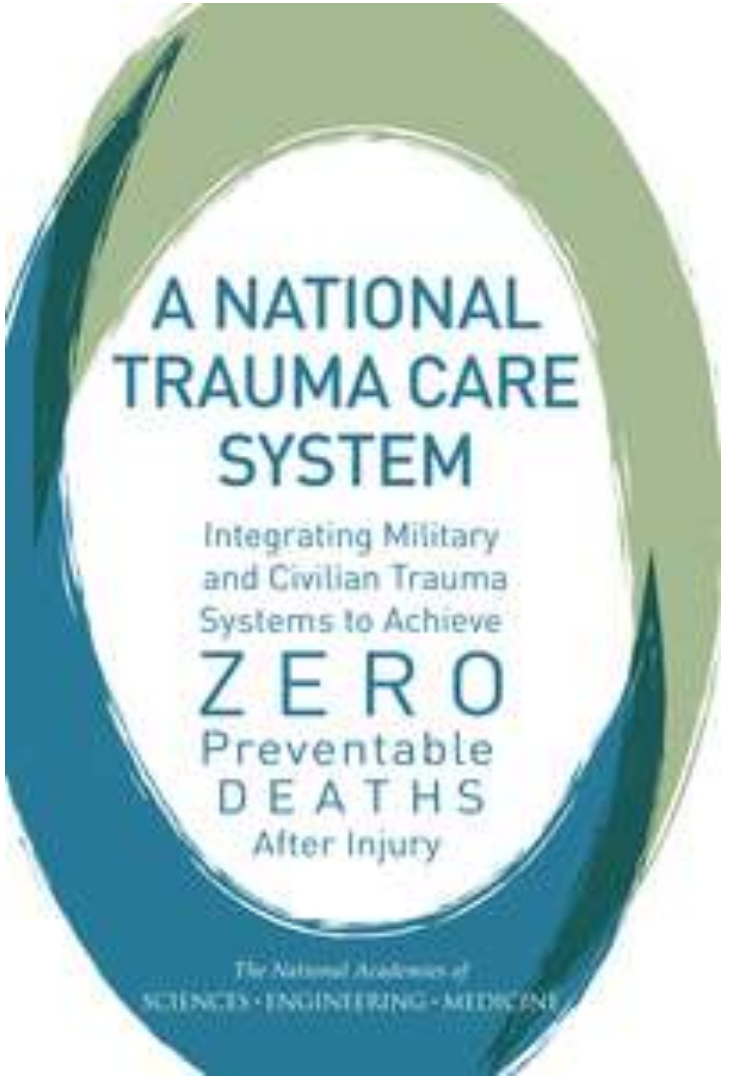
- Understand out of hospital hemorrhage control options with evidence supporting these methods
- Understand methods of patient access and transport options
- Discuss public access hemorrhage control and other public health initiatives related to hemorrhage control

WHY TALK ABOUT THIS?

WHY TALK ABOUT THIS?

ZERO PREVENTABLE DEATHS

- Joint Project in 2016:
  - ACEP
  - ACS
  - NAEMSP
  - NAEMT
  - Trauma Center Association of America
  - Department of Defense
  - Department of Homeland Security
  - Department of Transportation



TOURNIQUETS

TOURNIQUET HISTORY

- *Tourner:* French for to turn
- 4th Century BC-Alexander the Great to control bleeding
- Roman Empire controlled bleeding from limb amputations during war- bronze straps with leather for comfort
- 1785: Sir Gilbert Blane suggested each Royal Navy sailor carry a tourniquet

TOURNIQUET PAST

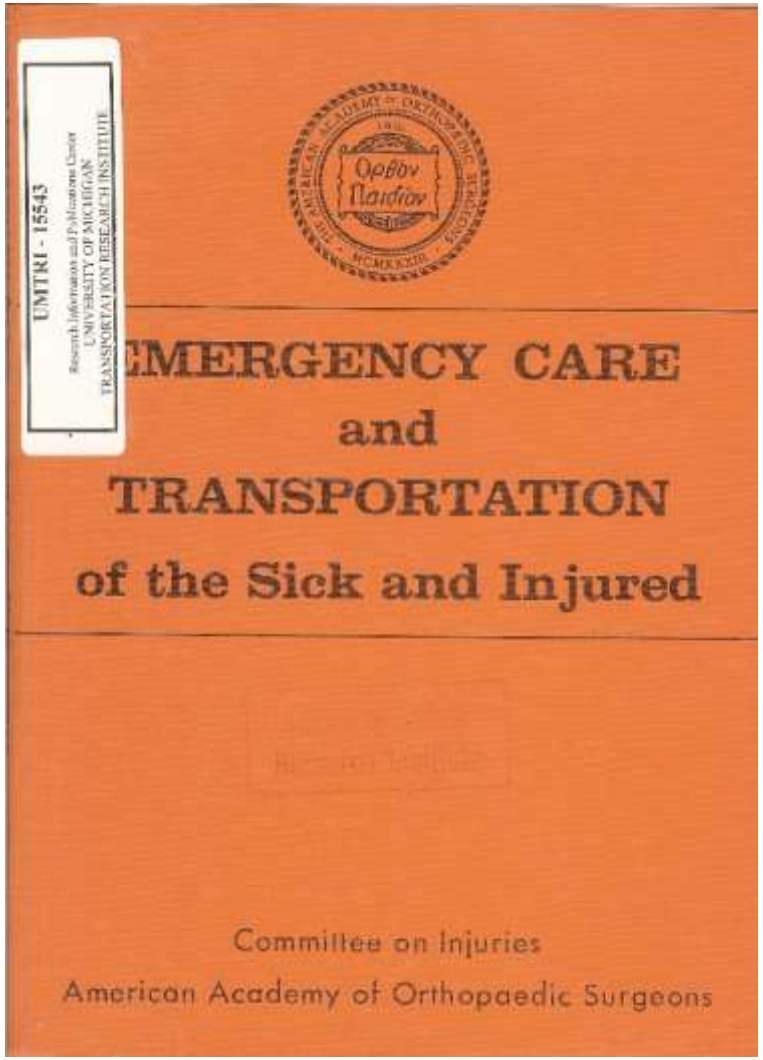
WHAT WOULD JOHNNY AND ROY DO?

FIRST EMS TEXTBOOK

rarily.

Use of a tourniquet. The use of a tourniquet in a case of bleeding is rarely, if ever, necessary. Tourniquets are not recommended because they have sometimes caused damage to nerves and blood vessels, and if left on for any length of time they may result in loss of an arm or leg. If a tourniquet must be used, then it must be properly applied:

1. A triangular bandage should be folded



TOURNIQUET PRESENT

- Change of thought after Somalia where uncontrolled hemorrhage caused 22% of the fatalities
- Between 2005 and 2011, 2,000 American lives saved due to tourniquets in Iraq and Afghanistan
- Frequently noted in recent MCIs

TOURNIQUET FUTURE

Salinas J, US Army ISR, 2014

- iTK- Intelligent Tourniquet
- Can be controlled remotely
- Pneumatic
- Responds to patient's physiology

SHOW ME THE EVIDENCE

- 499 patients with 862 tourniquets applied to 651 limbs
- 87% survival rate
- 1.7% morbidity rates with nerve palsies
- 0.4% major limb shortening
- ***Survival with prehospital application (89% vs. 78%)***
- ***Application before the onset of shock (96% vs. 4%)***

Kragh J, J Emer Med, 2011

MORE EVIDENCE

- 550 injured soldiers and civilians with 125 deaths (22%)
- 91 patients with 110 tourniquets applied
- Eighty-six (78%) tourniquet applications were effective.
  - 94% of tourniquets applied to the upper limbs were effective
  - 71% of tourniquets applied to the lower limbs were effective
- Neurologic complications attributed to tourniquet applications in 7 limbs (6.4%) of 5 patients (5.5%)
- ***No case of death resulting from uncontrolled limb hemorrhage***

Lakstein D, J Trauma, 2003

MORE IDF DATA

- 23 healthy males, combat teams members
  - 11 non-medics
  - 12 medics
- Three tourniquets: IRT, CAT, SOFTT with 828 tourniquet applications
- Medics didn't have any advantage over non-medics
- Assessment scores: CAT > SOFTT > IRT (4.6, 4.0, 2.1)
- Failure rate: CAT > SOFTT > IRT (22%, 23%, 38%)
- Application time: CAT > SOFTT > IRT (18, 26, 52 seconds)

Heldenberg E, Disaster Mil Med, 2015

MORE COMPARISONS

- Effectiveness of tourniquets on a manikin thigh
- Three models of tourniquets
  - Rapid Application Tourniquet System (RATS)
  - Tactical Mechanical Tourniquet (TMT)
  - Combat Application Tourniquet (CAT)
- Two users conducted 30 tests each
- Effectiveness did not differ significantly by model (hemorrhage control and distal pulse cessation)
- Time to hemorrhage control and fluid loss: CAT=TMT > RATS
- CAT applied more pressure than TMT for hemorrhage control

Gibson R, J Spec Oper Med, 2016

WHAT ABOUT THE CHILDREN?

- Retrospective review of 88 pediatric casualties at US military hospitals
- Average Age 11 years (range 4-17 years)
- Survival rate 93% (7 dead and 81 survivors)
- Survivor and dead casualties were similar in all independent variables measured except hospital stay duration (median 5 days vs 1 day)
- Six casualties (7%) had neither extremity or external injury indicating tourniquet use
- Survival rate similar to non-pediatric studies

Kragh J, Pediatr Emerg Care, 2012

PRACTICE MAKES PERFECT

MAYBE NOT THE HOLY GRAIL?

- Retrospective study of 12 public mass shootings
  - Average of 2.7 GSWs, 58% to head and chest vs 20% to extremity
  - Probable fatal wound was head or chest in 77% of cases
- Only 7% had “potentially survivable” wounds
- ***<u>NO DEATHS FROM EXSANGUINATION FROM AN EXTREMITY</u>***
- Pattern is different from combat--solution goes beyond tourniquets

Smith ER, Trauma Acute Care Surg, 2016

CONSISTENT DATA

- 107 victims (49 fatalities, 58 wounded) with 209 total GSWs
- Range of 1-13 GSWs per victim
- Mean 4.2 GSWs
- 6 single wounds (4 head wounds)
- No isolated extremity wounds

COMBAT COMPRESSION BANDAGES

ISRAELI BANDAGE

- Invented by Israeli military medic, Bernard Bar-Natan in 1998
- First used in Bosnia and Herzegovina with NATO
- Standard in US Army since 2003
- Allows pressure to be placed on the wound site

ISRAELI BANDAGE

OLAES MODULAR BANDAGE

- Developed by Ross Johnson, Special Forces Medic in 2006
- Named after Tony Olaes, Special Forces Medic KIA in Afghanistan
- Contains:
  - Occlusive plastic sheet
  - Removable gauze
  - Pressure bar that doubles as eye cup

OLAES MODULAR BANDAGE

SHOW ME THE EVIDENCE

- 10 healthy volunteers as representatives of medics and soldiers
- Evaluated the amount of pressure exerted by bandage with pressure bar over wound and surrounding areas (90° increments)
- Pressure bar very effective in elevating applied pressure while not applying unnecessary pressure over other areas (11.26 vs 30.08 PSI)
- Adding 2 twists increases pressure (14.18 vs 40.39 PSI)
- Perfusion of capillaries in hand and fingers found to be adequate (radial pulse and capillary refill)

Shipman N, Mil Med, 2009

WOUND PACKING

WOUND PACKING

- **Step 1: Stop the bleeding**
  - Immediately apply direct pressure to the wound and place your gloved fingers-with or without a dressing-into the wound to apply initial pressure to the target area and compress the source of bleeding.
- **Step 2: Pack the wound with gauze**
  - Completely and tightly pack the wound cavity to stop hemorrhage. Begin packing the gauze into the wound with your finger, while simultaneously maintaining pressure on the wound.

WOUND PACKING

WOUND PACKING

- **Step 3: Keep packing**
  - The wound should be *very* tightly packed, applying as much pressure as possible to the bleeding vessel. This pressure against the vessel is the most important component of hemorrhage control.
- **Step 4: Apply very firm pressure to the packed wound**
  - This step pushes the packing firmly against the bleeding vessel and aids in clotting.
- **Step 5: Secure a snug pressure dressing**
  - Place a snug pressure dressing over the wound. You may consider splinting or immobilizing the area--possible movement can dislodge the packing and allow hemorrhage to restart.

WOUND PACKING

HEMOSTATIC GAUZE

IDF RESEARCH

- 122 patients--133 hemostatic dressing applications
- 37 dressings (27.8%) junctional areas
- 92 dressings (72.1%) non-junctional areas
- 88.6% (31 of 35 available) successful in junctional areas
- 91.9% (57 of 62 available) successful in extremity applications

Shina A, J Trauma, 2015

HEMOSTATIC DRESSING IN SWINE

- 80 swine in five treatment groups (16 animals each)
- 5 different agents applied with 5 minutes of manual pressure
- Hemodynamic parameters were recorded over 180 minutes
  - Primary endpoints-initial hemostasis &incidence of rebleeding
- 15% (12/80) failed to achieve initial hemostasis
  - Not significantly different between groups (p= 0.11)
- Rebleeding rate 33%

  Not significantly different between groups (p= 0.25)

Littlejohn LF, Acad Emerg Med, 2011

STOP THE BLEED

- Launched in October of 2015
- Partnership between:
  - The White House
  - Department of Defense
  - ACEP
  - ACS-COT
- Effort to encourage bystanders to become trained, equipped, and empowered to help before professional help arrives

STOP THE BLEED

STOP THE BLEED

- Introduced through Presidential Policy Directive 8 (PPD-8)--aimed at strengthening national security through systematic preparation
- Similar to public access defibrillators
- Expand personal and public access to Bleeding Control Kits

STOP THE BLEED

STOP THE BLEED

https://stopthebleed.usuhs.edu

NATIONAL

STOP THE BLEED DAY

March 31

March 31ST, 2018

Supported by:

The Committee on Trauma

NAEMT

UNTIL HELP ARRIVES

ASPR
ASSISTANT SECRETARY FOR PREPAREDNESS AND RESPONSE

U.S. DEPARTMENT OF HOMELAND SECURITY
FEMA

- Launched in May 2017
- Collaboration between:
  - FEMA
  - HHS: ASPR
- Multiple Education Options:
  - Online interactive video course
  - Web-based training course
  - Hands-on, instructor-led training course

OSF LIFE FLIGHT

EMERGENCY MEDICINE RESIDENCY
PEORIA

UNTIL HELP ARRIVES

- Program teaching the public to take these five steps in situations where someone may have a life-threatening injury due to trauma:
  - Call 9-1-1
  - Protect the injured from harm
  - Stop bleeding
  - Position people so they can breathe
  - Provide comfort

IT PLAYS IN PEORIA!

IT PLAYS IN PEORIA!

OSF LIFE FLIGHT

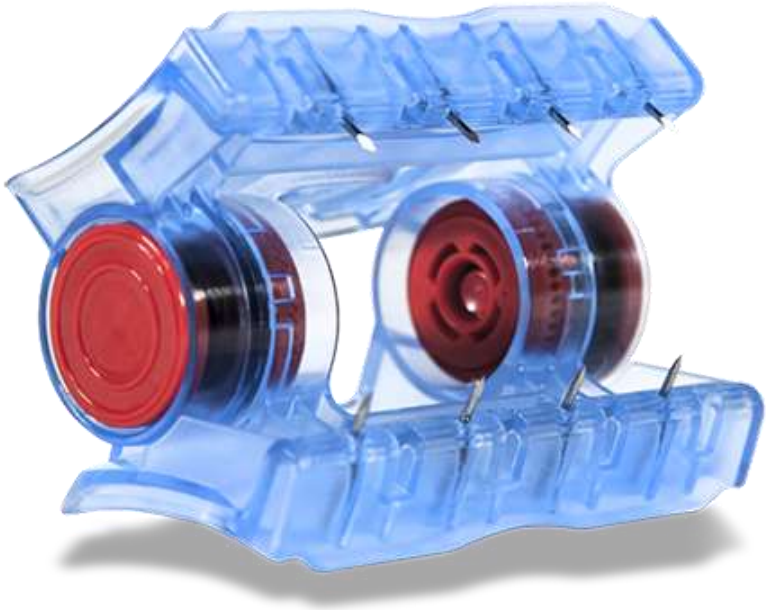
EMERGENCY MEDICINE RESIDENCY
PEORIA

IT PLAYS IN PEORIA!

OSF LIFE FLIGHT

EMERGENCY MEDICINE RESIDENCY
PEORIA

WOUND CLAMP



iTCLAMP

SWINE STUDY

- Lethal hemorrhagic injury to 20 swine
- 100% (10/10) of swine treated with iTClamp survived (Early & Late)
- 60% (3/5) treated with packing with standard gauze survived
- 0% (0/5) survival if the wound was left untreated
- iTClamp Superior:
  - Overall survival ($p<0.009$)
  - Total blood loss ($p=0.008$)
  - Survival time ($p=0.003$)

JUNCTIONAL TOURNIQUETS

JUNCTIONAL TOURNIQUET HISTORY

- Lister Abdominal Tourniquet
- Developed in 1862 by Dr. Joseph Lister
- Lister abandoned the tourniquet because it damaged other organs

JUNCTIONAL TOURNIQUET UASAGE

- World Health Organization states:

  “External aortic compression has long been recommended as a potential life-saving technique, and mechanical compression of the aorta, if successful, slows blood loss. The GDG placed a high value on this procedure as a temporizing measure in the treatment of postpartum haemorrhage.”

EVIDENCE FOR USE

- 2017 swine study using AAJT with 40 subjects– 4 groups of 10
  - Hemorrhage w/wo AAJT and No Hemorrhage w/wo AAJT
- 40% of blood volume removed in hemorrhage group
- All groups received 500 mL bolus x 2 per TCCC guidelines
- AAJT provides favorable hemodynamic profile due to increased afterload support
- No adverse consequences caval compression, bowel injury, pulmonary dysfunction

Rall JM, J Surg Res, 2017

JUNCTIONAL TOURNIQUETS

EVIDENCE FOR USE

- 30 users with 270 tests of simulated hemorrhage from a manikin
- Analyzed hemorrhage control, time to hemostasis, blood loss, & user ranked performance
- CRoC, Junctional Emergency Treatment Tool (JETT), and SAM Junctional Tourniquet (SJT)
- All tourniquet uses were 100% effective for hemorrhage control
- CRoC and SJT performed best in blood loss
- CRoC performed best in time to hemostasis
- Users did not differ in preference of model

Kragh J, Prehosp Disaster, 2016

MORE EVIDENCE FOR USE

- 14 medics used 4 junctional tourniquets:
  - Combat Ready Clamp (CRoC)
  - Abdominal Aortic Junctional Tourniquet (AAJT)
  - Junctional Emergency Treatment Tool (JETT)
  - SAM Junctional Tourniquet (SJT)
- Assessment categories
  - Safety
  - Effectiveness
  - Time to effectiveness
  - Two categories of user preference

- All tourniquet uses were safe
- CRoC and AAJT had the highest percentage effectiveness
- SJT and JETT had fastest mean times to effectiveness
- SJT, AAJT, and JETT most preferred

Chen J, J Spec Oper Med, 2016

MOMENT OF PAUSE

- 2016 swine study with 18 pigs (6 per group)
  - Group 1 with full ventilator support, Group 2 with spontaneous breathing, and Group 3 with spontaneous breathing during but ventilator support turning tourniquet release
- Monitored for 2 hours post 25% controlled hemorrhage and AAJT application
- AAJT produced increased MAPs
- Concerns for ischemia induced hyperkalemia and lactic acidosis (cardiac arrest)—need resuscitation assistance with AAJT removal

Kheirabadi BS, Shock, 2016

JUNCTIONAL TOURNIQUETS

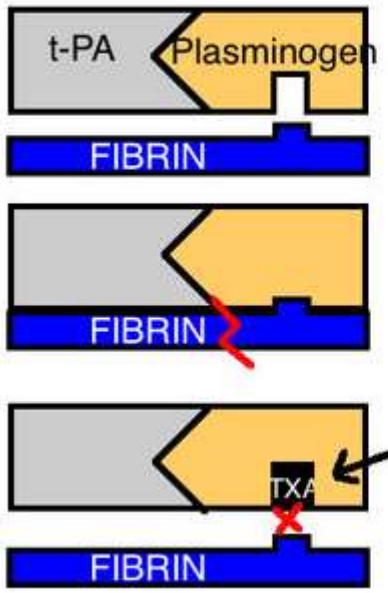
X-STAT

TRANEXAMIC ACID

TRANEXAMIC ACID

- Synthetic analog of lysine
- Antifibrinolytic by reversibly binding four to five lysine receptor sites on plasminogen or plasmin
- Prevents plasmin from binding to and degrading fibrin which preserves the framework of fibrin's matrix structure
- Eight times the antifibrinolytic activity of ε-aminocaproic acid

TRANEXAMIC ACID

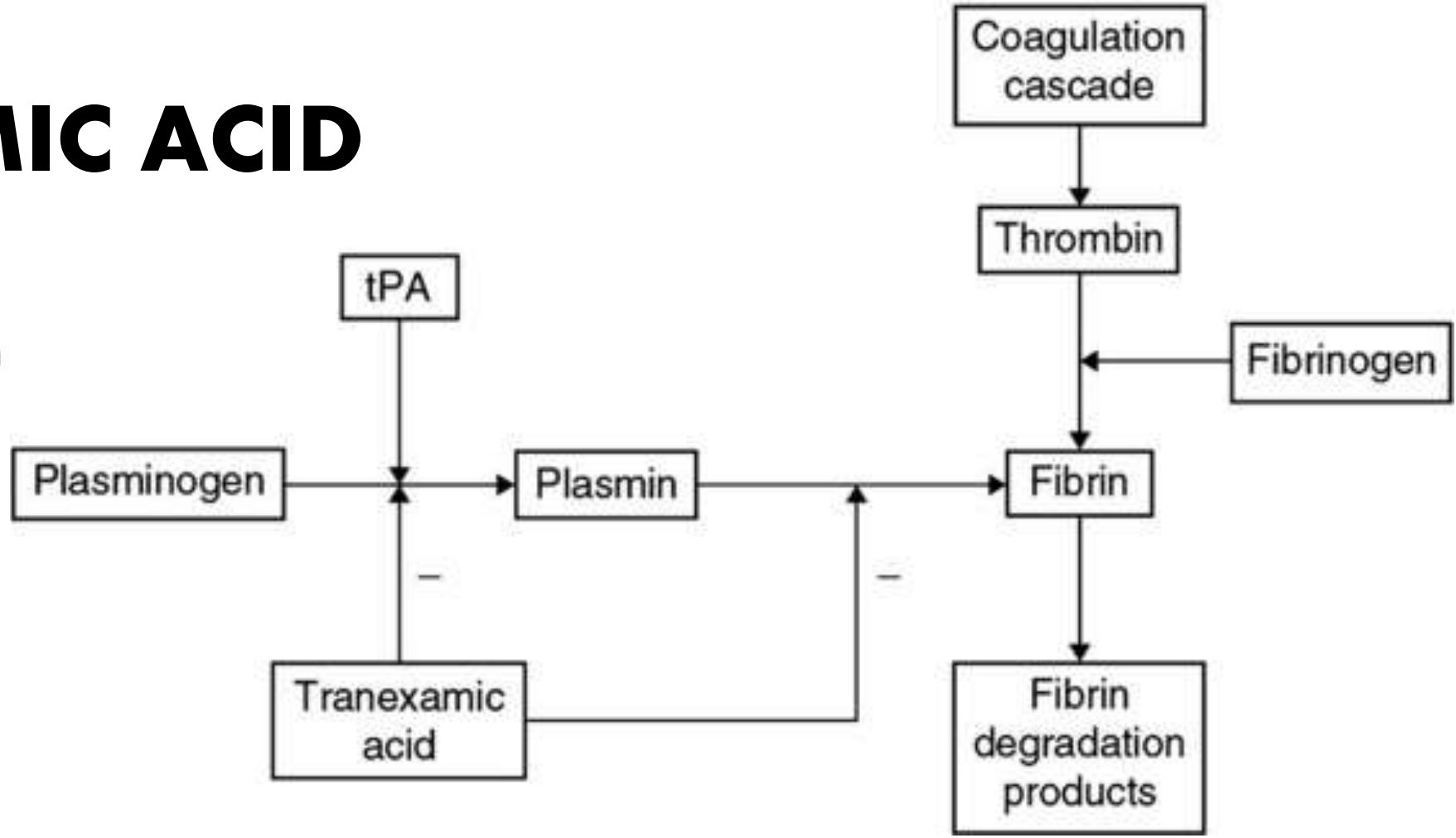


normally...
Activated Plasminogen binds to Fibrin

&

Breaks the Fibrin Clot

TXA interferes with the binding site



CRASH COURSE…

CRASH-2
Clinical Randomisation of an Antifibrinolytic in Significant Haemorrhage

- Multicenter international study of 20,207 trauma patients within 8 hours of injury
- Primary Outcome—Death in hospital or within 4 weeks:
  - 14.5% vs. 16.0% (RR 0.91, 95% CI 0.85–0.97; p=0.0035)
- Secondary Outcomes:
  - Vascular occlusive events: 1.7% vs. 2.0% (p=0.084)
  - Surgical intervention: 47.9% vs 48% (p=0.79)
  - Blood Transfusion: 50.4% vs. 51.3% (p=0.21)

CRASH COURSE…

CRASH-2
Clinical Randomisation of an Antifibrinolytic in Significant Haemorrhage

- Second publication with a priori subgroup analysis
- Death due to bleeding:
  - <1 hour from injury: 5.3% vs. 7.7% (RR 0.68, 95% CI 0.57-0.82; p<0.0001)
  - 1-3 hours from injury: 4.8% vs.6.1% (RR 0.79, 95% CI 0.64-0.97; p<0.0001)
  - >3 hours from injury: 4.4% vs. 3.1% (RR 1.44, 95% CI 1.12-1.84; p<0.0001)
- All-cause mortality:
  - <1 hour from injury: RR 0.87, 95% CI 0.76-0.97
  - 1-3 hours from injury: RR 0.87, 95% CI 0.77-0.97
  - >3 hours from injury: RR 1.00, 95% CI 0.90-1.13

TXA MATTERS…

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

- 896 patients looking at 24 hour, 48 hour, and in-hospital mortality
- TXA: 293 patients and Non-TXA: 603 patients
  - Massive Transfusion & TXA : 125 patients
  - Massive Transfusion & Non-TXA: 196 patients
- Injury Severity Score: 25.2 vs. 22.5 ($p < .001$)
- TXA independently associated with survival (OR= 7.228; 95% CI, 3.016-17.322)

TXA MATTERS…

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

- Mortality TXA vs. Non-TXA:
  - 24 hours: 9.6% vs. 12.4% (p=0.2)
  - 48 hours: 11.3% vs 18.9% (p=0.004)
  - In-hospital: 17.4% vs 23.9% (p=0.03)
- Mortality TXA vs. Non-TXA in Massive Transfusion
  - 24 hours: 9.6% vs 14.8% (p=0.17)
  - 48 hours: 10.4% vs. 23.5% (p=0.003)
  - In-hospital: 14.4% vs. 28.1% (p=0.004)

TXA MATTERS…

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

- 24-hr transfusion mean:
  - PRBCs:
    - TXA: 11.8 (21 in Massive Transfusion)
    - Non-TXA: 9.8 (22.5 in Massive Transfusion)
  - FFP:
    - TXA: 10.3 (11.5 in Massive Transfusion)
    - Non-TXA: 8.6 (14.3 in Massive Transfusion)

- Pulmonary Embolisms: TXA-8 vs. Non-TXA-2
- Deep Venous Thrombosis: TXA: 7 vs. Non-TXA: 1

Gayet-Ageron A, Lancet, 2017

META ANALYSIS

- Meta-analysis of 2 randomized trials with more than 1000 patients each (CRASH-2 and WOMAN)
- 40,138 patients total
  - CRASH-2: 20,127 patients
  - WOMAN: 20,011 patients
- 3,558 total deaths
  - 1,408 (40%) of deaths from bleeding
  - 884 (63%) of the bleeding deaths occurred within 12 hours of onset

META ANALYSIS

- Overall Survival from Bleeding:
  - 96.6% vs. 96.0%
  - OR 1.20; 95% CI 1.08 – 1.33; p = 0.001
- Vascular Occlusive Events
  - 0.2% vs. 0.3%
  - OR 0.73; 95% CI 0.49 – 1.09; p=0.1204
- Effect of Treatment Delay on Survival:
  - Survival decreased by 10% with every 15 minutes of treatment delay until 3 hours

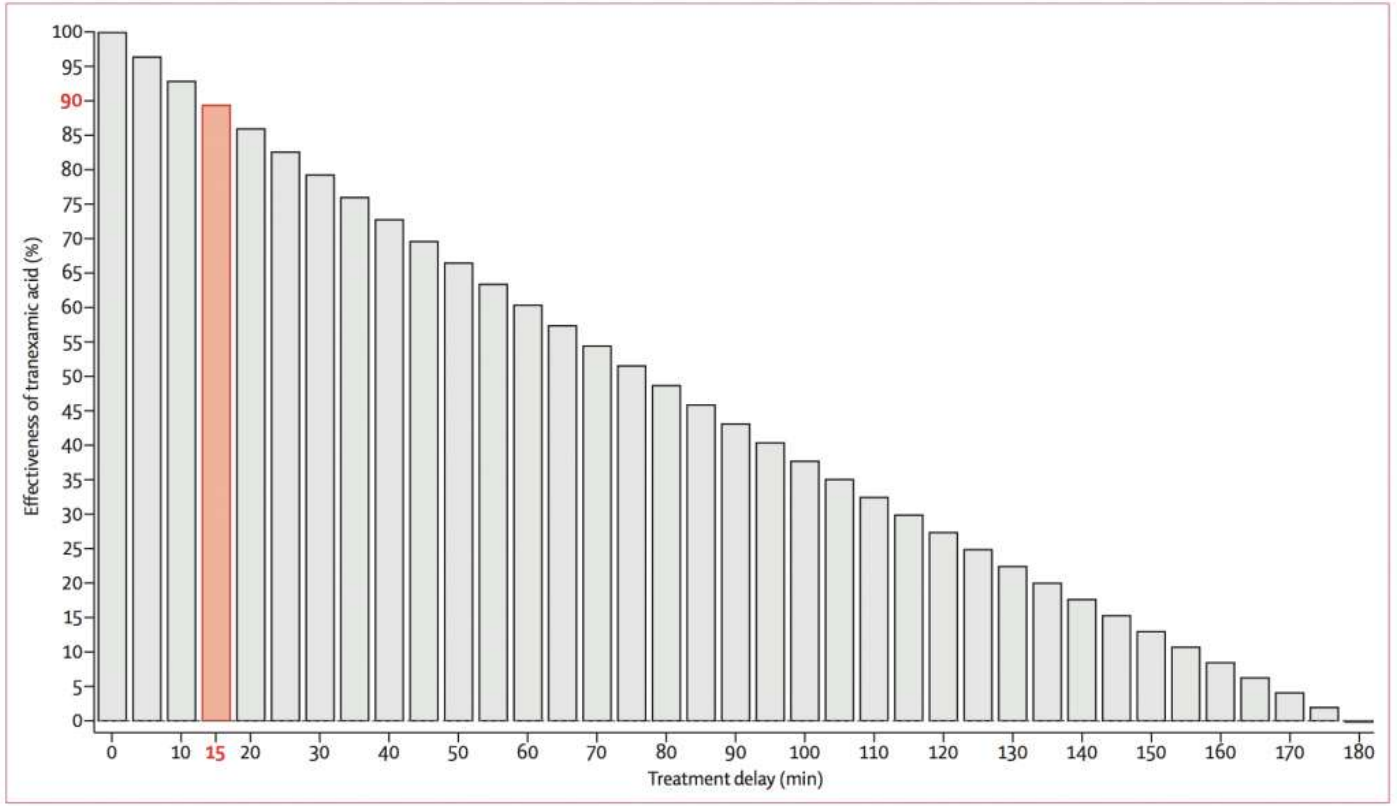


Figure 4: **Reduction in effectiveness of tranexamic acid with increasing treatment delay**
The bars represent the estimated treatment effectiveness (y-axis, estimated by [(OR at time *t*−1)/ (OR at *t* = 0−1) × 100] in %) at 5-min intervals of treatment delay. The bar highlighted in red shows the estimated treatment effectiveness (90%) with a treatment delay of 15 min.

Gayet-Ageron A, Lancet, 2017

A MOMENT FOR PAUSE?

- 455 US military casualty patients
- 173 patients (38.0%) received a massive transfusion and 139 (30.5%) received TXA
- Tranexamic acid administration was an independent risk factor for venous thromboembolism (OR 2.58; 95% CI, 1.20-5.56; p= .02)

Johnston L, JAMA Surgery, 2017

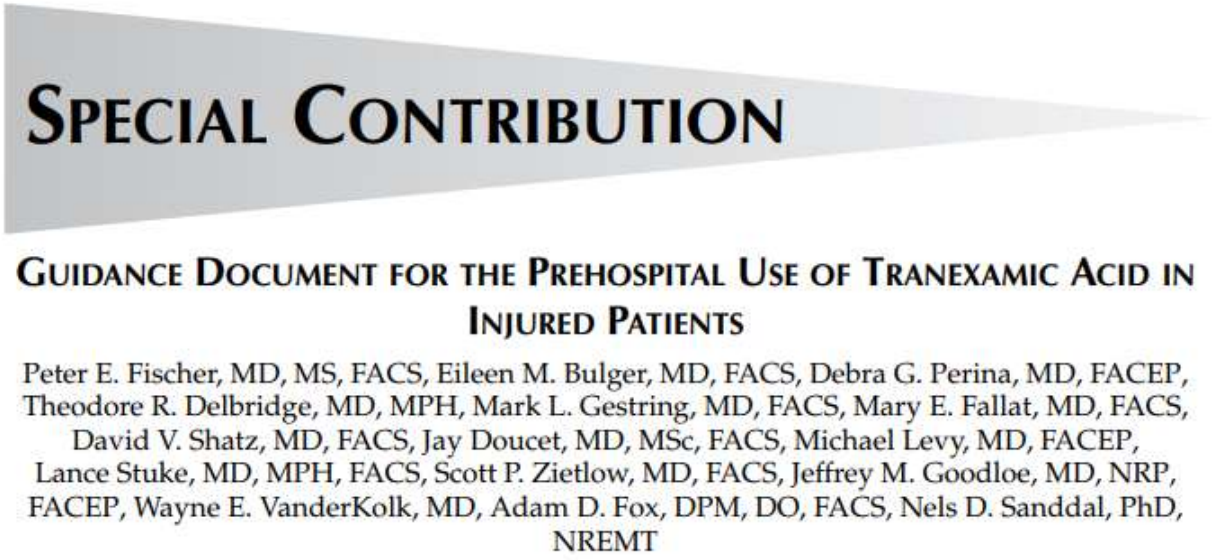
A MOMENT FOR PAUSE?

- 3,775 combat trauma patients
- No statistically significant association between TXA use and mortality
- TXA associated with increased risk of DVT in total sample (HR, 2.00; 95% CI, 1.21-3.30; p= 0.02)
- TXA associated with increased risk of PE in total sample (HR, 2.82; 95% CI, 2.08-3.81; p< 0.001)

Howard J, J Trauma, 2017

GUIDANCE ON PREHOSPITAL USAGE

- Joint statement from:
  - NAEMSP
  - ACEP
  - ACS-COT
- Insufficient evidence to support or refute prehospital
- System integration key
- TXA in pediatric patients not recommended outside of research



SPECIAL CONTRIBUTION

GUIDANCE DOCUMENT FOR THE PREHOSPITAL USE OF TRANEXAMIC ACID IN INJURED PATIENTS

Peter E. Fischer, MD, MS, FACS, Eileen M. Bulger, MD, FACS, Debra G. Perina, MD, FACEP, Theodore R. Delbridge, MD, MPH, Mark L. Gestring, MD, FACS, Mary E. Fallat, MD, FACS, David V. Shatz, MD, FACS, Jay Doucet, MD, MSc, FACS, Michael Levy, MD, FACEP, Lance Stuke, MD, MPH, FACS, Scott P. Zietlow, MD, FACS, Jeffrey M. Goodloe, MD, NRP, FACEP, Wayne E. VanderKolk, MD, Adam D. Fox, DPM, DO, FACS, Nels D. Sanddal, PhD, NREMT

WHAT ABOUT OUR KIDDOS?

- 766 patients 18 years or younger
- 66 (9%) received TXA
- TXA associated with decreased mortality (OR, 0.27; 95% CI, 0.85–0.89; p= 0.03)
- Similar trend for severely injured (ISS > 15) and transfused patients
- No difference in thromboembolic complications or other cardiovascular events
- TXA demonstrated significant improvements in discharge neurologic status as well as decreased ventilator dependence (6% vs. 22%; p< 0.01)

Eckert MJ, J Trauma, 2014

WHAT ABOUT OUR KIDDOS?

- The Royal College of Pediatrics and Child Health in the United Kingdom issued an Evidence statement in November 2012 entitled *"Major trauma and the use of tranexamic acid in children"*
- Dosages:
  - 12 y/o or older: 1 g loading dose over 10 minutes within the first 3 hours post-injury, followed by a 1 g infusion over 8 hours
  - <12 y/o: Loading dose of 15 mg/kg (maximum dose 1 g) followed by an infusion of 2 mg/kg/hour for at least 8 hours or until the bleeding stops

TXA PROTOCOLS

- Indications: Symptomatic trauma patients
- Initial Bolus 1g over 10 minutes
- Infusion of 1g over 8 hours

Tranexamic Acid Protocol
ALS ONLY

Indications:
Any trauma patient ≥ 14 years of age, at high risk for ongoing internal hemorrhage and meeting one or more of the following criteria:

- Systolic BP < 90mmHg
- Patients ≥ 65 years of age with systolic BP < 110mmHg.
- Tachycardia > 120 beats per minute with signs of hypoperfusion (confusion, altered mental status, cool extremities, etc.)

Contraindications:

- Injuries > 3 hours old.
- Evidence of Disseminated Intravascular Coagulation (DIC)
- Patients < 14 years of age.
- Hypersensitivity to the drug.

1. **How Supplied**: 10mL vial containing 1000mg
2. **Preparation**: Mix 1000mg of TXA in 250 mL of 0.9% Normal Saline.
3. **Administration**: Infuse over 10 minutes
    - 10 gtts/mL tubing at a drip rate of 4 gtts/second.
    - Infusion pump (if available) at 1500mL/hr.
4. Notify receiving hospital of TXA administration.
5. Clearly document mechanism of injury, time injury/incident occurred, indications for use and time TXA was administered.

PREHOSPITAL BLOOD PRODUCTS

EVIDENCE FOR BLOOD

- 2016 study with 1,440 critical care transports with transfusion
- 81% medical patients (GI Bleed Most Common-26%)
- Transfusions in 3 groups (<350 mL, 350-700 mL, >700 mL)
- Looked at associations between mortality, subsequent transfusions, emergency surgery
- Emergent Surgery (OR 1.81, 95% CI 1.31-2.5)
- In-Hospital Transfusion (OR 2.00, 95% CI 1.46-2.76)
- >700 mL and emergent surgery (OR 1.79, 95% CI 1.10-2.92) and mortality (OR 2.11, 95% CI 1.21-3.69)

Mena-Munoz J, Prehosp Emerg Care, 2016

EVIDENCE FOR BLOOD

- 502 US military combat casualties in Afghanistan between April 1, 2012 and August 7, 2015
  - 55 received transfusions prehospital and 447 did not receive transfusions
  - 345 that did not receive transfusion frequency matched to transfusion group
- Entire study population:
  - 24 hours MEDEVAC, 3/55 (5%) prehospital transfusion recipients died, 85/447 (19%) non-recipients (Between group difference -14%; 95% CI -21% to -6%; p=0.01)
  - 30 days MEDEVAC, 6 prehospital transfusion recipients died (11%), 102 non-recipients (23%) (Between group difference -12%; 95% CI -21% to -2%; p=0.04)

Shackelford SA, JAMA, 2017

EVIDENCE FOR BLOOD

- Matched study cohorts:
  - 24 hours MEDEVAC, 3 (5%) prehospital transfusion recipients died, 69 (20%) matched non-recipients (Between group difference -15%; 95% CI -22% to -7%; p=0.007)
  - 30 days MEDEVAC, 6 (11%) prehospital transfusion recipients died, 78 (23%) matched non-recipients (Between group difference -12%; 95% CI -21% to -2%; p=0.05)
- Survival analysis:
  - Among the 386 patients within the matched groups, adjusted hazard ratio for mortality was 0.26 (95% CI 0.08 to 0.84; p=0.02) within the first 24 hours. Within the first 30 days, the adjusted hazard ratio for mortality was 0.39 (95% CI 0.16 to 0.92; p=0.03).
- Time to first transfusion:
  - Time to initial transfusion was associated with reduced mortality within 24 hours only up to the first 15 minutes after MEDEVAC (Adjusted hazard ratio 0.17 95% CI 0.04-0.73; p = 0.02)

Shackelford SA, JAMA, 2017

PREHOSPITAL BLOOD

- 8,536 potential patients, 1,677 eligible.
- Represent the most severely injured patients
  - Injury severity score of > 24 and mortality rates of 26%
- Varying Transports
  - 716 were transported by Hermann LifeFlight
  - 169 were transported by other air ambulances
- Only 19% (137/716) of LifeFlight patients given blood products
- 942 units (244 RBCs and 698 plasma) on LifeFlight helicopters with 1.9% waste rate
- Decreased mortality trend at 6-hour (OR 0.23, 95% C.I. 0.106–1.056, p=0.088)
  - Admitted to the ICU/IR/OR/Morgue: 6-hour mortality was lower among those transported by LifeFlight (OR 0.23, 95% CI 0.062–0.890, p=0.033)

Holcomb J, Prehosp Emerg Care, 2015

EVIDENCE FOR PLASMA

- Multi-Center study with 501 qualified patients at risk for hemorrhagic shock from 2014-2017 from 27 air medical transport bases
- 2 units of universal donor plasma versus crystalloid resuscitation
- 230 received plasma and 271 received crystalloid resuscitation
- Average prehospital time was 40 minutes (95% CI 33-51) in the plasma group and 42 minutes (95% CI 34 to 53) in the standard group

Sperry JL, N Engl J Med, 2018

EVIDENCE FOR PLASMA

- Mortality at 30 days significantly lower in plasma group (23.2%) versus standard group (33.0%)
- Absolute reduction was 9.8% in plasma group (95% CI 1.0 to 18.6%; P=0.03)
- Median INR was lower in plasma group compared to standard group (1.2 vs 1.3; p<0.001)
- No significant difference found in outcomes with respect to other variables (multi organ failure, acute lung injury/ARDS, transfusion-related reactions)
- Number needed to treat (NNT) 10

Sperry JL, N Engl J Med, 2018

BLOOD PRODUCTS

- Many Flight Systems are carrying blood products
- 2 Ground EMS Systems carrying blood products
- In first two months CCEMS transfused blood products 12 times:
  - 4 auto-vs.-pedestrian accidents
  - 1 fall from height
  - 1 gunshot wound
  - 1 motor vehicle incident with entrapment
  - 1 laceration from an assault
  - 1 cardiac arrest from bleeding related to cancer
  - 3 cases of hemorrhagic shock related to internal/GI bleeding
- 11/12 arrived at the hospital alive

WHY WHOLE BLOOD?

- Whole blood is superior to crystalloids and colloids
- Administration is easier than blood components. Whole blood is simplest way to deliver the functionality of lost blood back to the patient
  - Serious Hazards of Transfusion (SHOT) study from the U.K. found that 78% of the incident reports resulted from human error
- Safety of whole blood is similar to component therapy
  - U.S. military has successfully transfused over 10,000 units of whole blood across the world

NON-TRADITONAL TRANSPORT

NON-TRADITONAL TRANSPORT

- Identified penetrating trauma patients with OR for mortality with police vs. EMS transport in the National Trauma Databank
- 88,564 total patients
  - 97% transported by EMS
  - 2.8% transported by PD

Wandling MW, J Trauma, 2016

NON-TRADITONAL TRANSPORT

- Unadjusted mortality: 17.7% for PD transport and 11.6% for EMS
- After risk adjustment PD transport no increased in mortality (OR=1.00, 95% CI: 0.69-1.45)
- 87.8% of PD transports in 3 cities (Philadelphia, Sacramento, and Detroit)
  - Unadjusted mortality: 19.9% for PD transport and 13.5% for EMS
  - Risk Adjusted mortality no difference (OR=1.01, 95% CI 0.68-1.50)

Wandling MW, J Trauma, 2016

RECENT DATA

- PD transported 30% of victims at Pulse (15 patients)
- Aurora movie theater-60 victims to hospital
  - 27-28 PD
  - 13-14 POV
  - 20 EMS

QUESTIONS?

Brandon.B.Bleess@osfhealthcare.org

BBBleess

REFERENCES

- Elster EA, Butler FK, Rasmussen TE. Implications of Combat Casualty Care for Mass Casualty Events. *JAMA.*2013;310(5):475–476.
- National Academies of Sciences, Engineering, and Medicine. 2016. *A national trauma care system: Integrating military and civilian trauma systems to achieve zero preventable deaths after injury.* Washington, DC: The National Academies Press.
- Kragh JF Jr, Littrel ML, Jones JA, et al. Battle casualty survival with emergency tourniquet use to stop limb bleeding. J Emerg Med. 2011 Dec;41(6):590-7.
- Committee on Injuries, American Academy of Orthopedic Surgeons. Emergency care and transportation of the sick and injured. W.B Saunders Co.: Philadelphia, Pa., 1971.
- Smith ER, Shapiro G, Sarani B. The profile of wounding in civilian public mass shooting fatalities. J Trauma Acute Care Surg. 2016 Jul;81(1):86-92.
- Mabry RL, Holcomb JB, Baker AM, et al. United States Army Rangers in Somalia: an analysis of combat casualties on an urban battlefield. *J Trauma*. 2000;49:515–528; discussion 528–529.

REFERENCES

- Heldenberg E, Aharon S, Wolf T, Vishne T. Evaluating new types of tourniquets by the Israeli Naval special warfare unit. Disaster Mil Med. 2015 Jan 27;1:1.
- Gibson R, Housler GJ, Rush SC, Aden JK 3rd, Kragh JF Jr, Dubick MA. Preliminary Comparison of New and Established Tacticla Tourniquets in Manikin Hemorrhage. J Spec Oper Med. 2016 Spring;16(1):29-35.
- Shipman N, Lessard CS. Pressure applied by the emergency/Israeli bandage. Mil Med. 2009 Jan;174(1):86-92.
- Kragh JF Jr, Cooper A, Aden JK, Dubick MA, Baer DG, Wade CE, Blackbourne LH. Survey of trauma registry data on tourniquet use in pediatric war casualties. Pediatr Emerg Care. 2012 Dec;28(12):1361-5.
- Blane G(1785). Observations on the diseases incident to seamen. London: Joseph Cooper; Edinburgh: William Creech. pp. 498–499.
- Lakstein D, Blumenfeld A, Sokolov T, et al. Tourniquets for hemorrhage control on the battlefield: a 4-year accumulated experience. *J Trauma*. 2003;54(5 suppl):S221–S225.

REFERENCES

- Hunter C. #OrlandoUnited: Coordinating the medical response to the Pulse nightclub shooting. Lecture presented at; 2017; NAEMSP Annual Conference.
- Wipfler III, E. John; Wipler, E. John; Campbell, John E.; Lawrence E. Heiskell (2010). *Tactical Medicine Essentials*. Jones & Bartlett Learning. p. 158.
- Horowitz D. (2011-04-29). "Editor's Notes: The guy with the bandage". The Jerusalem Post. Retrieved Jan 17, 2018.
- Schmidt MS. (January 19, 2014). "Reviving a Life Saver, the Tourniquet". New York Times.
- Fischer PE, Bulger EM, Perina DG, Delbridge TR, et al. Guidance Document for the Prehospital Use of Tranexamic Acid in Injured Patients. Prehosp Emerg Care. 2016 Sep-Oct;20(5):557-9.
- Roberts I, et al. The importance of early treatment with tranexamic acid in bleeding trauma patients: an exploratory analysis of the CRASH-2 randomised controlled trial. Lancet. 2011; 377(9771):1096-10.

REFERENCES

- Morrison JJ, Dubose JJ, Rasmussen TE, Midwinter MJ. Military Application of Tranexamic Acid in Trauma Emergency Resuscitation (MATTERs) Study. Arch Surg. 2012;147(2): 113-9.
- Gayet-Ageron A et al. Effect of Treatment Delay on the Effectiveness and Safety of Antifibrinolytics in Acute Severe Haemorrhage: A Meta-Analysis of Individual Patient-Level Data From 40138 Bleeding Patients. Lancet 2017.
- Shina A, Lipsky AM, NAdler R, Levi M, et al. Prehospital use of hemostatic dressings by the Isreal Defense Forces Medical Corps: A case series of 122 patients. J Trauma Acute Care Surg. 2015 Oct;79(4 Suppl 2):S204-9.
- Filips, D., Logsetty, S., Tan, J., Atkinson, I., & Mottet, K. (2013). The iTClamp Controls Junctional Bleeding in a Lethal Swine Exsanguination Model. Prehospital Emergency Care, 17(4), 526-532.
- Wandling MW, Nathens AB, Shapiro MB, Haut ER. Police transport versus ground EMS: A trauma system-level evaluation of prehospital care policies and their effect on clinical outcomes. J Trauma Acute Care Surg. 2016 Nov;81(5):931-935.
- “Trauma medicine has learned lessons from the battlefield". The Economist. 12 October 2017.

REFERENCES

- Galvan, Steven. “Tourniquets of the Future: Intelligent.” *U.S. Institute of Surgical Research*, 3 May 2012, www.usaisr.amedd.army.mil/news/news_stories/NOV2012_Tourniquets_of_the_Future.html.
- Hardesty, Abe. “Army Medic's Tactical Equipment Company Saves Lives on the Battlefield.”*EMS1*, 7 Aug. 2015, www.ems1.com/ems-products/medical/equipment/services/articles/3021971-Army-medics-tactical-equipment-company-saves-lives-on-the-battlefield.
- Korompilas AV, Beris AE, et al. The mangled extremity and attempt for limb salvage. J Orthop Surg Res. 2009 Feb 13;4:4.
- Taillac P, Bolleter S, Heightman AJ. Wound packing essentials for EMTs and Paramedics. JEMS. 42 (4), 2017.
- Littlejohn LF, Devlin JJ, Kircher SS, Lueken R, Melia MR, Johnson AS. Comparison of Celox-A, ChitoFlex, WoundStat, and combat gauze hemostatic agents versus standard gauze dressing in control of hemorrhage in a swine model of penetrating trauma. Acad Emerg Med. 2011 Apr;18(4):340-50.
- Royal College of Paediatrics and Child Health: Evidence statement. Major trauma and the use of tranexamic acid in children. November 2012 http://www.rcpch.ac.uk/system/files/protected/page/121112_TXA%20evidence%20statement_final%20v2.pdf.

REFERENCES

- Eckert MJ, Wertin TM, et al. Tranexamic acid administration to pediatric trauma patients in a combat setting: the pediatric trauma and tranexamic acid study (PED-TRAX). J Trauma Acute Care Surg. 2014 Dec;77(6):852-8.
- Howard JT, Stockinger ZT, et al. Military use of tranexamic acid in combat trauma: Does it matter? J Trauma Acute Care Surg. 2017 Oct;83(4):579-588.
- Keller M. “Battlefield ER: Combat Medicine Fights To Keep More Troops Alive.” *Txchnologist*, 24 Oct. 2013, txchnologist.com/post/64949632380/battlefield-er-combat-medicine-fights-to-keep.
- Kragh JF Jr , Lunati MP , Kharod CU , Cunningham CW , Bailey JA , Stockinger ZT , Cap AP , Chen J , Aden JK 3d , CancioLC . Assessment of Groin Application of Junctional Tourniquets in a Manikin Model. *Prehosp Disaster Med*. 2016;31(4):358–363.
- Chen J, Benov A, et al. Testing of Junctional Tourniquets by Medics of the Israeli Defense Force in Control of Simulated Groin Hemorrhage. J Spec Oper Med. 2016 Spring;16(1):36-42.
- Sadek S, Lockey DJ, et al. Resuscitative endovascular balloon occlusion of the aorta (REBOA) in the pre-hospital setting: An additional resuscitation option for uncontrolled catastrophic haemorrhage. Resuscitation. 2016 Oct;107:135-8.

REFERENCES

- Moore LJ, Brenner M, Kozar RA, et al. Implementation of resuscitative endovascular balloon occlusion of the aorta as an alternative to resuscitative thoracotomy for noncompressible truncal hemorrhage. J Trauma Acute Care Surg. 2015;79(4):523-30.
- Dubose JJ, Scalea TM, Brenner M, et al. The AAST prospective Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) registry: Data on contemporary utilization and outcomes of aortic occlusion and resuscitative balloon occlusion of the aorta (REBOA). J Trauma Acute Care Surg. 2016;81(3):409-19.
- Inoue J, Shiraishi A, Yoshiyuki A, Haruta K, Matsui H, Otomo Y. Resuscitative endovascular balloon occlusion of the aorta might be dangerous in patients with severe torso trauma: A propensity score analysis. J Trauma Acute Care Surg. 2016;80(4):559-66.
- Vartanian L. “Blood on the Ground.” *EMS World*, 17 Jan. 2017, www.emsworld.com/article/12295924/blood-on-the-ground.
- Escott MEA, Bank EA, et al. Blood Therapy: Considerations for using blood products for prehospital trauma patients. JEMS. 2017 Mar;42(3):47-51, 67.
- Holcomb JB, Donathan DP, et al. Prehospital Transfusion of Plasma and Red Blood Cells in Trauma Patients. Prehosp Emerg Care. 2015 January-March;19(1):1-9.

REFERENCES

- WHO Reproductive Health Library. WHO recommendation on the use of external aortic compression for the treatment of postpartum haemorrhage. (September 2012). The WHO Reproductive Health Library; Geneva: World Health Organization.
- Rall JM, Ross JD, et al. Hemodynamic effects of the Abdominal Aortic and Junctional Tourniquet in a hemorrhage swine model. J Surg Res. 2017 May 15;212:159-166.
- Kheirabadi BS, Terrazas IB, Miranda N, et al. Physiological Consequences of Abdominal Aortic and Junctional Tourniquet (AAJT) Application to Control Hemorrhage in a Swine Model. Shock. 2016 Sep;46(3 Suppl 1):160-6.
- Mena-Munoz J, Srivastava U, Martin-Gill C, et al. Characteristics and Outcomes of Blood Product Transfusion During Critical Care Transport. Prehosp Emerg Care. 2016 Sep-Oct;20(5):586-93.
- Shackelford SA, Del junco DJ, Powell-Dunford N, et al. Association of Prehospital Blood Product Transfusion During Medical Evacuation of Combat Casualties in Afghanistan With Acute and 30-Day Survival. JAMA. 2017;218(16):1581-1591.
- Sperry JL, Guyette FX, Brown JB, et al. Prehospital Plasma during Air Medical Transport in Trauma Patients at risk for Hemorrhagic Shock. N Engl J Med. 2018;379(4):315-326.

REFERENCES

- HockeyFeed. “Minor League Player Suffers Gruesome Injury (VIDEO).” *HockeyFeed*, HockeyFeed, 26 Oct. 2014, www.hockeyfeed.com/videos/minor-league-player-suffers-gruesome-injury-video.
- http://www.usaisr.amedd.army.mil/news/news_stories/2015_OCT/USAISR_Research_Crucial_in_Implementing_New_Stop_the%20Bleed_Initiative.html
- TomoNewsUS. “Hair Clip-Inspired Clamp Device Controls Traumatic Bleeding.” *YouTube*, YouTube, 28 Oct. 2013, www.youtube.com/watch?v=txCd7nbP468.
- SurvivalMetrics. “Trauma & Emergency Bandage, Combat, Israeli Battle Dressing.” *YouTube*, YouTube, 22 Nov. 2011, www.youtube.com/watch?v=j9cJXsjVRHc.
- “OLAES® Modular Bandage Basic Instructions.” *YouTube*, YouTube, 1 Sept. 2008, www.youtube.com/watch?time_continue=220&v=YbKDNuLB54A.
- Narescue. “Jett™ Junctional Emergency Treatment Tool Overview/Instructions for Use.”*YouTube*, YouTube, 8 Jan. 2013, www.youtube.com/watch?v=HVY0_y5AE7Q.

REFERENCES

- http://www.latimes.com/local/lanow/la-me-ln-police-car-taxi-hybrid-targets-new-years-eve-drinkers-20141231-story.html
- https://www.jems.com/articles/print/volume-41/issue-5/features/implementing-protocols-to-administer-blood-products-in-the-prehospital-setting.html
- https://www.jems.com/articles/print/volume-42/issue-3/features/considerations-for-using-blood-products-for-prehospital-trauma-patients.html
- https://www.dailydot.com/debug/uber-health/

OSF LIFE FLIGHT

EMERGENCY MEDICINE RESIDENCY
PEORIA