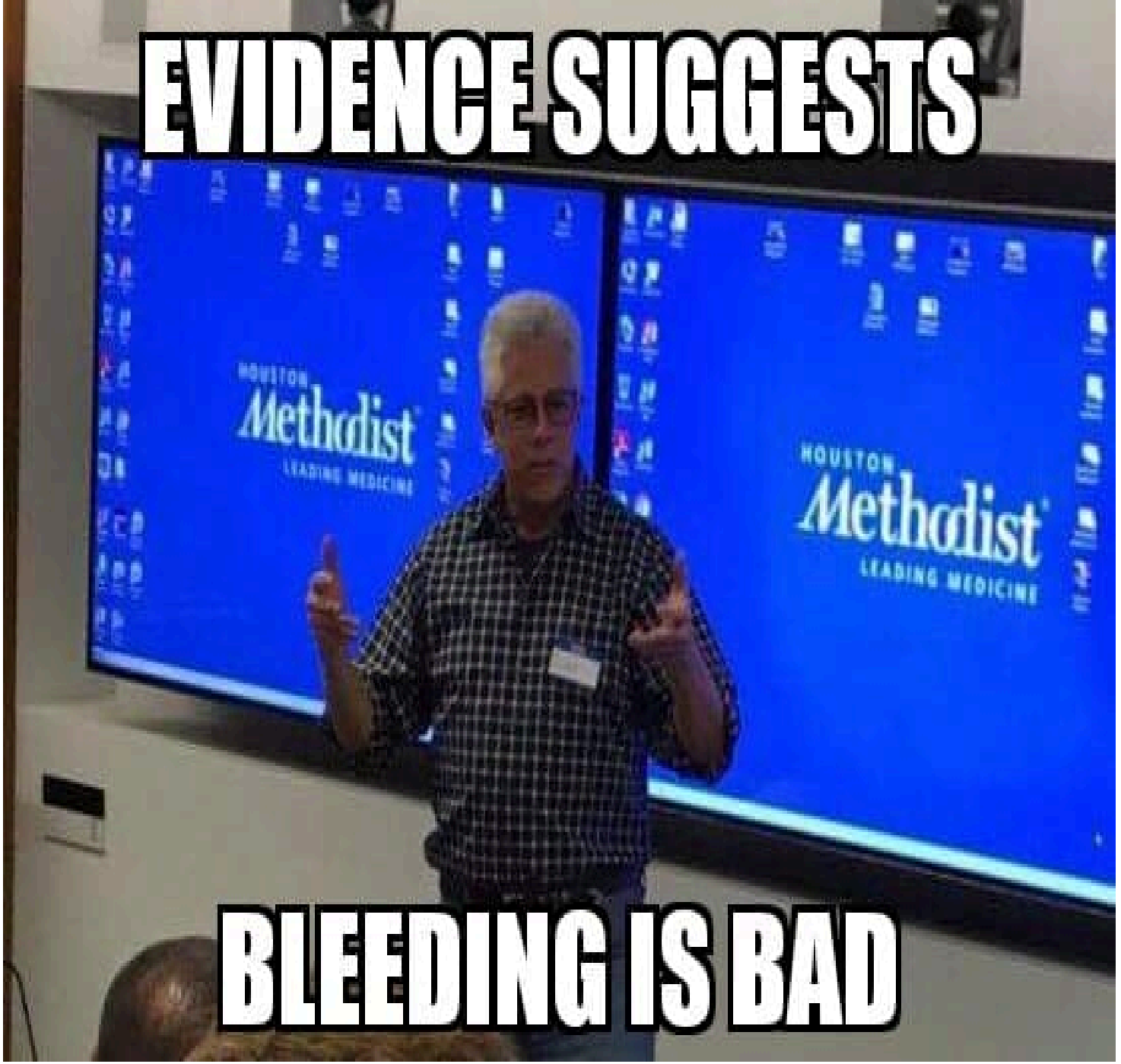
Trauma Resuscitation and Whole Blood In EMS

JOSEPH CASCIOTTI, RN, BSN, CFRN, CEN, CP-C

ERIC BANK, LP, NRP
ASST. CHIEF OF EMS HCESD 48 FIRE DEPT
CO-CHAIR SETRAC TRAUMA COMMITTEE

HARRIS COUNTY ESD 48

- Suburban West Houston
- 50 Square Miles
- Population of 150,000
- 8,000 calls per year
- 5 Ambulances with 1 EMS Supervisor
- Dr. David Reininger, MD Medical Director
- Dr. Lesley Osborn, MD Assoc. Medical Director


EVIDENCE SUGGESTS
HOUSTON Methodist LEADING MEDICINE
HOUSTON Methodist LEADING MEDICINE
BLEEDING IS BAD

Death from Bleeding

- I have 10 minutes to speak with you today.
- Imagine yourself just having been injured – and presently bleeding from a large artery or vein.
- You now have just about that long to live.
- Unless somebody stops your bleed.

Dr. Jonathan Woodson
Assistant Secretary of defense for Health Affairs
White House "Stop the Bleed" Forum
6 October 2015

Salt water is for Pasta, Make Whole Blood Great Again

JUST DO IT.


WHOLE BLOOD
Rh POSITIVE
Low Titer O Whole Blood
Whole Blood/CPDA-1/450mL
Titer <1:256
450 mL containing
approx 63 mL of
CPDA-1 Anticoagulant

THANK YOU WE NOW HAVE 1 HOUR TO DISCUSS THE TOP 10 SIMPSON'S EPISODES

BACK TO THE SUBJECT AT HAND. MAJOR ANDREW FISHER STARTED THE ROLO PROJECT WITH THE 75TH RANGERS, PROPS AND CREDIT TO HIM FOR STARTING US DOWN THIS ROAD AND FOR THE PASTA WATER ANALOGY!

You Can Not Control the Uncontrollable.

This one of the best take aways I have gotten from a class in quite some time. Credit to the Leadership Under Fire Program from Jason Brezler.

A Tale of Two Patients Plus 1

TURN BACK THE CLOCK TO 1994

Patient presents in a vehicle S/P assault with a knife

- Adult Male approximately 30 Semi-Conscious
- Large Laceration upper Right Abdomen, not bleeding
- Multiple defense would on the arms with brachial artery involvement
- Skin is cool, ashen and diaphoretic with: HR 130s with B/P 60/Systolic

What's your treatment plan (remember it's 1994)

- Patient Rapidly Extricated from the vehicle
- Hemorrhage Control via pressure dressing or rather attempted control
- Patient Received multiple liters of room temperature Normal Saline
- Rapid transport to a level 1 Trauma Center

Upon arrival bleeding slowed, but now clear with tinges of blood, B/P has improved.

The patient has gone from ashen gray to pale white in color, but again Bleeding is slower and Blood Pressure has increased, Mission accomplished ?

1990's Trauma Care

FAST FORWARD TO 2016

Patient presents supine at home with large caliber GSW to the right mid back

- Adult Female approximately 40 Semi-Conscious
- Large caliber GSW, minimal bleeding with no exit wound
- Skin is cool, ashen and diaphoretic with: HR 127 with a B/P 75 systolic

What's your treatment plan (remember it's 2016)

- Patient Rapidly Extricated from the home, aircraft secured for distance and traffic
- Patient is extricated to the stretcher and to the ambulance with no Spinal Motion Restriction
- Enroute to the LZ pt received
  - (2) 20 g IVs (Yes thats 20g for trauma)
  - 50 ml of warmed plasma lyte
  - 250ml of Warmed Liquid Plasma
  - 250ml of Warmed PRBcs

On transfer to the flight crew, the patient has improved color, HR is 99 with a B/P of 130/systolic. Pt contact to lift Off was 15 minutes with blood products on board. Mission Accomplished?

EMS TRAUMA CARE

1. First Major change is in the mid 90s, where fluid studies indicate less is more

2. 2008 Enhanced Hemorrhage control including the use of tourniquets and hemostatic gauze

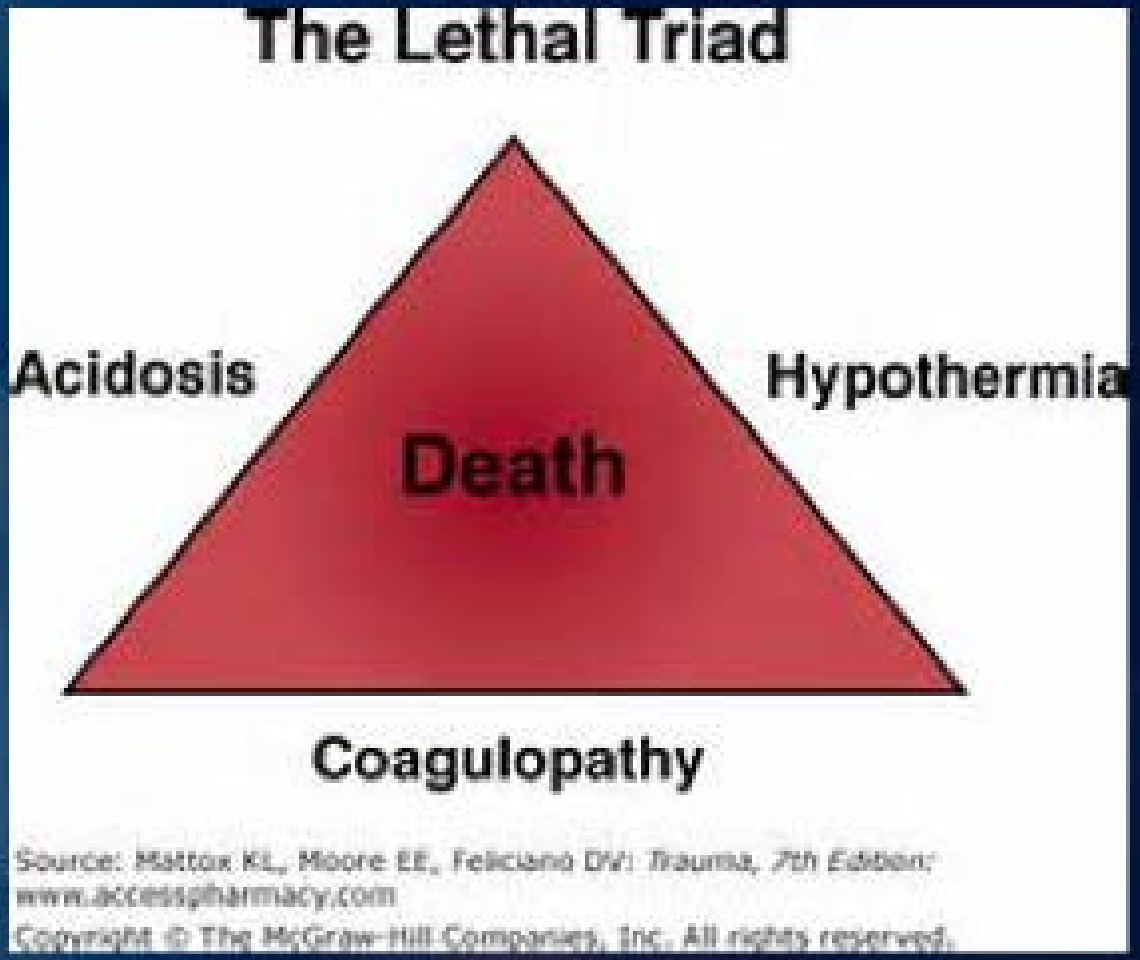
3. 2014 Studies indicate C-Spine Immobilization and long spine boards are not effective for blunt trauma care and increase mortality in penetrating trauma care

4. 2016 Component blood products on Ground EMS

5. 2017 LTOWB in Ground EMS

Think about how many changes there have been to ACLS in the same time frame

The Trauma Triad



TRAUMA TRIAD AND PASTA WATER

Hypothermia

- Yes even in Gulf Coast Texas
- Back of the Ambulance Temps are 70 degrees
- Fluid is 74 degrees
- Shivering Increases Acidosis

Acidosis

- pH of Normal Saline 5.7
- pH of Lactated Ringers 6.4

Coagulopathy

- Crystalloid Dilution
- TXA Yes! No! And Maybe !

All 3 factors influence the other ultimately leading to blood failure

And the inability to coagulate

TRAUMA TRIAD
KEYS TO SURVIVAL

Hypothermia

- Passively Warm the patient with blankets
- Actively Warm the patient, use a fluid warmer

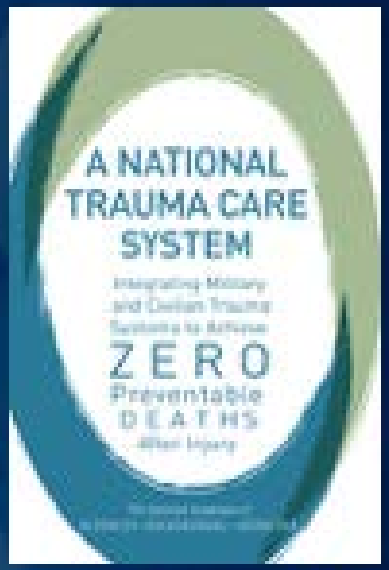
Acidosis

- pH of Whole Blood is 7.4
- pH of Component Blood Therapy is 7.4
- Blood Products add oxygen carrying capacity

Coagulopathy

- Blood Products add clotting factors to help reverse blood failure
- TXA Yes! No! And Maybe !

National Academies of Medicine 2016 Paper

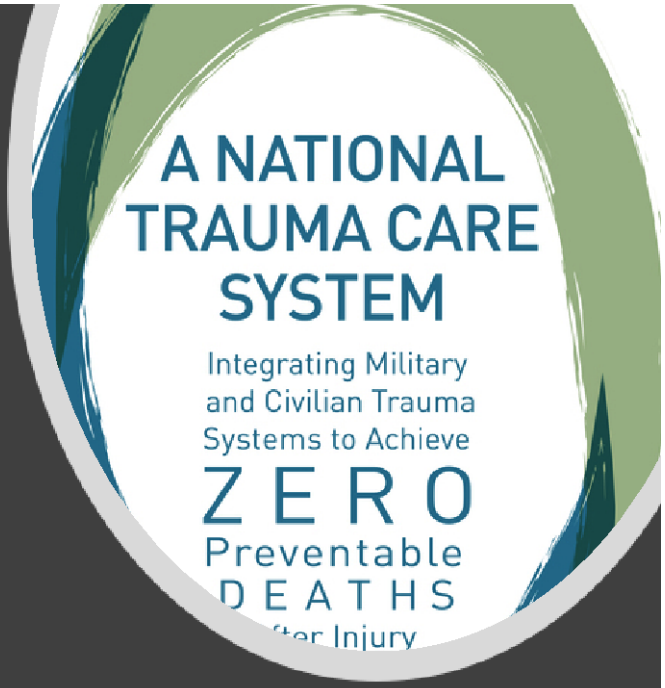


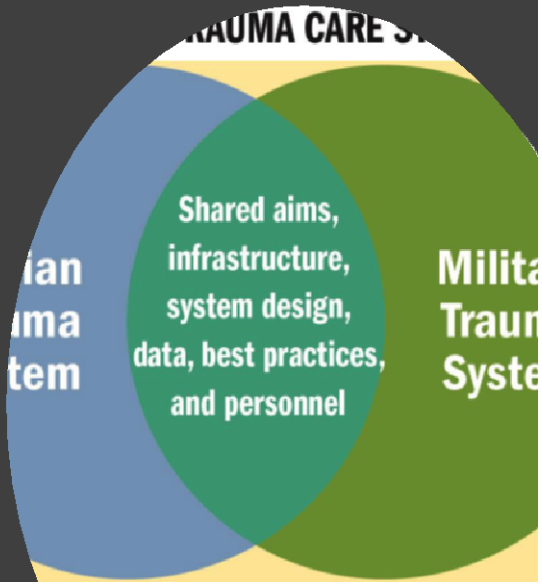
Landmark study of combining Military and Civilian Pre-Hospital Medicine. We both learn from each other at times of War, how do me maintain and improve that relationship. Out of this is born the American College of Surgeons Zero Preventable Trauma Deaths Campaign.

National Trauma System Vision

A unified effort is needed to ensure the delivery of optimal trauma care to save the lives of Americans injured within the United States and on the *battlefield.*

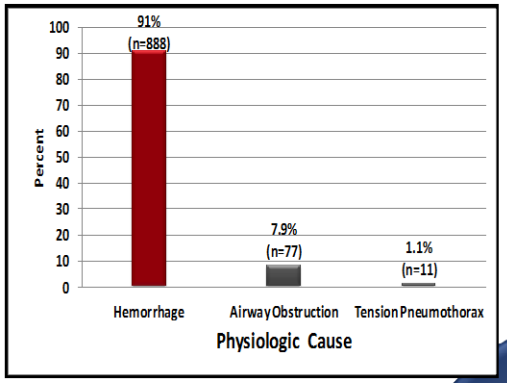
*Predicated upon estimates of potentially preventable injury death

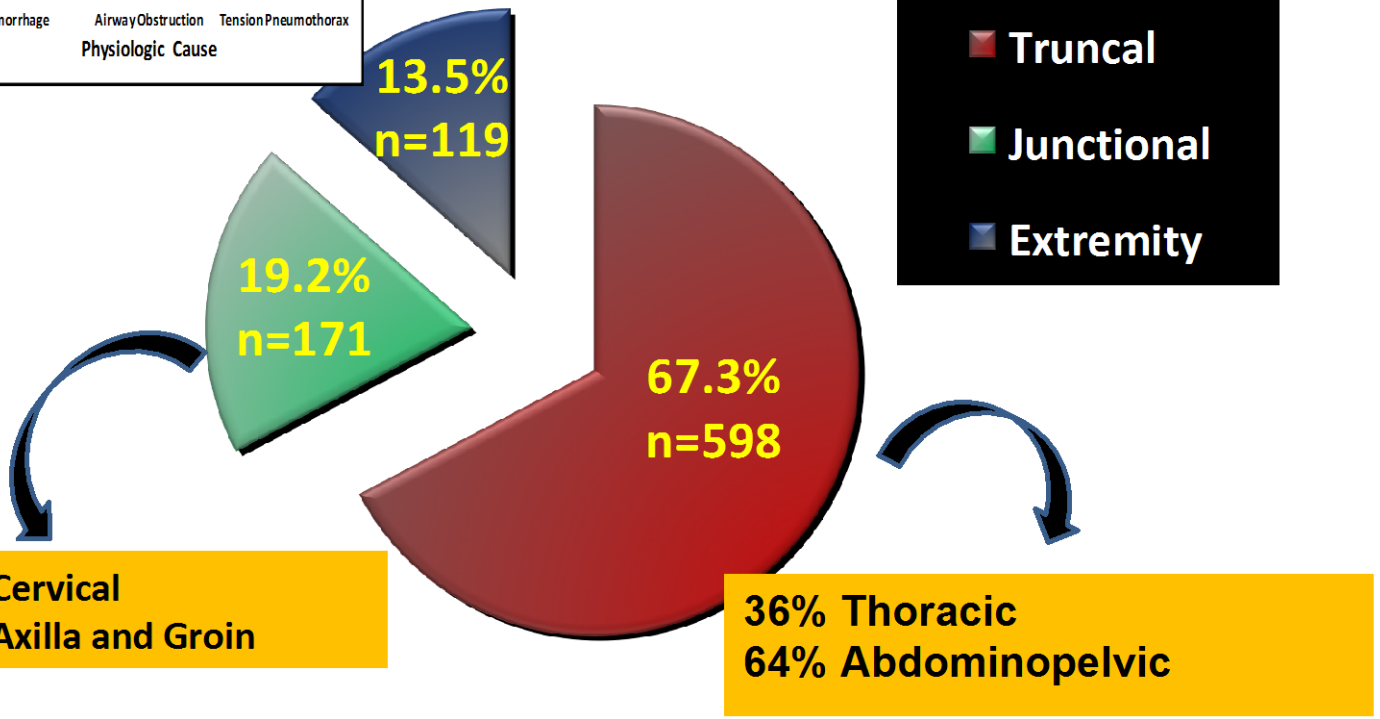




Slide from Dr. Brian Eastridge

Anatomic / Physiologic Cause of Death





Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma, 2012. In press.

The Golden Hour

Abstract Presentation for:
Committee on Tactical Combat Casualty Care Meeting
Atlanta, Georgia – February 4, 2015

Saving Lives on the Battlefield: The Golden Hour and the Gates Effect

COL (R) Russ S. Kotwal, MD MPH FAAFP

- **YES – evacuating urgent casualties to surgical care in 60 minutes or less helps save lives.**
- **BUT – not all critically injured casualties will live for 60 minutes without hemorrhage control and blood**

Alarhayem AQ et al. 2016

Contents lists available at ScienceDirect

The American Journal of Surgery 2016

journal homepage: www.ajconline.org

Southwestern Surgical Congress

Time is the enemy: Mortality in trauma patients with hemorrhage from torso injury occurs long before the "golden hour"

A.Q. Alarhayem [a], J.G. Myers [a], D. Dent [a], L. Liao [a], M. Muir [a], D. Mueller [a], S. Nicholson [a], R. Cestero [a], M.C. Johnson [a], R. Stewart [a], Grant O'Keefe [b], B.J. Eastridge [a, *]

[a] The University of Texas Health Science Center at San Antonio, Department of Surgery, Division of Trauma, Critical Care, and Acute Care Surgery, United States

[b] University of Washington, Department of Surgery, Division of Trauma and Acute Care Surgery, United States

- **Incredibly important paper**
- NTDB data
- 2.5 million patients retrospective study (2012-14)
- AIS 4 chest and abd, significant TBI excluded
- Prehospital time and mortality

Slide: Dr. John Holcomb

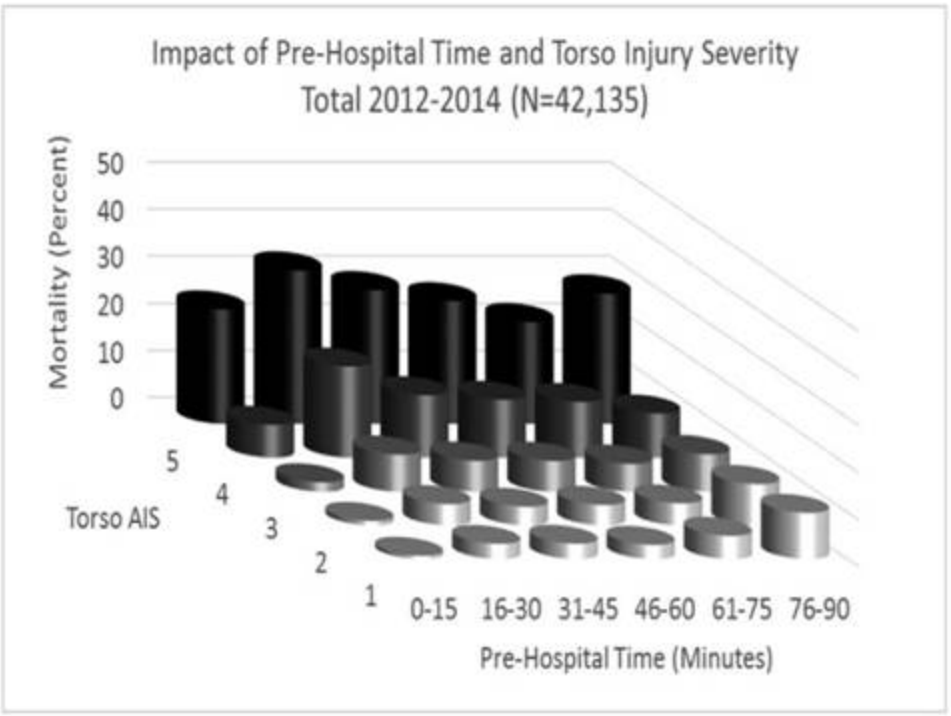


Fig. 1. Mortality Impact of prehospital time and torso injury severity for composite population 2012–2014 (N = 42,135).

Median
Prehospital
Time = 37 minutes

"We noted a precipitous incremental rise in patient mortality in patients with high-grade injuries at prehospital times 0-15 and 16-30 min, **irrespective of mechanism**."

Slide: Dr. John Holcomb

BLOOD VS CRYSTALLOIDS LETS LOOK AT A FEW STUDIES

Far-Forward Blood: MINUTES MATTER

JAMA | Original Investigation

Association of Prehospital Blood Product Transfusion During Medical Evacuation of Combat Casualties in Afghanistan With Acute and 30-Day Survival

"Among medically evacuated US military combat causalities in Afghanistan, blood product transfusion prehospital or within minutes of injury was associated with greater 24-hour and 30-day survival than delayed transfusion or no transfusion."

Shackelford et al
JAMA 2017

Slide courtesy of Dr. Frank Butler

FAR-FORWARD BLOOD: MINUTES MATTER

CLINICAL REGISTRY-BASED STUDY

The effect of prehospital transport time, injury severity, and blood transfusion on survival of US military casualties in Iraq

Russ S. Kotwal, MD, Laura L.F. Scott, MS, MPH, Jud C. Janak, PhD, Bruce W. Tarpey, Jeffrey T. Howard, PhD, Edward L. Mazuchowski, MD, PhD, Frank K. Butler, MD, Stacy A. Shackelford, MD, Jennifer M. Gurney, MD, *and* Zsolt T. Stockinger, MD, *Fort Sam Houston, Texas*

"Regardless of conflict, early delivery of blood transfusion was associated with increased survival. Thus, timely treatment capability was paramount for casualty survival on the battlefield of Iraq, as it was in Afghanistan."

Kotwal J Trauma 2018

Pre-Trauma Center Red Blood Cell Transfusion Is Associated with Improved Early Outcomes in Air Medical Trauma Patients

Presented at the National Association of Emergency Medical Service Physicians Annual Meeting, New Orleans, LA, January 2015.

Joshua B. Brown, MD, Jason L. Sperry, MD, MPH, FACS Anisleidy Fombona, BS, Timothy R. Billiar, MD, FACS, Andrew B. Peitzman, MD, FACS, Francis X. Guyette, MD, MPH

240 patients received blood products pre-trauma center; compared to 480 patients receiving standard fluid treatment.

Pre-trauma center blood products transfusion associated with:

- **Increased odds of 24-hour survival**
- **Lowered odds of shock**
- **Lowered 24-hour RBC requirements.**

Every minute counts: Time to delivery of initial massive transfusion cooler and its impact on mortality.
J Trauma Acute Care Surg. 2017
Meyer DE , Vincent LE, Fox EE, O'Keeffe T, Inaba K, Bulger E, Holcomb JB, Cotton BA.

Among 680 patients, the median time from patient arrival to MT protocol activation was9 minutes with a median time from MT activation call to delivery of first cooler of 8 minutes. An increase in both time to MT activation and time to arrival of first cooler were associated with prolonged time to achieving hemostasis (coefficient, 1.09; $p = 0.001$ and coefficient, 1.16; $p < 0.001$, respectively). Increased time to MT activation and time to arrival of first cooler were associated with increased mortality (odds ratio [OR], 1.02; $p = 0.009$ and OR, 1.02; $p = 0.012$, respectively). Controlling for injury severity, physiology, resuscitation intensity, and treatment arm (1:1:1 vs. 1:1:2), increased time to arrival of first cooler was associated with an increased mortality at 24 hours (OR, 1.05; $p = 0.035$) and 30 days (OR, 1.05, $p = 0.016$).

Conclusions

Delays in MT protocol activation and delays in initial cooler arrival were associated with prolonged time to achieve hemostasis and an increase in mortality. Independent of products ratios, every minute from time of MT protocol activation to time of initial cooler arrival increases odds of mortality by 5%.

What if we brought the cooler to the patient ?

We have! the military is routinley providing POI blood transfusions and we are seeing the same in HEMS and Ground EMS in the US

Prehospital Plasma during Air Medical Transport in Trauma Patients at Risk for Hemorrhagic Shock.

Sperry JL[1], Guyette FX[1], Brown JB[1], Yazer MH[1], Triulzi DJ[1], Early-Young BJ[1], Adams PW[1], Daley BJ[1], Miller RS[1], Harbrecht BG[1], Claridge JA[1], Phelan HA[1], Witham WR[1], Putnam AT[1], Duane TM[1], Alarcon LH[1], Callaway CW[1], Zuckerbraun BS[1], Neal MD[1], Rosengart MR[1], Forsythe RM[1], Billiar TR[1], Yealy DM[1], Peitzman AB[1], Zenati MS[1]; PAMPer Study Group.

CONCLUSIONS:
In injured patients at risk for hemorrhagic shock, the prehospital administration of thawed plasma was safe and resulted in lower 30-day mortality and a lower median prothrombin-time ratio than standard-care resuscitation. (Funded by the U.S. Army Medical Research and Materiel Command; PAMPer ClinicalTrials.gov number, NCT01818427

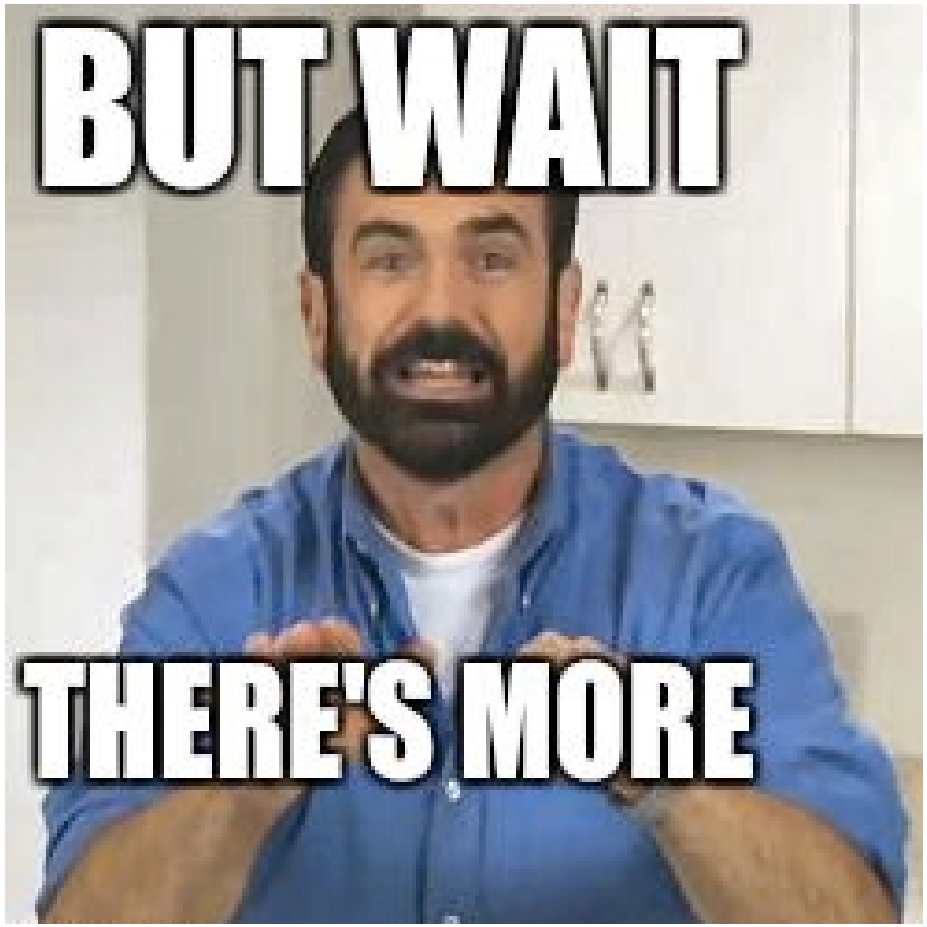
TCCC FLUID RESUSCITATION FOR HEMORRHAGIC SHOCK

- Whole Blood
- 1:1:1 Plasma, RBCs, Platelets
- 1:1 Plasma and RBCs
- Freeze Dried Plasma
- Plasma or RBCs alone
- Lactated Ringers or Plasma Lyte

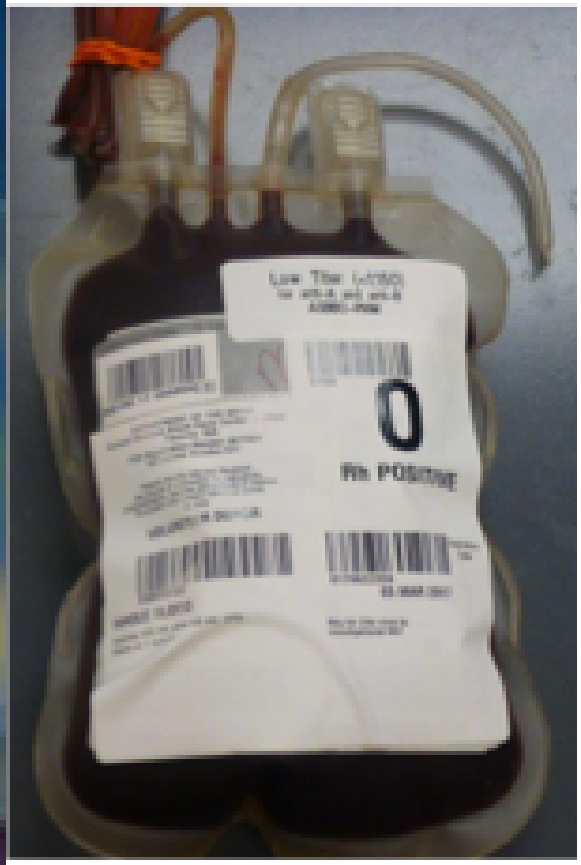
WHY WHOLE BLOOD

Its Simple !

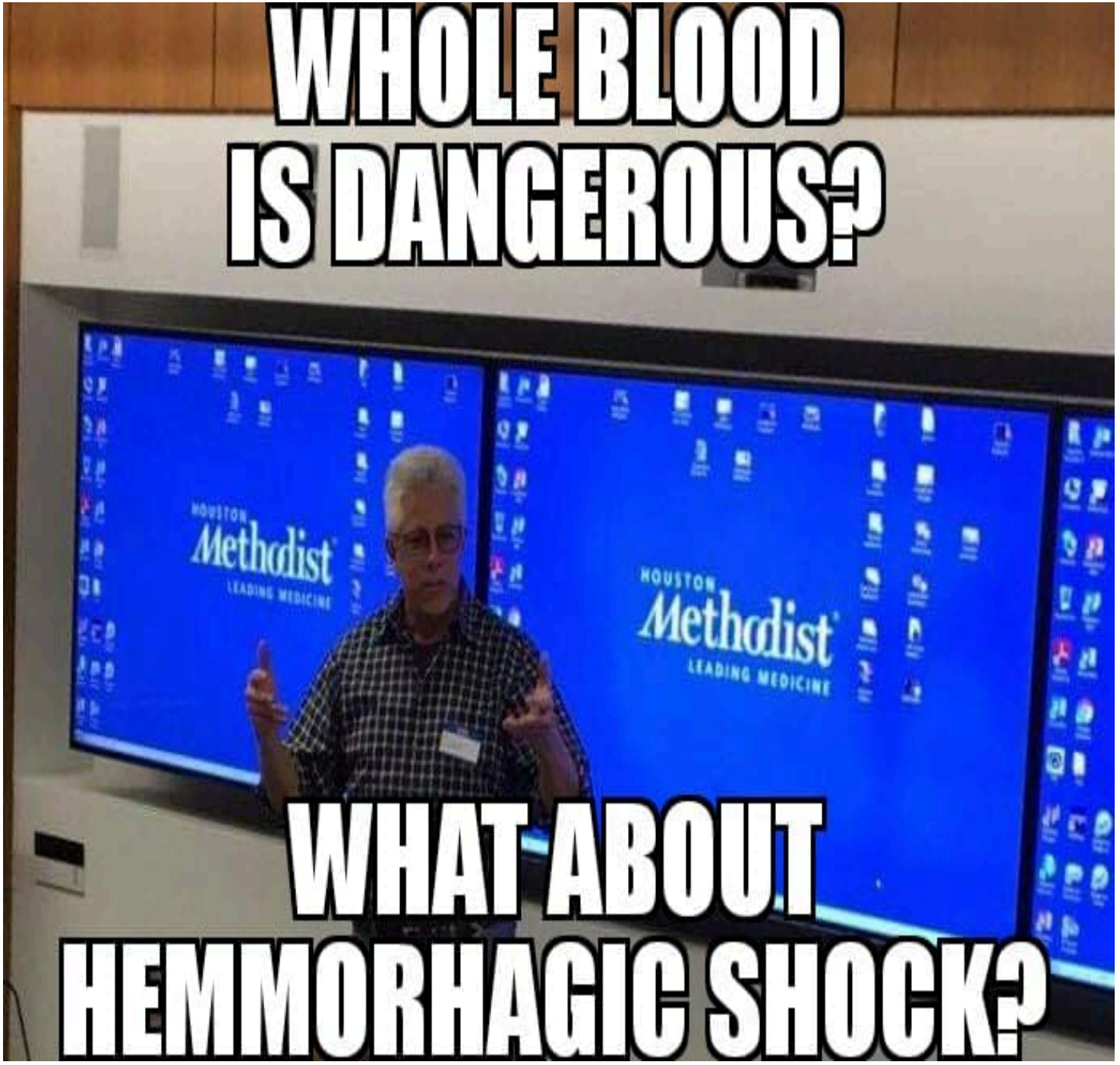
- One product vs 2 or 3
- Does not make the patient worse
- Carries Oxygen
- Improves Hemostasis and blood failure
- We are replacing what the patient is losing


BUT WAIT
THERE'S MORE

WB vs. Components:
More Concentrated, Simpler



	WB 4°C	Components (1:1:1)
Hgb HCT	12-13 35-37	9 28
PLT	138-165	90-120
Fibrinogen, Factors	Normal @ baseline, FVIII ≥ 50% d7	All 62% dilution @ baseline, plus loss FVIII
TEG	Nearly normal d21	Reduced vs. WB
PLT aggregation	≥ 50% baseline d7-10	Nearly complete loss d5 in RT-PLT
Practical aspects (4L)	8 bags, one storage mode (8 U, 4000 ml)	13 bags, three storage modes (6:6:1, 4150 ml)


WHOLE BLOOD
IS DANGEROUS?
HOUSTON
Methodist
LEADING MEDICINE
HOUSTON
Methodist
LEADING MEDICINE
WHAT ABOUT
HEMMORHAGIC SHOCK?

HEMOLYTIC REACTIONS

A **hemolytic** transfusion **reaction** is a serious complication that can occur after a blood transfusion. The **reaction** occurs when the red blood cells that were given during the transfusion are destroyed by the person's immune system.

The risk = 1 in 20,000 units transferred!

Thankfully we have had zero

ALLERGIC REACTIONS

- Same as with other medications ,may range from mild to severe. But again these are Allergic and not Hemolytic reactions. Much more common and most are Slight fever and pruritus type rash
- Treat as an allergic reaction and if reaction is mild we would typically continue the transfusion
- We have also had zero allergic reactions

Low-Titer Whole Blood Safety Profile

- WWII
  - Practically all transfusions during WWII were group O whole blood, regardless of titer or Rh factor
  - Of 256 ABO incompatible group O whole blood transfusions, there were three mild hemolytic reactions reported
    - All ABO IgM anti—A and anti—B titers were >1:500
  - One Soldier received 75ml of a unit with an IgM anti—A titer of 1:8000
  - This prompted the US Army Blood Program to define LTOWB as IgM anti—A and anti—B level was <1:250

Korean War

- Over 400,000 units of LTOWB were transfused in the Korean War
- All units transfused on the Korean peninsula was Rh negative
- There were **no adverse reactions** associated with this protocol

- Vietnam War
  - Over 230,300 LTOWB whole blood transfusions, 1967-1969
  - 1 severe hemolytic transfusion reaction
  - High titer (> 256) Group O whole blood used accidentally (mislabeled)

US MILITARY SAFETY PROFILE IRAQ AND AFGHANISTAN

- 10,000 Transfusions
  - Mostly Walking Blood Banks (Pre-Screened for Type Speciosity only)
  - 1 major transfusion reaction, mislabeled unit
- LTOWB is extremely safe, titer is 1:256 of Anti-A and Anti-B antibodies

THE QUESTIONS !

- How do you know my blood type or How did you know the patients blood type ?
- Did you draw any blood first ?
- Ummm is that blood ?
- WHAT ! Thats Whole Blood ?
- Who lets you give blood?
- Where did that blood come from ?
- NO, NO, Ummm Yes, Our Dr and the Blood Bank!!

THAT +1 , MEDICINE BASED HEMORRHAGIC SHOCK

- Symptomatic bleeding, regardless of cause needs to be treated
- We initially added medicine guidelines to cover these patient's since we carried blood. What we learned is we treat them 4:1 versus trauma patients
- The Trauma TRIAD is in effect for medical based bleeding, hemorrhagic shock is the same regardless of the cause

FIRST WHOLE BLOOD TRANSFUSION SEPTEMBER 2017

- We believe First Whole blood Transfusion (Civilian Ground EMS)
  - Mid 30's Female with syncopal episode while shopping, 2 weeks post partum
  - Hemodynamically Unstable HR >120, B/P 70/Systolic, MAP 60
  - Patient is pale, Temp 96.5 with POC lactate of 4.7
  - Difficulty catching her breath
  - Vaginal Bleeding x 2 weeks in Hemorrhagic Shock
- Patient Received 1unit (570ml) of Warmed LTOWB
  - Syncope Resolved
  - Improved Hemodynamics HR 64, B/P 98/Systolic with MAP of 64
  - Skin Color Improved, Temp 97.7

FROM MEDICINE TO LOGISTICS

1. Gain medical direction: Through researching local and military studies , our medical directors felt the medicine and science was sound. Texas is a delegated practice state

2. Work with regional hospitals and/or the blood bank for stocking blood products. We utilize the Gulf Coast Regional Blood Center as our vendor

3. Develop logistics and Maintenance
   - What are you usage levels and guidelines
   - How do you replace it ? (And pay for it)
   - How do you hand off a patient at the ED or for Flight
   - How do you bill for it

4. Convince and partner your local hospitals and trauma centers

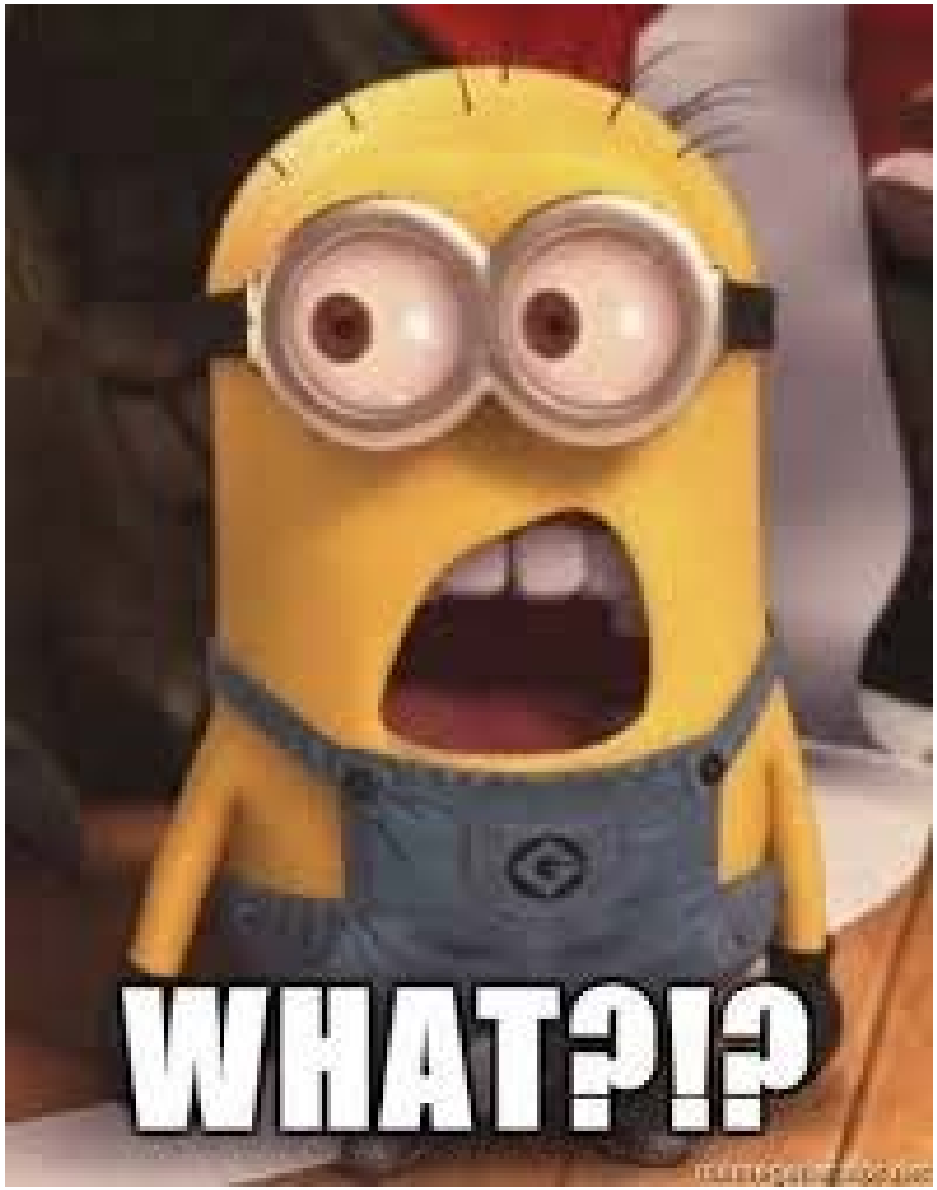
From concept to inception for us was just over a year long project

STATION STORAGE

- Helmer Blood Refrigerator, multiple alarms, including cellular connectivity. Multiple back up Thermometers as well.

UNIT STORAGE

- Cant be electric, vibrations can damage the cells
- Maintain 1-6 degrees Celsius
- Texas Summer Resistant
- Portable and easy to access
- Easy to maintain
- Measurable Temperature
- Hold 2-4 units of 500ml Blood Products

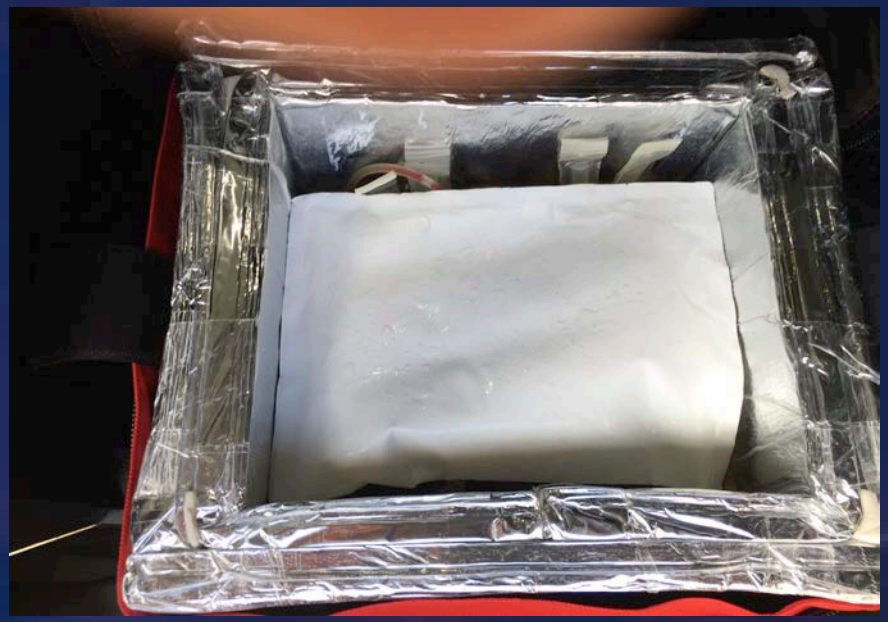

WHAT?!?

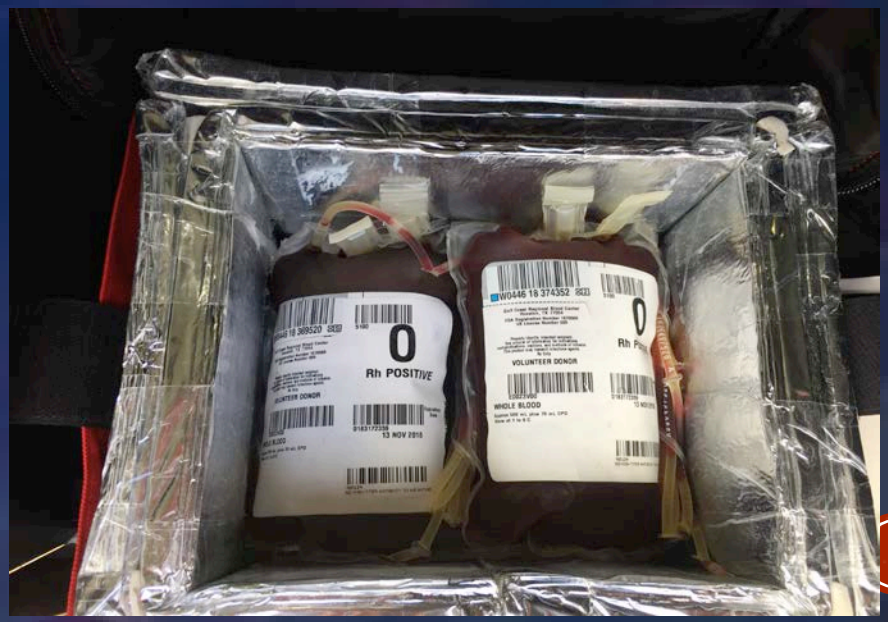
OUR ANSWER

Blood Boxx, from Combat Medical Systems

This is the product that works for us and as luck would have it, we got to test it through Hurricane Harvey!

BLOOD BOXX




0
Rh POSITIVE
VOLUNTEER DONOR
WHOLE BLOOD
13 NOV 2018
0
VOLUNTEER DONOR

FLUID WARMERS

We currently use the QinFlow Warrior. It warms fluid to 37c at all flow rates, its easy to use and its used by MH life flight so it allows for fast continuum of care

Back to the Future ?

- Whole Blood, currently deployed in Theater with 75th Rangers
  - FDA Approved for use in the US
  - Pilot project in the works
- Freeze Dried Plasma
  - Not Currently FDA approved
  - Being used by the Military in theater
  - Being used in other countries
  - Originally used in WW-II
- Advanced Hemostatic Agents
  - Foam Deployment Device
  - Direct Injection Hemostatic Sponges (X-Stat)
- Pre-Hospital Trauma Care
  - Ultrasound
  - REBOA

BACK TO THE FUTURE REVISED !

- ROLO has expanded through the military and LTOWB is now used in multiple hospital and pre-hospital systems in the US
- Freeze Dried Plasma
  - Working through the FDA process
  - More readily used in the Military, currently a French Product
  - Current US markets look like a complete packaged room temperature stable product with 1 year shelf life
- Advanced Hemostatic agents
  - Arsenal Medical Foam deployment in FDA trials currently
  - X-Stat TCCC approved and FDA approved for Junctional Hemorrhage
- Advance pre-hospital care
  - Pre-Hospital Ultrasound (POCUS) has moved into the EMS Field
  - REBOA readily used in hospital, ARC or advanced resuscitative care working its way through TCCC and into civilian EMS

LTOWB DEPLOYMENTS

- HCESD 48 Fire-EMS
- Cypress Creek EMS
- San Antonio Fire Department- Part of the Brothers in Arm Collaborative
- Memorial Hermann Life Flight
- MD 1 Program in New Jersey
- Many programs in development
- Are you next ?

ESD 48 DATA

- 24 units of LTOWB Delivered in the field
  - 18 Medical
  - 6 Trauma
- All Survived with no hemolytic reactions
- Mean initial B/P 73/S , post Transfusion 103/S
- All patients where mild or moderately hypothermic to start
- No inappropriate transfusions, definitely missed opportunities

BLOODPRODUCTS FOR MCI/ASHER

- Can this work for the MCI ?

YES !!

- Here is our current working plan
  - Gulf Coast Regional Blood Center on an alert or call can have a cooler with LTOWB if available and/or
    - 8 units of Liquid Plasma
    - 8 units of PRBCs
    - We will utilize a LE aircraft to pick up and deliver to the scene
    - All HCESD 48 Fire-EMS Medic units carry the Warrior Fluid Warmer

Lessons Learned

1. Train all staff in the use of Blood Products
2. Add Blood Y's to the Ambulances
3. Add Fluid Warmers to the Ambulances
4. Take the cooler to the hospital
5. Be flexible in deployment of products
6. Contact the on call EMS Physician

QUESTIONS

Eric.Bank@hcesd48.org

Joseph.Casciotti@hcesd48.org