



# **Remote Damage Control Resuscitation: An Overview for Medical Directors and Supervisors**

THOR Collaboration



# Agenda

- What is Remote Damage Control Resuscitation?
- Putting RDCR into Practice
  - Control Hemorrhage
  - Resuscitate Hemorrhage
  - Adjunctive Measures
- Timing of DCR matters: sooner is better, with decreased mortality benefits



# What is RDCR?

# Remote

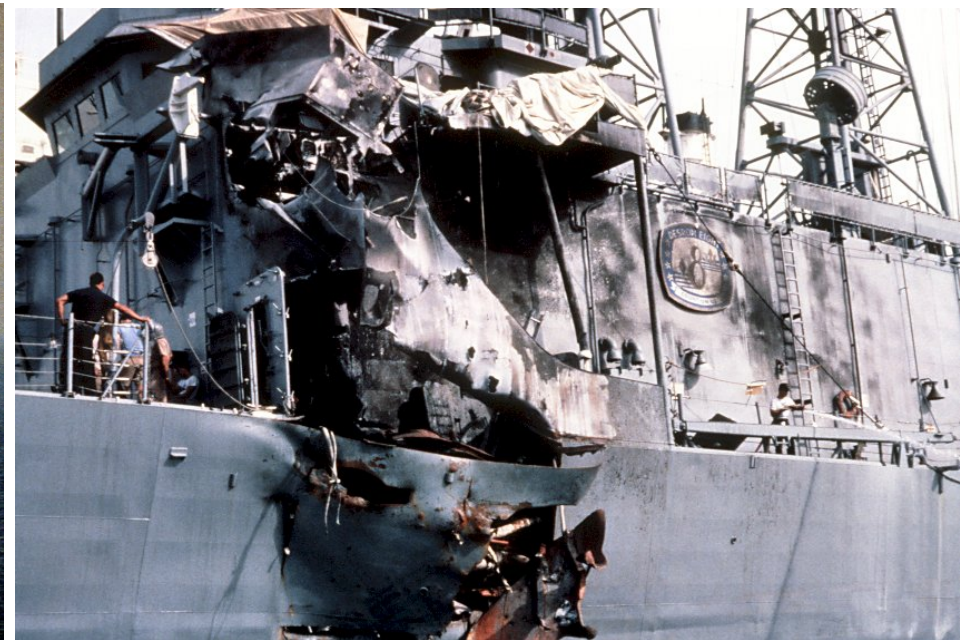


Prehospital (or far-forward/ austere) phase of resuscitation





# + Damage Control



## Damage Control:

**First, only do the things essential to keeping the ship afloat.**



# + Resuscitation

Emergency treatment to restore:

Circulating volume

Aid oxygen delivery

Replace hemostatic potential

*(and a few  
other things...)*

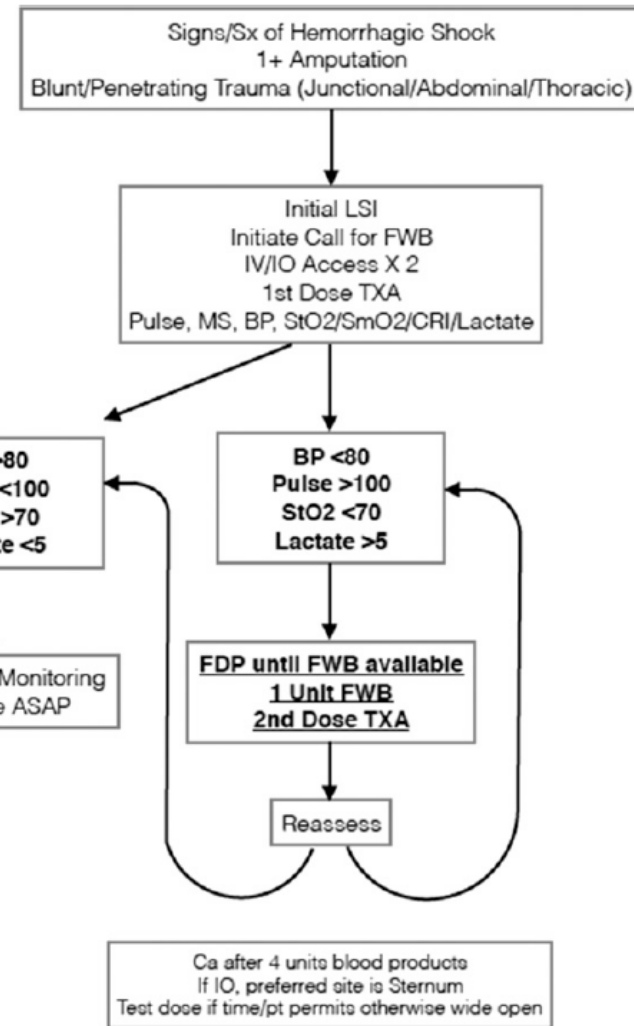




# = RDCR (today in U.S. military)

## The essentials:

- Hemorrhage control
- Resuscitation
  - TXA
  - **WHOLE BLOOD**
  - Avoid clear fluids
  - Plasma (FDP) as a bridge to WB



**ROLO!**



# DCR Definitions

- The initial definition of DCR, by Holcomb and colleagues, states ***“DCR addresses the entire lethal triad immediately upon admission to a combat hospital”***.
- DCR principles include: compressible hemorrhage control; hypotensive resuscitation; rapid surgical control of bleeding; avoidance of the overuse of crystalloids and colloids, prevention or correction of acidosis, hypothermia, and hypocalcemia; and hemostatic resuscitation (early use of a balanced amount of red blood cells (RBCs), plasma, and platelets).
- RDCR: *REMOTE* Damage Control Resuscitation has been defined as the *pre-hospital application* of Damage Control Resuscitation (DCR) concepts.
  - The term RDCR was first published by Gerhardt and colleagues from the United States Army Institute of Surgical Research and since been promoted by the THOR Network.

[THOR Position Paper on Remote Damage Control Resuscitation: Definitions, Current Practice and Knowledge Gaps.](#)

Jenkins DH, et al.; SHOCK, Vol. 1, Supplement 3, 2014.



# Why RDCR?

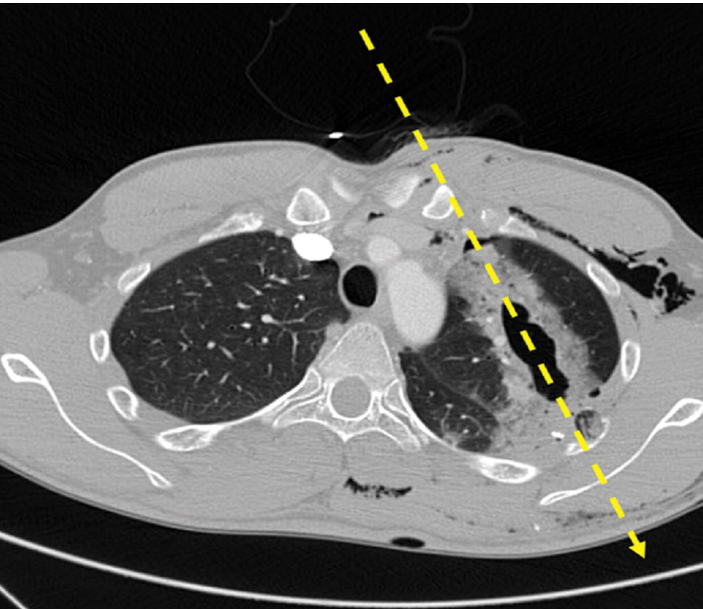
## HEMORRHAGIC SHOCK:

Low cardiac output →  
Poor tissue perfusion →  
Oxygen debt →  
Acidosis →  
Fibrinolysis/  
Coagulopathy/  
Platelet dysfunction →  
More bleeding →

***BLOOD FAILURE***

DEATH... IN MINUTES

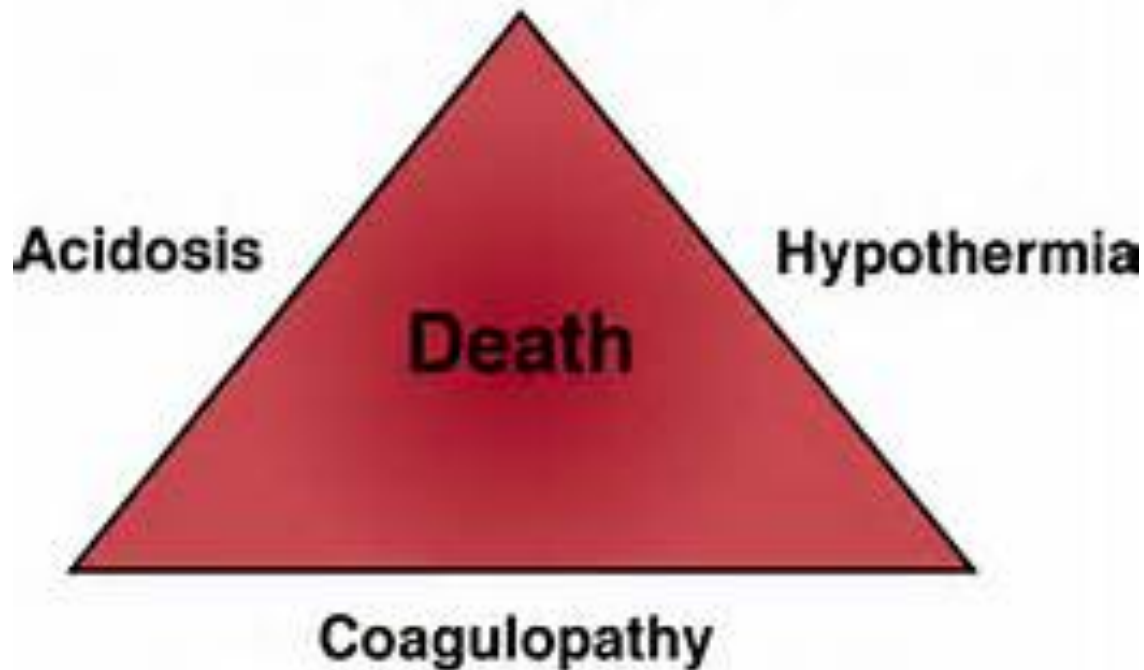
*Need to restore functionality of WB!*





# Goal of RDCR: Prevent the “Lethal Triad” (i.e. Blood Failure) Close to Point of Injury

## The Lethal Triad



Source: Mattox KL, Moore EE, Feliciano DV: *Trauma, 7th Edition*:  
[www.accesspharmacy.com](http://www.accesspharmacy.com)

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# DCR, and the case for RDCR

- “Pre-surgical” resuscitation
- Prepping the patient physiologically for best results during surgery
- Preventing complications and shock
- REMOTE DCR = moving the capability of DCR forward closer to the point of injury (POI)
  - It has been applied in the prehospital phase safely
  - It has been shown to decrease mortality if started as soon as possible



# Putting RDCR into Practice





# Control Hemorrhage

- Core concept inherent in Tactical Combat Casualty Care (TCCC) protocols
  - Validated, universally accepted combat trauma management principles
- Liberal use of tourniquets, hemostatic dressings, junctional tourniquets
- Early and far-forward at the Point of Injury (POI)
  - Self- and Buddy-aid
- *Recognition* of need for rapid evacuation to surgical care

# TCCC Fluid Resuscitation from Hemorrhagic Shock: 2014

## Updated Fluid Resuscitation Plan

Order of precedence for fluid resuscitation of casualties in hemorrhagic shock

1. Whole blood
2. 1:1:1 plasma:RBCs:platelets
3. 1:1 plasma: RBCs
4. (tie) Plasma (liquid, thawed, dried) or RBCs alone
- .....
8. Hextend
9. (tie) Lactated Ringers or Plasma-Lyte A

# Why WB?

*It's simple!*



**Don't make things worse (clear fluids)!**

**Give the patient what he or she is losing!**

**Keep it simple (one product)!**



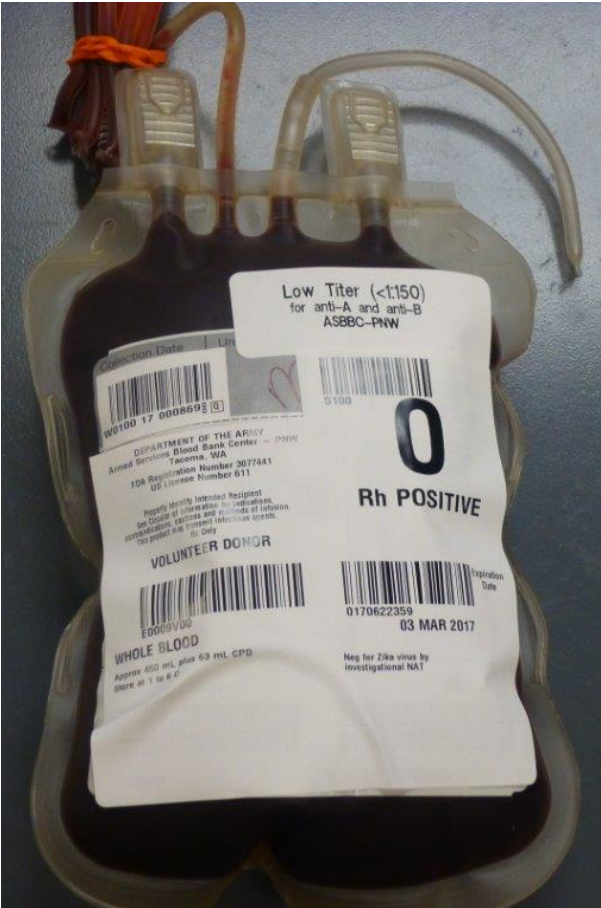
# Benefits of Low Titer Group O Whole Blood Compared to Blood Components for Blood Failure

- **Efficacy**
  - The cold stored platelets provide improved hemostasis compared to room temperature platelets
  - More concentrated product that contains less anticoagulants and additive solution than an equal amount of components
- **Safety**
  - Reduced risk of hemolysis from the low titer minor incompatible plasma compared to the risk from untitered minor incompatible plasma or platelets
  - Reduced risk of bacterial contamination compared to room temperature stored platelets
  - Impressive safety record with over 1 million units transfused in combat and civilian settings
- **Logistics**
  - Increased access to platelets for both pre-hospital and early in-hospital resuscitations
  - Simplifies and accelerates the provision of all blood components needed to treat hemorrhagic shock



# 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)

# Anti-coagulants and Additives



## 1:1:1 Component Therapy:

6 x RBC (AS-5)    6 x 120 ml = 720ml

6 x FFP            6 x 50 ml = 300ml

1 x aPLT            1 x 35 ml = 35ml

Total = 1055ml



## Whole Blood x 6 Units:

6 x 63ml = 378ml

Total: 378ml

***3 times the volume of anticoagulant & additives in reconstituted whole blood from components (1:1:1) compared to whole blood!***

# Whole Blood Recent Combat Data

**Fresh whole blood use by forward surgical teams in Afghanistan is associated with improved survival compared to component therapy without platelets**

*Shawn C. Nessen, Brian J. Eastridge, Daniel Cronk, Robert M. Craig, Olle Berséus, Richard Ellison, Kyle Remick, Jason Seery, Avani Shah, and Philip C. Spinella*

*The Journal of TRAUMA<sup>®</sup> Injury, Infection, and Critical Care*

**Warm Fresh Whole Blood Is Independently Associated With Improved Survival for Patients With Combat-Related Traumatic Injuries**

*Philip C. Spinella, MD, Jeremy G. Perkins, MD, Kurt W. Grathwohl, MD, Alec C. Beekley, MD, and John B. Holcomb, MD*

**Comparison of platelet transfusion as fresh whole blood versus apheresis platelets for massively transfused combat trauma patients**

*Jeremy G. Perkins, Andrew P. Cap, Philip C. Spinella, Andrew F. Shorr, Alec C. Beekley, Kurt W. Grathwohl, Francisco J. Rentas, Charles E. Wade, John B. Holcomb, and the 31st Combat Support Hospital Research Group*



# Adjunctive DCR Measures

- TXA administration
- Calcium administration
- Trending vital signs/monitoring
  - Consider monitoring urine output
  - Consider measuring point of care labs (lactate)
- Nursing care
- Warming/maintaining body temperature of the patient
- Wound care/antibiotics
- Pain control





# Tranexamic Acid Summary

- CRASH-2: 20,211 patients, 274 hospitals, 40 countries
- **Tranexamic acid is the only drug to have a demonstrated mortality benefit in trauma.**
- Timing of administration appears to be critical in trauma (use only within 3 hours of injury). Overall safety profile is very reassuring.
- Only available dosing guidance provided by CRASH-2 (1gm load over 10 minutes, then 1gm over 8 hours).
- Tranexamic acid is no longer patent-protected. DoD formulary cost is \$39.12 for a 1gm vial (about \$80 total for the C regimen).





# Calcium Supplementation

**CALCIUM:** hypoCa → long QTc, decreased cardiac output, coagulopathy, seizures, etc.

**97.4% of trauma MTP patients hypocalcemic (<1.12mmol/L)**

**50-70% severe (<0.8-0.9mmol/L)**

- More coagulopathy
- More blood transfused
- Double mortality (49% vs. 24%)
- Calcium replacement after 4U, but never resolved (still <1.12mmol/L)

**One unit of citrated blood product can drop iCa**

**Give 2g CaCl or 6gm Ca gluconate EARLY (<4 U transfused)**



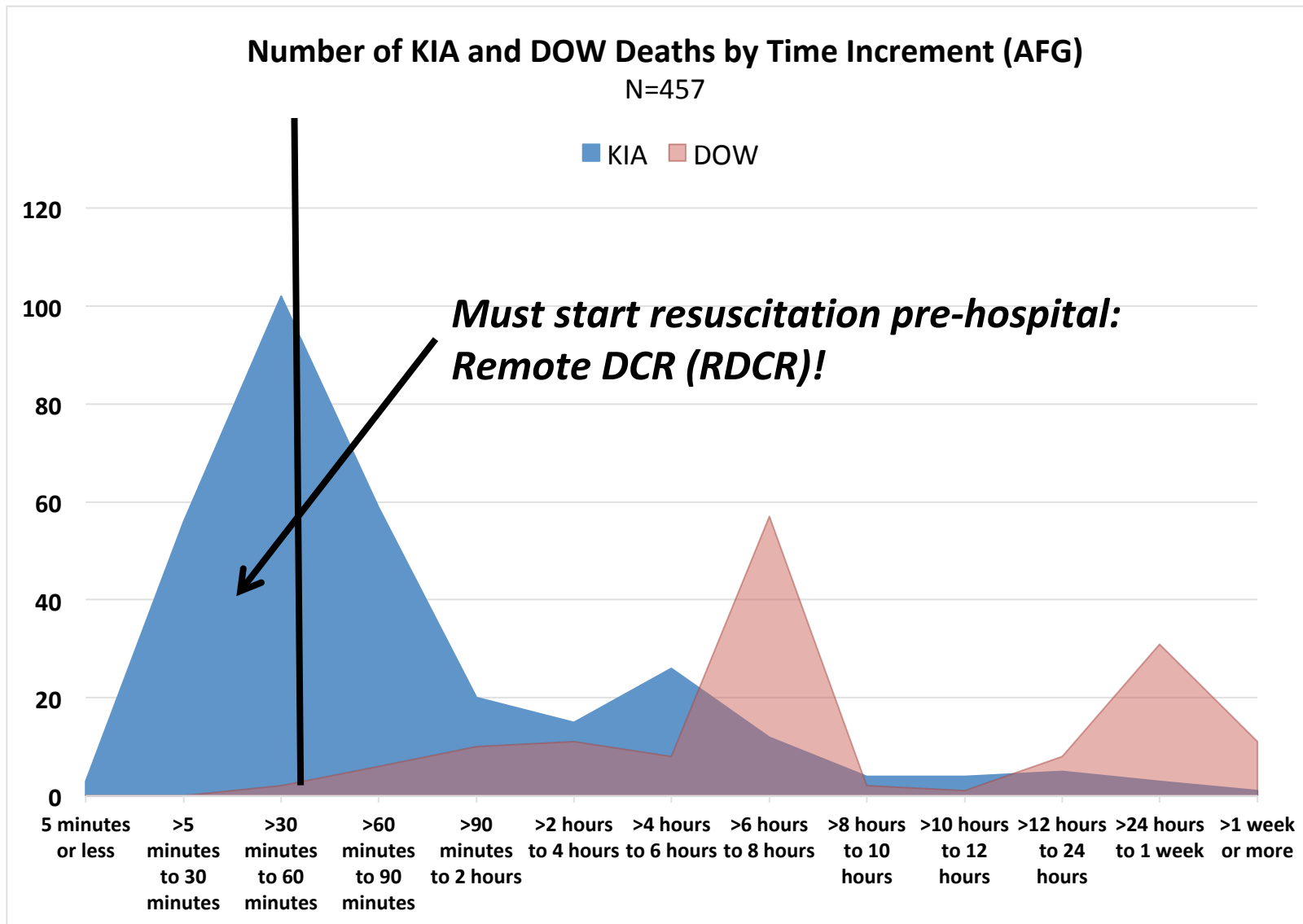


# Timing of RDCR



# Time to Death: KIA/DOW

## Golden Hour is too late to start DCR...







# RDCR: immediately if not sooner!

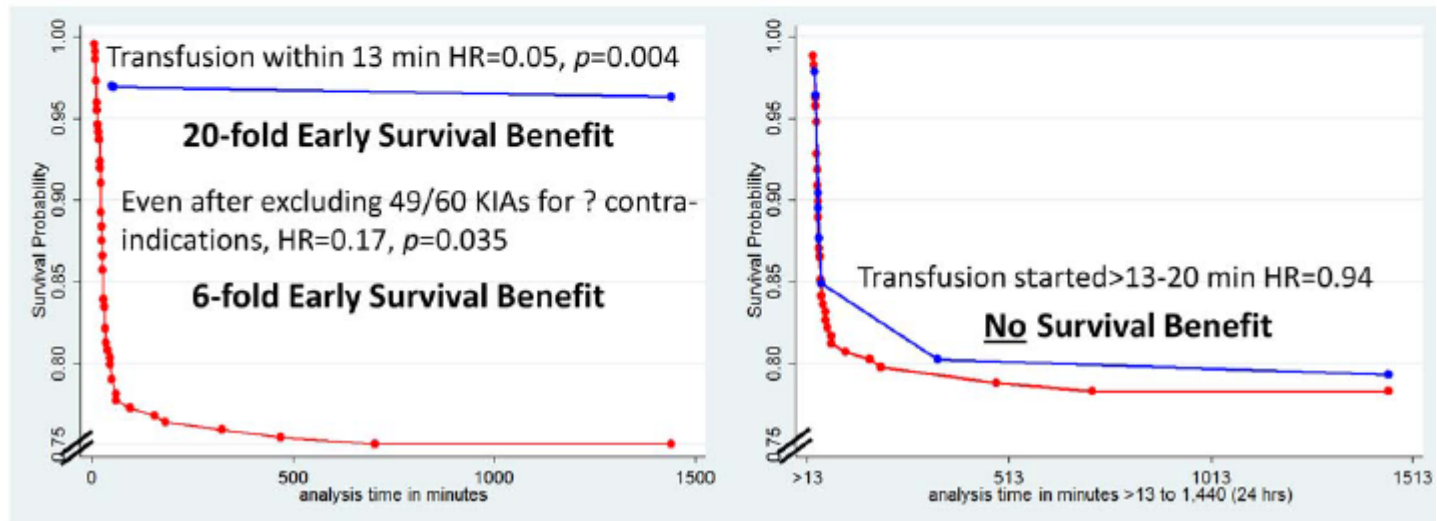
## Rapid Pre- or In-Hospital Transfusion

### Adjusted Cox Models for 24 hour Survival

Transfusion started within 13\*  
vs. >13 minutes after MEDEVAC  
take-off from POI

Among survivors past minute  
13, transfusion started >13-20  
vs. >20 minutes after take-off

\*34 min  
from injury



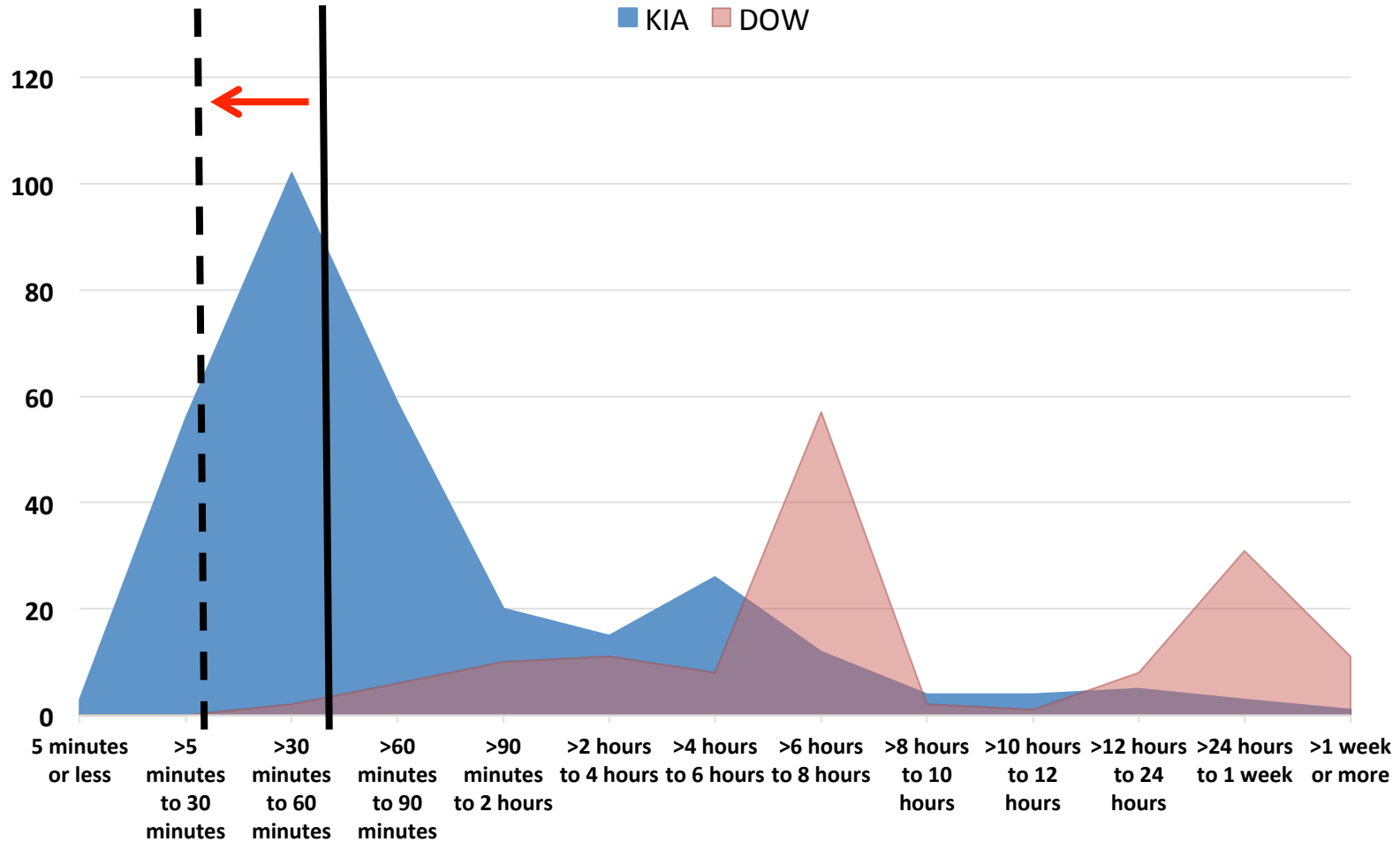
Increasing duration of shock is not helpful.

*Think BLS. How many minutes before myocardium and brain die?*



# Golden Hour is too late... NEED BLOOD at POI

Number of KIA and DOW Deaths by Time Increment  
N=457





# RDCR 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.