Update from the Acute Life Threatening Haemorrhage Working Group

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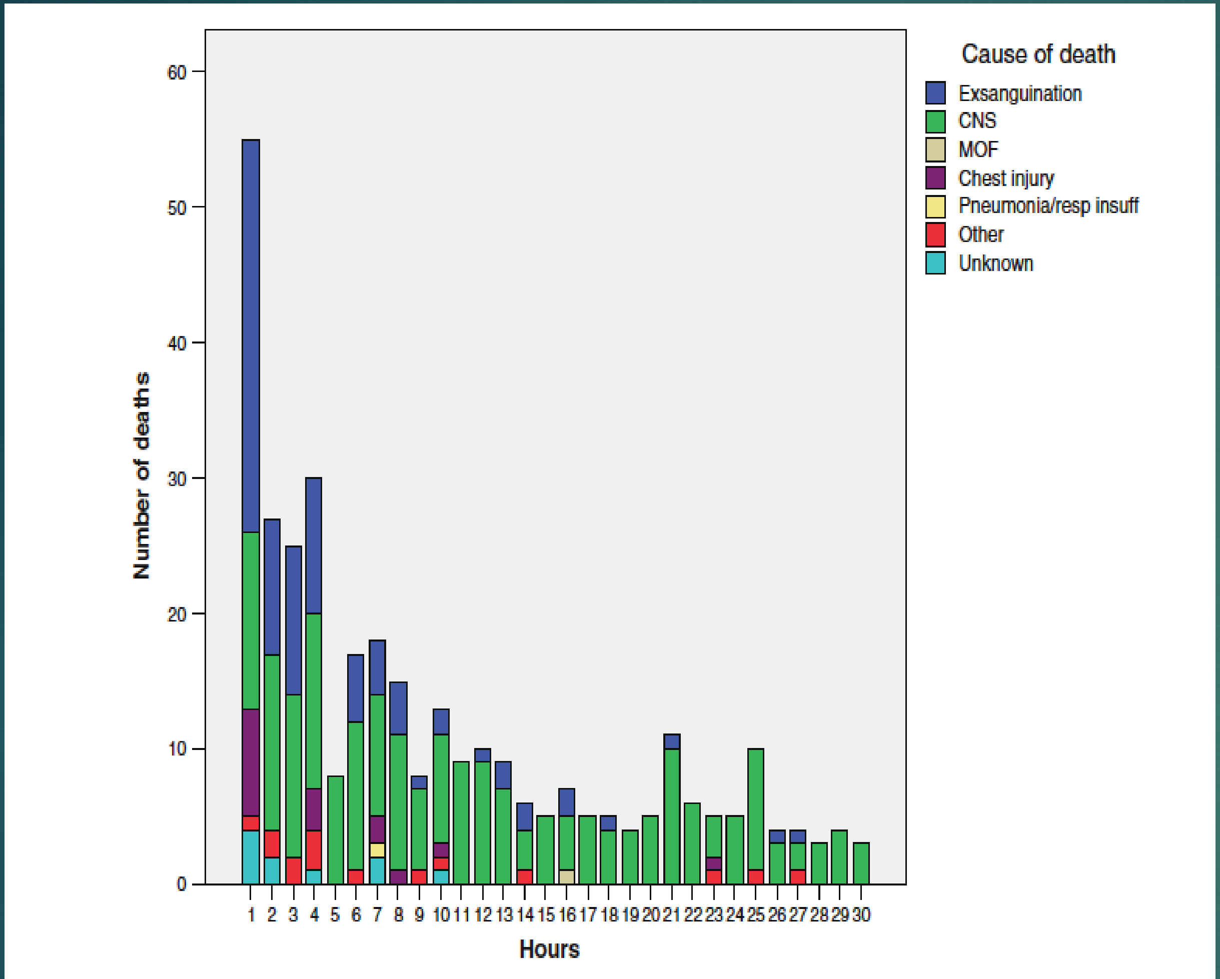
Four Broad Areas

- Trauma / exsanguinating haemorrhage after polytrauma
- Post-partum haemorrhage
- GI haemorrhage
- Paediatrics

Why Do Trauma Patients Die?



Eur J Trauma Emergency Surg 2013:39:375-383

Major Trauma Outcome Study (ACS COT):

- 30-40% of early trauma deaths are directly attributable to ***haemorrhage***
- It is estimated that 62% of all in-hospital trauma deaths occur within ***the first four hours***, of which ***haemorrhage*** is either the primary cause or a major contributing factor
- Major haemorrhage is probably the most important remediable contributor to both mortality and morbidity in the trauma patient
  - ***Early haemorrhage control***, whether it occurs naturally or after iatrogenic intervention such as embolisation or intraoperatively by a surgeon, is paramount in achieving good patient outcomes
  - ***Effective and timely haemorrhage recognition*** and control may be the single most important step in the emergency management of the severely injured patient

Exsanguinating Haemorrhage

- Definition / recognition
- Pre-emptive
- Site of the most compelling source of bleeding
- Pre-hospital & ED (pre-operative) techniques
  - Hypotensive resuscitation
- Operative techniques
- Resuscitation
  - Fluids
  - Blood
  - Blood products
  - Adjuncts

Management

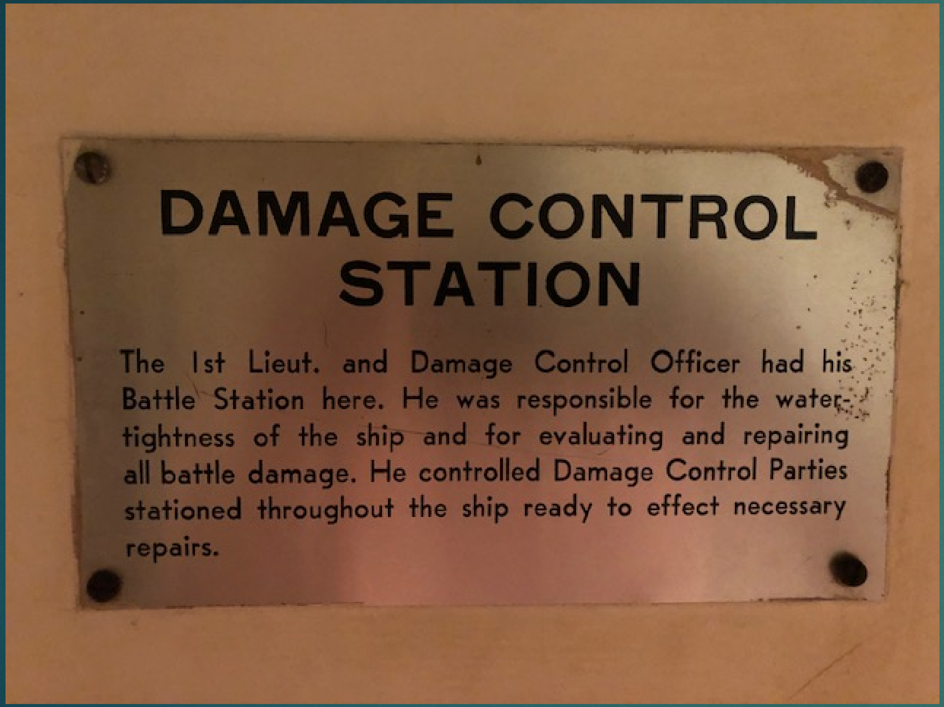
Recognition

Stopping the bleeding

Transfusion resuscitation

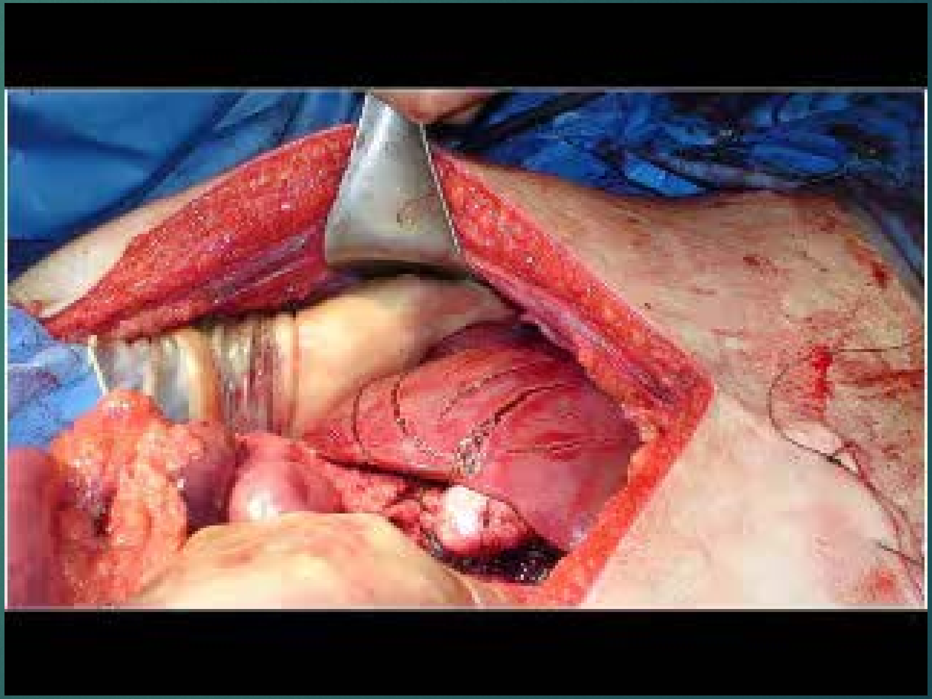
- Reversing the triad
  - Acidosis
  - Hypothermia
  - Coagulopathy

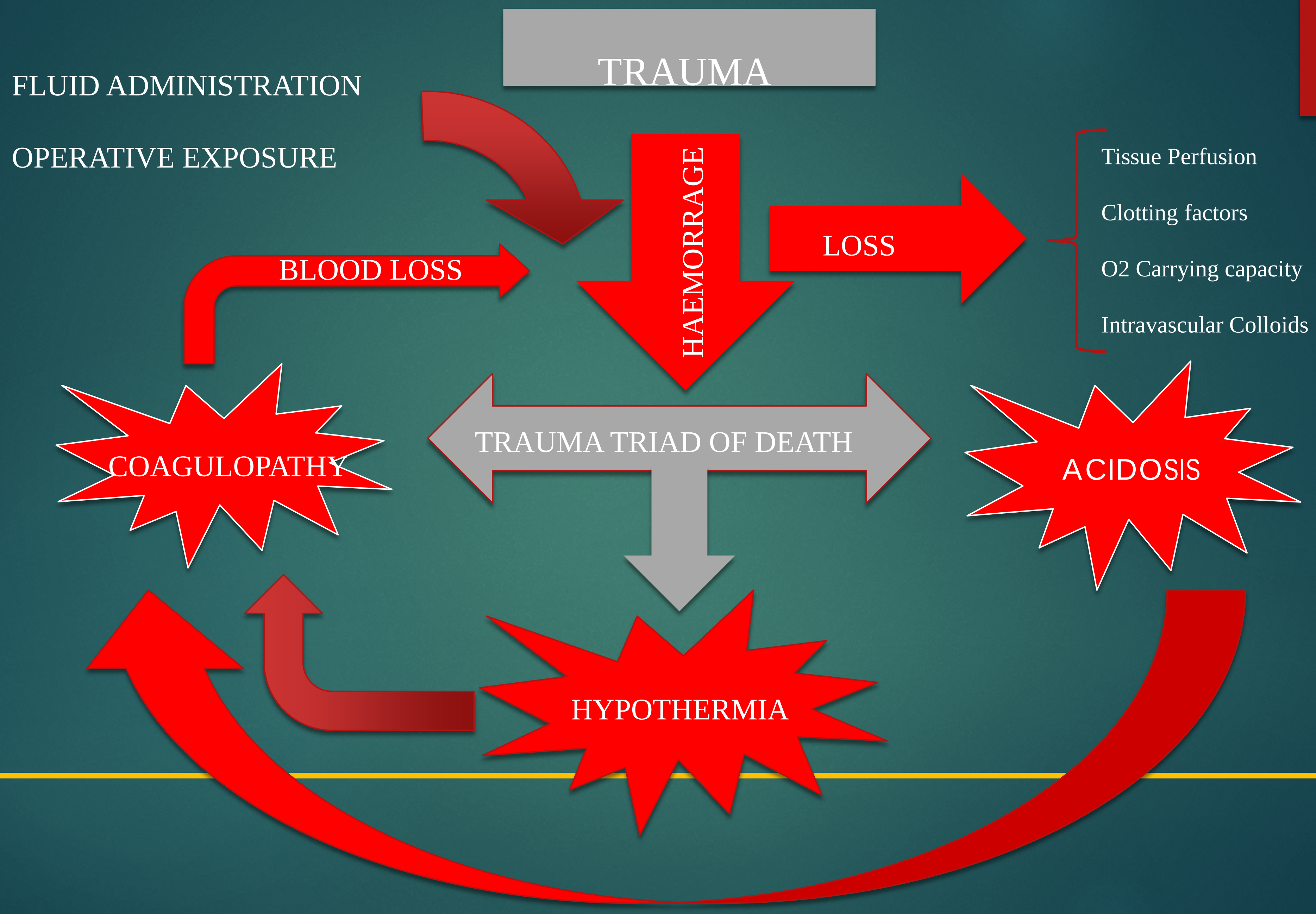
Damage control at sea



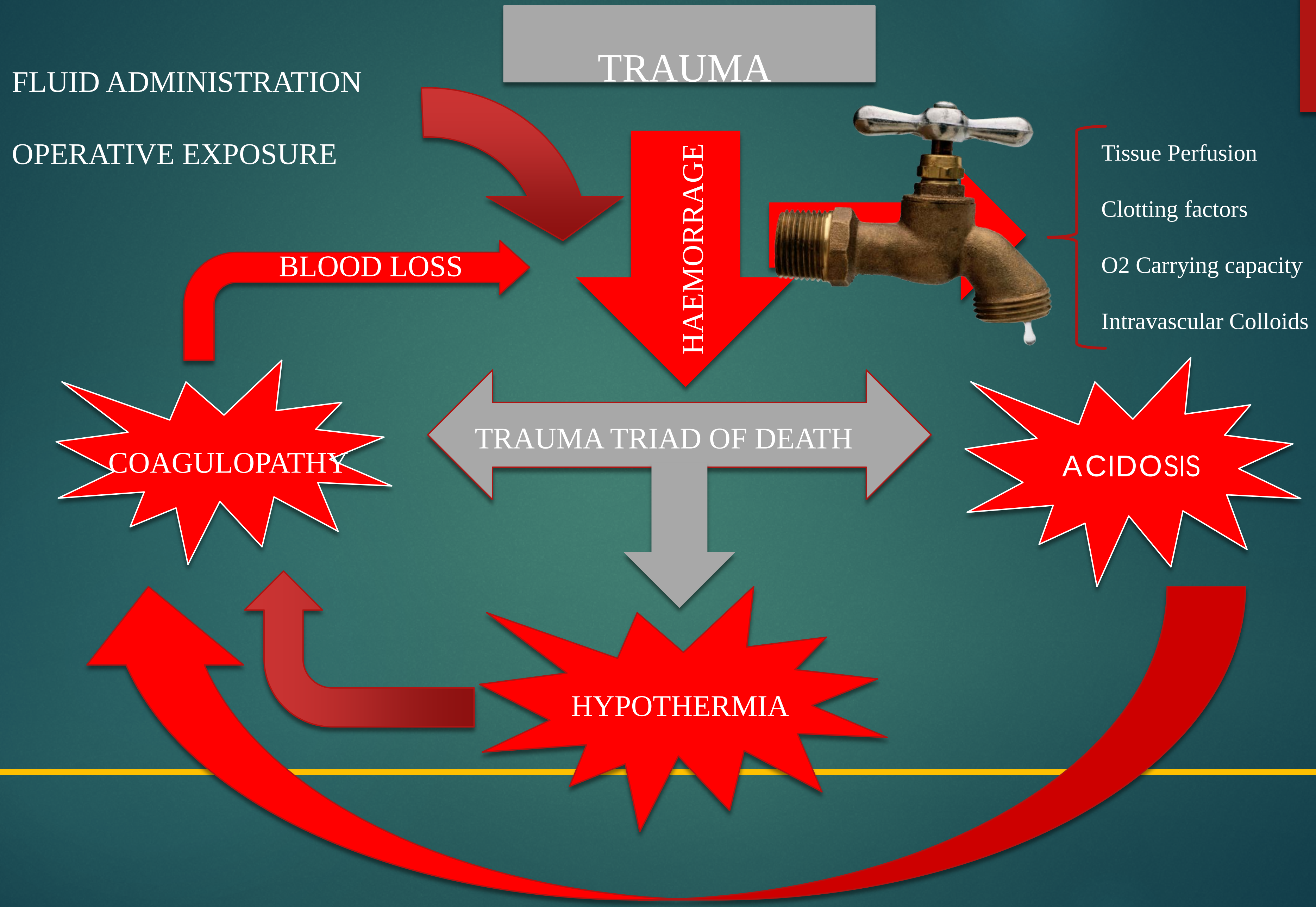
Capacity of ship
to absorb damage
&
maintain mission integrity

Damage control in trauma





TRAUMA
FLUID ADMINISTRATION
OPERATIVE EXPOSURE
HAEMORRAGE
LOSS
Tissue Perfusion
Clotting factors
O2 Carrying capacity
Intravascular Colloids
BLOOD LOSS
COAGULOPATHY
TRAUMA TRIAD OF DEATH
ACIDOSIS
HYPOTHERMIA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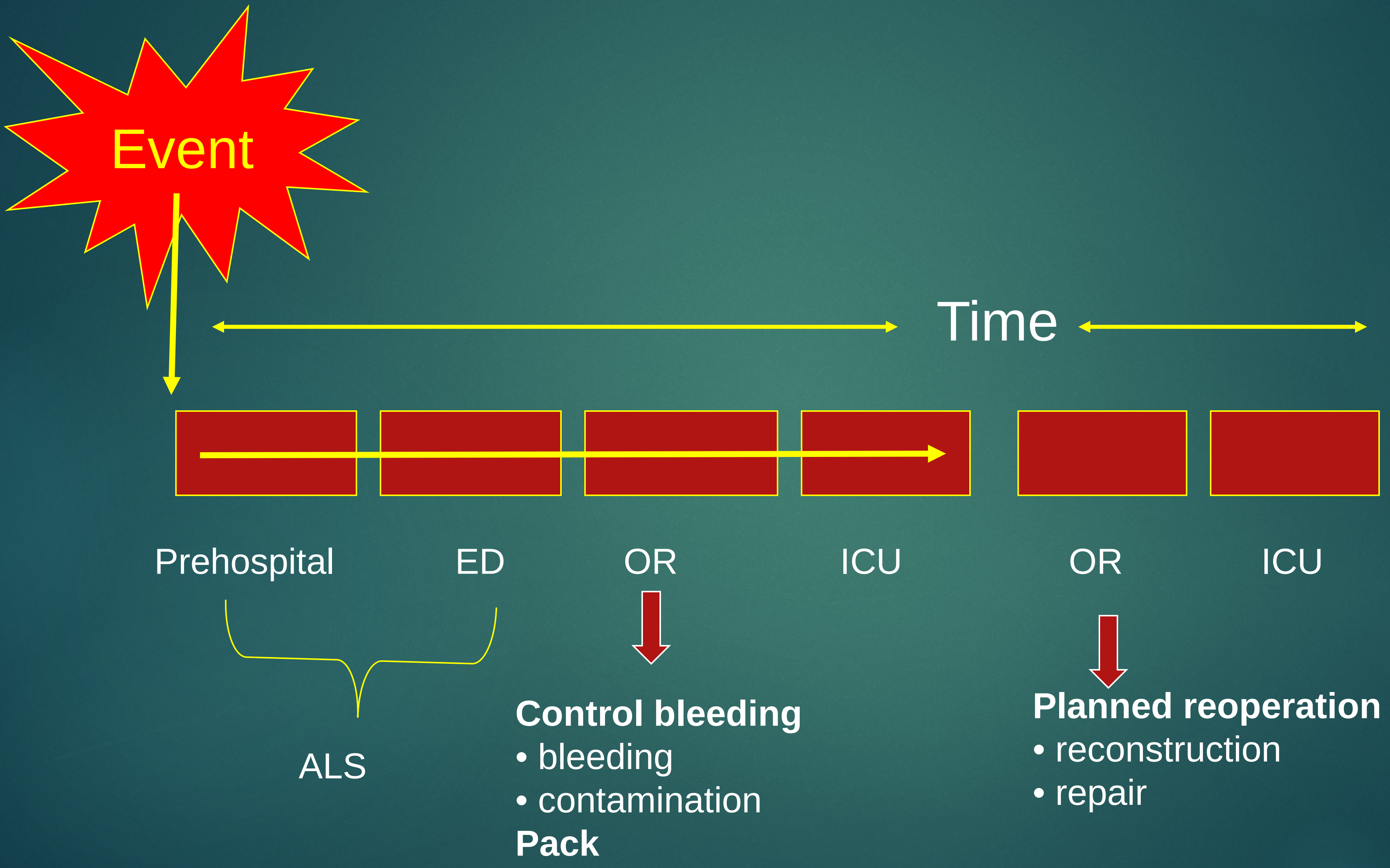
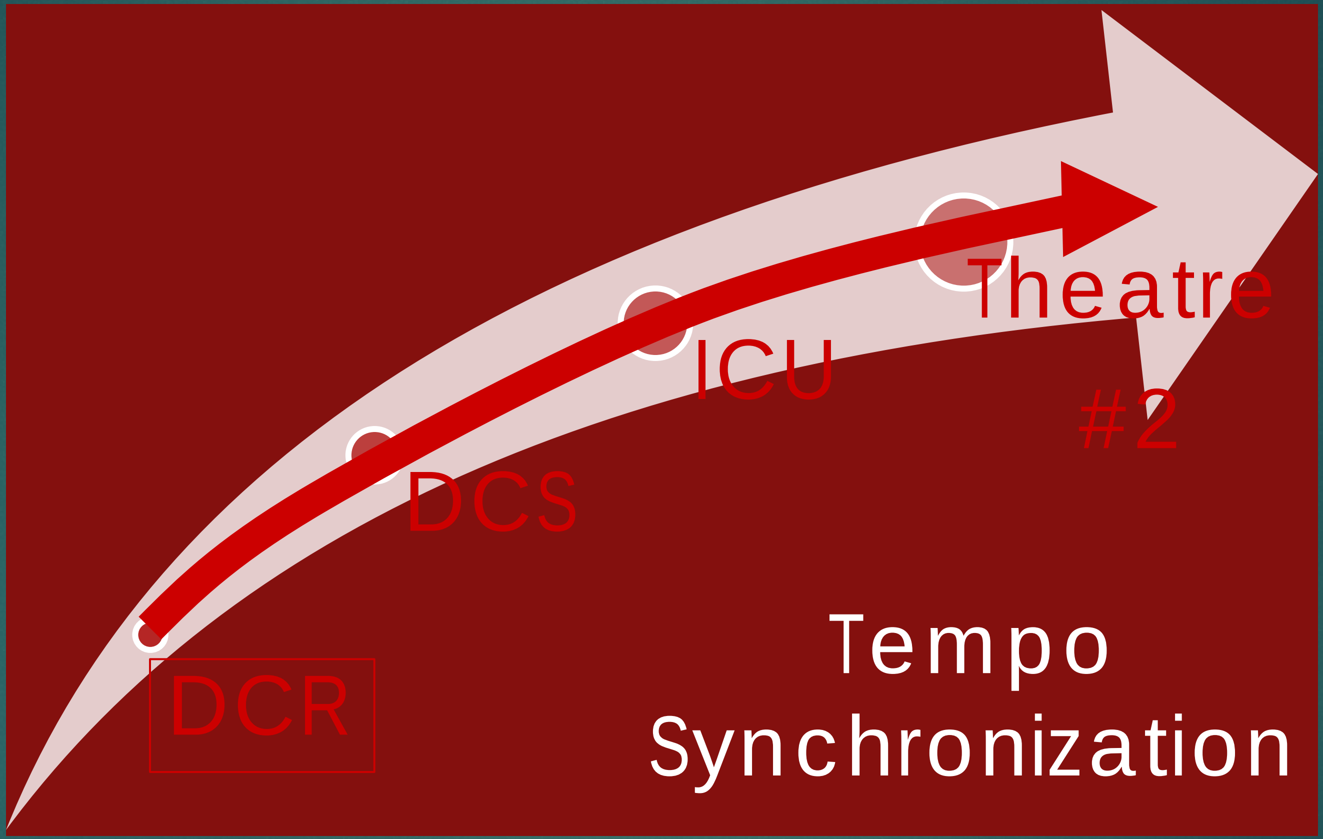
Damage Control



Damage control pathway



DAMAGE CONTROL: An approach for improved survival in exsanguinating penetrating abdominal injury

PART I - OR

- Control hemorrhage
- Control contamination
- Intraabdominal packing
- Temporary closure

….standard lap vs Dam Control: 11 vs 77% survival

PART II - ICU

- Core rewarming
- Correct coagulopathy
- Maximize hemodynamics
- Ventilatory support

PART III - OR

- Pack removal
- Definitive repairs

Rotondo, Schwab et al *J Tra* 1993

Damage Control: HOW?

DC0 "Ground zero" - Recognition

- **Rapid transport (EMS)**
- **Decision ----> OR**
- **Resuscitation (TB)**
  - **O2, Blood, Prevent heat loss Massive transfusion protocol**

Minutes

DC I – OR (warmed)

- Control hemorrhage
- Control contamination
- Intraabdominal packing
- TAC

< 2 hrs

DC II - ICU

- Rewarming
- Correct coagulopathy
- Maximize hemodynamics
- Ventilatory support
- Re-exam

~24-36 hrs

DC III - OR

- Pack removal
- Definitive repairs
- Closure ?

48hrs – 1yr

DC IV - OR

- Definitive Closure

Johnson, Gracias, Schwab, et al. *JTrauma* 2001.

Permissive hypotension

Dutton et al RCT of blunt pts with hypotensive resuscitation beginning in ED *J Trauma 2002*

While no survival difference, authors noted aiming for SBP of 70 mmHg (vs. >100 mmHg) was safe in patients arriving with evidence of hemorrhage.

ORIGINAL ARTICLE

Hypotensive Resuscitation Strategy Reduces Transfusion Requirements and Severe Postoperative Coagulopathy in Trauma Patients With Hemorrhagic Shock: Preliminary Results of a Randomized Controlled Trial

C. Anne Morrison, MD, MPH, Matthew M. Carrick, MD, Michael A. Norman, MD, Bradford G. Scott, MD, Francis J. Welsh, MD, Peter Tsai, MD, Kathleen R. Liscum, MD, Matthew J. Wall, Jr., MD, and Kenneth L. Mattox, MD

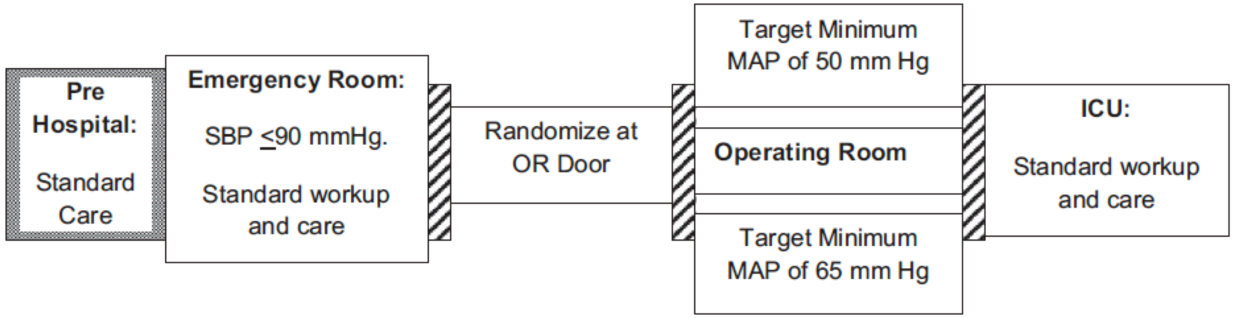


Figure 1. Diagram of the patient flow from left to right.

A controlled resuscitation strategy is feasible and safe in hypotensive trauma patients: Results of a prospective randomized pilot trial

J Trauma Acute Care Surg
Volume 78, Number 4

Eligibility: out-of-hospital SBP of ≤ 90 mm Hg.

CR: 250 mL bolus if no radial pulse or SBP <70 mm Hg; boluses to maintain a radial pulse or an SBP of 70 mm Hg or greater.

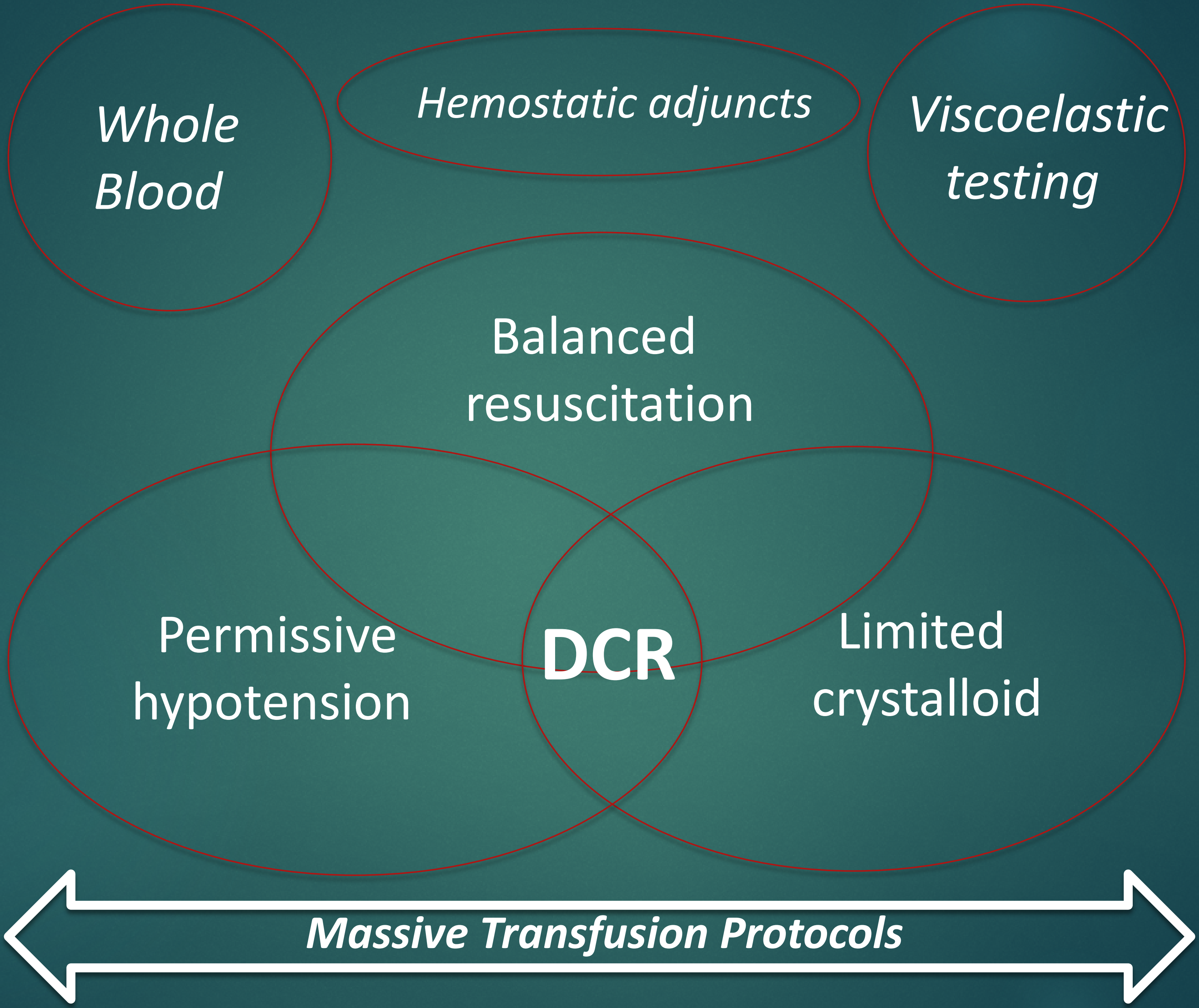
SR: received 2 L, boluses to maintain SBP ≥110.

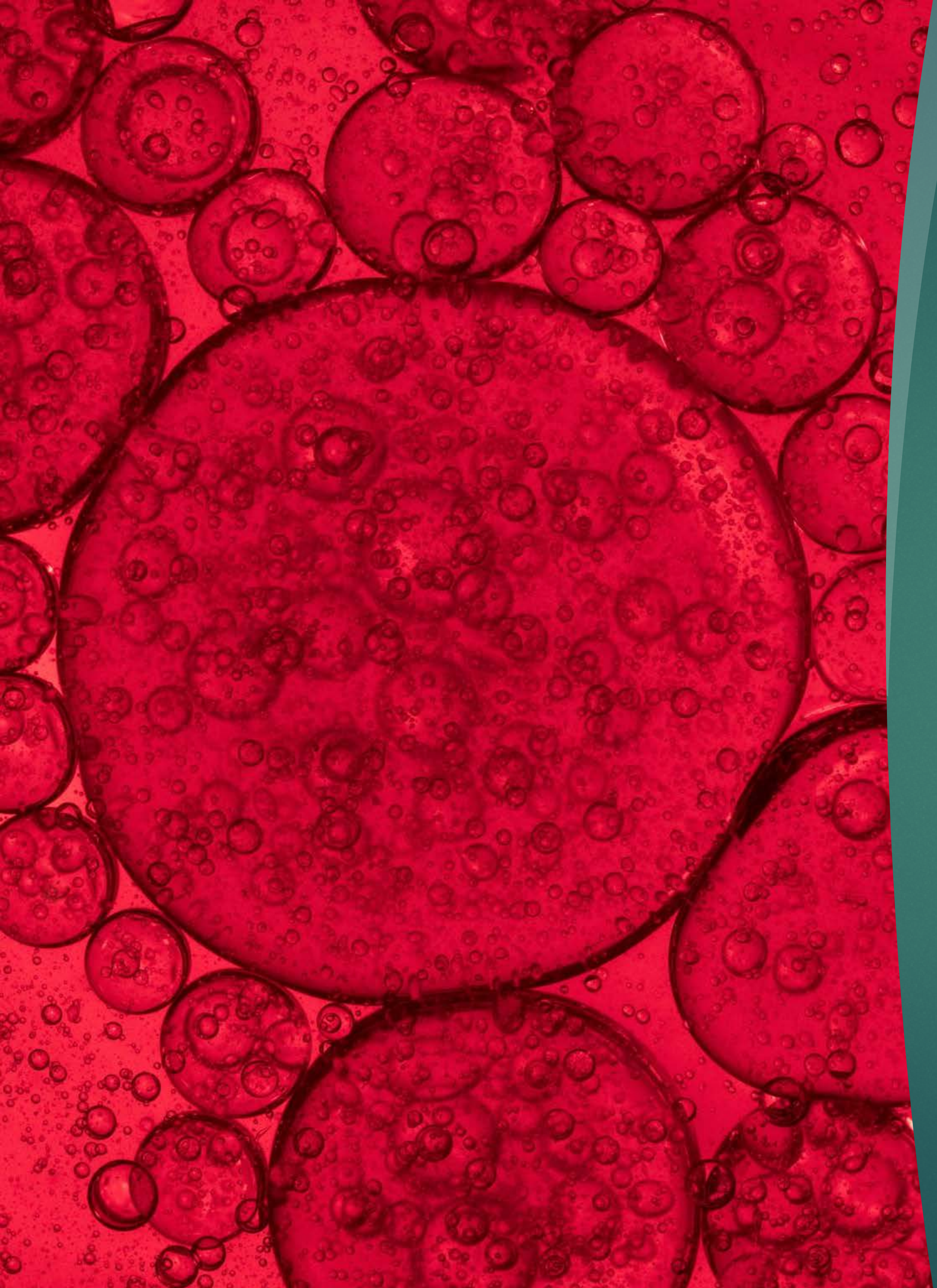
Protocol maintained until hemx controlled/2-hrs

- Among blunt trauma patients, 24-hour mortality was 3% (CR) and 18% (SR); adjusted odds ratio of 0.17 (0.03-0.92)

AAST 2014 PLENARY PAPER

A controlled resuscitation strategy is feasible and safe in hypotensive trauma patients: Results of a prospective randomized pilot trial


Whole Blood
Hemostatic adjuncts
Viscoelastic testing
Balanced resuscitation
Permissive hypotension
DCR
Limited crystalloid
Massive Transfusion Protocols



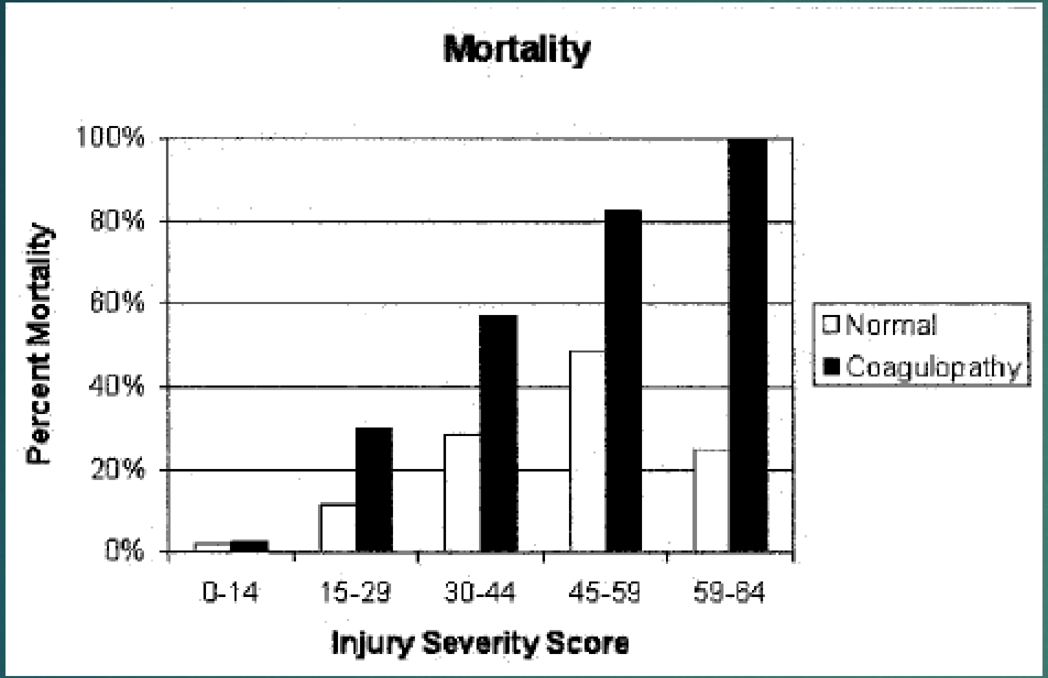
Massive Transfusion Protocolization

- WHAT IS EXSANGUINATING HAEMORRHAGE?

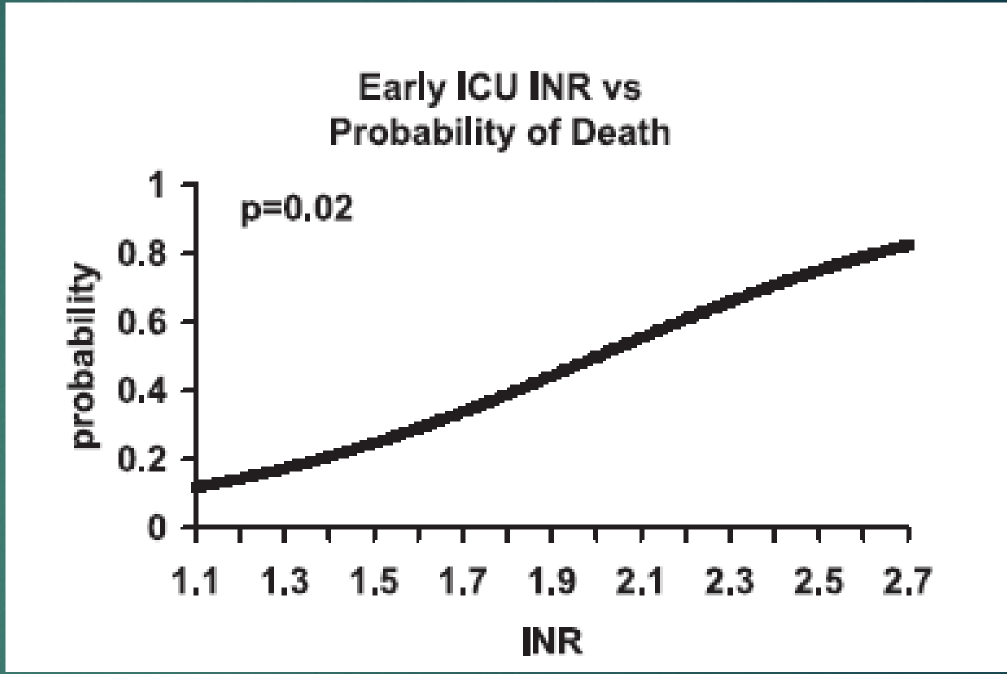
Massive transfusion protocol

- Limit crystalloid
- Resuscitate with blood products
  - 1:1:1 PRBCs:FFP:Platelets
  - Cryoprecipitate
- Consider pro-coagulants
  - Tranexamic acid

Coagulopathy & Mortality



Brohi, J Trauma 2003; 54:1127-30

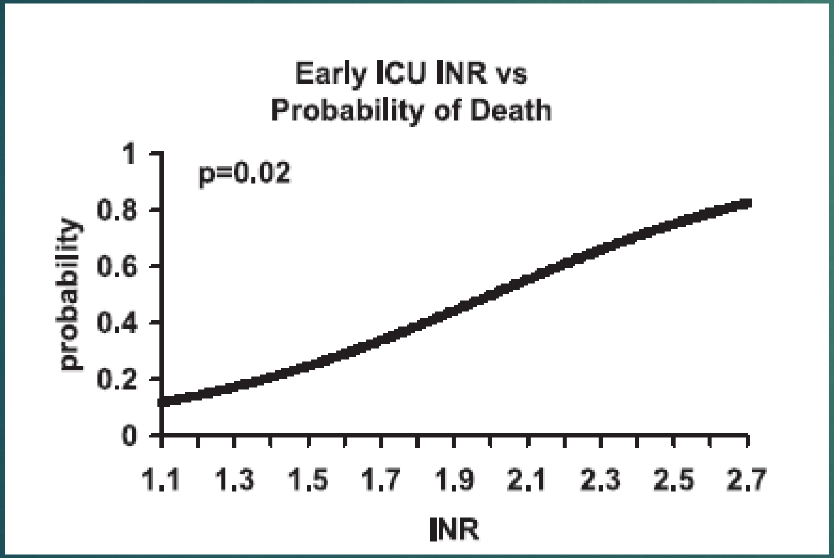


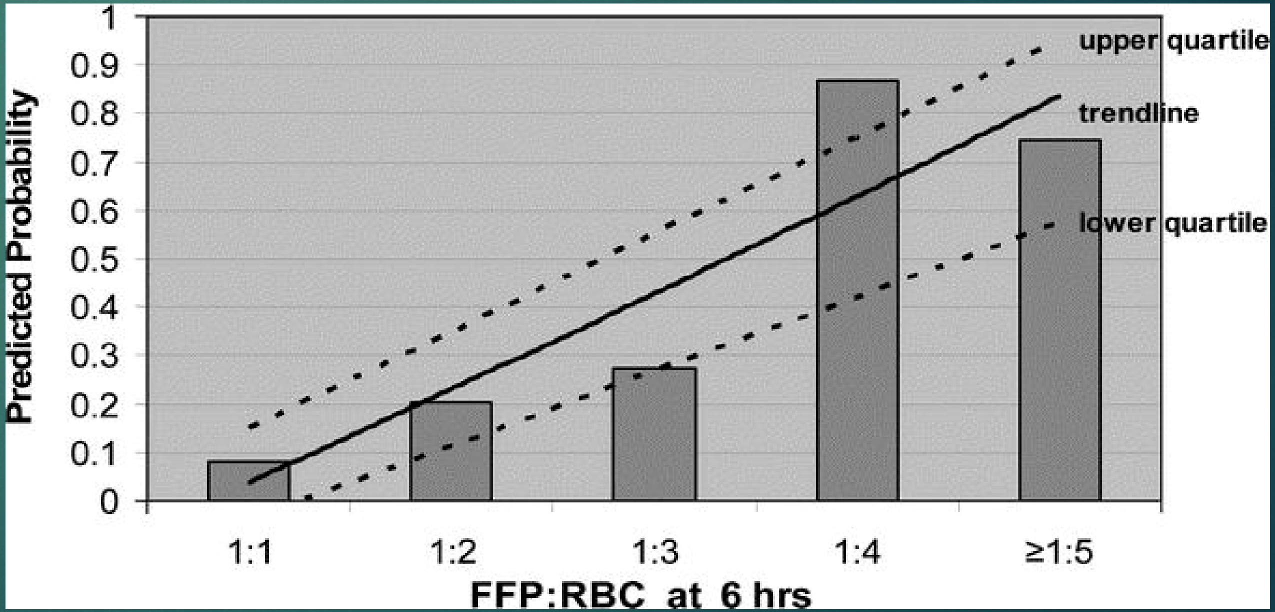
Gonzalez E. J Trauma 2007; 62:112

The Journal of **TRAUMA**® *Injury, Infection, and Critical Care*

Fresh Frozen Plasma Should be Given Earlier to Patients Requiring Massive Transfusion

Ernest A. Gonzalez, MD, Frederick A. Moore, MD, John B. Holcomb, MD, Charles C. Miller, PhD, Rosemary A. Kozar, MD, PhD, S. Rob Todd, MD, Christine S. Cocanour, MD, Bjorn C. Balldin, MD, and Bruce A. McKinley, PhD





Kashuk, J. J Trauma 2008; 65 : 261

TABLE 4. Multivariate Logistic Regression Model Predicting 30-day Survival

	Odds ratio	95% CI	*P*
Damage control resuscitation	2.48	1.10–5.58	0.028
ED arrival base value	1.10	1.02–1.20	0.011
ED arrival INR value	0.93	0.79–1.10	0.414
ED arrival SBP, mm Hg	1.02	0.99–1.02	0.075
Age, yr	0.98	0.96–1.01	0.192

95% CI indicates 95 percent confidence interval; ED, emergency department; INR, international normalized ratio; SBP, systolic blood pressure.

Article:SLA202469 **Date:**August 16, 2011 **Time:** 17:46

Damage Control Resuscitation Is Associated With a Reduction in Resuscitation Volumes and Improvement in Survival in 390 Damage Control Laparotomy Patients

Bryan A. Cotton, MD, MPH, Neeti Reddy, BS,* Quinton M. Hatch, MD,* Eric LeFebvre, BS,* Charles E. Wade, PhD,* Rosemary A. Kozar, MD, PhD,† Brijesh S. Gill, MD,† Rondel Albarado, MD,† Michelle K. McNutt, MD,† and John B. Holcomb, MD†*

Damage Control Hematology: The Impact of a Trauma Exsanguination Protocol on Survival and Blood Product Utilization

Bryan A. Cotton, MD, Oliver L. Gunter, MD, James Isbell, MD, Brigham K. Au, BS, Amy M. Robertson, MD, John A. Morris, Jr., MD, Paul St. Jacques, MD, and Pampee P. Young, MD, PhD

Background: The importance of early and aggressive management of trauma-related coagulopathy remains poorly understood. We hypothesized that a trauma exsanguination protocol (TEP) that systematically provides specified numbers and types of blood components immediately upon initiation of resuscitation would improve survival and reduce overall blood product consumption among the most severely injured patients.

Methods: We recently implemented a TEP, which involves the immediate and continued release of blood products from the blood bank in a predefined ratio of 10 units of packed red blood cells (PRBC) to 4 units of fresh frozen plasma to 2 units of platelets. All TEP activations from February 1, 2006 to July 31, 2007 were retrospectively evaluated. A comparison cohort (pre-TEP) was selected from all trauma admissions between August 1, 2004 and January 31, 2006 that (1) underwent immediate surgery by the trauma team and (2) received greater than 10 units of PRBC in the first 24 hours. Multivariable analysis was performed to compare mortality and overall blood product consumption between the two groups.

Results: Two hundred eleven patients met inclusion criteria (117 pre-TEP, 94 TEP). Age, sex, and Injury Severity Score were similar between the groups, whereas physiologic severity (by weighted Revised Trauma Score) and predicted survival (by trauma-related Injury Severity Score, TRISS) were worse in the TEP group (p values of 0.037 and 0.028, respectively). After controlling for age, sex, mechanism of injury, TRISS and 24-hour blood product usage, there was a 74% reduction in the odds of mortality among patients in the TEP group ($p = 0.001$). Overall blood product consumption adjusted for age, sex, mechanism of injury, and TRISS was also significantly reduced in the TEP group ($p = 0.015$).

Conclusions: We have demonstrated that an exsanguination protocol, delivered in an aggressive and predefined manner, significantly reduces the odds of mortality as well as overall blood product consumption.

Key Words: Hemorrhage, Exsanguination, Trauma, Massive transfusion.

J Trauma. 2008;64:1177–1183.

Table 2 Univariate Analyses of Primary and Secondary Outcome Measures

Variable	Pre-TEP (n = 117)	TEP (n = 94)	*p*
30-d mortality (%)	65.8	51.1	0.030*
24-h blood product use (units)	39 ± 28	31.8 ± 19	0.017*
24-h RBC use (units)	19.8 ± 12.8	18.8 ± 11.2	0.695
24-h FFP use (units)	12.4 ± 12.5	9.9 ± 7	0.595
24-h PLT use (units)	6.8 ± 7.2	3.1 ± 3.7	<0.001*
Intraoperative RBC use (units)	11.1 ± 8.5	16 ± 11.4	0.001*
Intraoperative FFP use (units)	4.3 ± 4	8.2 ± 6.8	<0.001*
Intraoperative PLT use (units)	1.1 ± 2.6	2.2 ± 2.3	<0.001*
Intraoperative crystalloid (L)	6.7 ± 4.2	4.9 ± 3.0	0.002*
Unexpected survivors (%)	5.1	22.3	<0.001*
Unexpected deaths (%)	22.2	8.5	0.007*

Hypothesis: A massive transfusion protocol (MTP) decreases the use of blood components, as well as turnaround times, costs, and mortality.

Design: Retrospective before-and-after cohort study.

Setting: Academic level I urban trauma center.

Patients and Methods: Blood component use was compared in 132 patients during a 2-year period following the implementation of an MTP; 46 patients who were treated the previous year served as historical control subjects.

Intervention: Introduction of an MTP that included recombinant factor VIIa for patients with exsanguinating hemorrhage.

Main Outcome Measures: The amount of each blood component transfused, turnaround times, blood bank and hospital charges, and mortality rates.

Results: After introduction of the MTP, there was a significant decrease in packed red blood cells, plasma, and platelet use. The turnaround time for the first shipment was less than 10 minutes, and the time between the first and second shipments was reduced from 42 to 18 minutes, compared with historical controls. The decreased use of blood products represented a savings of $2270 per patient or an annual savings of $200 000, despite increased costs for recombinant factor VIIa. There was no difference in mortality in either group; it remained around 50%. Thromboembolic complications did not increase, despite a significant increase in the use of recombinant factor VIIa.

Conclusions: The MTP resulted in a reduction in the use of blood components with improved turnaround times and significant savings. Mortality was unaffected. The use of recombinant factor VIIa did not increase thromboembolic complications in these patients.

Arch Surg. 2008;143(7):686-691

PAPER

A Massive Transfusion Protocol to Decrease Blood Component Use and Costs

Terence O'Keeffe, MB, ChB, MSPH; Majed Refaai, MD; Kathryn Tchorz, MD; John E. Forestner, MD; Ravi Sarode, MD

Table 3. Differences in Units of Blood Component Transfused Between Groups

Component	Pre-MTP[a]	MTP[a]	*P* Value
PRBCs	15.5 (15.5)	11.8 (11.8)	<.001
Thawed plasma	8.7 (6.9)	5.7 (5.4)	<.02
Platelets	3.8 (5.2)	1.1 (1.3)	<.001
Cryoprecipitate	0.7 (0.9)	0.6 (0.8)	.32
rFVIIa, mg	0.63 (1.8)	1.91 (2.5)	<.002

Abbreviations: MTP, massive transfusion protocol; PRBCs, packed red blood cells; rFVIIa, recombinant factor VIIa.

[a] Data are given as mean (SD).

TABLE 3. Multivariate Regression Predicting 30-d Mortality

	OR	95% CI	*p*
Time to receipt of first cooler, min	1.05	1.01–1.09	0.016
Anatomic injury severity (ISS)	1.05	1.03–1.06	<0.001
Disturbed arrival physiology (w-RTS)	0.61	0.53–0.69	<0.001
Randomization group (1:1:2)	1.46	0.92–2.29	0.102
RI, units	1.03	0.60–1.44	0.184

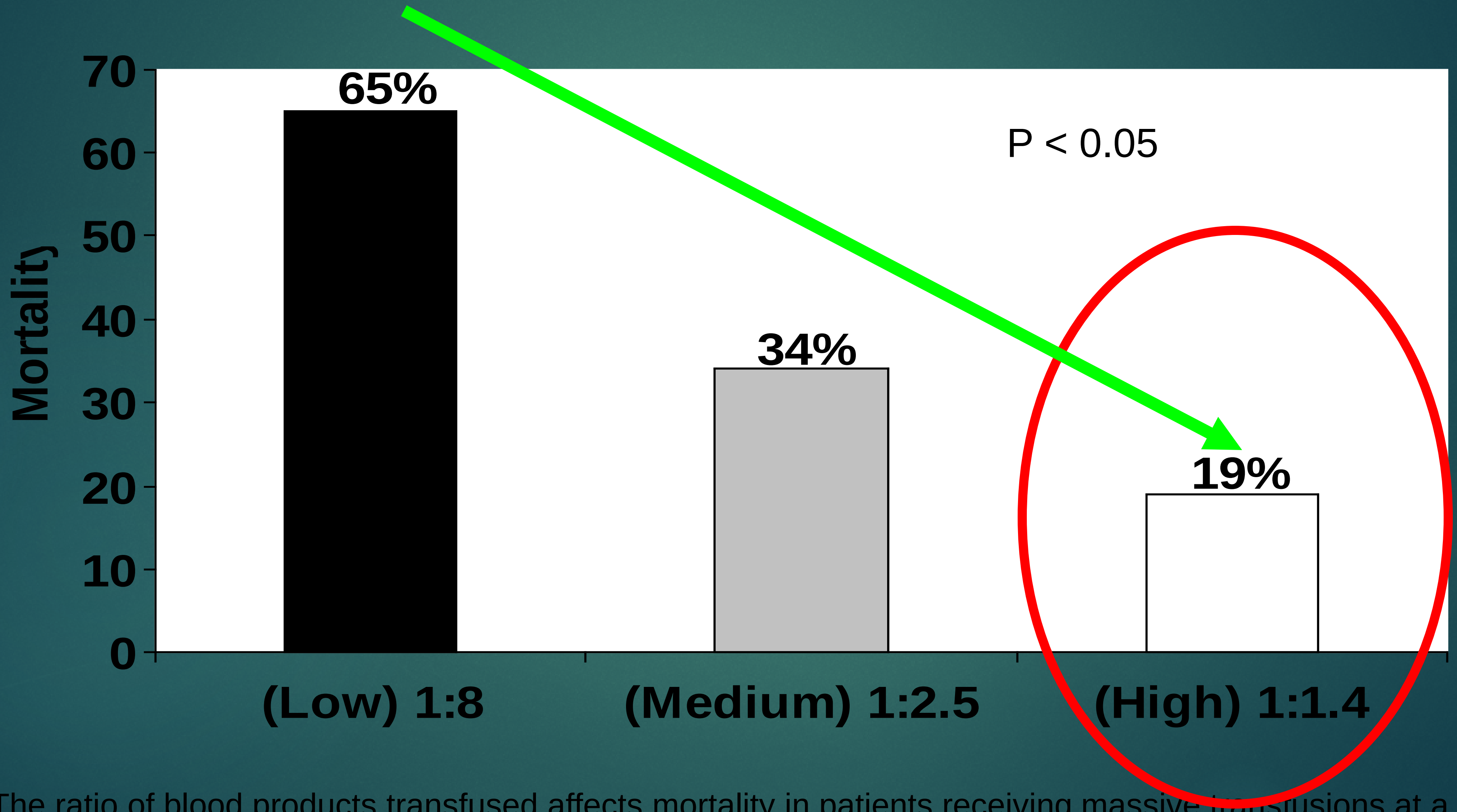
Every minute counts: Time to delivery of initial massive transfusion cooler and its impact on mortality

David E. Meyer, MD, Laura E. Vincent, RN, Erin E. Fox, PhD, Terence O'Keeffe, MBChB, Kenji Inaba, MD, Eileen Bulger, MD, John B. Holcomb, MD, *and* **Bryan A. Cotton, MD,** *Houston, Texas*

A Randomized Controlled Pilot Trial of Modified Whole Blood Versus Component Therapy in Severely Injured Patients Requiring Large Volume Transfusions

Bryan A. Cotton, MD, MPH,† Jeanette Podbielski, BSN,† Elizabeth Camp, MSPH,† Timothy Welch, NREMT-P,† Deborah del Junco, PhD,† Yu Bai, MD, PhD,‡ Rhonda Hobbs, MT (ASCP),‡ Jamie Scroggins, MT (ASCP),§ Beth Hartwell, MD,§ Rosemary A. Kozar, MD, PhD,* Charles E. Wade, PhD,*† and John B. Holcomb, MD*† on behalf of The Early Whole Blood Investigators*

Mortality by Plasma : RBC Ratio
n = 252



The ratio of blood products transfused affects mortality in patients receiving massive transfusions at a combat support hospital. Borgman MA, et. submitted, J Trauma, 2007.

Tranexamic acid

Antifibrinolytic agent that prevents clot breakdown

≤ 3 hrs: 1 gm bolus, then 1 gm over 8 hrs

CRASH-2

- **1.5% absolute risk reduction**
- **9% relative risk reduction**

Cap, J Trauma 2011;71:S9-S14; US Defense Health Board 2011

Damage Control Resuscitation (DCR)

Modern term where best outcomes practice in the severely injured or major haemorrhaging patient, starting in the pre-hospital environment and continuing right through Emergency Department arrival and immediately on to Stages I and II. DCR takes in to account;

- Blood loss volume
- Injury burden
- Patient physiology

The approach in DCR may be considered unorthodox to traditional surgical dogma including;

- Minimal fluid resuscitation
- Rapid transportation to a Major Trauma Centre
- 1:1:1 transfusion ratios
- Hypotensive resuscitation
- Early and aggressive haemorrhage control
    - Damage control surgery (abbreviated to <90mins)
    - Tourniquets
    - Vascular shunting & ligation
    - Abdominal packing
    - Pelvic packing & binder
    - Contamination control
- ICU correction of the Trauma Triad
    - Acidosis
    - Coagulopathy
    - Hypothermia

Damage control pitfalls

- Delayed recognition of need
- Decision paralysis
- Poor communication
- Failure to monitor temperature
- Inadequate monitoring of resuscitation
- Unnecessary investigations immediately after DCS

How it Differs...

Post-partum haemorrhage

- Techniques available to the obstetrician
- How the blood product replacement may differ
- Outcome measurements

GI Haemorrhage

- Evidence for management
  - Adjuncts
- Availability of endoscopic management

Paediatrics

- Evidence
- Dosing
- Adjuncts uasge

Thank you!