Concepts and challenges in the prehospital management of trauma related shock

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Disclosures

- Principle Investigator
  - Resuscitation Outcomes Consortium (ROC)
    Portland-Vancouver site
- Unpaid consultant
  - Philips Health Care
“It is the mark of an educated mind to be able to entertain a thought without accepting it”

Aristotle
Objectives

- Review current concepts and challenges in the diagnosis and management of shock in the context of trauma in the prehospital setting
State of generalized cellular hypoperfusion in which oxygen delivery is inadequate to meet metabolic needs

<table>
<thead>
<tr>
<th>Category</th>
<th>Common Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolemic</td>
<td>Hemorrhage, fluid loss, third spacing</td>
</tr>
<tr>
<td>Cardiogenic</td>
<td>MI, cardiomyopathy, valve disease</td>
</tr>
<tr>
<td>Obstructive</td>
<td>Tension pneumothorax, cardiac tamponade, pulmonary embolism</td>
</tr>
<tr>
<td>Distributive</td>
<td>Neurogenic, sepsis, anaphylaxis, adrenal crisis</td>
</tr>
</tbody>
</table>
MAP = Cardiac Output (CO) x Systemic Vascular Resistance (SVR)

CO = Stroke Volume x Heart Rate

Pulse pressure = SBP – DBP

MAP ≈ DBP + 1/3 (SBP – DBP)
Mortality After Trauma

- MOF: 9%
- Other: 3%
- Hemorrhage: 21%
- CNS + Hem: 16%
- CNS: 51%

N = 753

Hemorrhagic Shock

Table 1: Classes of hemorrhagic shock

<table>
<thead>
<tr>
<th></th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood loss (mL)</td>
<td>≤750</td>
<td>750–1500</td>
<td>1500–2000</td>
<td>≥2000</td>
</tr>
<tr>
<td>Blood loss (% blood volume)</td>
<td>≤15%</td>
<td>15%–30%</td>
<td>30%–40%</td>
<td>≥40%</td>
</tr>
<tr>
<td>Pulse rate (BPM)</td>
<td>&lt;100</td>
<td>&gt;100</td>
<td>&gt;120</td>
<td>&gt;140</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Normal</td>
<td>Normal</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Pulse pressure</td>
<td>Normal or ↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Capillary refill</td>
<td>Normal</td>
<td>Delayed</td>
<td>Delayed</td>
<td>Delayed</td>
</tr>
</tbody>
</table>

Shock in trauma is hemorrhagic until proven otherwise
Hemorrhagic shock - Recognition

- Elevated HR, Low BP, narrowed pulse pressure
- **Shock Index (HR/SBP [0.5 to 0.8, ≥ 1 bad])**
- Organ perfusion
  - Decreased capillary refill, cool clammy extremities, AMS, decreased urinary output
- Challenges
  - Pediatric, Elderly, Athletes, Pregnancy, Medications
# 2011 Guidelines for Field Triage of Injured Patients

## 1. Measure vital signs and level of consciousness

<table>
<thead>
<tr>
<th>Glasgow Coma Scale</th>
<th>≤13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic Blood Pressure (mmHg)</td>
<td>&lt;90 mmHg</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>&lt;10 or &gt;29 breaths per minute, or need for ventilatory support (&lt;20 in infant aged &lt;1 year)</td>
</tr>
</tbody>
</table>

## 2. Assess anatomy of injury

- All penetrating injuries to head, neck, torso, and extremities proximal to elbow or knee
- Chest wall instability or deformity (e.g. flail chest)
- Two or more proximal long-bone fractures
- Crushed, degloved, mangled, or pulseless extremity
- Amputation proximal to wrist or ankle
- Pelvic fractures
- Open or depressed skull fracture
- Paralysis

**YES**

Transport to a trauma center. Steps 1 and 2 attempt to identify the most seriously injured patients. These patients should be transported preferentially to the highest level of care within the defined trauma system.
## Importance of SBP < 90 (ROC-HS secondary analysis data)

<table>
<thead>
<tr>
<th>Lowest prehospital SBP</th>
<th>Hypotensive on ED arrival</th>
<th>Emergent Procedure (%)</th>
<th>28 day mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;55</td>
<td>92</td>
<td>84 (91.3)</td>
<td>50 (54.4)</td>
</tr>
<tr>
<td>55-64</td>
<td>32</td>
<td>28 (87.5)</td>
<td>11 (34.4)</td>
</tr>
<tr>
<td>65-74</td>
<td>39</td>
<td>33 (84.6)</td>
<td>8 (20.5)</td>
</tr>
<tr>
<td>75-84</td>
<td>19</td>
<td>21 (91.3)</td>
<td>4 (17.4)</td>
</tr>
<tr>
<td>85-90</td>
<td>18</td>
<td>12 (60.0)</td>
<td>2 (10.0)</td>
</tr>
<tr>
<td>All</td>
<td>206</td>
<td>178 (86.4)</td>
<td>75 (36.4)</td>
</tr>
</tbody>
</table>

Shock recognition – is there anything else that can help us?
Lactate

- By-product of anaerobic metabolism
  - Produced when tissues cannot get or process oxygen and substrates quickly enough
- Biological marker for ischemic organs
- May identify patients who may not appear to be sick by history, clinical examination or vitals
Biomarker Lactate Assessment in Shock & Trauma (ROC - BLAST)
Inclusion Criteria

- Patients meeting local trauma triage criteria and...
  - Systolic blood pressure ≤100 mmHg, and...
  - Placement of an IV, and...
  - Transported to a level I or II trauma center or
  - Died in the field or en route

Exclusion Criteria

- Age <15, hanging, drowning, prisoners, isolated penetrating head injury, primary burn trauma
The primary endpoint was the need for resuscitative care (RC) defined as any of the following within 6 hours of ED arrival:

- Blood transfusion
- Hemorrhage control requiring thoracotomy, laparotomy, pelvic fixation or embolization
- Death
Results (Ground - AHA ReSS 2012)

Receiver operating characteristic analysis demonstrated that P-LAC is superior to both SBP and SI for the prediction of RC.
POC-field lactate is a better predictor of the need for resuscitative care

Lactate Pro meter no longer available

Lactate Plus

- Meter ($275)
- Strips ($46 per vial of 25)
- Results in 13 seconds
Lactate Plus vs. Lactate Pro

Portable Analyzer Correlation Plots for Lactate Plus Analyzer Versus Lactate Pro Analyzer.

correlation $r = 0.999$

Tanner RK et al. Euro J App Physiol 2010
Heart Rate Variability

- Traumatic hemorrhage compensation involves autonomic nervous system
  - Low PSNS, high SNS associated with survival
  - High PSNS, low SNS associated with death
- Can ECG heart rate variability analysis help with early detection and assist with prehospital triage
Fig. 3. Average R–R interval power spectral density (RRI PSD) is shown for 15 patients who lived (solid line) and 15 patients who died (broken line with red shading) traumatic injuries requiring transport to a level one trauma center; vertical dotted line denotes the demarcation of low-frequency (0.05–0.15 Hz) and high-frequency (0.15–0.4 Hz) spectral bands.
Prehospital Ultrasound

- Philips Nuvis
- Sonosite Nanomaxx
- GE Vscan
Prehospital Ultrasound Apps

- Lung
  - Pneumothorax, hemothorax
- Heart
  - Pericardial tamponade, Stroke Volume
- FAST
  - Intra-abdominal hemorrhage
- IVC
  - Volume status
- Long bones
  - Fractures
# Etiology of shock based on ↓SV or ↓SVR

## Table 2. Etiology Of Shock Classified By A Reduction In Stroke Volume Or A Reduction In Systemic Vascular Resistance\(^{11,12}\)

<table>
<thead>
<tr>
<th>Category of Shock</th>
<th>Pulse Pressure</th>
<th>Diastolic Blood Pressure</th>
<th>Extremity Temperature</th>
<th>Capillary Refill</th>
<th>Central Venous Pressure</th>
<th>Ultrasound Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolemic</td>
<td>Narrow</td>
<td>Preserved</td>
<td>Cool</td>
<td>Delayed</td>
<td>Low</td>
<td>• Small inferior vena cava with respiratory collapsibility</td>
</tr>
<tr>
<td>Cardiogenic</td>
<td>Narrow</td>
<td>Preserved</td>
<td>Cool</td>
<td>Delayed</td>
<td>High</td>
<td>• Poor left ventricle contractility</td>
</tr>
</tbody>
</table>
| Obstructive       | Narrow         | Preserved                | Cool                  | Delayed           | High                    | • Tamponade: Pericardial effusion  
• Massive pulmonary embolism: Right ventricle dilation  
• Tension pneumothorax: Absence of "lung sliding" |
| Distributive      | Wide           | Reduced                  | Warm                  | Brisk             | Normal                  | • Hyperdynamic left ventricle |
Hemorrhagic Shock – Prehospital

- Maintain perfusion and oxygen delivery to vital organs
- Identify & treat causes (external hemorrhage)
  - Splints, Tourniquets, Hemostatic Bandages
- Rapid transport (internal hemorrhage)
- Treatment considerations
  - Position maneuvers, Impedance threshold device
  - Large bore IV’s and fluid replacement therapy
  - Anti-fibrinolytic therapy
Friedrich Trendelenburg
- Improve surgical exposure of pelvis

Walter Cannon (WWI)
- Recommended it as an anti-shock measure
- Retracted this advice 10 years later but it remains entrained in our practice

Friedrich Trendelenburg 1844-1924
8 hypovolemic post-op ICU patients
- MAP increased from 64.9 to 75.6 mm Hg (P< .05), pulmonary artery wedge pressure increased from 4.6 to 7.9 mm Hg (P< .05), and the systemic vascular resistance rose to 2,965 from 2,302 (P< .05)
- There was **no significant change** in cardiac index, oxygen delivery, oxygen consumption, or oxygen extraction ratio

Potential Complications

- Hypoventilation & atelectasis
- Altered ventilation/perfusion ratios
- Venous congestion with increased ICP
- Impaired venous return leading to further decrease in cardiac output and hypotension
- Increase aspiration risk
- Increased intra-ocular pressure
- Retinal detachment
Routine use of the Trendelenburg position is unwarranted

When confronted with a hypotensive patient your time and attention should be spent thinking about dilemmas like whether to resuscitate the patient with crystalloid and how much to raise the blood pressure……
ITD-7 causes low level of inspiratory resistance (-7 cm H₂O)
Enhances negative intrathoracic pressure generated during normal breathing
Increases venous return to the heart cardiac output
• Non-blinded feasibility study in EMS
• Applied for patients with SBP < 100 adult, < 90 pediatrics
• Suspected blood loss, dehydration, sepsis

47 patients, majority tolerated it well
Fluid Therapy

- Crystalloid
  - Normal saline
  - Balanced Salt Solutions
    - Ringers Lactate
    - Plasma-Lyte
  - Hypertonic saline
- Colloid
  - Increased MR in TBI
# Crystalloids

<table>
<thead>
<tr>
<th>Variable</th>
<th>Human Plasma</th>
<th>NS (0.9%)</th>
<th>RL</th>
<th>Plasma-Lyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osmolarity</td>
<td>291</td>
<td>308</td>
<td>280.6</td>
<td>294</td>
</tr>
<tr>
<td>Sodium</td>
<td>135-145</td>
<td>154</td>
<td>131</td>
<td>140</td>
</tr>
<tr>
<td>Potassium</td>
<td>4.5-5.0</td>
<td></td>
<td>5.4</td>
<td>5.0</td>
</tr>
<tr>
<td>Calcium</td>
<td>2.2-2.6</td>
<td></td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.8-1.0</td>
<td></td>
<td></td>
<td>3.0</td>
</tr>
<tr>
<td>Chloride</td>
<td>94-111</td>
<td>154</td>
<td>111</td>
<td>98</td>
</tr>
<tr>
<td>Acetate</td>
<td></td>
<td></td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>Lactate</td>
<td>1-2</td>
<td></td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Gluconate</td>
<td></td>
<td></td>
<td></td>
<td>23</td>
</tr>
</tbody>
</table>

Myburgh et al. NEJM 2013
Swine model of blunt liver trauma
Uncontrolled hemorrhage for 30 minutes followed by crystalloid resuscitation with NS or RL to baseline MAP

Outcomes
- Acid base status
- Coagulopathy measurements including standard tests and TEG
- Blood loss in abdomen

Kiraly L et al. J Trauma 2006
NS vs. RL - pH

Kiraly L et al. J Trauma 2006
NS vs. RL - TEG

<table>
<thead>
<tr>
<th></th>
<th>R Baseline</th>
<th>R 30'</th>
<th>R 60'</th>
<th>R 90'</th>
<th>R 120'</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN NS</td>
<td>6.7</td>
<td>5.3</td>
<td>4.8</td>
<td>5</td>
<td>5.1</td>
</tr>
<tr>
<td>MEAN LR</td>
<td>6.4</td>
<td>4.0</td>
<td>2.7</td>
<td>2.3</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Kiraly L et al. J Trauma 2006
Compared 2 fluids  NS vs. Plasma-Lyte A (calcium free)

- Mean ISS score = 23 ±16
- 20% had SBP < 90
- 78% needed an operation within 60 minutes
- Primary outcome was change in base excess

Ann Surg 2014
No difference in volume of fluids used, urine output or mortality between groups
Hypertonic Saline

- Hypertonicity pulls fluid into vessels
  - Increase in serum osmotic pressure
  - Redistribution of fluid from the interstitial to intravascular space
- Rapid restoration of intravascular volume
  - With a smaller volume of fluid
  - Decreased accumulation of extravascular volume

<table>
<thead>
<tr>
<th>Volume Infused (ml)</th>
<th>Fluid Type</th>
<th>Volume Expansion (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>D5W</td>
<td>100</td>
</tr>
<tr>
<td>1000</td>
<td>NS</td>
<td>250</td>
</tr>
<tr>
<td>250</td>
<td>7.5% Saline</td>
<td>1000</td>
</tr>
</tbody>
</table>
Benefits of Hypertonic Resuscitation
- Lighter fluid load (250cc), combat advantage
- More rapid restoration of tissue perfusion
- Reduction of Increased ICP without compromising cerebral perfusion
- Modulation of the inflammatory response, decreased organ injury

Prior clinical trials with inconclusive results
- Limited by sample size
- Limited comparison of hypertonic fluids with or without dextran
- Lower than expected mortality, more penetrating trauma
ROC – HS Trial

Out-of-hospital Hypertonic Resuscitation After Traumatic Hypovolemic Shock
A Randomized, Placebo Controlled Trial

Eileen M. Bulger, MD*, Susanne May, PhD*, Jeffery D. Kerby, MD, PhD†, Scott Emerson, MD, PhD*, Ian G. Stiell, MD‡, Martin A. Schreiber, MD§, Karen J. Brasel, MD, MPH¶, Samuel A. Tisherman, MD¶, Raul Coimbra, MD, PhD#, Sandro Rizoli, MD, PhD**, Joseph P. Minei, MD††, J. Steven Hata, MD‡‡, George Sopko, MD, MPH‡‡, David C. Evans, MD||, and David B. Hoyt, MD¶¶ for the ROC investigators

• 3 treatment arms
  • HS group: 250cc 7.5% saline
  • HSD group: 250cc 7.5% saline/6% Dextran 70
  • NS group: 250cc 0.9% saline
• Initial fluid given by pre-hospital providers
• Further fluid per local EMS protocol
Primary Outcome: 28 day survival

<table>
<thead>
<tr>
<th>Treatment</th>
<th>28 day survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSD</td>
<td>74.5%</td>
</tr>
<tr>
<td>HS</td>
<td>73.0%</td>
</tr>
<tr>
<td>NS</td>
<td>74.4%</td>
</tr>
</tbody>
</table>

P value: 0.91
NS leads to a hyperchloremic metabolic acidosis which can worsen trauma associated coagulopathy in hemorrhagic shock

Balanced salt solutions such as RL or Plasma-Lyte may be preferable when large volumes of crystalloid are being administered

A single 250 cc bag of 7.5% Hypertonic Saline does not improve outcomes
The Question

- While there is still a hole in a named blood vessel, what is the best fluid resuscitation strategy to keep the victim alive until hemostasis can be achieved, and to promote intact survival?
In uncontrolled internal hemorrhage, SBP may drop and clots begin to form at the points of rupture

- Body’s attempt to stop the flow of blood; similar to plugging a hole in a leaking hose

Aggressive resuscitation with large amounts of fluids:

- Dilutes the blood (minimizing the ability to clot)
- Raises systolic BP and ultimately “pops” the clots, leading to continued hemorrhage

Resuscitation with minimal fluids, while maintaining a lower SBP, may result in better outcomes
Delayed Fluid Resuscitation

- Houston, TX
- 1989-92
- Penetrating torso trauma
- SBP ≤90 mmHg
- Randomization
  - Even days: immediate resuscitation (n=309)
  - Odd days: delayed resuscitation (n=289)

Bickell WH et al. NEJM 1994
## Delayed Fluid Resuscitation

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Immediate</th>
<th>Delayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>% Male</td>
<td>88</td>
<td>91</td>
</tr>
<tr>
<td>SBP</td>
<td>58±35</td>
<td>59±34</td>
</tr>
<tr>
<td>Injury Severity Score</td>
<td>26±14</td>
<td>26±14</td>
</tr>
<tr>
<td>Probability of survival</td>
<td>69</td>
<td>72</td>
</tr>
<tr>
<td>Response interval</td>
<td>8±5</td>
<td>8±6</td>
</tr>
<tr>
<td>Scene interval</td>
<td>9±8</td>
<td>7±6</td>
</tr>
<tr>
<td>Transport interval</td>
<td>13±6</td>
<td>12±6</td>
</tr>
<tr>
<td>Trauma-center interval</td>
<td>44±65</td>
<td>52±99</td>
</tr>
</tbody>
</table>

Bickell WH et al. NEJM 1994
# Delayed Fluid Resuscitation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Immediate Resuscitation</th>
<th>Delayed Resuscitation</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival to discharge—no. of patients/total patients (%)</td>
<td>193/309 (62)</td>
<td>203/289 (70)</td>
<td>0.04</td>
</tr>
<tr>
<td>Estimated intraoperative blood loss—mL</td>
<td>3127±4937</td>
<td>2555±3546</td>
<td>0.11</td>
</tr>
<tr>
<td>Length of hospital stay—days</td>
<td>14±24</td>
<td>11±19</td>
<td>0.006</td>
</tr>
<tr>
<td>Length of ICU stay—days</td>
<td>8±16</td>
<td>7±11</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Bickell WH et al. NEJM 1994
Hypotensive Resuscitation Strategy Reduces Transfusion Requirements and Severe Postoperative Coagulopathy in Trauma Patients With Hemorrhagic Shock: Preliminary Results of a Randomized Controlled Trial

Morrison CA et al. J Trauma 2011
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>MAP 50 group</th>
<th>MAP 65 group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>30.8</td>
<td>33.8</td>
</tr>
<tr>
<td>Male</td>
<td>41/44</td>
<td>40/46</td>
</tr>
<tr>
<td>Injury severity score</td>
<td>17.9</td>
<td>25.1</td>
</tr>
<tr>
<td>Revised trauma score</td>
<td>7.0</td>
<td>6.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fluid</th>
<th>MAP 50 group</th>
<th>MAP 65 group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystalloid</td>
<td>2883</td>
<td>3282</td>
</tr>
<tr>
<td>Colloid</td>
<td>512</td>
<td>609</td>
</tr>
<tr>
<td>PRBC</td>
<td>1335</td>
<td>2244</td>
</tr>
<tr>
<td>FFP</td>
<td>198</td>
<td>528</td>
</tr>
<tr>
<td>Platelets</td>
<td>61</td>
<td>114</td>
</tr>
<tr>
<td>Total blood products</td>
<td>1594</td>
<td>2898</td>
</tr>
</tbody>
</table>

Morrison CA et al. J Trauma 2011
Houston Hypotensive Resuscitation

Kaplan-Meier survival estimates

Time (days)

0.00 0.25 0.50 0.75 1.00

0 10 20 30

group = 50

group = 65

Morrison CA et al. J Trauma 2011
Hypotensive Resuscitation versus Standard Resuscitation (ROC – HYPORESUS)
Field Intervention Procedures

ELIGIBLE PATIENT

- Hang 1000 mL bag
- Administer 2000 ml
- TKVO if SBP ≥110 mmHg, restart if SBP <110 mmHg

Hang 250 mL bag

- Radial pulse or SBP ≥70 mmHg
  - TKVO

- No radial pulse or SBP <70 mmHg
  - Give 250 ml*

*Reassess SBP or radial pulse and repeat algorithm after each bag is infused.
In-Hospital Procedure

ELIGIBLE PATIENT

Hang 1000 mL bag

TKVO if SBP >110 mmHg, restart if SBP <110 mmHg

Hang 250 mL bag

Radial pulse or SBP ≥70 mmHg

TKVO

No radial pulse or SBP <70 mmHg

Give 250 ml*

*Reassess SBP or radial pulse and repeat algorithm after each bag is infused.
Hypotensive resuscitation to a radial pulse or a MAP of 50 is emerging as an important component of field trauma resuscitation.

ROC-HYPORESUS pilot complete (192 patients) and results submitted for presentation at the 2014 AAST meeting.
Tranexamic Acid (TXA)

- Antifibrinolytic
  - Prevents breakdown of clot
- First used in 1966
- Used to control bleeding in many clinical settings:
  - Ruptured intracranial aneurysms
  - Hemophilia (FDA approval)
  - Oral maxillofacial surgery
  - Cardiopulmonary bypass
  - Trauma associated hemorrhagic shock
Coagulation and Fibrinolysis

In bleeding trauma patients:

- Coagulation occurs rapidly at the site of damaged blood vessels
- Fibrinolysis breaks down blood clots
- In patients with serious bleeding fibrinolysis can make bleeding worse
Fibrinolysis

- Plasminogen activators from injured blood vessel convert plasminogen to plasmin.

- Plasmin binds to the fibrin blood clot and breaks it down. This is fibrinolysis.
CRASH-2 Trial

- 20,211 trauma patients in 40 countries.

- Eligibility criteria:
  - Within 8 hours of injury.
  - SBP < 90 mmHg and/or HR > 110.
  - Considered to be at risk for hemorrhage.
  - Enrollment in hospital based on physician discretion (uncertainty principle).

- Randomized to 1 gm TXA over 10 min followed by 1 gm infusion over 8 hours vs. placebo.
CRASH-2: Bleeding deaths

TXA (n= 10,060)  
489 (4.9%)

Placebo (n= 10,067)  
574 (5.7%)

RR (95% CI)  
0.85 (0.76–0.96) 2P=0.0077
CRASH-2: Early treatment better

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>RR (99% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1 hour</td>
<td>0.68 (0.54–0.86)</td>
<td>p=0.000008</td>
</tr>
<tr>
<td>&gt;1 to ≤ 3 hours</td>
<td>0.79 (0.60–1.04)</td>
<td></td>
</tr>
<tr>
<td>&gt;3 hours</td>
<td>1.44 (1.04–1.99)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.85 (0.76–0.96)</td>
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CRASH-2 Trial Concerns

- Enrollment criteria?
- Are the results generalizable to countries with advanced EMS and trauma care?
- Mechanism of action?
- PATCH trial underway in Australia
- Currently incorporated into massive transfusion protocol in many hospitals
- What about EMS?
  - Transport time and distance
PARAMEDIC

ADULT: IN SETTING OF HEMORRHAGIC SHOCK FROM TRAUMA LESS THAN 3 HOURS OLD, WITH SUSPECTED NEED FOR MASSIVE BLOOD TRANSFUSION DUE TO MARKED INTERNAL OR EXTERNAL BLOOD LOSS.

CRITERIA FOR TRANEXAMIC ACID ADMINISTRATION:

SUSTAINED TACHYCARDIA 110 BEATS PER MINUTE OR GREATER AND
SUSTAINED HYPOTENSION SYSTOLIC BP 90 mmHg OR LESS

TRANEXAMIC ACID (TXA) 1 GRAM IV/IVP B OVER 10 MINS. ADMINISTER IN 100 mL or 250 mL NS.

CONTINUOUS ASSESSMENT & TREATMENT PER APPLICABLE PROTOCOL(S)
Questions?