Combative Behaviors::
Translocating Military Medicine
Research into Civilian Lifesaving

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Disclosures

- Prytime Medical, Chief Medical Officer
- Decisio Health, Founder and BoD
- Terumo BCT, Consultant
- Arsenal Medical, MAB
- Co-Inventor of the JETT, Royalty from UT
Mil to Civ Translation

WW I

2016
Question

What is the only silver lining of war?

Civilian  Military
Practical Use of Emergency Tourniquets to Stop Bleeding in Major Limb Trauma

John F. Kragh, Jr., MD, Thomas J. Walters, PhD, David G. Baer, PhD, Charles J. Fox, MD, Charles E. Wade, PhD, Jose Salinas, PhD, and COL John B. Holcomb, MC

- 232 patients
  - 220 males
  - ages: 4–70
    • median 28
- 309 limbs
- 428 tourniquets

Survival: Prehospital vs. ED Tourniquet Use (1st 25 Days)

p=0.05
2008 -- Transition of “new military” devices to Civilian use
Tourniquet and Combat Gauze
THE TRAUMA CENTER IS TOO LATE: MAJOR LIMB TRAUMA WITHOUT A PRE-HOSPITAL TOURNIQUET HAS INCREASED DEATH FROM HEMORRHAGIC SHOCK

J Trauma, 2017

Michelle H. Scerbo MD, MS¹,², John B. Holcomb MD¹,², Ethan Taub DO², Keith Gates MD³, Joseph D. Love DO²,⁴, Charles E. Wade PhD¹,², and Bryan A. Cotton MD, MPH¹,²

PH = 252
- 3% died of hemorrhage

TC = 29
- 14% died of hemorrhage
Training

• Military
  – TCCC
  – Start with physicians / nurses / medics
  – Now non medical folks

• Civilian
  – Stop the bleed
  – Resiliency of the population
White House, Military and Civilian Leadership working together on the Stop the Bleed Program

Dr Rick Hunt
HHS
Where are your Bleeding Control Kits?
Transfusion

Military
– blood

Civilian
– crystalloid
By the end of WWII
Lyophilized Plasma Resuscitation + WB
> 800,000 transfusions
• Fresh Whole Blood
• Hypotensive resuscitation
• Limited volume
• Use pulse character instead of blood pressure
  – Normal, weak, absent
Rapid progress in trauma care occurs during a war.

Damage control resuscitation addresses diagnosis and treatment of the entire lethal triad immediately upon admission.
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

8,000 units of FWB since 2001
(now > 10,000)

Table 1 Comparison of Variables Between WFWB and CT Groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>WFWB (n = 100)</th>
<th>CT (n = 254)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>24 (21–29)</td>
<td>23 (21–28)</td>
<td>0.16</td>
</tr>
<tr>
<td>Temperature (F)</td>
<td>97.6 (96.4–98.2)</td>
<td>98.5 (97.4–99.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>112 (95–136)</td>
<td>115 (91–138)</td>
<td>0.88</td>
</tr>
<tr>
<td>SBP (mm Hg)</td>
<td>110 (80–122)</td>
<td>109 (80–130)</td>
<td>0.67</td>
</tr>
<tr>
<td>GCS eye</td>
<td>4 (2–4)</td>
<td>4 (1–4)</td>
<td>0.32</td>
</tr>
<tr>
<td>GCS verbal</td>
<td>5 (1–5)</td>
<td>5 (1–5)</td>
<td>0.53</td>
</tr>
<tr>
<td>GCS motor</td>
<td>6 (3–6)</td>
<td>6 (1–6)</td>
<td>0.19</td>
</tr>
<tr>
<td>Hemoglobin (g/dL)</td>
<td>11.6 (10–14)</td>
<td>11.8 (9.8–13.4)</td>
<td>0.44</td>
</tr>
<tr>
<td>Base deficit</td>
<td>6 (4–10)</td>
<td>6 (3–11)</td>
<td>0.77</td>
</tr>
<tr>
<td>INR</td>
<td>1.4 (1.1–1.6)</td>
<td>1.4 (1.2–1.8)</td>
<td>0.83</td>
</tr>
<tr>
<td>ISS</td>
<td>18 (10–26)</td>
<td>18 (10–26)</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Data presented as Median (IQR) or as percentages
SBP, systolic blood pressure; INR, International Normalized Ratio.
Prehospital and Hospital WB
Mayo, Camden, Pitt, San Antonio, Houston…
Damage control resuscitation in patients with severe traumatic hemorrhage: A practice management guideline from the Eastern Association for the Surgery of Trauma
J Trauma 2017


- **DCR significantly improve outcomes in severely injured bleeding patients.**
  - After a review of the best available evidence, we recommend the use of a MT/DCR protocol in hospitals that manage such patients and recommend that the protocol target a high ratio of PLAS and PLT to RBC.
  - This is best achieved by transfusing equal amounts of RBC, PLAS, and PLT during the early, empiric phase of resuscitation.
Association of Prehospital Blood Product Transfusion During Medical Evacuation of Combat Casualties in Afghanistan With Acute and 30-Day Survival

Stacy A. Shackelford, MD; Deborah J. del Junco, PhD; Nicole Powell-Dunford, MD; Edward L. Mazuchowski, MD, PhD; Jeffrey T. Howard, PhD; Russ S. Kotwal, MD, MPH; Jennifer Gurney, MD; Frank K. Butler Jr, MD; Kirby Gross, MD; Zsolt T. Stockinger, MD

“Prehospital blood product transfusion in trauma care remains controversial due to poor-quality evidence and cost”

N = 505
5 vs 19% 24 hr mortality
11 vs 23% 30 day mortality
Crystalloids are going away in shock resuscitation.
Implementation of resuscitative endovascular balloon occlusion of the aorta as an alternative to resuscitative thoracotomy for noncompressible truncal hemorrhage

Laura J. Moore, MD, Megan Brenner, MD, Rosemary A. Kozar, MD, PhD, Jason Pasley, DO, Charles E. Wade, PhD, Mary S. Baraniuk, PhD, Thomas Scalea, MD, and John B. Holcomb, MD, Houston, Texas

Truncal Hemorrhage Control
REBOA (Zone 1 and 3 very different)

- FDA cleared, used in > 200 hospitals, 100 Level 1 centers, and austere deployed setting
- Avoid use with significant hemorrhage above diaphragm
- Zone 1 shorter occlusion time than Zone 3
- 3 Multicenter human studies ongoing

In multiple animal studies, controls liver, spleen and iliac artery injuries above and below aortic bifurcation.

3 hour treatment duration safe in animals.

Potentially avoid use in patients with significant diaphragm or abdominal wall holes.
Avoid use with significant hemorrhage above diaphragm.
Cleared to start multicenter FDA regulated human trial (2018)

Research Funding

• Public Health Issue

• Military
  – Up after war starts and down in-between

• Civilian
  – Rate less than middle ear infections
Transfer of Practice

• In between wars Civilians set the standard of care
• During wars, Military leads innovative trauma care

• Drift from Military to Civilian
  – Ex military that move into civilian practice
  – Literature and meetings

• With military style injuries increasing
  – Imperative to broadly implement the hard won lessons learned
• Thank you for letting me participate

• Prehospital teams
  – Military and Civilian
    • Especially in Houston

• Paul Pepe and the Eagles
  – Background work in so many areas
  – Just getting stuff done