Advanced Hemostasis

LTCLTC(P) John McManus MD, MCR, FACEP, FAAEM
Center for Pre-deployment Medicine, Director
EMS Fellowship Director, Brooke Army Medical Center
Associate Professor of Emergency Medicine, UTHSCSA
- This presentation does not represent official policy or doctrine of the US ARMY, AMEDD or DOD.

- This presentation in no way represents an endorsement of any type of any discussed products by DOD, AMEDD or US ARMY.

- The presenter has no financial interests of any type in any of the products mentioned.
Soldier Attempts to Eat Iraqi Child
Other warnings

• “We” are not the typical “war monger”
• Pictures can be gruesome..but limited
• Will comply with ethics, HIPAA etc.

Above all do no harm!
War/Austere is no fun!!
Other Events

- 911
- Oklahoma City
- West VA
- Cleveland
Civilian Setting Can Become Tactical!
Goals of Combat Surgery
and Now some
Civilian Incidents

• Return greatest number to combat/work
• Save life
• Save limb
• Save eyesight
Who brought the cat?
Hemostasis
Why should “We” care?

• Rarely see hemorrhage control as a problem
• Quick transport times
• Most civilian hemorrhage is internal and untreatable?
• Concentration is on the “A” and “B” in training education and practice
Epidemiology
Trauma Problem

- Trauma is the leading cause of death for ages 1 to 44
- 5th leading cause of death in the U.S.
- The leading case of life years lost
- Hospital death rate (DOW) of 3%
- 34% prehospital deaths
- Penetrating Trauma:
  - 95% death within 1st 48 hours

Combat Mortality

Combat Casualty Mortality (Cumulative % of All Wounded)

- No demonstrable decrease in combat zone mortality

Mortality after Entering Echelon Hospital Chain

- Crimean War
- American Civil War
- Russian-Japanese War
- WWI
- WWI
- Korean War
- Vietnam War

Combat Zone Mortality Prior to First MTF
Potentially Preventable SOF Deaths

Potentially preventable
16%
ISS = 35 ± 9 *

Non-preventable
84%
ISS = 58 ± 35

* p < .05
Break out of Potentially Preventable SOF Deaths n = 15 causes

- Compressible hemorrhage: 33%
  - Tourniquet = 3
  - Manual press = 2
- Non-compressible hemorrhage: 46%
- Head / Sepsis: 7%
- Airway: 7%
- Ten Pneumo: 7%
Site of Fatal Primary Injury - Vietnam

- **Head**: 37%
- **Chest**: 24%
- **Abdomen**: 9%
- **Face**: 3%
- **Multiple**: 17%
- **Neck**: 6%
- **Extremity**: 3%
- **Soft Tissue**: 0.6%
## How are we doing? Why?

<table>
<thead>
<tr>
<th></th>
<th>WW II</th>
<th>Vietnam</th>
<th>Iraq/Afghanistan</th>
</tr>
</thead>
<tbody>
<tr>
<td>% KIA</td>
<td>25.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.5&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>% DOW</td>
<td>3.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>CFR</td>
<td>19.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

a,b,c < 0.001
Research Versus Therapy

- IRB approved
- None on Civilians, Detainees etc
- Added requirements
- Consent?
- Standard-of-care or “Best Practice”
- FDA
Parachute Theory
Areas of Interest

• Hemorrhage recognition and control
  – Blood products / Advanced agents / Tourniquets/Access?

• Airway problems – recognition and treatment
  – Rescue position?/devices/cric’s

• Accurate Triage
  – Not treatment!!

• Accurate Evacuation
  – Asset utilization
  – Priority
  – Care in route

• Other concepts
  – Hypothermia
  – Infection control
  – Damage control
  – Pain management
  – Ultrasound and gadgets
1. Primary Pressure Wave Injuries
   (... ears, lungs, abdomen, head, etc)
1. Primary Pressure Wave Injuries (… ears, lungs, abdomen, head, etc)

2. Secondary Blast Injuries (missiles, blast fragments, etc)
1. Primary Pressure Wave Injuries
   (... ears, lungs, abdomen, head, etc)

2. Secondary Blast Injuries
   (missiles, blast fragments, etc)

3. Tertiary Blast Injuries
   (from impalement or landing on hard surface, sharp objects, etc)
Thermal (Quaternary)
Secondary

- Penetrating (fragments and debris)
  - Unprotected torso
  - Extremity
  - Eye
  - Head/neck

Responsible for wounding
Civilian Trauma

- Explosive injury will happen
  - Madrid/London/Israel/ etc.
- GSW are certainly happening
- Current trauma belief is due to selection bias
- Life threatening hemorrhage does occur
  - Pressure/staples don’t always work
- Bandage/agents also can allow to concentrate on resuscitation
  - Limit blood products
  - Limit coagulopathy
Our Injuries are Different? Are they?
Civilian vs. Battlefield Setting
Or future terrorist event?

**Civilian Trauma**
- Focus: treatment
- Multiple casualties
- Unlimited resources
  - Personnel, equipment, supplies
- Established trauma system
- Secure facility

**Battlefield Trauma**
- Focus: sustain fighting strength
- Mass Casualties
- Constrained resources
  - Personnel, equipment, supplies
- Variable lines of evacuation
- Safety/security unknown
Level I / II
Tactical Combat Medical Care
CBA’S!!
Here we Go!

- Pressure points, splint, gauze
- Tourniquets
- Bandages / Agents
- Other Tricks
Personal Protection

Body armor
Eye protection
Gloves
Fire / NBC
Emphasize Pressure Points
Ideal agent/device

- First, it should be able to stop large-vessel arterial and venous bleeding within 2 minutes of application on the wound.
- Second, it should be ready to use, with no requirement for mixing or special preparation.
- Third, it should be simple to apply by the wounded individual, his buddy, or a medic/EMT with minimal training required.
- Fourth, it should be lightweight and durable.
- Fifth, it should be stable and functional at room temperature for at least 2 years and in extreme ambient temperatures (between -10º C and 55º C) for several weeks or longer.
- Sixth, it should be safe to use, posing no risk of either injury in the tissue to which it is applied or of bacterial or viral transmission.
- Finally, it should be inexpensive.
Improved Hemostatic Products on the Battlefield
Tourniquets are life savers – not the devil’s tool!!
Medic First to Die, Soldiers not Trained
Recent Army Tourniquet Work

- Tourniquet Guidelines, Tactical Combat Casualty Care, 2009.
New Tourniquets and Guidelines
Tourniquet

• The leg
  – The CAT, EMT, and SOFT-T were effective in all subjects.
  – The MAT was effective in 88% (14/16) of the subjects tested.
  – The EMT resulted in significantly less circumferential pain

• The Arm
  – The CAT, EMT, and SOFT-T were effective in all subjects.

Walters..McManus et al. Prehospital Emerg Care
Survival: Prehospital vs. ED Tourniquet Use (1st 25 Days)

p=0.05
Bottom Line

1. An effective tourniquet save lives
2. Implement the tourniquet guidelines in TCCC/severe hemorrhage

NOT LAST RESORT!
Extremity Injury Amendable to Tourniquets
Extremity Injury Not Amendable to Tourniquets
External Hemorrhage Control

- **Combat Gauze**
  - Quickclot zeolite powder (Quickclot)
  - HemCon chitosan bandage (HemCon)/Chitoflex /Chitogauze
  - TraumaStat
  - **WoundStat** - ON HOLD
- Celox chitosan powder
- Quick Relief (QR)
Chitosan

- Chitosan Bandage
  - 68 Cases collected
  - 8 probable duplicates
  - 60 cases total
  - >96% effective

*Wedmore, McManus et al. J of Trauma*
Application of chitosan dressings to open pelvic fracture
Other Products

- QuickClot – human data – but had burn potential earlier on – new agent not tested in humans
- >100 cases
Celox

- No human trials
- Very limited animal data (not ideal model)
  - Average Time to Clot Whole Blood: 30.5 Seconds
  - Average Time to Clot Heparinized Blood: 48 Seconds
  - Average Time to Clot Extreme Cold Blood: 68.65°F: 25.5 Seconds

The study found that Celox reduced bleeding to nothing, HemCon to 33 percent and QuikClot to 8 percent, as opposed to a standard dressing, which brought bleeding down by 50 percent.
Summary Results: Total Blood Loss

Total Blood Loss

P = 0.007 (ANOVA)

CG vs. CX vs. WS = NS

HemCon Bandage (HC)
Trauma Stat bandage (TS)
Celox Powder (CX)
Plain gauze (PG)
Combat gauze (CG)
Wound stat (WS)

*P < 0.05 vs. HC
Summary Results: Total Hemostasis Time

Total Hemostasis Time

P = 0.002 (non parametric ANOVA)

CG vs. CX vs. WS = NS

P < 0.01 vs. HC

HC

PG

CG

CX

WS
Summary Results: Survival Time

Survival Time Analysis

% Survival

Time (min)

WS* (100%)
CG* (80%)
CX* (60%)
PG (33%)
TS (20%)
HC (10%)

P<0.0001 (Logrank test)
* P<0.05 vs. HC

P<0.0001 (Logrank test)
Laboratory studies have demonstrated two new hemostatic agents are superior to the current hemostatic agents.

New Hemostatic Agents
- Combat Gauze* (CG)
- WoundStat Granules* (WS)
Lethal Triad

HYPOTHERMIA → COAGULOPATHY → ACIDOSIS
Coagulopathy and Trauma

- Derangements in coagulation occur rapidly after trauma

- By the time of arrival at the ED, 28% (2,994 of 10,790) of trauma patients had a detectable coagulopathy that was associated with poor outcome (MacLeod et al., 2003)
Temp data from the 31st CSH, Baghdad

1878 casualties
Hypothermia and the Deadly Triad

- Hypothermia, coagulopathy and acidosis occurs in the sickest casualties
- Military = Civilian casualties
- Very difficult to reverse in the deployed setting
- Better to prevent
- Develop a coherent hypothermia prevention plan
Heat loss during transport
Field Expedient Warming
Body Bags and Cardboard Boxes
Commercial products to prevent / treat hypothermia
6 – Cell
“Ready-Heat” Blanket

4- Cell
“Ready-Heat” Blanket

Blizzard “Survival Blanket”
Hypothermia Prevention
Preventing Coagulopathy

- Limit crystalloids
  - Hetastarch (Hespan)
- Use of 1:1:1:1 component therapy
  - Cells:Plasma:platelets
- Fresh whole blood
- Freeze Dried Blood
- Factor VIIa
- Hemoglobin Carriers
Hypotensive Resuscitation “Don’t pop the clot”

Most Recent rFVIIa Combat Trauma Paper

- Perkins, et al. Early versus Late Recombinant Factor VIIa (rFVIIa) in Combat Trauma Patients Requiring Massive Transfusion.
  - 2006, J Trauma.
  - Early vs late
  - 252 MT casualties, 90% penetrating
    - 17 early and 44 late
  - Decrease in 23% (5 units) compared to late group
  - No increase in complications
AND YOU THINK YOUR JOB STINKS?
Tough Decisions!!!
Finally, Thanks

Soldiers, Sailors, Airman and Marines
who take the risks and without question for our freedom!

My colleagues and all the deployed Medical Units performing their mission so well!
Don’t Forget Our Deployed Colleagues!!!!
Contact Information

John.mcmanus@amedd.army.mil

Center for Pre-deployment
ATTN: MCCS-HR
2405 Reynolds Rd, Suite G
Ft. Sam Houston, TX 78234
Comm (210) 391-7025
Cell (210) 240-6995