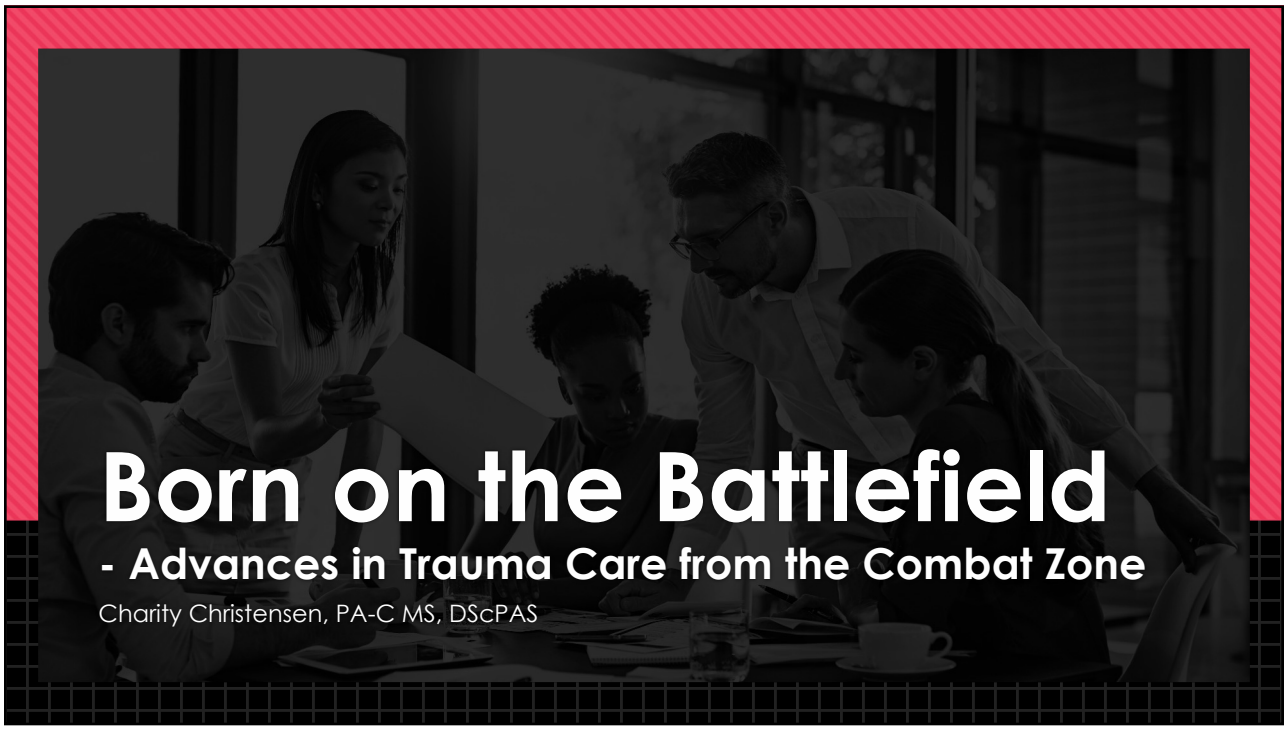

Born on the Battlefield

- Advances in Trauma Care from the Combat Zone

Charity Christensen, PA-C MS, DScPAS

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Disclosures

No Financial Disclosures

None of my pictures have actual patients in them (all simulations)

2

Overview

- The process of Military Medicine
- Alphabet Soup: TCCC, MARCH, THREAT
- Damage Control Resuscitation
- Surgical Care
- What's on the Horizon?

3

A day on the Job

4

Echelon's of care

- In 'Theater'
  - Role I
  - Role II
  - Role III
- Role IV/V

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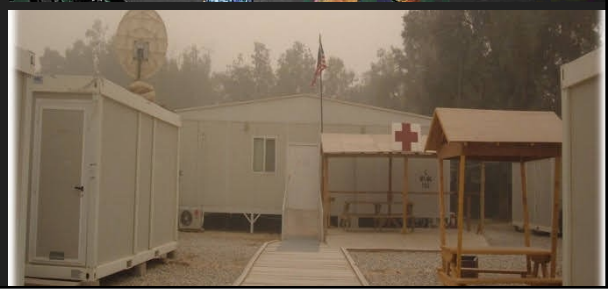
Role I

- Basic medical care
- No lab
- No x-ray
- No surgical capability
- *Short term / small numbers of troops



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Role II

- X-ray
- Limited lab
- Behavioral Health
- +/- Surgical Capability

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Role III

- A.K.A 'Field Hospital'
- Surgical Capabilities
- More advanced Lab
- X-ray, often CT
- Blood Bank

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Tactical Combat Casualty Care (TCCC)

- Originally developed in 1996 for the Special Operations Command medical community[1]
- Created combat-appropriate and evidence-based trauma care guidelines, to address preventable combat deaths from prior conflicts.
  - Aggressive use of tourniquets and hemostatic dressings,
  - improved fluid resuscitation techniques
  - Importance of airway management tailored to battlefield conditions
- TCCC is an evolving care philosophy, undergoing regular revisions based on continuous feedback from the field, and updated regularly by the Committee on TCCC (CoTCCC).
  - The guidelines have been adopted by all U.S. military services and many allied nations

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TCCC Phases of Care

- **Care Under Fire (CUF):** Immediate care provided while under enemy fire. Focuses on stopping life-threatening hemorrhage using tourniquets.
- **Tactical Field Care (TFC):** Care provided once the casualty is no longer under direct fire.
  - Includes comprehensive assessment and management using the MARCH acronym (Massive hemorrhage, Airway, Respirations, Circulation, Hypothermia prevention).
  - **Prolonged Field Care:** Care provided in a pre-hospital setting, but with a goal to maintain patient's relative stability over several hours.
- **Tactical Evacuation Care (TACEVAC):** Care provided during evacuation to a medical treatment facility. Involves advanced procedures and continued management of injuries.

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TCCC Phases of Care to Civilian Settings

Care Under Fire (CUF):	Tactical Field Care (TFC):	Prolonged Field Care:	Tactical Evacuation Care (TACEVAC):
Bystander/Immediate Response	EMS care	Stabilization in a rural non-hospital setting	Care during transport

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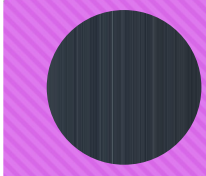
Civilian TCCC - THREAT



T: threat suppression

H: hemorrhage control

RE: rapid extrication from the scene

A: assessment by medical providers

T: transport to definitive care

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Advances in Hemorrhage Control – Treatment Priorities

1. **Chest/Abdomen**: Resuscitate with permissive hypotension, Aortic occlusion, Priority for surgical care
2. **Junctional**: Pack wound (hemostatic gauze) or junctional tourniquet- 2nd priority for surgical care
3. **Extremity:** Pressure to artery → Tourniquet. If hemorrhage is well controlled, can wait hours for surgical care

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Abdominal/Junctional Tourniquet (AAJT-S)

Impact on Traumatic Cardiac Arrest[3]:

- 83% survival with AAJT-S application and blood transfusion.
- 17% survival with blood and CPR alone.

Implications for Medical Training:

- Previous belief: No benefit CPR for cardiac arrest due to exsanguination.
- New finding: AAJT-S can save most patients due to its REBOA effect.

Abdominal/junctional tourniquet (AAJT-S) shown to be equivalent to Zone 3 REBOA[2].

Image courtesy of Trauma System News https://trauma-news.com/2019/08/combat-tested-abdominal-junctional-tourniquet-proven-equivalent-to-reboa/

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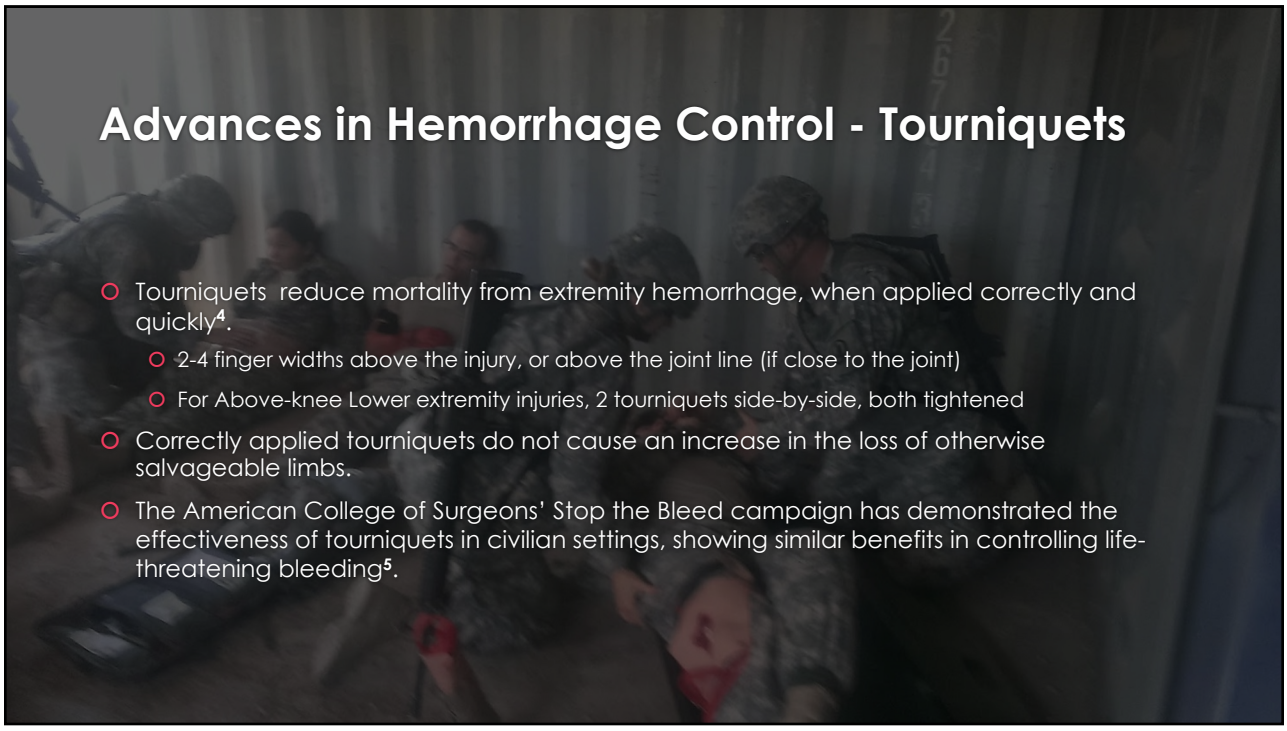
Advances in Hemorrhage Control - Tourniquets
Tourniquets reduce mortality from extremity hemorrhage, when applied correctly and quickly[4].
2-4 finger widths above the injury, or above the joint line (if close to the joint)
For Above-knee Lower extremity injuries, 2 tourniquets side-by-side, both tightened
Correctly applied tourniquets do not cause an increase in the loss of otherwise salvageable limbs.
The American College of Surgeons' Stop the Bleed campaign has demonstrated the effectiveness of tourniquets in civilian settings, showing similar benefits in controlling life-threatening bleeding[5].

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TCCC: Breathing and Airway
Lower Threshold to attempt Needle Chest Decompression (and use of a longer needle)
Encourage casualties with Maxillofacial Trauma to sit up/lean forward when possible
Supraglotic Airways for less experienced providers
Lower threshold to convert to Surgical Airway, and use of advanced tools such as the Cric Key™ [6].

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Pain Management

- Mild-Moderate Pain: Acetaminophen and Meloxicam
- Moderate pain: Fentanyl
- Sever Pain: Ketamine (even with eye injury or TBI)
- Less use of Morphine (due to hypotensive effects)

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Damage Control Resuscitation

- **Priorities**
  - Maintain circulating volume
  - Control hemorrhage
  - Restore normal physiology (temperature, pH, and coagulation)
- **Permissive Hypotension:** Maintaining lower blood pressure to reduce bleeding until surgical control is achieved
  - Uses parameters such as Mental Status, and Urine Output to guide fluid administration vs only Vitals

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Damage Control Resuscitation

- **Hemostatic Resuscitation:** Early use of blood products to maintain hemostasis and minimize crystalloid use.
  - In low-resource settings, use of 1:1 product resuscitation, or Fresh Whole Blood

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The Walking Blood Bank

- Rapid Identification of suitable donors, and blood collection from the Donors at or near the point of care
- Effective at providing fresh whole blood for patients in extremis
- Special considerations:
  - Donors need to by type-matched to recipients (Same ABO and Rh type)
  - In addition to standard donor screening, it is ideal to also screen donors for prior receipt of blood products
  - Because blood is being taken for an often apparent need, it is important to protect donors from coercion and promote honesty in screening
  - Because these are unplanned donations, consideration should also be given to donor roles and responsibilities.

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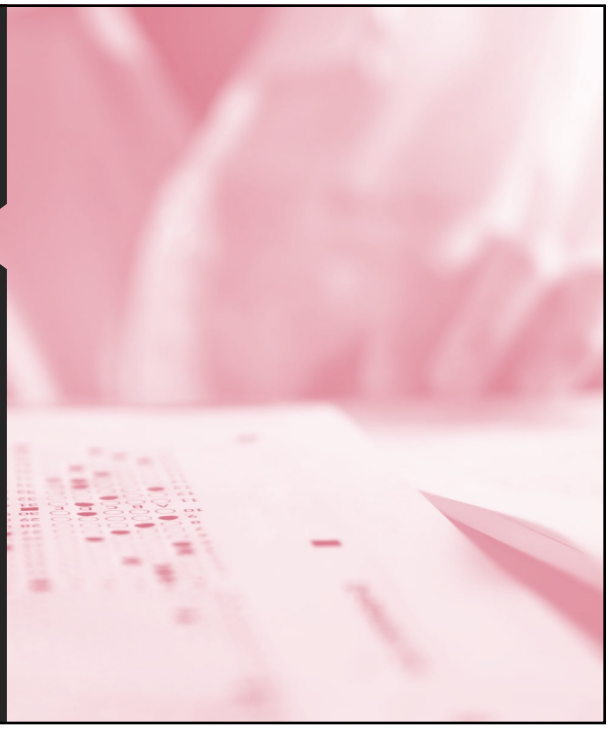
WBB Ideal – Pre-Screen Donor Pool

- Establish a pre-screened donor pool. Initial Screening includes:
  - Verify blood type
  - Consider HIV/Hep B/ Hep C testing
  - Potential Donors should complete the Blood Donor Questionnaire.
  - Potential Donors should be provided with a handout to define terms.
  - Check current donor medications against the deferral list.
  - Baseline weight – must be ≥ 110 lbs
- Keep list of pre-screened donors by blood type, along with contact information for the potential donor.
- Consider donor education and/or regular check in to maintain eligibility



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WBB - Activation

- Important to have set activation criteria
  - Typically vitals/labs/injury type
  - Because these collections take time, could include a criteria for NOT imminently evacuating
- Establish a number of donors to initially collect from (e.g. 6 per casualty)
  - If collecting more blood – e.g. for a Mass Injury event, consider a plan for short term unit storage

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WBB – Prepare the Donors

- Pre-Screened – priority to front of line
  - Review original screening
    - Document "No Changes" or Repeat full screening if changes
  - Labs (Hct, Rapid HIV, Hep B, Hep C, +/- Hcg)
  - Vital Signs
    - HR >100, SBP <100, or temp > 99.5 F, reconsider use of Donor.
- New Donor - Full Screen
  - Use the Donor Questionnaire
  - Vitals/ Lab Draw
    - ABO & Rh/ HIV/Hep B/Hep C/+/- Hcg
    - HR >100, SBP <100, or temp > 99.5 F, reconsider use of Donor.

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WBB – Collect the Blood

- 1 unit (450 cc) + tubes for full testing – label ALL with Donor's info
- Monitor Donors for at least 15 minutes after Donation
- Recommend 1 week light duty
- Offer multivitamin with Iron x 1-2 weeks.

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WBB – Transfusion and Post-Transfusion

Transfusion Reactions

- Fresh whole blood has theoretically less risk of inflammatory transfusion reactions[7]
- Greater risk of donor-recipient incompatibility due to less detailed typing/crossmatching

Post-transfusion

- Ensure follow-up on results of formal testing, and appropriate notifications of positive results
- Unused Blood products may be stored for up to 5 days if refrigerated properly within 8 hours of collection.

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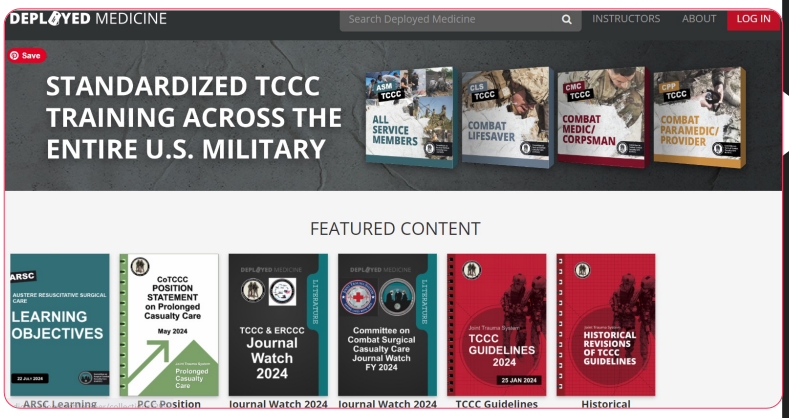

For Further Reading…

- https://jts.health.mil/index.cfm/PI_CPGs/cpgs
- https://deployedmedicine.allogy.net/learner/collections

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TCCC Journal Watch: Traumatic Brain Injury (TBI)

Prehospital Identification of Intracerebral Hemorrhage:

- **Findings**: Early clinical features and portable devices like microwave imaging and transcranial ultrasound show promise in detecting intracerebral hemorrhage (ICH) in suspected stroke patients.
- **Reference**: Almubayyidh M, et al. BMJ Open. 2024 Apr 19;14(4):e079316.

Tranexamic Acid (TXA) for TBI:

- **Findings**: TXA administration within two hours of injury reduces 28-day mortality and improves 6-month Disability Rating Scale scores in patients with ICH.
- **Reference**: Rowell S, et al. J Trauma Acute Care Surg. 2024 Apr 30.

Comparison of Mannitol and Hypertonic Saline for Brain Herniation:

- **Findings**: Hypertonic saline solution (HSS) is associated with lower ICU mortality compared to mannitol in TBI patients with mydriasis.
- **Reference**: Codorniu A, et al. Eur J Emerg Med. 2024 Aug 1;31(4):287-293.

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TCCC Journal Watch: Hemorrhage Control

Tranexamic Acid in Trauma:

- **Findings**: TXA is effective if administered early post-injury, but its use beyond 3 hours increases the risk of death due to bleeding in polytrauma patients.
- **Reference**: Barrett CD, et al. Transfusion. 2024 May;64 Suppl 2:S11-S13.

Prehospital Blood Transfusion:

- **Findings**: Early administration of blood products in urban prehospital settings improves survival rates in patients with severe hemorrhage.
- **Reference**: Duchesne J, et al. J Trauma Acute Care Surg. 2024 May 1.

Tourniquet Use in Civilian Trauma:

- **Findings**: Prehospital tourniquet application significantly reduces mortality in patients with extremity vascular injuries without increasing the risk of complications like amputation or compartment syndrome.
- **Reference**: Ko YC, et al. World J Emerg Surg. 2024 Mar 19;19(1):10.

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TCCC Journal Watch: Fluid Resucitation

Trends in Prehospital Volume Resuscitation:

- **Findings**: A trend towards reduced prehospital fluid administration is associated with improved coagulation function and decreased mortality rates in blunt trauma patients.
- **Reference**: Bath MF, et al. Crit Care. 2024 Mar 15;28(1):81.

Prehospital Advanced Resuscitative Care:

- **Findings**: Implementation of advanced resuscitative care bundles, including TXA and packed red blood cells, reduces in-hospital mortality in urban EMS systems.
- **Reference**: Broome JM, et al. J Trauma Acute Care Surg. 2024 May 1;96(5):702-707.

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TCCC Journal Watch: Airway Management

Cricothyroidotomy Skill Retention:

- **Findings**: Skills in performing cricothyroidotomy degrade significantly over time, but a brief refresher course can help maintain proficiency.
- **Reference**: Kraemer LS, et al. Mil Med. 2024 Apr 23.

Emergency Airway Management in Prone Position:

- **Findings**: Supraglottic airway devices are the most effective for managing accidental extubation when the patient is in the prone position. It was compared to video laryngoscopy and fiberoptic bronchoscopy, all in the hands of anesthesia providers.
- **Reference**: Rajaleelan W, et al. Adv Simul (Lond). 2024 Apr 6;9(1):14.

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TCCC Journal Watch:

Prehospital Antibiotic Administration for Open Fractures:

- **Findings**: Early administration of antibiotics by EMS reduces the time to treatment and is associated with a lower risk of infection.
- **Reference**: Muniz AD, et al. Prehosp Emerg Care. 2024 Apr 25.

Simulation-Based Education for Ultrasound in Trauma:

- **Findings**: Simulation-based training significantly improves the ability of paramedics to perform FAST exams under physician guidance.
- **Reference**: Ohira A, et al. Sci Rep. 2024 Feb 20;14(1):4190.

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3. Jason Rall, Jennifer M. Cox, Joseph Maddry, The Use of the Abdominal Aortic and Junctional Tourniquet During Cardiopulmonary Resuscitation Following Traumatic Cardiac Arrest in Swine, Military Medicine, Volume 182, Issue 9-10, September 2017, Pages e2001–e2005, https://doi.org/10.7205/MILMED-D-16-00409

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