



Summer 2016
Volume 16, Edition 2

J SOM

JOURNAL of SPECIAL OPERATIONS MEDICINE™



THE JOURNAL FOR OPERATIONAL MEDICINE AND TACTICAL CASUALTY CARE



Inside this Issue:

- › Case Report: A Herpes Zoster Outbreak on the Sinai Peninsula
- › Case Report: Activation of Walking Blood Bank Based on Mechanism of Injury
- › Case Report: Anthrax Case Report Relevant to Special Operations Medicine
- › In Brief: Measures of Instructor Learning
- › In Brief: Tourniquet Effectiveness When Placed Over JSLIST
- › Comparison of Pneumatic Tourniquet Models
- › Single, Wider, and Paired Tourniquet Pressures
- › Field Sterilization in the Austere Environment
- › Simulation Versus Live Tissue for Training Trauma Procedures
- › Inner Ear Barotrauma
- › Effect of Cooling Shirt on Core Body Temperature
- › Integration of TECC Into the National TEMS Competency Domains
- › Letters to the Editor: AAJT Design and Testing and Field Electronic Medical Records
- › Ongoing Series: Clinical Corner, Human Performance Optimization, Infectious Diseases, Injury Prevention, Picture This, Prolonged Field Care, Special Talk, World of Special Operations Medicine, TCCC Updates, TacMed Updates, and more!

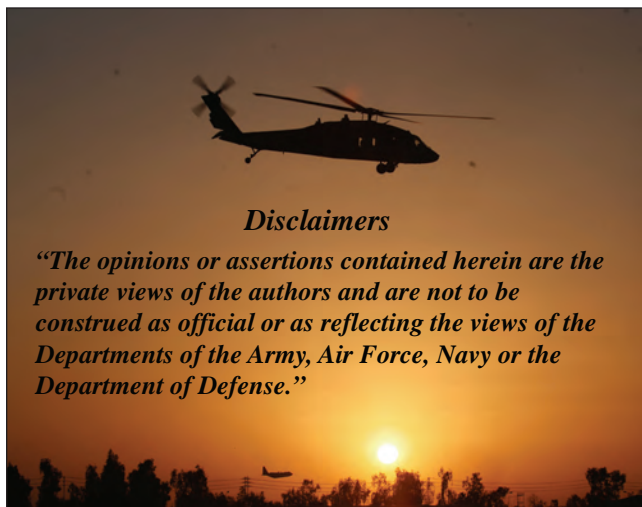
*Dedicated to the
Indomitable Spirit
and Sacrifices of
the SOF Medic*

A Peer-Reviewed Journal That Brings Together the Global Interests of Special Operations' First Responders

Tactical Combat Casualty Care: Top Lessons for Civilian EMS Systems from 14 Years of War

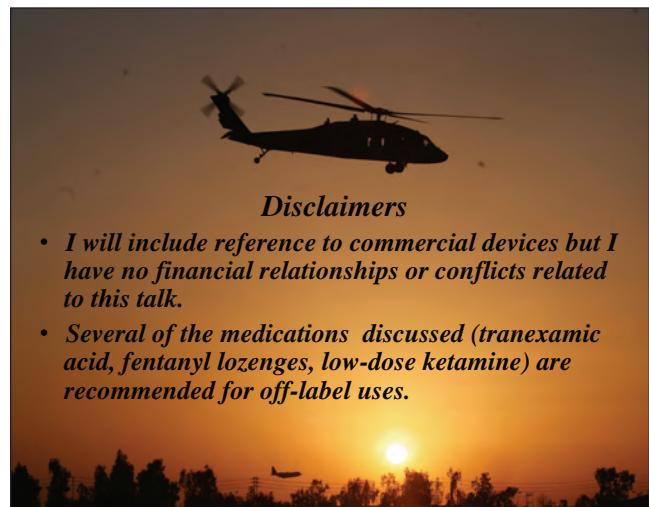


Dr. Frank Butler
16 May 2016



Disclaimers

“The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Departments of the Army, Air Force, Navy or the Department of Defense.”



Disclaimers

- I will include reference to commercial devices but I have no financial relationships or conflicts related to this talk.
- Several of the medications discussed (tranexamic acid, fentanyl lozenges, low-dose ketamine) are recommended for off-label uses.



DoD Joint Trauma System

Coalition forces at the end of the Afghanistan conflict had the best definitive care and evacuation system in history.



- TCCC's job is to make sure that the casualties get to the hospital alive so that they can benefit from it -
- 87% of combat fatalities die in the prehospital phase. ⁴

Tactical Combat Casualty Care

The Prehospital Arm of the US Military's Joint Trauma System

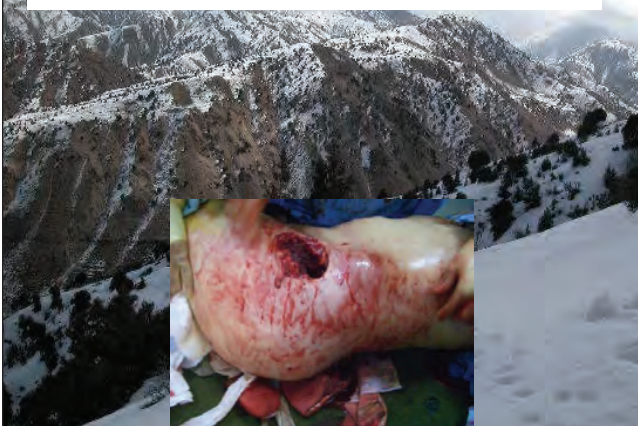


TCCC

- Medics, Corpsmen, PJs
- Combat Lifesavers
- All Combatant Self/Buddy Care
- Includes Tactical Evacuation Care

Photo - MSG Harold Montgomery ⁵

Tactical Trauma Care at 8000 ft in the Hindu Kush



A Look Back: Battlefield Trauma Care: 1970

“The striking feature was to see healthy young Americans with a **single injury of the distal extremity** arrive at the magnificently equipped field hospital, usually within hours, but **dead on arrival**. In fact there were **193 deaths** due to wounds of the upper and lower extremities, of the 2600.”

CAPT J.S. Maughon
Mil Med 1970

* **Extremity hemorrhage math in Vietnam:**
193 of 2600 = 7.4% x 46, 233 fatalities = 3,421
preventable US deaths from extremity hemorrhage ⁷



Battlefield Trauma Care: 1970

“All seem uncertain regarding the best method to implement factual knowledge to the man most in need, the front line trooper....**citing our ineptness in the field of self-help and first aid**”little if any improvement has been made in this phase of treatment of combat wounds in the past 100 years.”

CAPT J.S. Maughon
Mil Med 1970 ⁸



Battlefield Trauma Care 1995

- Based on trauma courses NOT developed for combat
- Medics taught NOT to use tourniquets
- No hemostatic dressings
- Large volume crystalloid fluid resuscitation for shock
- 2 large bore IVs on all casualties with significant trauma
- Civil War-vintage technology for battlefield analgesia (IM morphine)
- No focus on prevention of trauma-related coagulopathy
- No tactical context for care rendered
- Special Ops Medics – venous cutdowns if trouble starting an IV
- Heavy emphasis on endotracheal intubation for prehospital airway management ⁹



Tourniquets Reconsidered: 1992

- ATLS 1992: NO tourniquets
- Fear of ischemic damage to limbs
- **But**
- **Exsanguination from extremity hemorrhage was the #1 cause of preventable death among US casualties in Vietnam (estimated 3,421 deaths)**
- Tourniquets can control extremity hemorrhage
- **Tourniquets are used routinely during orthopedic surgery**
- Limbs are not lost there as a result
- Also - if you had to choose between death and losing a leg....
- **“No TQ” rule: NOT evidence-based; NOT logic based** ¹⁰



Tactical Combat Casualty Care (TCCC) : A Different Approach

- Battlefield trauma care research effort – Special Operations and USUHS: 1993-1996
- Combat environment and mission considered
- Combat medic training and equipment considered
- **Project included input from combat medics, corpsmen, and pararescuemen (PJs)**
- **Evidence-Based – INCLUDING requiring evidence for prevailing practice at that time**
- **Goal – To Prevent Preventable Deaths** ¹¹



Combat Fatalities: Two Types

- Non-Preventable:
 - Helicopter hit by a rocket and explodes in mid-air
- Potentially Preventable:
 - Special Forces Soldier
 - Shot in the knee
 - No other major wounds
 - Bled to death - 2003

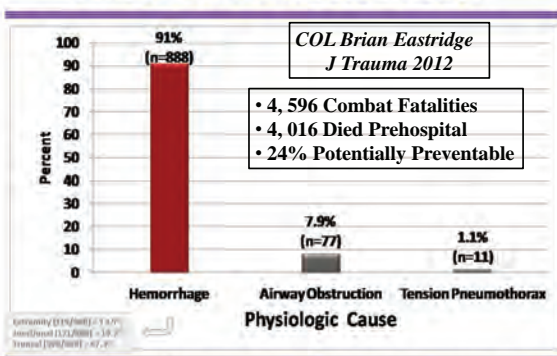


The acceptable number of preventable deaths is – ZERO.



13

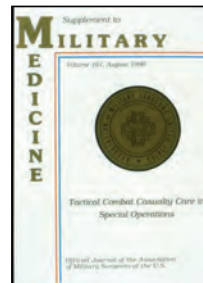
What is the Cause of Death?



Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. *Journal of Trauma*, 2012. In press.




Tactical Combat Casualty Care in Special Operations



Military Medicine Supplement
August 1996

Evidence-based trauma care guidelines customized for use on the battlefield





Tourniquets in TCCC Mil Med 1996

“It is very important, however, to stop major bleeding as quickly as possible since injury to a major vessel may result in the very rapid onset of hypovolemic shock..... Ischemic damage to the limb is rare if the tourniquet is left in place for less than an hour and tourniquets are often left in place for several hours during surgical procedures. In the face of massive extremity hemorrhage, in any event, it is better to accept the small risk of ischemic damage to the limb than to lose a casualty to exsanguination.....The need for immediate access to a tourniquet in such situations makes it clear that all SOF operators on combat missions should have a suitable tourniquet readily available at a standard location on their battle gear and be trained in its use.”

16

How Is TCCC Updated?


The Committee on TCCC

Committee on Tactical Combat Casualty Care (CoTCCC)


- First funded by USSOCOM in 2001-2002 at the Naval Operational Medicine Institute (NOMI)
- Later sponsored by Navy and Army Surgeons General and the U.S. Army Institute of Surgical Research
- 42 members - all services
- **Trauma Surgeons, EM and Critical Care physicians, operational physicians and PAs; medical educators; combat medics, corpsmen, and PJs**
- **100% deployed experience in 2015**
- Relocated to the Defense Health Board in 2007 at the direction of ASD/HA
- **Moved to the Joint Trauma System in 2013**

18



Battlefield Trauma Care: Now


- **Phased care in TCCC**
- **Aggressive use of tourniquets initially**
- **Combat Gauze as hemostatic agent**
- **Aggressive needle thoracostomy**
- **Sit up and lean forward airway positioning**
- Surgical airways for maxillofacial trauma
- Hypotensive resuscitation with blood products
- IVs only when needed; IO access if required
- PO meds, fentanyl lozenges, ketamine as “Triple Option” for battlefield analgesia
- Hypothermia prevention; avoid NSAIDs
- Battlefield antibiotics
- Tranexamic acid (TXA)
- Junctional Tourniquets; XStat




TCCC: How Do We Know That it's Working?




20



Tactical Combat Casualty Care (TCCC)

- Paper published 1996 in Mil Med
- First used by Navy SEALs, 75th Ranger Regiment, Army Special Missions Unit, and Air Force Pararescue in 1997
- PHTLS, ACS COT and NAEMT endorsement 1999
- All of Special Ops adopted in 2005
- Now used throughout U.S. military
- Allied nations and civilian sector as well





TCCC: Success in Combat 3rd Infantry Division

“The adoption and implementation of the principles of TCCC by the medical platoon of TF 1-15 IN in OIF 1 resulted in **overwhelming success**. Over 25 days of continuous combat with 32 friendly casualties, many of them serious, we had 0 KIAs and 0 Died From Wounds, while simultaneously caring for a significant number of Iraqi civilian and military casualties.”

*CPT Michael Tarpey
Battalion Surgeon 1-15 IN
AMEDD Journal 2005*

22



Eliminating Preventable Death on the Battlefield



- Kotwal et al – Archives of Surgery 2011
- All Rangers and docs trained in TCCC
- U.S. military preventable deaths: **24%**
- Ranger preventable death incidence: **3%**

23



TCCC in Canadian Forces Savage et al: Can J Surg 2011

CONCLUSION

For the first time in decades, the CF has been involved in a war in which its members have participated in sustained combat operations and have suffered increasingly severe injuries. Despite this, the CF experienced the highest casualty survival rate in history. Though this success is multifactorial, the determination and resolve of CF leadership to develop and deliver comprehensive, multileveled TCCC packages to soldiers and medics is a significant reason for that and has unquestionably saved the lives of Canadian, Coalition and Afghan Security Forces. Further-



ASDHA TCCC Letter 14 February 2014



“...uniform TCCC training throughout the Department.”



What Can TCCC Offer to My Civilian EMS System?



What Can TCCC Offer to My Civilian EMS System?

- Tourniquets
- Hemostatic dressings
- Trauma airway approach
- TCCC Needle Decompression Plan
- Tranexamic Acid (TXA)
- Hypotensive resuscitation - with blood products where possible
- Intraosseous vascular access
- Triple-Option Analgesia



CAT SOFT-T



Lest we forget – most of the U.S. military went to war in Afghanistan and Iraq without tourniquets



Tourniquets in the U.S. Military - 2003



Tourniquet Outcomes in TCCC Transition Initiative Report

- **Sixty-seven** successful tourniquet applications identified
- **No avoidable loss of limbs** due to tourniquet use identified

*Butler, Greydanus, Holcomb
2006 USAISR Report
“TCCC: Combat Evaluation 2005”*

30



Tourniquets – Kragh et al Annals of Surgery 2009



- Ibn Sina Hospital, Baghdad, 2006
- Prehospital tourniquets are saving lives on the battlefield
- **31 lives saved in 6 months** period
- **232 patients with tourniquets on 309 limbs**
- **No limbs lost to tourniquet ischemia**
- This paper turned the tide on tourniquets in the military³¹



Preventable Combat Deaths from Not Using Tourniquets

- Maughon – *Mil Med 1970: Vietnam*
 - 193 of 2,600 fatalities
 - 7.4% of total combat fatalities
- Kelly – *J Trauma 2008: OEF + OIF (2003/4 and 2006)*
 - 77 of 982 (in both cohorts of fatalities)
 - 7.8% of total fatalities – no better than Vietnam
- **Tourniquets became widely used in 2005-2006**
- Eastridge – *J Trauma 2012: OEF + OIF (to Jun 2011)*
 - 119 of 4,596 fatalities
 - **2.6% of total fatalities – a 67% decrease**

32



Tourniquets in the US Military

“Tourniquets have been the signature success in battlefield trauma care in Afghanistan and Iraq. Based on the work of Army COL John Kragh and colleagues, the number of lives saved from this intervention has been estimated to be between 1,000 and 2,000.”

*Davis et al
Journal of Trauma Acute Care Surg
2014*

- And the “1,000-2,000 lives saved” estimate was made in 2008 – six years before the end of the conflicts.



Tourniquet Phobia

- **“But - I learned that tourniquets are dangerous and should only be used only as a last resort!”**
- This is a **medical “Urban Myth”** that has cost the lives of thousands of casualties and trauma victims.
- **Many thousands** of tourniquets were used in the US Military in Iraq and Afghanistan.
- **ZERO** limbs were lost from tourniquet use in those two conflicts.
- **2 hours** of tourniquet time is very safe.



Prehospital use of Hemostatic Bandages and Tourniquets; Translation from Military Experience to Implementation in Civilian Trauma Care

Scott P. Zietlow, MD
Associate Professor of Surgery
College of Medicine, Mayo Clinic
Division of Trauma, Critical Care & General Surgery
Chair, Medical Director, Mayo Clinic Medical Transport

CoTCCC Meeting – Feb 2014

Use and Success Rate

- **77** tourniquets were used for 73 patients
- Only 1 was used on the same extremity due to incorrect application of the first CAT at outside ED. All others were used for different extremity injuries
- All CAT were successful except for one listed above (**98.7%**)
- Improvised tourniquets used prior to our arrival were universally unsuccessful



What Can TCCC Offer to My Civilian EMS System?

- Tourniquets
- Hemostatic dressings
- Trauma airway approach
- TCCC Needle Decompression Plan
- Tranexamic Acid (TXA)
- Hypotensive resuscitation - with blood products where possible
- Intraosseous vascular access
- Triple-Option Analgesia



When You Can't Use a Tourniquet

- Groin, axilla
- Neck



Use a hemostatic dressing!

38



CoTCCC-Recommended Hemostatic Dressings



Combat Gauze
First Choice



Celox Gauze




ChitoGauze

** Always apply with 3 minutes of firm direct pressure!*

Hemostatic Agent Comparison

	QC ACS	HemCon	Celax	WoundStat	Combat Gauze
Hemostatic efficacy	+	+	+++	++++	++++
Side effect	None	None	---	---	None
Ready to use	✓	✓	✓	✓	✓
Training requirement	+	+	+	+++	++
Lightweight and durable	++	+++	+++	++	+++
2 yrs Shelf life	✓	✓	✓	✓	✓
Stable in extreme condition	✓	✓	✓	✓	✓
FDA approved	✓	✓	✓	✓	✓
Biodegradable	No	No	Yes	No	No
Cost (\$)	~30	~75	~25	30-35	~25

Courtesy Dr. Bijan Kheirabadi USAISR



Combat Gauze When You Can't Use a Tourniquet

ORIGINAL ARTICLE

Prehospital use of hemostatic dressings by the Israel Defense Forces Medical Corps: A case series of 122 patients

Avi Shina, MD, MHA, Ari M. Lipsky, MD, PhD, Roy Nadler, MD, Moran Levi, Avi Benov, MD, MHA, Yuval Ran, MD, MHA, Avraham Yitzhak, MD, and Eilon Glassberg, MD, MHA, Tel Hashomer, Israel

“The 88.6% self-reported success rate in junctional hemorrhage control is encouraging, as junctional hemorrhage is increasingly looked at as the currently most common cause of preventable death in the battlefield.”

Dr. Avi Shina et al
Journal of Trauma 2015 41




Prehospital use of Hemostatic Bandages and Tourniquets; Translation from Military Experience to Implementation in Civilian Trauma Care

Scott P. Zietlow, MD
Associate Professor of Surgery
College of Medicine, Mayo Clinic
Division of Trauma, Critical Care & General Surgery
Chair, Medical Director, Mayo Clinic Medical Transport

CoTCCC Meeting – Feb 2014


Use and Success Rate


- 62 total Quik Clot Combat Gauze rolls were used for 52 patients
- 8 (15%) patients required more than 1, but only 1 was needed per wound location
- 59 (95%) were successful
 - 1 required CAT
 - 1 Head
 - 1 Face
- All were used per protocol, after unsuccessful use of standard compression bandages



Use and Success Rate

- 77 tourniquets were used for 73 patients
- Only 1 was used on the same extremity due to incorrect application of the first CAT at outside ED. All others were used for different extremity injuries
- All CAT were successful except for one listed above (98.7%)
- Improvised tourniquets used prior to our arrival were universally unsuccessful





External Hemorrhage Control Practice Guidelines

SPECIAL CONTRIBUTION

AN EVIDENCE-BASED PREHOSPITAL GUIDELINE FOR EXTERNAL HEMORRHAGE CONTROL AMERICAN COLLEGE OF SURGEONS COMMITTEE ON TRAUMA

Editor: M. Bales, MD, FACS, FRCR, FRCR (P), FRCR (S), FRCR (C), FRCR (E), FRCR (G), FRCR (H), FRCR (I), FRCR (J), FRCR (K), FRCR (L), FRCR (M), FRCR (N), FRCR (O), FRCR (P), FRCR (Q), FRCR (R), FRCR (S), FRCR (T), FRCR (U), FRCR (V), FRCR (W), FRCR (X), FRCR (Y), FRCR (Z)

Prehospital Emergency Care 2014

American College of Emergency Physicians
External Hemorrhage Control
Policy Statement
October 2014

- The American College of Surgeons Committee on Trauma now endorses the use of both tourniquets and hemostatic dressings
- So does the American College of Emergency Physicians
- So does the National Association of EMTs 45



Individual First Aid Kits (IFAKs)

At this point in time, the US Military has more experience with tourniquets and hemostatic dressings than any other organization in history. (14 years of war and 50,000 + casualties)



Cost: \$128

- In 2001 – very few American combatants had tourniquets - no one had hemostatic dressings
- In 2015 - no American combatant goes onto the battlefield without an IFAK that contains both

Translating Military Advances in External Hemorrhage Control to Law Enforcement



Dr. Frank Butler
International Association of Chiefs of Police
26 October 2015



Ft. Hood Shootings 2009 Officer Kim Munley

- 12 dead; 31 wounded on 5 Nov 09
- Officer Munley got the shooter
- She was in turn shot in both thighs
- Direct pressure and improvised tourniquets used by several physicians unsuccessful at controlling hemorrhage – went into shock
- Saved by Army 68W medic with a CAT tourniquet on left thigh



TCCC in the Civilian Sector

Injured transit police officer went into cardiac arrest following Watertown gunfight

MBTA Transit Police Officer Richard Donohue remains in critical condition at Mt. Auburn hospital

CAMBRIDGE, Mass. — Richard Donohue, the MBTA transit police officer critically wounded in a gun battle with the bombing suspects, had lost nearly all his blood and his heart had stopped from a single gunshot wound that severed three major blood vessels in his right thigh.

** No mention of tourniquet use in the story*



The Hartford Consensus: ACS Response to Sandy Hook

- American College of Surgeons
- FBI
- White House – Medical Policy
- White House Medical
- Asst Secretary of Defense - Health Affairs
- Asst Secretary of Homeland Security – Health Affairs
- Medical Section – Major Chiefs of Police
- ACS Committee on Trauma
- DoD Committee on TCCC




Hartford Consensus III

- Recommended tourniquets and hemostatic dressings for EMS/ Fire and Rescue/Law Enforcement Officers.
- **“All hemostatic dressings and tourniquets must be clinically effective as documented by valid scientific data. The Tactical Combat Casualty Care guidelines for the U.S. military contain objective evidence to support the safety and efficacy of the various options for tourniquets and hemostatic dressings.”**

Dr. Lenworth Jacobs - ACS

“When discussing tourniquets and hemostatic dressings in 2015, one can be either evidence-based or brand neutral – but not both.”

FKB - CoTCCC



Implementing the Hartford Consensus: 6 Saves in 2 Years

THE HARTFORD CONSENSUS ON ACTIVE SHOOTERS: IMPLEMENTING THE CONTINUUM OF PREHOSPITAL TRAUMA RESPONSE

Peter T. Pons, MD,¹ Jesse Jeromo, EMT-P,² Jeffrey McMullen, EMT-P,³ James Manson, EMT-P,⁴ James Robinson, EMT-P,⁵ and Will Chapleau, EMT-P, MS,⁶



¹Prehospital Trauma/Life Support, National Association of Emergency Medical Technicians, Clinton, Mississippi; ²Denver Paramedic Division, EMS Education Department, Denver Health and Hospital Authority, Denver, Colorado; ³Denver Paramedic Division, Denver Health and Hospital Authority, Denver, Colorado and ⁴American College of Surgeons, Chicago, Illinois; ⁵Hospital Authority, Denver, Colorado and ⁶American College of Surgeons, Chicago, Illinois; ⁷Abstract Address: Peter T. Pons, MD, 10433 Leyden Street, Brighton, CO 80602-6057

“ Three of the cases in our paper were police officers who were ambushed and sustained arterial injuries (Lakewood, Colorado July 2014 and Aurora, Colorado December 2014). There is no doubt that they would have exsanguinated without application of a TQ, in one case self applied and in the other two, buddy care.”

Dr. Peter Pons et al
Journal of Emergency Medicine 2015 52




White House “Bystander – Stop the Bleed”

Bystander “Stop the Bleed” Forum
October 6, 2015


- White House meeting on this topic 6 October 2015
- Emphasis was on **BYSTANDERS** – now renamed “Immediate Responders” being able to use tourniquets and hemostatic dressings

53



What Can TCCC Offer to My Civilian EMS System?


- Tourniquets
- Hemostatic dressings
- **Trauma airway approach**
- TCCC Needle Decompression Plan
- Tranexamic Acid (TXA)
- Hypotensive resuscitation - with blood products where possible
- Intraosseous vascular access
- Triple-Option Analgesia



Airway Management in Maxillofacial Trauma




- Most airway fatalities in combat are from direct trauma to the airway
- **Casualties with severe facial injuries can often protect their own airway by sitting up and leaning forward.**
- Let them do it if they can!




What Can TCCC Offer to My Civilian EMS System?

- Tourniquets
- Hemostatic dressings
- Trauma airway approach
- **TCCC Needle Decompression Plan**
- Tranexamic Acid (TXA)
- Hypotensive resuscitation - with blood products where possible
- Intraosseous vascular access
- Triple-Option Analgesia

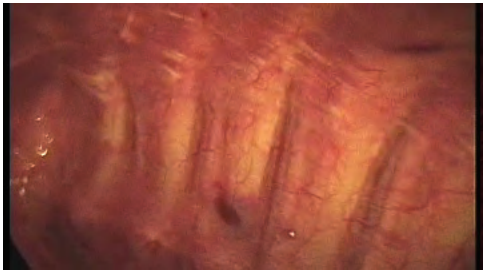


Evolution of Needle Decompression (NDC) in TCCC

- Revised indications - 1996
- Chest tubes usually not needed for initial management - 1996
- 3.25-inch, 14-gauge catheter – 2008
- Bilateral NDC for loss of VS - 2011
- External anatomy landmark - 2012
- Lateral site as alternative - 2012




57



Needle Decompression Works!

Video courtesy Dr. Oleksandr Linchevskyy
Medical Director, Patriot Defence
Ukraine



Tension Pneumothorax Military Medicine 2008


MILITARY MEDICINE 172 (3-00): 2007

Chest Wall Thickness in Military Personnel: Implications for Needle Thoracostomy in Tension Pneumothorax

Guarantor: COL H. Theodore Harcke, MC USA
Contributors: COL H. Theodore Harcke, MC USA**§; LCDR Lisa A. Pearce, MC USN§;
COL Angela D. Levy, MC USA§; John M. Getz, BS§; CAPT Stephen R. Robinson, MC USN§

- **Several NDC failures seen at autopsy with 5 cm catheters – then performed 100 virtual autopsies**
- **Mean chest wall thickness was 4.86 cm**
- **Predicted success rate for 5 cm catheter - 50%**
- **8 cm catheter would have reached the pleural space in 99% of subjects – other papers confirm**

59



NDC – Mayo Clinic February 2016


ORIGINAL ARTICLE

Needle thoracostomy: Clinical effectiveness is improved using a longer angiocatheter

Johnathon M. Aho, MD, Cornelius A. Thiels, DO, Moustafa M. El Khatib, MBBCh, Daniel S. Uhl, Daniel V. Laan, MD, Kathleen S. Berns, APRN, Elizabeth B. Halbermann, PhD, Scott P. Zietlow, MD, and Martin D. Zielinski, MD, Rochester, Minnesota

- **Mayo Clinic: 91 NDC procedures on 71 patients**
- **Pre-March 2011: 5 cm NDC catheters**
- **Post-March 2011: 8 cm NDC catheters**
- **Success rates: 5 cm – 41%; 8 cm 83%**
- **No complications with either length**


60



Old Army Ranger Saying


Lessons Learned aren't really lessons learned - unless you actually learn them.

What length NDC needle is your EMS using?



JTTS VTC 10 Mar 11 TBI and Tension Pneumo

- **Mounted IED attack**
- **LOC from closed head trauma**
- **Lost vital signs prehospital**
- **CPR on arrival at hospital**
- **Bilateral NDC done in ER**
- **Rush of air from left-sided tension pneumo**
- **Return of VS**
- **Significant DAI at WRAMC**
- **TCCC Guidelines changed: Don't pronounce a casualty with torso trauma until bilateral NDC has been performed**



Needle Decompression Site J Am Coll Surg 2008

An Evaluation of Tactical Combat Casualty Care Interventions in a Combat Environment

Maj Homer C. Tien, MD, MSc, FRCSC, Vincent Jung, Sandro B. Rizoli, MD, PhD, FRCSC, FACS, Maj Sanjay V. Acharya, MD, FRCPC, LCdr John C. MacDonald, MD, FRCPC

- **134 consecutive trauma patients at Afghanistan MTF**
- **Seven needle decompression performed**
- **All seven decompressions performed at least 2 cm medial to MCL – no major complications noted**
- **Recommended using nipple line as landmark – don't enter the chest medial to this line**
- **Later recommended 4-5 ICS at AAL as alternate site**

63



What Can TCCC Offer to My Civilian EMS System?

- Tourniquets
- Hemostatic dressings
- Trauma airway approach
- TCCC Needle Decompression Plan
- **Tranexamic Acid (TXA)**
- Hypotensive resuscitation - with blood products where possible
- Intraosseous vascular access
- Triple-Option Analgesia



CRASH-2: Timing of TXA Dosing – Lancet 2011

The importance of early treatment with tranexamic acid in bleeding trauma patients: an exploratory analysis of the CRASH-2 randomised controlled trial

- **Subgroup analysis** of 20,211 trauma patients based on time of administration of TXA
- **Timing; only deaths due to bleeding**
- **3076 overall deaths; 1063 due to bleeding**
- **Risk of death due to bleeding was significantly reduced (5.3% vs 7.7%) if TXA was given within 1 hour of injury. At 1-3 hrs after injury, also significant (4.8 vs 6.1%) At times > 3 hrs, mortality increased.**



MATTERS Paper Summary Morrison – Arch Surg - 2011

- **896 consecutive combat casualties: TXA or no-TXA**
- **First report of TXA use in combat casualties**
- **TXA group had lower mortality (17.4% vs 23.9%; P=0.03) despite TXA group being more severely injured (ISS 25.2 vs 22.5)**
- **Benefit was greatest in casualties who received a MT: mortality with TXA was 14.4% vs 28.1 % in the no-TXA group (p=0.004)**
- **Both DVT and PE were increased in the TXA group, (PE in TXA MT group 3.2% vs 0% in no-TXA MT group); no PE fatalities in the study**



TXA



Beyond CRASH-2 and MATTERS



Karam – TXA in BTKA J Arthroplasty 2013

Evaluation of the Efficacy and Safety of Tranexamic Acid for Reducing Blood Loss in Bilateral Total Knee Arthroplasty

Joseph A. Karam, MD¹, Michael R. Bloomfield, MD², Timothy M. Dilorio, MD³, Andrea M. Irizarry, MD⁴, Peter F. Sharkey, MD⁵

¹ The Williams Institute of Thomas Jefferson University, The Shenkin, Philadelphia, Pennsylvania

² The Williams Institute at Middle Tennessee Hospital, Health Center 4, Murfreesboro

- **Simultaneous, bilateral total knee replacements**
- **Retrospective review; historical controls**
- **TXA group n= 37; control group n = 50**
- **IV TXA 20 mg/kg - given BEFORE incision or at time of tourniquet release**
- **Transfusion needed post-op: Control 50%; TXA 11%**
- **No thromboembolic events in either group**



Huang – TXA Meta-Analysis J Surg Res 2013

The use of tranexamic acid to reduce blood loss and transfusion in major orthopedic surgery: a meta-analysis

Fei Huang, MD,^{1,3} Dan Wu, PhD,^{1,3} Guangwen Ma, MD,² Zongsheng Yin, MD,^{1,3} and Qing Wang, MD³

¹ Department of Orthopaedics, The Fourth Affiliated Hospital of Anhui Medical University, Hefei, Anhui, People's Republic of China

² Department of Scientific Research and Medical Education, The First Affiliated Hospital of Anhui Medical University, Hefei, Anhui, People's Republic of China

³ Department of Orthopaedics, The First Affiliated Hospital of Anhui Medical University, Hefei, Anhui, People's Republic of China

- **Results: “A total of 46 randomized controlled trials involving 2925 patients were included. The use of TXA reduced total blood loss by a mean of 408.33 mL....”**

Conclusions: TXA significantly reduced blood loss and blood transfusion requirements in patients undergoing orthopedic surgery, and did not appear to increase the risk of DVT.



Question 1

- For a trauma patient with ongoing life-threatening extremity hemorrhage – what is the best time to apply a tourniquet?
- Within 1 hour?
- Within 3 hours?
- RIGHT NOW?



Question 2

- For a trauma patient with ongoing major noncompressible blood loss – what is the best time to reduce the bleeding?
- Within 1 hour?
- Within 3 hours?
- RIGHT NOW?

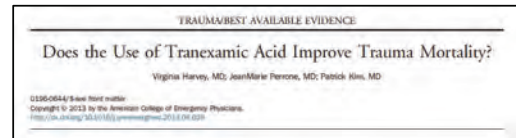


TXA Take-Homes

- There is Level A evidence that TXA reduces mortality in trauma patients.
- There is Level A evidence that TXA reduces blood loss in elective surgery patients.
- There is Level A evidence that TXA does not increase the risk of thromboembolic complications in elective surgery patients.
- (NOTED – that elective surgery is not trauma.)
- The best way to prevent death from hemorrhage is to PREVENT blood loss.
- Likely more benefit if TXA is given as soon as possible after injury
- 2016 - TXA added to USA Medical Equipment Set - COL Lance Cordoni



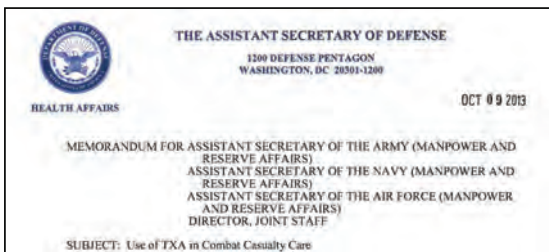
Harvey – TXA Annals Emerg Med 2014



BOTTOM LINE
According to the available evidence, tranexamic acid has been shown to significantly decrease mortality in bleeding trauma patients, with no significant increase in serious thrombotic complications if administered within 3 hours of injury. There is, however, no evidence of benefit in patients with traumatic brain injury. As such, we recommend early treatment with tranexamic acid in trauma patients without isolated brain injuries who have or are at risk for significant hemorrhage and in patients who receive resuscitation with blood products, particularly if they require massive transfusion or have a high risk of death at baseline.



ASDHA Letter on TXA 9 October 2013



- Response to CENTCOM Surgeon request
- TXA use no longer restricted to SOF and MTFs
- Need to accumulate data; monitor outcomes



What Can TCCC Offer to My Civilian EMS System?

- Tourniquets
- Hemostatic dressings
- Trauma airway approach
- TCCC Needle Decompression Plan
- Tranexamic Acid (TXA)
- Hypotensive resuscitation - with blood products where possible
- Intraosseous vascular access
- Triple-Option Analgesia



Fluid Resuscitation from Hemorrhagic Shock

“The historic role of crystalloid and colloid solutions in trauma resuscitation represents the triumph of hope and wishful thinking over physiology and experience.”

*LTC Andre Cap
J Trauma, 2015*

There is an increasing awareness that fluid resuscitation for casualties in hemorrhagic shock is best accomplished with fluid that is identical to that lost by the casualty - whole blood.



Ideal Resuscitation Fluid

	Volume	Hemostatic	O2 Carrying Capacity
Crystalloid	Y	N	N
Colloid	Y	N	N
Plasma	Y	Y	N
1:1:1	Y	Y	Y
Whole Blood	Y	Y	Y



TCCC Fluid Resuscitation fm Hemorrhagic Shock: 2014

Updated Fluid Resuscitation Plan

Order of precedence for fluid resuscitation of casualties in hemorrhagic shock

1. Whole blood
2. 1:1:1 plasma:RBCs:platelets
3. 1:1 plasma and RBCs
4. (tie) Plasma (liquid, thawed, dried) or RBCs alone
8. Hextend
9. (tie) Lactated Ringers or Plasma-Lyte A



Forrest Gump on Fluid Resuscitation



Slide: Dr Marty Schreiber



Damage Control Resuscitation



- 246 combat casualties with massive transfusions
- Mortality at hospital D/C by plasma to RBC ratio
- Low ratio (1:8) – Mortality was 65%
- Medium ratio (1:2.5) – Mortality was 34%
- High ratio (1:1.4) – Mortality was 19%
- P < 0.001



Titration Fluid Resuscitation: A Look Back: 1993



- Prehospital fluid resuscitation in 1993 per ATLS – 2 liters of crystalloid (NS or LR)
- TCCC recommendation: Titrate to improved level of consciousness or palpable radial pulse
- Systolic BP of 80-90 mmHG; 90 or more in TBI

**The New England
Journal of Medicine**

©Copyright, 1994, by the Massachusetts Medical Society

Volume 331 OCTOBER 27, 1994 Number 17

IMMEDIATE VERSUS DELAYED FLUID RESUSCITATION FOR HYPOTENSIVE PATIENTS WITH PENETRATING TORSO INJURIES

WILLIAM H. BURGEL, M.D., MATTHEW J. WALL, JR., M.D., PAUL E. POPE, M.D.,
R. ROSELLI MARTIN, M.D., VICTORIA F. GOSCH, M.S.N., MARY K. ALLEN, B.A.,
AND KENNETH L. MATYOS, M.D.

- Prospective RCT; community consent obtained
- Aggressive early crystalloid resuscitation vs resuscitation delayed until after repair of vascular injury
- Penetrating torso trauma; systolic BP < 90 mmHg
- Early n = 309; Delayed n = 289
- Volume: Early = 2,478 mL; Delayed = 375 mL
- Survival: Early = 62%; Delayed = 70% (p=0.04)

**Blood Pressure and
Rebleeding – J Trauma 2003**

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

Blood Pressure at which Rebleeding Occurs after Resuscitation in Swine with Aortic Injury

Jill L. Sawlein, PhD, Valerie G. Coppes, BS, and John B. Holcomb MD.

- 70 swine with 1.5, 2.0, or 2.8 mm aortic punch
- Resuscitation was with LR after 5-30 min delay
- 5 animals died before fluid resuscitation
- 3 died at onset of fluid resuscitation
- For remaining 62 animals, rebleeding occurred at mean SBP of 94; MAP of 64

**Crystalloids in Trauma
Patients – J Trauma 2011**

Emergency Department Crystalloid Resuscitation of 1.5 L or More is Associated With Increased Mortality in Elderly and Nonelderly Trauma Patients

Eric J. Ley, MD, Morgan A. Clond, PhD, Marissa K. Srou, BS, Moshe Barnajian, MD, James Mirocha, MS, Dan R. Margulies, MD, and Ali Salim, MD

- Retrospective study – 3,137 patients
- Subgroups: 1, 1.5, 2, and 3 liters
- Overall mortality 5.2%; elderly 17.3%; non 4%
- Did not specify which crystalloid
- “ED volume replacement of 1.5 L or more was an independent risk factor for mortality.”

**Restrictive Fluid Resuscitation
Duke – J Trauma - 2012**

ORIGINAL ARTICLE

Restrictive fluid resuscitation in combination with damage control resuscitation: Time for adaptation

Marquian D. Duke, MD, Chrissy Guidry, DO, Jordan Guice, Lance Strake, MD, MPH, Alan R. Marr, MD, John E. Hunt, MD, MPH, Peter Meade, MD, MPH, Norman E. McSwain, Jr., MD, and Juan Carlos Duchesne, MD, New Orleans, Louisiana

- 307 trauma patients - retrospective study
- Penetrating torso injury; SBP < 90
- RFR = Less than 150 mL of crystalloid prior to damage control surgery (DCS) (n=132)
- SFR = 150 mL or more prior to DCS (n=175)

**Restrictive Fluid Resuscitation
Duke – J Trauma - 2012**

ORIGINAL ARTICLE


Restrictive fluid resuscitation in combination with damage control resuscitation: Time for adaptation

Marquian D. Duke, MD, Chrissy Guidry, DO, Jordan Guice, Lance Strake, MD, MPH, Alan R. Marr, MD, John E. Hunt, MD, MPH, Peter Meade, MD, MPH, Norman E. McSwain, Jr., MD, and Juan Carlos Duchesne, MD, New Orleans, Louisiana

- Pre-op crystalloid: RFR mean = 129 mL
- Pre-op crystalloid: SFR mean = 2757 mL
- RFR intra-op mortality 9%; SFR mortality 32%
- P = 0.001


**28 January 2016
Somewhere in Theater**

- 2 GSW to the chest – entered above the chest plates
- 2+ liters of blood from chest tube
- Resuscitated with thawed FFP, freeze-dried plasma, and PRBCs
- “Not a drop of crystalloid”
- Ketamine for pain – no opioids
- Found at surgery to have a right pulmonary vein injury
- Arrested on the table – revived successfully
- Survived and doing well




What Can TCCC Offer to My Civilian EMS System?

- Tourniquets
- Hemostatic dressings
- Trauma airway approach
- TCCC Needle Decompression Plan
- Tranexamic Acid (TXA)
- Hypotensive resuscitation - with blood products where possible
- **Intraosseous vascular access**
- **Triple-Option Analgesia**



Intraosseous Vascular Access

- Studied at US Army Institute of Surgical Research in 2000
- Pioneered in prehospital trauma by TCCC in 2002
- First recommended for TCCC by a CoTCCC Ranger Medic (SFC Rob Miller)
- **Special Ops medics previously taught to do battlefield venous cutdowns when peripheral IV access was difficult to obtain**
- PYNG FAST-1 and EZ-IO are the most commonly used devices
- **IO techniques are used universally in the military**



IO Vascular Access Save Houston – 27 March 2016

- Memorial Hermann Hospital
- Multiple stab wound victim – including left popliteal artery and intercostal artery injuries
- BP reported as 90 systolic at scene; no pulse in ED
- **Multiple peripheral IV attempts failed**
- **Central line attempt failed**
- **IO started and 2 units RBCs/2 units plasma infused**
- ED thoracotomy
- pH 6.83; lactate 26; BD 24
- Survived and doing well
- Trauma surgeon: “Would have died without IO”

Courtesy Dr. John Holcomb




What Can TCCC Offer to My Civilian EMS System?

- Tourniquets
- Hemostatic dressings
- Trauma airway approach
- TCCC Needle Decompression Plan
- Tranexamic Acid (TXA)
- Hypotensive resuscitation - with blood products where possible
- Intraosseous vascular access
- **Triple-Option Analgesia**



150 Years of Evolution: Civil War vs US Mil 2001

 <p>Civil War Soldier</p>	 <p>Modern Soldier</p>
 <p>British 1853 Enfield Musket</p>	 <p>M4A1 Carbine</p>
 <p>Battlefield analgesia: Intramuscular morphine</p>	 <p>Battlefield analgesia: Intramuscular morphine</p>



Triple-Option Analgesia in TCCC

The simplified “Triple-Option” approach to battlefield analgesia has three primary goals:

1. Preserve the fighting force
2. Provide rapid and maximal relief of pain from combat wounds
3. Minimize the likelihood of adverse effects on the casualty from the analgesic medication used



Triple-Option Analgesia

Tactical Field and TACEVAC Care

- Analgesia on the battlefield should generally be achieved using one of three options depending on the level of the casualty's pain and the nature of his or her injuries.



Triple-Option Analgesia Option 1

Tactical Field and TACEVAC Care:

1) Mild to Moderate Pain

Casualty is still able to fight

- **TCCC Combat pill pack:**
- **Tylenol** - 650-mg bilayer caplet, 2 PO
- **Meloxicam** - 15 mg PO



Triple-Option Analgesia Option 2

2) Moderate to Severe Pain

Casualty IS NOT in shock or respiratory distress
AND

Casualty IS NOT at significant risk of developing either condition

- **Oral transmucosal fentanyl citrate (OTFC) 800 ug**
- Place lozenge between the cheek and the gum
- Do not chew the lozenge



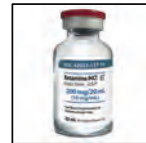
Triple-Option Analgesia Option 3

3) Moderate to Severe Pain

Casualty IS in hemorrhagic shock or respiratory distress
OR

Casualty IS at significant risk of developing either condition

- **Ketamine 50 mg IM or IN**
- Or
- **Ketamine 20 mg slow IV or IO**



- * Repeat doses q30min prn for IM or IN
- * Repeat doses q20min prn for IV or IO
- * End points: Control of pain or development of nystagmus (rhythmic back-and-forth movement of the eyes)




Warning: Morphine and Fentanyl **Contraindications**

- Hypovolemic shock
- Respiratory distress
- Unconsciousness
- Severe head injury
- **DO NOT give morphine or fentanyl to casualties with these contraindications.**



Ketamine - Safety

- Very favorable safety profile
- Few, if any, deaths attributed to ketamine as a single agent
- **FDA Insert:**
 - *"Ketamine has a wide margin of safety; several instances of unintentional administration of overdoses of ketamine (up to ten times that usually required) have been followed by prolonged but complete recovery."*



ACEP and Triple Option Analgesia


POLICY STATEMENT

Policy Statement

Policy statements and clinical policies are the official policies of the American College of Emergency Physicians and, as such, are not subject to the same peer review process as articles appearing in the Journal. Policy statements and clinical policies of ACEP do not necessarily reflect the policies and beliefs of *Annals of Emergency Medicine* and its editors.

Out-of-Hospital Use of Analgesia and Sedation
Approved by the ACEP Board of Directors June 2015

- American College of Emergency Physicians
- Leaders in prehospital trauma care
- **2015 Policy statement mirrors the TCCC Triple-Option Analgesia Plan**



Questions?

