Saving Lives on the Battlefield: TCCC Update 2019

Dr. Frank Butler
SOMSA
10 May 2019

Disclaimers

“The opinions or assertions contained herein are the private views of the author 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.”
- No financial interests in items discussed

THANKS

• Thanks to the SOMA membership for all that you do!

• “The greatest resource that the JTS has is the time and talent of all the individuals who volunteer to help with the JTS mission.”

Col Jeff Bailey
Interim Director
Joint Trauma System
9. “Evidence” does not drive advances in trauma care. **PEOPLE do that.**

*People like the ones in the SOMA audience today!*

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White House Stop the Bleed Rollout
6 October 2015

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9. “Evidence” does not drive advances in trauma care. **PEOPLE do that.**
Why We Are Here

Thanks:
SFC (R) Dom Greydanus

ZERO Preventable Deaths!

Where can we save the most lives?

Tactical Combat Casualty Care

The Prehospital Arm of the Joint Trauma System

• Medics, Corpsmen, PJs
• Combat Lifesavers
• All Combatants/All Service Members
• Includes Tactical Evacuation Care

Photo – MSG (R) Harold Montgomery
Tourniquets: The Primary Driver for TCCC

“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

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 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.”

Battlefield Trauma Care: 2001

- Based on trauma courses NOT developed for combat
- Medics taught NOT to use tourniquets
- No hemostatic agents
- No junctional tourniquets
- Large volume crystalloid fluid resuscitation for shock
- Civil War-vintage technology for battlefield analgesia IM morphine)
- SOF medics – IV cutdowns for difficult venous access
- No tactical context for care rendered
- 2 large bore IVs on all casualties with significant trauma
- No focus on prevention of trauma-related coagulopathy
- Heavy emphasis on endotracheal intubation
Changing Cultures

“It seems unthinkable. Special Operators, America’s best warriors, getting shot in the arm or the leg and bleeding to death. But it was happening over and over.”

Chancellor William McRaven – May 2017

A Preventable Death: 2003

- RPG explosion
- Bled to death from his right knee wound despite three field-expedient tourniquets
- “A picture is worth 1000 words”
- This one was worth 1000+ lives

Battlefield Trauma Care: Now

- Phased care in TCCC
- Aggressive use of tourniquets in CUF
- Combat Gauze as hemostatic agent
- Aggressive needle thoracostomy
- Sit up and lean forward airway positioning
- Extraglottic airways – i-gel
- Surgical airways for maxillofacial trauma
- Hypotensive resuscitation with blood products
- IVs only when needed/IO access if required
- PO meds, OTFC, ketamine as “Triple Option” for battlefield analgesia
- Hypothermia prevention; avoid NSAIDs
- Battlefield antibiotics
- Tranexamic acid – given ASAP when indicated
- Junctional Tourniquets/XStat
TCCC: How Do We Know That it’s Working?

Tourniquets – Kragh et al Annals of Surgery 2009

- Ibn Sina Hospital, Baghdad, 2006
- Tourniquets are saving lives on the battlefield
- 31 lives saved in 6 months period by the use of prehospital tourniquets
- No loss of limbs from tourniquet ischemia
- Author estimated 1000+ lives saved with TQs

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%
**DOD Instruction on Medical Readiness Training**

16 March 2018

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**DOD Instruction on Medical Readiness Training**

Section 2.a.b  Policy

“TCCC is the DoD standard of care for first responders (medical and non-medical) …..All Service members receive role based TCCC training and certification in accordance with the skill level (i.e., All Service Members, Combat Lifesaver, Combat Medic/Corpsmen, and Combat Paramedic/Provider) outlined by the Joint Trauma System, the DoD’s Center of Excellence for trauma as designated in DoD Instruction (DoDI) 6040.47.

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**TCCC Leadership Lessons Learned**

9. “Evidence” does not drive advances in trauma care. PEOPLE do that.

Thanks to: Mr. Ed Whitt, Ms. Elizabeth Fudge, Mr. Kevin Kelley, CDR Tara Cozzarelli
Recent Changes to the TCCC Guidelines

TCCC Changes: 2017-2019

- Pelvic Binding Devices
  - Col Stacy Shackelford
- Comprehensive Review
  - MSG (Ret) “Monty” Montgomery
- Extraglottic Airways
  - Dr. Mel Otten
- Management of Suspected Tension Pneumothorax
  - Butler
- Advanced Resuscitative Care
  - Butler

Journal of Special Operations Medicine

TCCC’s Most Important Strategic Communications Partner

Makes TCCC Change Papers a Permanent Part of the Published and Searchable Medical Literature
Mr. Harold Montgomery
6 May 2019

A Relook at Tourniquets in TCCC

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Mr. Harold Montgomery

A Relook at Tourniquets in TCCC

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Mr. Harold Montgomery

A Relook at Tourniquets in TCCC

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Proposed Changes to the TCCC Guidelines: 2019

TCCC will always be a work in progress.

TXA Modifications
CAPT Brendon Drew

Relook at TXA
- 2 gm dose for TBI?
- Same dose for bleeding in the absence of TBI?
- 1 minute slow IV push vs over 10 minutes?
- Second dose given like first?
- Give second dose prehospital at all?
- Change dose for ongoing hemorrhage?

Dr. Brad Bennett

Hypothermia Prevention
Colloids and crystalloids are the LEAST desirable of the options for fluid resuscitation of hemorrhagic shock. Dried plasma is a much better option. Dried plasma can be carried by medics in the field. DoD-FDA Panel has now approved. Now - need to produce and field it!

Photo – SGM F Bowling

Thanks to: COL Dave Marcozzi, COL Andre Cap and MRMC

Conclusion: In injured patients at risk for hemorrhagic shock, the prehospital administration of thawed plasma was safe and resulted in lower 30-day mortality and a lower median prothrombin time ratio than standard-care resuscitation.
Fluids - Is It Time for Hextend and Crystalloids to Go?

• Sperry 2018 – Plasma better
• COL Jenn Gurney pending paper – Whole Blood better
• FDA approval of US dried plasma product by 2020?
• Crystalloids and hetastarch solutions – negative reports

Maj Marc Northern

LTC Jamie Riesberg

Management of Eviscerating Injuries

Recent Developments in TCCC
150 Years of Evolution: Civil War vs US Mil 2001

Civil War Soldier

Modern Soldier

British 1853 Enfield Musket

M4A1 Carbine

Battlefield analgesic: Intramuscular morphine

Battlefield analgesic: Intramuscular morphine

OTFC/Ketamine

Oral Transmucosal Fentanyl Citrate

- As powerful as IV morphine
- Almost as fast as IV morphine
- No need to start an IV

Ketamine

- Safer than opiates
- Can supplement opiates
- Can be used for casualties in shock
“...the production of morphine autoinjectors has ceased and all back orders have been cancelled.”

Improving TCCC Training

Dr. Stephen Giebner

TCCC Curriculum 2018
TCCC Curriculum Changes
2018

- New TCCC changes incorporated
- More DHA Deployed Medicine videos
- TCCC Critical Decision Case Studies
- TCCC test questions revised
- Learning objectives revised

* TCCC Curriculum development will soon be done by the JTS Joint Trauma Education and Training Branch

Dr. Stephen Giebner

PHTLS 9 - Military

TCCC Critical Decision Case Studies

August 2017
The Biggest Challenge in TCCC

- Knowing WHEN to use the interventions taught in TCCC
- Based on a suggestion by COL Bob Mabry
- TCCC Critical Decision Case Studies will help to illustrate which interventions to perform for casualties with life-threatening conditions.

COL Bob Mabry
2018 Letterman Award Winner
Museum of Civil War Medicine

TCCC Critical Decisions
Circulation Case Study 3

The Setting
- An Army infantry squad is on foot patrol in Iraq
- A dismounted IED detonates
- There are multiple casualties
- There is no effective incoming fire at the moment
TCCC Critical Decisions
Circulation Case Study 3

The Casualty
- Your casualty has bilateral lower extremity amputations
- There was previously severe bleeding from the amputation sites
- Limb tourniquets were quickly applied to both legs and are effective
- The casualty is alert and in significant pain
- His radial pulse is normal
- The casualty also has multiple penetrating wounds of the abdomen and pelvis

TCCC Critical Decisions
Circulation Case Study 3

Casualty Dashboard
- AVPU: Alert
- Airway: Patent with patient dazed but breathing well
- Breathing: RR 16 and unlabored
- Radial Pulse: Strong
- O2 Saturation: 95%

TCCC Critical Decisions
Circulation Case Study 3

Question
What is the NEXT action you should take?
1. Start an IV and administer 1 gm of TXA
2. Start an IV and administer 500 mL of Hextend, since there are no blood products available on this operation
3. Administer 50 mg of ketamine IM
4. Try to convert both tourniquets to other modes of hemorrhage control
Mr. Harold Montgomery - President of SOMA

TCCC Critical Decisions
Circulation Case Study 3

Correct Answer and Feedback

1. Start an IV and administer TXA

This casualty does need battlefield analgesia, but the most important aspect of care right now is to start an IV and administer 1 gm of TXA. He is at risk of non-compressible hemorrhage due to his penetrating abdominal and pelvic wounds. He does not require fluid resuscitation at the moment.

TCCC in Social Media: Thanks, Monty!
Non-Standard TCCC for Medical Personnel Courses

- In the past, many “TCCC” courses (unit-based, service-based, and vendor-based) - weren’t!
- Examples of NON-TCCC Messaging
  - “Open globe injuries should be treated with a pressure patch”
  - “Never take a tourniquet off in the field”
  - “Let the tourniquet down every 15 minutes”
  - “Give benzos whenever you give ketamine”
- Incorrect messaging has been DIRECTLY associated with adverse outcomes

Examples of Preventable Adverse Outcomes

- One Special Operations member suffered a leg amputation from prolonged tourniquet use in a non-CENTCOM operation – the only amputation from tourniquet use in US forces. Unit members had been told “never to take off a tourniquet in the field” at their “TCCC” course. Tourniquet was left on for over 8 hours.
- A casualty suffered pulmonary edema at a foreign medical facility from getting 9 liters of NS during resuscitation from hemorrhagic shock
- 2 deaths from unrecognized tension pneumothorax
- Respiratory arrest from using midazolam after fentanyl lozenges or other opiates
TCCC-MP Curriculum 2018: Warning: Opioids and Benzos

• Ketamine can safely be given after a fentanyl lozenge.
• Some practitioners use benzodiazepine medications such as midazolam to avoid ketamine side effects BUT:
  • Midazolam may cause respiratory depression, especially when used with opioids.
  • Avoid giving midazolam to casualties who have previously gotten fentanyl lozenges or morphine.

Do You Really Know What Your Medics Are Learning?

Course widely used in DoD
Banned by USSOCOM in 2005
Continued to be used by other DoD organizations
Until Medical Director lost his license
How does this happen?
It could be avoided by a training standard.

TCCC Training – The Need for a Standard

In the absence of a standard high-quality TCCC course with a professionally developed curriculum, "TCCC Training" in the DoD can wind up being an hour of Powerpoint slides or 11 days of inappropriate training - or anything in between.

This is UNSAT!
Joint Trauma System
White Paper to Service SGs

• Outlined the problem
• Documented the bad outcomes from non-standardized TCCC training
• Recommended that we use the JTS-developed TCCC curriculum as taught through NAEMT.

Why NAEMT-Offered TCCC-MP Courses?

• They use the JTS/CoTCCC curricula.
• They QA their instructors.
• Have a system for establishing training sites
• Certification card at the end of the course.
• NAEMT registry of all who complete the course.
• Less expensive than commercial training vendors.
• Cost: $10 per student (medics, physicians, PAs - who need to be certified)
• The course with the “Shock Labs” - cost $2000 per student plus 10 days travel (another $2000)

TCCC Training Standardization

• ASDHA Memo - 4 April 2019
• “All trauma training institutions.....must teach the new DHA standardized TCCC curriculum developed in coordination with the Secretaries of the MILDEPs, upon distribution by the Director, DHA.”
What Can TCCC Offer to My Civilian EMS System?

- Tourniquets
- Hemostatic dressings
- Prehospital whole blood for resuscitation from hemorrhagic shock
- TCCC trauma airway approach
- TCCC mgt plan for suspected tension pneumothorax
- Tranexamic Acid (TXA) – soon in a TBI dose?
- Intraosseous vascular access
- Triple-Option Analgesia
- Pelvic binders

Tourniquet Use 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

*No mention of tourniquet use in the story*
**Tourniquet Phobia**

- "But - I learned that tourniquets are dangerous and should only be used only as a last resort!"
- This was 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 in US casualties from tourniquet use in those two conflicts.
- 2 hours of tourniquet time is very safe.

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**Tourniquets and Hemostatic Dressings in the Civilian Sector**

Lifethreatening injuries in active shooter incidents such as those in Fort Hood, Tucson, and Aurora are similar to those encountered in combat settings. Military experience has shown that the number one cause of preventable death in victims of penetrating trauma is hemorrhage. Tactical Combat Casualty Care (TCCC) program, when implemented with strong leadership support, have produced dramatic reductions in preventable death.

Recognizing that active shooter incidents can occur in any community, the Hartford Consensus encourages the use of existing techniques and equipment, validated by over a decade of well-documented clinical evidence.

- The Hartford Consensus - Dr. Lenworth Jacobs
- White House Stop the Bleed program
- Emphasis is on early and definitive control of external hemorrhage

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**Civilian Tourniquets: Minutes Matter!**

*AAST 20th Plenary Paper*

The trauma center is too late: Major limb trauma without a pre-hospital tourniquet has increased death from hemorrhagic shock.

- Level 1 Trauma Center in Houston; 70% BLUNT trauma
- 306 patients with 326 tourniquets: 281 patients (92%) had indications for tourniquet use
- Death from hemorrhagic shock was lower (3% vs. 14%) when indicated tourniquets were applied prehospital rather than waiting until arrival at the trauma center.
Discusses the Hartford Consensus and the White House “Stop the Bleed” programs. A quote from the article:

“For nearly 2 decades, the US military, other global armed forces, along with the civilian tactical medicine communities, have realized the potential of early lifesaving hemorrhage control. Pioneered by the US Military’s Committee on Tactical Combat Casualty Care (TCCC), and adapted by the civilian Committee for Tactical Emergency Casualty Care (C-TECC), the importance of early hemorrhage control and the ability to address immediately correctible causes of death has proven to save lives. Now considered standard for military and civilian tactical medical units, these concepts are being adopted by law enforcement and emergency medical services worldwide.”

Stop the Bleed
June 2015

16 y/o boy with arm bitten off – in shock
Surfers 1; 911 Dispatcher 0

Stop the Bleed
April 2019

Chicago Fire – 354 tourniquets uses
Chicago PD – 66 tourniquet uses

* Unpublished data – Detective Ralph Cruz • CPD
In the year 2018, there's no excuse for somebody to die from extremity hemorrhage — absolutely none.”

Dr. Mark Gestring
Quoted in the Washington Post

Evidence alone does not drive advances in trauma care. People do that.
Leadership Lessons Learned in TCCC
Journal of Trauma 2017

2018 US Army Hero of Military Medicine: MAJ Andy Fisher

2018 TCCC Award

MAJ Andy Fisher
75th Ranger Regiment
Texas A&M Medical School
External Hemorrhage Control Practice Guidelines

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.

Tourniquet Use in the Civilian Sector: Goodwin et al: J Trauma 2019

Incidence of reported tourniquet utilization per EMS activation according NEMSIS Database (2008-2016)

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Advanced Resuscitative Care in TCCC

Dr. Frank Butler
Joint Trauma System Teleconference
2 May 2019
Bottom Line
Up Front

The new Advanced Resuscitative Care plan in Tactical Combat Casualty Care could prevent at least 40 out of every 100 potentially preventable deaths in US combat casualties, IF performed at or near the point of wounding.

* Based on data from the 2012 J Trauma paper by COL Brian Eastridge et al. “Death on the Battlefield”

Potentially Preventable Prehospital Deaths in Combat Casualties

- Most combat fatalities (88% in the Eastridge study) die before they reach a hospital or a surgeon
- Remarkable progress has been made in reducing preventable prehospital deaths by TCCC and through reducing casualty evacuation times

- MOST OF THE REMAINING PREHOSPITAL DEATHS COULD BE PREVENTED BY THIS NEW CHANGE TO TCCC

Preventable Prehospital Deaths in Combat Casualties

For 100 Preventable Combat Deaths (Eastridge 2012):

- 7 are due to airway obstruction
- 1 is due to tension pneumothorax
- 92 are due to hemorrhage
  - 12 are due to extremity hemorrhage
  - 18 are due to junctional hemorrhage
  - 62 are due to non-compressible torso hemorrhage
  - 22 are due to thoracic bleeding
    - Might be helped by whole blood resuscitation
  - 40 are due to abdominopelvic bleeding

* These 40 lives could be saved by ARC (whole blood resuscitation and Zone 1 REBOA – if these interventions are provided soon after wounding.
If We Can Just Get the Casualty to the Hospital Alive.....

- Stephen Ambrose – *Citizen Soldiers* – Normandy 1944
- But 13% of the fatalities in the Eastridge study were DOWs

Hemorrhagic Shock and Mortality

- Martin 2008 – 32% of deaths in Level 3 MTFs are due to hemorrhage (Military)
- Buehner 2017 – Hypotension on arrival at a Level 3 MTF = 23% mortality (Military)
- Harvin 2018 – Emergent trauma laparotomy + hypotension = 46% mortality (Civilian)
- Marsden 2018 – Emergent trauma laparotomy + hypotension = 26% mortality (Military)

Advanced Resuscitative Care in TCCC - 2019

- Journal of Special Ops Medicine 2019
- THANKS to the ARC author team!
Whole Blood for Hemorrhagic Shock

- A proven lifesaver
- Prehospital whole blood now transitioning to the civilian sector
- No Golden Hour for internal hemorrhage - MINUTES MATTER!
- The overwhelming majority of US ground forces DO NOT HAVE whole blood at the point of injury!

Whole Blood - don't go to war without it!

Far-Forward Blood: MINUTES MATTER

“Among medically evacuated US military combat casualties in Afghanistan, blood product transfusion prehospital or within minutes of injury was associated with greater 24-hour and 30-day survival than delayed transfusion or no transfusion.”

Shackelford et al JAMA 2017

Far-Forward Blood: MINUTES MATTER

“Regardless of conflict, early delivery of blood transfusion was associated with increased survival. Thus, timely treatment capability was paramount for casualty survival on the battlefield of Iraq, as it was in Afghanistan.”

Kotwal J Trauma 2018
Far-Forward Whole Blood: MINUTES MATTER!

• COL Jennifer Gurney et al
• Paper pending

Far-Forward Whole Blood Options in Order of Preference

#1 FDA-Compliant cold-stored LTOWB
#2 LTOWB from a walking blood bank
#3 Untitered Type O whole blood from a walking blood bank
#4 Type-specific whole blood from a walking blood bank
REBOA – MINUTES
MATTER Here as Well

- A relatively new technology
- Can control abdominal and pelvic hemorrhage – the #1 remaining cause of potentially preventable death in combat casualties. Keeps blood from getting to the bleeding site.

- If you meet the TCCC criteria for REBOA, you are already well on your way to bleeding to death.

Zone 1 Balloon Occlusion of the Aorta

REBOA – But Isn’t It Potentially Dangerous?

- Yes – continuous occlusion of the aorta for 60 minutes or longer can cause sudden death when blood flow is resumed.

- BUT – 30 minutes occlusion is safe.

- AND – new research findings from the Army research laboratory at Madigan indicate that intermittent aortic occlusion can enable 100% survival out to 120 minutes even in the presence of an otherwise lethal vascular injury in the abdomen or pelvis.

- AND – an additional modification proposed by Col Todd Rasmussen at USUHS makes the procedure even safer.

Manley et al; JSOM 2017
Out of Hospital REBOA

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* All 4 casualties survived to next level of care
• 20 combat casualties treated with prehospital REBOA; mean SBP 71
• Large majority Zone 1; 19 of 20 successful; #20 balloon rupture
• Mean SBP increase on balloon inflation was 56 mmHG
• Mean balloon time was 21 minutes (range 7-34 min)
• No procedural complications – 7 done by EM physicians
• Also resuscitated with whole blood
• 100% survival to the next level of care

REBOA Indications in ARC
Per TCCC Change 18-01
• External hemorrhage controlled AND
• TXA given AND
• Pelvic binding done if indicated AND
• Electronic BP monitoring established AND
• Whole blood resuscitation initiated AND
• Still in shock (SBP < 90) after first unit of whole blood AND
• The casualty has penetrating or severe blunt force injury to the abdomen or pelvis and a positive FAST exam or is judged to be at high risk for NCTH or is noted to have difficult-to-control junctional hemorrhage. AND
• Intra-thoracic bleeding and cardiac tamponade have not been found on bilateral chest tube insertion and an EFAST exam.

Kuckelman et al
J Trauma 2018
“If new techniques and/or technologies can be developed to significantly prolong the duration of tolerable therapeutic REBOA, it may be utilized to limit ischemia reperfusion prior to definitive surgical care in the pre-hospital or prolonged field care scenario. We hypothesized that the development of alternative strategies involving intermittent aortic occlusion and restoration of flow based off simple bedside measurements may significantly extend the tolerable duration of zone 1 REBOA placement.”
Kuckelman 2018
Zone 1 REBOA + Survival

• Controls – 100% mortality (Mean time to death 15 min after hemorrhage initiated)

• 60 minute REBOA – 100% mortality (Mean 63 min – 3 min after balloon deflated)

• 120 minutes of intermittent (15 min inflation - then repeated 3 min deflation/10 min inflation) cycles of Zone 1 REBOA had 100% survival

The Rasmussen Modification

• Rather than follow the exact protocol used at Madigan for intermittent REBOA, Col Todd Rasmussen from USU proposed the following:

  After the initial 15 minute inflation period, when the balloon is deflated - if the systolic blood pressure (SBP) remains above 80 mmHg, there is no need to re-inflate the balloon.

• BUT - what if SBP does drop below 80 mmHG? That presents two options.
The Modified Madigan Technique: Option 1

- If the SBP drops below 80 mmHg after balloon deflation, re-inflate the balloon and continue resuscitation with whole blood.

- As long the periods of balloon deflation continue to be 3 minutes or more, use 10-minute inflation periods (as per Kuckelman) followed by another deflation up to a maximum of 120 minutes.

The Modified Madigan Technique: Option 2

- If the SBP drops below 80 mmHg immediately after balloon deflation, re-inflate the balloon and continue resuscitation with whole blood.

- If the casualty does not maintain an SBP of 80 mmHg or higher for at least 3 minutes of balloon deflation, then use a maximum of 30 minutes total balloon inflation time.

Zone 1 vs Zone 3
REBOA: Hemodynamics

<table>
<thead>
<tr>
<th>Location is everything: The hemodynamic effects of REBOA in Zone 1 versus Zone 3 of the aorta</th>
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</thead>
<tbody>
<tr>
<td>Emily M. Tibbitts, MD, Guillaume L. Houtran, DVM, PhD, Meryl A. Simon, MD, Anders J. Davidson, MD, Erik S. DeSousa, DO, E. Robert Faunce, MBBS, Joseph J. Bottom, MD, Lucas P. Neff, MD, J. Kevin Grayson, DVM, PhD, Timothy K. Williams, MD, and M. Austin Johnson, MD, PhD, Sacramento, California</td>
</tr>
</tbody>
</table>

- CONCLUSIONS: In our swine model of hemorrhagic shock, Zone 3 REBOA provided minimal proximal hemodynamic support when compared with Zone 1 REBOA, albeit with less ischemic burden and instability upon reperfusion. In cases of impending hemodynamic collapse, Zone 1 REBOA placement may be more efficacious regardless of injury pattern, whereas Zone 3 should be reserved only for relatively stable patients with ongoing distal hemorrhage.
Early Common Femoral Artery Access!

- Over 4000 uses of REBOA have taught that early common femoral artery (CFA) access is a critical first step
- Allows continuous arterial pressure monitoring
- Technically much easier to do early vs late
- Early CFA access does not mandate REBOA catheter placement

What ARC IS NOT

- ARC is NOT envisioned as a single combat medic working out of an aid bag.
- Too complex; too much equipment
- ARC requires a specially trained and equipped TEAM. This team would not require (or replace) a surgeon, but may serve to keep the casualty alive for several hours until he or she reaches a surgeon for definitive care.

What ARC IS NOT

- Advanced Resuscitative Care is also NOT Prolonged Field Care.
- There is no representation intended in this change that ARC can reliably keep a critically injured casualty who has NCTH alive for 72 hours, which is the time frame used as a target for PFC. Rapid transport to surgical care is essential for good outcomes in casualties with NCTH and shock.
The Biggest Challenge in ARC

- Getting specially trained and equipped teams with an ARC capability as close as possible to the point of wounding
- **Minutes Matter!**
- Options:
  - Purposed advanced trauma care teams
  - Casualty Collection Point teams
  - Battalion Aid Station teams
  - Loitering insertion helicopter
  - Advanced capability TACEVAC platforms
  - Others?

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TCCC Lessons Learned

2. It doesn’t matter how good the plan is – if nobody’s using it.

Are there units in the US military using ARC at present?

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Implementing ARC

- Joint Special Operations Command – Oct 2018
- 160th Special Operations Aviation Regiment – Nov 2017
- USASOC SORT Teams – Fall 2018
- USMC FRSS/STP units – March 2019
On 25 March 2019, Senior Medical Leaders at the USMC MEF and MARFOR level unanimously voted to adopt and implement Advanced Resuscitative Care. An Urgent UNS submission is being prepared to implement REBOA for USMC FRSS and STP units and whole blood for all USMC combat units.

Advanced Resuscitative Care in the USMC

Training for ARC: The RAPToR Course

- Dr. Zaffir Qassim
  443.562.6205
- Sept 9-10 in Houston
- “Designed to train ARC”
- Whole blood administration
- REBOA at point of injury.
- Training on both simulator and cadaver models
- Cutdown training
- Faculty: Qassim, Holcomb, Dubose, Fisher, etc
- Open to military and civilians
- Physicians of all specialties
- Possible NAEMSP affiliation under discussion
ARC – The Long View

• This change to TCCC is a first step into ARC.
• Anticipate continued advances in whole blood availability.
• Also - anticipate increases in the time that hemorrhage can be controlled with Zone 1 REBOA based on further advances in intermittent and partial REBOA techniques.

ARC – The Long View

• The true limits of how long a casualty can be kept alive with intermittent Zone 1 REBOA have not yet been defined
• RAPID delivery of casualties to definitive surgical control remains the objective!!!
• BUT intermittent REBOA may have the potential to extend the survivability of these patients beyond the “Golden Hour”
  • Golden Two Hours? Longer?

Closing Thought

We should never forget the sacrifices that our country’s warriors make to defend our lives and our freedoms. These men and women are counting on military medicine to provide them with the best care possible if they are wounded in combat.

We must live up to that trust every day.
Thank You!