Committee on Tactical Combat Casualty Care
Meeting Minutes

3-4 August 2010
Denver, Colorado

Attendance

CoTCCC Members

Dr. James Bagian	VA
Dr. Brad Bennett	USUHS
Dr. Dave Callaway	OMI
Dr. Howard Champion	USUHS
COL Jim Czarnik	JSOC
COL Virgil Deal, Jr	USSOCOM
Mr. William Donovan	75th Ranger Regiment
Col Warren Dorlac	USAF
CAPT James Dunne	USN
COL Warner Farr	SOCCENT
COL Stephen Flaherty	USA
Dr. Douglas Freer	Raytheon Polar Services
Dr. John Gandy	Emergency Medicine-Las Vegas, NV
COL Jonathan Jaffin	OTSG Army
Dr. Donald Jenkins	Mayo Clinic
CAPT Kenneth Kelly	Tripler AMC
LTC (P) Russ Kotwal	USASOC
MAJ Robert Mabry	USAISR
MSG Harold Montgomery	75th Ranger Regiment
COL Kevin O'Connor	Physician for the Vice President
CDR Luis Ortega	USCG
Dr. Edward Otten	University of Cincinnati
MSG Joseph Paisley	USASOC
Mr. Donald Parson	DCMT
CMSgt Thomas Rich	58RQS
HSCS Glenn Royes	USGC
HMCM Eric Sine	JSOMTC
Mr. Richard Strayer	JSOMTC
CAPT Jeffery Timby	II MEF SG (FWD)

CoTCCC and Defense Health Board Staff

Ms. Christine Bader	DHB

Dr. Frank Butler	CoTCCC
Ms. Christina Cain	DHB
Ms. Danielle Davis	CoTCCC
Dr. Stephen Giebner	CoTCCC
Ms. Olivera Jovanovic	DHB
Dr. Joanne McPherson	DHB

Guests

SFC Alex Alvarez	USASOC
CAPT Roland Arellano	USMC
CDR Timothy Bleu	NMPTE/BUMED
CDR Linda Beltra	BUMED
Mr. William Cauley	DAGEAA
CPT Christopher Cordova	USA
Mr. Brad Coughlin	2/10 SFG(A)
CDR Martha Cutshall	HQMC
Mr. Joseph Dubose	Baltimore C-Stars
Dr. Andrew Dunn	SG, New Zealand Army
Maj Colleen Forestier	Canadian Forces
MSgt Bruce Graybilly	NCOIC CSTARS
Dr. Thomas Gross	FBI
COL Andy Jose	UK Liaison Officer - OTSG
Mr. Kevin Joyner	MARCORSYSCOM
SFC Kenneth Hale	82nd TSMTC NCOIC
CDR John Hariadi	USCG Personnel Command
MSG Richard Hines	USASFC
LtCol Douglas Hodge	DMMPO
Maj Sean Kennaway	SO2 Health Ops, Australia
SFC David Lowe	USASOC
Mr. Mark Lueder	PHTLS
Dr. Perry Malcom	DDR+E, OSD
LCDR Anne McKeague	NAMRU-SA
Mr. Donald Merrill	CPDM
Mr. John Miles	FMTB East
Mr. Jeffery Mott	CPDM
CAPT Tammy Nathan	NMPTE/BUMED
Mr. John Parson	SOCOM
COL Andre Pennardt	USASOC
Dr. Peter Pons	PHTLS
HM2 Raymond	HQMC
Maj Keyan Riley	HQ AFSOC/SGO
CAPT Scott Rineer	MARCENT
Major Brandi Ritter	DMMPO
Mr. Rory Saliger	82nd Airborne Div
Dr. Richard Schwartz	MCG

SGT Nicholas Thompson	82nd TSMTC
COL Laura Torres-Reyes	DMMPO
Mr. Rory Travis	Med Ops/10 SFG (A)
MSG Oscar Ware	USASOC SEMA
Mr. Gary Zigler	TCMC

Tuesday 03 August
CoTCCC Public Session

Administrative Remarks **Dr. Frank Butler**

Dr. Butler called the meeting to order and asked that CoTCCC members and guests introduce themselves. He reviewed the agenda for the meeting and asked that individuals in the audience reveal any financial interests in the agenda items to be discussed. There were no financial interests disclosed.

Dr. Jim Kirkpatrick introduced medical representatives from ABCA (Australia, Britain, Canada, America and New Zealand) military services who are holding their meeting in Denver concurrently.

The next CoTCCC meeting is planned for November 16th and 17th at the Chateau Bourbon in New Orleans, LA. The next DHB Core Board meeting will be at West Point on August 18th and 19th.

2010 TCCC Award **Dr. Frank Butler**

The 2010 TCCC Award was presented to MSG Harold Montgomery of the 75th Ranger Regiment in recognition of his numerous contributions to TCCC and his long history of leadership in military prehospital medicine. MSG Montgomery is the Senior Medic For the Regiment. He has served the Rangers for 19 of his 23 years in the Army and has deployed to combat 10 times, once for Operation Desert Storm, once for Operation Uphold Democracy, 4 for Operation Enduring Freedom, and 4 for Operation Iraqi Freedom. MSG Montgomery has been a member of the Committee on Tactical Combat Casualty Care since 2006. He is also on the subcommittees for membership and bylaws, hemostatics, and new technology.

Far- Forward Use of Fresh Whole Blood **CPT Chris Cordova**

CPT Cordova presented a casualty scenario from OEF. Seventy soldiers in two observation posts in the Kamdesh District of Afghanistan were attacked by approximately 350 hostiles. Medical support included one Physician Assistant (PA), and three medics. The operating plan for casualty response included air evac to the nearest Field Surgical Team. A total of 43 U.S. and Afghani

casualties were treated that day. Sixteen were evacuated, and eight were fatalities.

CPT Cordova reviewed the treatment of a casualty that received fresh whole blood (FWB) in the field. This casualty had sustained an open fracture of his left distal tibia and fibula as well as multiple shrapnel and gunshot wounds (GSWs) to his proximal left thigh, pelvis, left lower abdominal quadrant, and right arm. Helicopter CASEVAC was delayed for nine hours (requested at 1200, arrived at 2100) because of the threat of hostile fire to the aircraft. After initial care per the TCCC guidelines, including resuscitation for hemorrhagic shock with Hextend, the casualty was transfused with 5 units of FWB. The buddy donors were matched to the casualty's ABO blood type by medical history and dog tags. The transfusion set had been left in the Aid Station by the post's previous occupants. After each unit transfused, the casualty's clinical status improved. The casualty was still alive when eventually evacuated by helicopter, but later died during surgery. CPT Cordova had never before managed a blood product transfusion in any setting, yet he was able to keep a severely wounded casualty alive for over five hours by transfusing FWB from donors in the field during combat.

CPT Cordova's comments, observations and lessons learned included:

1) Medic training and rehearsals proved vital for successful casualty care in battle;

2) Routine fielding of blood transfusion kits and training for buddy transfusions should be considered; and

3) Data on field transfusions should be collected to monitor the frequency of this procedure and the casualty outcomes.

TCCC Update **Dr. Frank Butler**

The revised TCCC curriculum that incorporates the recently approved changes on management of burns in TCCC has now been posted on both the Military Health System and the Prehospital Trauma Life Support (PHTLS) websites.

In May 2010, the Center for Army Lessons Learned published a TCCC Handbook that incorporates the TCCC Guidelines into an Army publication that can be used to train and educate Army medics and other combatants.

COL George Costanzo, the new Director of the Joint Theater Trauma System (JTTS), briefed the Core Board of the Defense Health Board on 14 July on the structure, accomplishments, and proposed way ahead for the JTTS. The JTTS is currently funded entirely through Overseas Contingency Operations (OCO) supplemental funds. LTG Eric Schoomaker, the Army Surgeon General, has signed a decision brief recommending that the JTTS become a permanent organization. The JTTS would remain at the U.S. Army Institute of Surgical Research, with funding through the Army POM process and the Army serving as Executive Agent. The Core Board is currently considering their input to Health Affairs on this proposed course of action.

The CoTCCC maintains a Journal Watch to ensure that current publications relating to TCCC are reviewed. Recent publications of interest include:

1) *Grape, et al: Formulations of Fentanyl for the Management of Pain (Drugs, 2010).* Comments on this review article included:

- A number of references were cited that report that the oral transmucosal modality of fentanyl (OTFC) was successful in safely and effectively managing various types of pain.
- The article goes on to say that OTFC is contraindicated in opioid-naïve patients, including those with acute or postoperative pain, but there was no evidence cited to support this statement.
- Multiple published reports have indicated that OTFC is well-suited for battlefield analgesia.
- An ongoing Army process improvement effort has documented over 200 battlefield uses of OTFC with no episodes of serious side effects when used at the recommended dosage.
- No published case series of adverse events from OTFC use in otherwise healthy, military-age trauma patients have been identified to date.

A focused review of the literature on this topic is ongoing. The CoTCCC is working with the FDA to obtain and review adverse event reports related to the use of OTFC.

2) *CRASH-2 Collaborators: Effect of Tranexamic Acid on Death, Vascular Occlusive Events, and Blood Transfusions in Trauma Patients with Significant Hemorrhage (Lancet Online article 2010)*. This study is a very large (over 20,000 subjects) prospective, randomized, controlled, multi-center trial which found that tranexamic acid (TXA) significantly reduced all causes mortality from 16.0% to 14.5% and significantly reduced death from bleeding from 5.7% to 4.9%.

Comments on the Tranexamic Acid paper included:

<u>USAISR Information Paper:</u>

- TXA blocks plasmin activation and clot lysis.
- The loading dose is 1 gram over 10 minutes IV.
- TXA is FDA-approved for dental procedures in hemophiliacs.
- TXA has been noted to increase cerebral ischemia in subarachnoid hemorrhage.
- This is a randomized, double-blinded, placebo-controlled trial – the highest level of clinical evidence.
- There was no subgroup analysis for patients requiring massive transfusion or those with TBI.
- The cost is $80 for the 2-dose regimen used in CRASH 2.
- TXA has been used for the past year by UK forces in Afghanistan.
- TXA might have saved 23 of 1500 preventable deaths in OIF/OEF based on the numbers in the CRASH-2 study.

Dr. John Holcomb comments:
In a drug that was supposed to decrease bleeding:

- 50% of the patients did not get any RBCs.
- The rate of transfusion was the same between groups = 6 units.
- Only 48% had any surgery.
- The difference in mortality due to bleeding was 0.8%.
- Hours 1-3 after injury is where all the benefit was.
- How do you determine if there was a significant type 1 error?

Dr. Bryan Cotton comments:

- It would be interesting to study this drug in patients who actually had "traumatic hemorrhage."
- Not surprised to see that such a drug would not have any effect on the number of units transfused in such a general population.
- Sub-group analysis on patients arriving in shock?
- This is a trauma paper without any mention of ISS, base deficit, and lactate.
- MOST IMPORTANTLY: we're talking about a 0.8% absolute reduction in "death due to bleeding"
- This translates into a "number needed to treat" of 132.

Additional comments:

- TXA was administered 2.8-2.9 hours after injury.
- Patients who were "at risk" of hemorrhage were included in the study.
- 68% of patients had a systolic blood pressure > 90 mmHg.
- There has been no protocol developed for how TXA would be used in theater hospitals or in the prehospital combat environment.
- At the JTTS Directors conference held on 23 July 10, there was no decision made to add TXA to theater formulary.

A number of process improvement issues involving prehospital care noted on recent Joint Theater Trauma System weekly teleconferences were also presented and discussed.

Combat Medic Presentation **SFC Alex Alvarez**

In this operation from OEF, a night assault was conducted against a Taliban compound. After an offset helicopter insertion followed by a two-hour patrol, mission personnel arrived at the compound and secured the location. The compound was later attacked at daybreak by a large enemy force moving in from several sides.

SFC Alvarez treated a casualty who had sustained a gunshot wound (GSW) to the abdomen that entered in the left lower quadrant and exited in the right upper quadrant. The ongoing firefight delayed CASEVAC for 2.5 hours and the casualty had to be sustained in the field. A Halo dressing was applied to the wound. The casualty was given 5mg of recombinant factor VIIa intravenously for

his presumed non-compressible intra-abdominal hemorrhage. This was the first documented administration of rVIIa by a medic in the field. The casualty's pain was treated with oral transmucosal fentanyl citrate (OTFC), which was not effective, possibly because of his very dry mouth. The casualty was in extreme pain and was becoming agitated as a result of the pain. He was then treated with 7.5 mg of morphine IV and Versed. Hypothermia prevention was accomplished and 1 gm of Invanz was given.

The casualty was then moved to the casualty collection point, which took about 5 minutes, after which the Halo dressing was removed, a ChitoGauze was used to control external bleeding, and the Halo dressing was replaced. He was given another 7.5 mg of morphine IV with unsatisfactory results. The casualty was then treated with 20 mg of IV ketamine with prompt relief of pain. The ketamine succeeded where OTFC and repeated doses of IV morphine had failed. The casualty was also treated for nausea with Zofran. While waiting for evacuation, he went into shock (lost his radial pulse) and was given 500cc of Hextend. The casualty was found at surgery to have both liver and bowel injuries. He survived after a long and complicated recovery. There were no thromboembolic complications.

SFC Alvarez provided the following observations, comments and lessons learned:

1) Rapid evacuation of combat casualties is not always possible. Medics will continue to care for severely wounded casualties in austere locations in situations where evacuation is delayed. They should be trained and equipped with multiple agents for the management of non-compressible hemorrhage. In SFC Alvarez's opinion, the battlefield use of rVIIa saved this casualty's life.

2) Medics should carry more rVIIa to provide for multiple casualties and multiple doses during delayed or prolonged evacuation.

3) Ketamine worked better than narcotics in this casualty and is less likely to cause hypotension. This agent should be used early when it is indicated.

4) Abdominal wounds are hard to pack with HemCon. A gauze-type agent or a hemostatic agent that could be injected into the abdomen would be helpful.

5) The Halo chest seal would have worked better if it had been larger.

Evaluation of Combat Gauze vs ChitoGauze **Dr. Richard Schwartz**

These two hemostatic agents were compared in a study funded by HemCon, the manufacturer of ChitoGauze. Combat Gauze works as a pro-coagulant; ChitoGauze acts as a tissue adherent. In this bleeding model, a 6mm arteriotomy was created in the right femoral artery in a porcine bleeding model. A total of 14 animals were studied – seven in the ChitoGauze group and seven in the Combat Gauze group. All of the animals survived. Note that the higher survival rate seen in this study as compared to other studies that used a 6-mm femoral arteriotomy may be explained by the fact that the animals in this study were not splenectomized, allowing the potential for autotransfusion. Blood loss after application of the hemostatic agent was found to be 796cc for Combat

Gauze animals and 304cc for ChitoGauze animals. Less volume was needed for resuscitation in the ChitoGauze group.

This study had a relatively small number of animals and differences between groups were not statistically significant, though trends favored ChitoGauze. Clinically, both products have been observed to work well. In Dr. Schwartz's Emergency Department at the Medical College of Georgia, ChitoGauze is the first choice for a hemostatic agent, with Combat Gauze used as the back-up.

Preferred Features for Intraosseous Devices **Ms. Jan Skadberg, RN**

The Defense Medical Material Program Office (DMMPO) and the CoTCCC are working together to develop a list of preferred features for intraosseous infusion devices. Some points that have emerged from this effort include:

- The Infusion Nursing Society Guidelines now state: "Recently published ACLS guidelines direct IO medication administration as a preferred route over the endotracheal route (AHA, 2006a,b). The new guidelines also support IO as the preferential placement versus that of a central VAD during CPR if peripheral access is unobtainable."

- Multiple IO devices are fielded by the services. Are the services able to maintain proficiency in all these devices?

- Although no specific IO device has been identified in the TCCC Guidelines, the upcoming Tactical Field Care chapter in the Seventh Edition of the PHTLS Manual notes that the Pyng F.A.S.T. 1 has been widely used with good success on the battlefield.

- DMMPO research has found that the Pyng F.A.S.T. 1 posted $4.9 million in military sales in the past 12 months (33,000 units). Other IO devices have sold far less.

Ms. Skadberg presented the working draft for the preferred features for IO devices. The group discussed revisions to the list and the CoTCCC will return to it tomorrow to finalize.

Surgical Airways – A Case Series **MAJ Bob Mabry**

MAJ Mabry presented his unpublished data on 72 cricothyroidotomies (crics) in casualties from OEF & OIF (U.S., host nation military, police, and allied forces). The wounds sustained were mostly explosion injuries and GSWs. Of the crics attempted, 26% were unsuccessful. Sixty-two per cent of the crics were performed in the field, 38% in Aid Stations. There were 40 total complications in the data set, with some casualties having more than one. Ten of the crics followed failed Rapid Sequence Intubations (RSI). Data on the total number of RSIs attempted were not available. A thorough analysis of the data will be published in a series of planned journal articles.

MAJ Mabry also presented preliminary data on trauma outcomes when flight paramedics are present on the evacuation aircraft as compared to flights

with non-paramedic flight medics. This observational data came from a comparison of two units operating out of Baghram. Both units were operating in the same area and transporting similar types of casualties in the same time period; one unit had paramedics, the other did not. In the data, outcomes at 48 hours were recorded because Afghani casualties could not be tracked further out. Approximately 600 casualties were included in the study. Initial analysis shows mortality was reduced by half in the group attended by flight paramedics. The data has not yet been analyzed for severity of injury and other descriptive data. MAJ Mabry will present this information again when analysis is complete.

DMMPO-AFME Feedback to the Field **COL(sel) Douglas Hodge**

Col (select) Hodge presented a case from the ongoing DMMPO-AFME process improvement review of fatalities examined at autopsy. This case involved a perforation of the sternum by an IO infusion device. This individual had polytrauma and was noted to have multiple IO devices present at autopsy. The IO device in his sternum was located on the right side of the sternal body, and penetrated completely through the sternum into the mediastinum. The IO was a device intended for use at large bone insertion sites and was marked as such. It had a blue hub and a 25 mm needle. The clinical circumstances and specific details surrounding the delivery of emergency treatment in this case are not known, but this occurrence does raise questions regarding packaging, labeling, and user training in the use of IO devices.

DMMPO recommends that the services review training programs for IO devices to ensure that medics have mastered the skills required to insert them correctly and know which sites are specified for each device. DMMPO's Joint Medical Testing and Evaluation Department is working with the FDA and manufacturers to improve labeling, package insert warnings, and contraindication statements for medical devices.

PHTLS TCCC Training Program **Mr. Mark Lueder**

The Prehospital Trauma Life Support (PHTLS) office of the National Association of Emergency Medical Technicians (NAEMT) now offers TCCC courses in the U.S. and in other countries. These courses are available to medical, law enforcement, and military personnel. The PHTLS-sponsored TCCC courses feature certification and registration for providers, instructors, and courses. They also use the standard TCCC curriculum as posted on the PHTLS and Military Health System websites. Mr. Lueder reviewed the history of the program, starting with the PHTLS National Faculty TCCC training course in San Antonio in December 2009 at the Army Department of Combat Medic Training. He also presented the schedule of recently completed and currently planned training courses, both in the U.S. and in allied countries.

Proposed Change - Hypothermia Prevention **Mr. Don Parsons**

Mr. Parsons presented his position paper on changing the TCCC guidelines that deal with hypothermia prevention. The primary problems noted with the current recommendations are: 1) the Hypothermia Prevention Cap in the current Hypothermia Prevention and Management Kit (HPMK) tends to be blown off when casualties are being loaded into helicopters; 2) the Blizzard Rescue Blanket provides no easy access to the casualty to perform medical interventions or to check the status of IV sites and tourniquets; and 3) a new passive warming device called the Heat Reflective Shell (HRS) has been developed to overcome the problems with the Blizzard Blanket. The HRS is now included in the HPMK.

With regard to prevention of hypothermia in casualties, the TCCC guidelines currently state:

Tactical Field Care:
7. Prevention of Hypothermia
   a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.
   b. Replace wet clothing with dry if possible.
   c. Apply Ready-Heat Blanket to torso.
   d. Wrap in Blizzard Survival Blanket.
   e. Put Thermo-Lite Hypothermia Prevention System Cap on the casualty's head, under the helmet.
   f. Apply additional interventions as needed and available.
   g. If mentioned gear is not available, use dry blankets, poncho liners, sleeping bags, body bags, or anything that will retain heat and keep the casualty dry.

Tactical Evacuation Care:
6. Prevention of Hypothermia
   a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.
   b. Continue Ready-Heat Blanket, Blizzard Survival Blanket, and Thermo - Lite Cap.
   c. Apply additional interventions as needed.
   d. Use the Thermal Angel or other portable fluid warmer on all IV sites, if possible.
   e. Protect the casualty from wind if doors must be kept open.

Mr. Parsons moved to make these changes: (Proposed changes in **red text**.)

Tactical Field Care:
7. Prevention of Hypothermia
   a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.

b. Replace wet clothing with dry if possible.
c. Apply the Ready-Heat Blanket from the Hypothermia Prevention and Management Kit (HPMK) to the casualty's torso (not directly on the skin) and cover the casualty with the Heat Reflective Shell (HRS).
d. If an HRS is not available, the previously recommended combination of the Blizzard Survival Blanket and the Ready Heat blanket may also be used.
e. If neither of the above two options are available, heat loss may be prevented by wrapping the casualty with wool blankets, covering the wool blankets with a space blanket and then placing the casualty with blankets in a Human Remains Pouch (Body Bag).
f. Field expedient warming of IV fluids can be accomplished by using two Meals Ready to Eat (MRE) heaters for a 500 mL bag of IV Hextend.
g. If the items mentioned above are not available, use dry blankets, poncho liners, sleeping bags, or anything that will retain heat and keep the casualty dry.

Tactical Evacuation Care:
6. Prevention of hypothermia
a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.
b. Replace wet clothing with dry if possible if not previously done.
c. Apply the Ready-Heat Blanket from the Hypothermia Prevention and Management Kit (HPMK) to the casualty's torso (not directly on the skin) and cover the casualty with the Heat Reflective Shell (HRS).
d. If an HRS is not available, the previously recommended combination of the Blizzard Survival Blanket and the Ready Heat blanket may also be used.
e. If neither of the above two options are available, heat loss may be prevented by wrapping the casualty with wool blankets, covering the wool blankets with a space blanket and then placing the casualty with blankets in a Human Remains Pouch (Body Bag).
f. If the items mentioned above are not available, use poncho liners, sleeping bags, or anything that will retain heat and keep the casualty dry.
g. Use the Thermal Angel, the Enflow, or other portable fluid warmer on all IV sites, if possible.
h. Protect the casualty from wind if doors must be kept open.

The recommended changes replace the Blizzard Survival Blanket™ with the Heat Reflective Shell™ which has a Velcro® opening down each side to allow for exposure of IVs and tourniquets. It also has a built-in hood to replace the separate cap. Heating a 500cc bag of Hextend™ with 2 MRE heaters as a field expedient measure was also proposed for Tactical Field Care. Furthermore, there are now several small, light commercial IV fluid warmers that can readily be carried in vehicle kits and helicopters for use in TACEVAC care.

The Committee will consider this motion further in tomorrow's session.

Proposed Change – Fluid Resuscitation in TACEVAC **CAPT Jeff Timby**

CAPT Timby presented his position paper on changing the fluid resuscitation guidelines in Tactical Evacuation Care. He pointed out that the current recommendations: 1) do not call for use of blood pressure measurements where these may be available during TACEVAC; 2) could be interpreted to call for use of more than 1000 mL of Hextend when this has not been recommended; 3) do not reflect the current theater practice of giving PRBCs and thawed plasma in a 1:1 ratio; 4) call for Hextend to be used initially instead of plasma and PRBCs if both are available; and 5) should be modified to base decisions on fluid resuscitation in casualties with TBI on pulse character or measured blood pressure, not mental status.

The current guidance for fluid resuscitation in TACEVAC found in the TCCC Guidelines is:

Tactical Evacuation Care

5. Fluid resuscitation
   Reassess for hemorrhagic shock (altered mental status in the absence of brain injury and/or change in pulse character).
   a. If not in shock:
      - No IV fluids necessary.
      - PO fluids permissible if conscious and can swallow.
   b. If in shock:
      - Hextend 500-mL IV bolus.
      - Repeat once after 30 minutes if still in shock.
      - No more than 1000 mL of Hextend.
   c. Continue resuscitation with packed red blood cells (PRBCs), Hextend, or Lactated Ringer's solution (LR) as indicated.
   d. If a casualty with TBI is unconscious and has a weak or absent peripheral pulse, resuscitate as necessary to maintain a systolic blood pressure of at least 90 mmHg.

CAPT Timby moved to make the following changes: (Proposed changes in red text.)

Tactical Evacuation Care

5. Fluid resuscitation

Reassess for hemorrhagic shock (altered mental status in the absence of brain injury and/or change in pulse character). If BP monitoring is available, maintain systolic BP 70-90 mmHg.

a. If not in shock:
   - No IV fluids necessary.
   - PO fluids permissible if conscious and can swallow.

b. If in shock and blood products are available:
   - Resuscitate with freshly thawed plasma followed by packed red blood cells (PRBCs) in a 1:1 ratio, giving 2 units of plasma initially. Continue resuscitation as needed to maintain target BP or clinical improvement.

c. If in shock and blood products are not available:
   - Hextend 500-mL IV bolus if not previously done in Tactical Field Care
   - Repeat once after 30 minutes if still in shock.
   - No more than 1000 mL of Hextend.
   - Continue resuscitation with Lactated Ringer's solution (LR) as needed to maintain target BP or clinical improvement.

d. If a casualty with TBI has a weak or absent peripheral pulse, resuscitate as necessary to maintain a palpable radial pulse or a systolic BP of at least 90 mmHg.

The Committee will consider this motion further in tomorrow's session.

Wednesday 4 August
CoTCCC Internal Administrative Session

Administrative Remarks **Dr. Frank Butler**

The Membership and Bylaws Subcommittee voted to recommend SFC David Lowe to replace SFC Miguel Davila as a voting member of the CoTCCC. SFC Lowe is relieving SFC Davila as the training NCO at the U.S. Army Special Operations Command. The Chairman will issue an invitation to him to join the Committee pending successful completion of the DHB appointment process.

An electronic library of medical articles pertaining to TCCC is now maintained by the DHB staff in an online e-vault. Access is limited to Defense Health Board members and staff.

Danielle Davis offered administrative guidance to the membership on current travel issues such as travel claims, preferred procedures for expedited payment of travel claims, and airport shuttles available today after the meeting.

The next meeting after the November 16-17 CoTCCC meeting in New Orleans will be held on the 8th and 9th of February, 2011. Ms. Davis will investigate possible sites in Tampa, DC, Atlanta, Savannah, and Houston.

The Chairman discussed CoTCCC logo issues. Dr. Butler has contacted Ms. Laurie Rafferty in the Health Affairs legal office to initiate the process of transferring ownership of the TCCC logo copyright to the CoTCCC. Cease and desist letters will be sent to commercial entities using the logo without authorization.

MSG Montgomery announced the availability of the new and improved CoTCCC challenge coin and other logo items.

The Committee revisited the preferred features for cricothyroidotomy sets, and approved the following clarifications to the list:

- The set or its individual components must be FDA-approved
- Scalpel: #10 blade
- Should include a trach hook or other instrument to help define and expose the opening
- Tube features:
  - 6-7 mm internal diameter
  - Balloon cuff
  - Flanged
  - 5-8 cm intratracheal length
- 5 cc syringe to inflate cuff
- Ruggedized IAW Mil Std 8.10G

The Committee also revisited the preferred features for chest seals and approved the following clarifications to the list:

- FDA-approved
- Ruggedized IAW Mil Std 8.10G
- Non-valved
- Packaged two per package

The updated list of preferred features for cric sets and chest seals will be included in the final minutes from the April CoTCCC meeting.

Review of Presentations from 3 August **Group**

Discussion returned to points of interest from yesterday's clinical presentations, including the use by medics of rVIIa and TXA as well as FWB field transfusions. The Committee noted the need to review the clinical data from the British experience with TXA use at their hospital in Bastion. No decision was made regarding its use in TCCC at this time.

Dr. Jenkins noted that other hemostatic agents such as Bebulin and Feiba that are less expensive than rVIIa and that do not require refrigeration may be better suited for use on the battlefield than rVIIa.

With regard to buddy transfusions in the field, members noted that more work is needed to address the issues of HIV, hepatitis, ABO compatibility, and fielding transfusion kits.

Potential Changes to the TCCC Guidelines **Dr. Frank Butler**

The following potential changes to the CoTCCC Guidelines were discussed:

1) Maximum amount of Hextend to be used:

Several committee members noted that the evidence that 1000 mL is the maximum volume of Hextend that can be used without risking a Hextend-related coagulopathy is limited – the paper by Gan et al suggests that larger volumes might be safe. Dr. Butler noted that the patients in the Gan paper may have received blood component therapy in addition to the reported volumes of Hextend.

2) Fluid resuscitation in controlled vs uncontrolled hemorrhage:

Drs. Otten and Gandy noted that a specific goal for fluid resuscitation in controlled hemorrhage should be established. The best example of this type of hemorrhage on the battlefield is isolated extremity hemorrhage that has been effectively controlled with a tourniquet. Dr. Champion noted that shock may be considered to exist at a blood pressure lower than 105 systolic in trauma patients.

3) King LT Airways:

An e-mail was received from LTC Marty Schreiber, the Deployed Director of the Joint Theater Trauma System (JTTS) asking that the CoTCCC review the possible use of the King LT airway in light of the failed surgical airways that have been noted in the weekly JTTS Trauma Teleconferences. Surgical airways have emerged as the most technically challenging lifesaving intervention that medics and corpsmen (and other prehospital providers) are undertaking on the battlefield at present. Committee members noted that while the King LT has been found to be effective in cardiac arrest patients in the civilian sector, most airway deaths in combat casualties are related to maxillofacial and/or neck trauma and that the efficacy of the King LT in preventing deaths in these types of casualties has not been established. Casualties who are not unconscious from profound hypovolemic shock or severe head trauma do not tolerate King LTs well. MAJ Mabry also noted that there is a significant incidence of trismus in Traumatic Brain Injury (TBI) casualties that makes insertion of the King LT difficult. Proposed actions included: a) modifying the Lessons Learned presentation in the TCCC curriculum to emphasize that unconsciousness alone is not an indication for a surgical airway and that in casualties who have sustained maxillofacial trauma and are having trouble maintaining their airway, the first measure that should be used, if feasible, is the

sit-up and lean-forward airway position; b) CoTCCC tracking of surgical airways in the weekly Trauma teleconferences; and c) a research effort was proposed to evaluate various training methodologies for surgical airways with successfully accomplished cadaver procedures to be used as the definitive outcome measure.

4) Pyng FAST-X:

HMCM Sine noted that the Pyng FAST-X might be a preferred IO device once it is approved by the FDA.

Preferred Features – Intraosseous Devices **Group**

The Committee revisited the discussion on preferred features for intraosseous devices from yesterday and approved the following list:

- FDA approved
- Sternal insertion site as the primary (Clearly labeled for site of insertion and needle size)
- Big bone insertion site if desired as a backup (Clearly labeled for site of insertion and needle size)
- Easily inserted without the need for powered devices
- Supports infusion of all prehospital resuscitation fluids
- Latex-free
- Minimum flow rate of 125cc/min
- Self-retaining once inserted
- Able to be removed without the need for a removal tool
- Easily trained for battlefield or simulated battlefield environments
- Compatible with other systems via a standard luer-lock
- Able to be left in place for up to 24 hours
- Sterile, trauma-resistant packaging
- Meets MILSTAN 8.10G
- Shelf life: 3 years minimum; 5 years goal
- Used with high rate of success in battlefield reports when available
- Includes attachments and instructions to facilitate training
- High rate of user acceptance when data is available
- Device facilitates ease of use in low light environments
- Minimal chance for provider injury
- Minimal chance for retained parts of device after removal
- Unlikely to be traumatically displaced
- Bag friendly – minimal weight and cube - malleable
- Low rate of complications from battlefield use

Additional comments from the group on this topic:

- Mr. Don Parsons: It is more important that the device stay in than that it be easily removed;
- Dr. Mel Otten: Other sites besides the sternum should be included as options;

- Mr. Rick Strayer: The provider may be unsuccessful in his first attempt and should have an alternate site as a backup;
- Dr. John Gandy: The casualty's body armor must be removed in order to use a sternal IO insertion site;
- Mr. Don Parsons – quoting Dr. John Hagmann: Tibial IOs are very painful during fluid infusion;
- MAJ Bob Mabry: It is harder for medics to do tibial insertions than sternal insertions;
- Dr. Frank Butler: There have been multiple reports from AFME of tibial IO placements being done in the wrong location;
- Dr. Don Jenkins: Humeral IO devices are more likely to be traumatically displaced than sternal IOs;
- SFC Ricardo Flores-Artola: There will not be any power drills in my aid bag.

Proposed Change - Hypothermia Prevention **Group**

The Committee returned to its consideration of Mr. Parsons' proposed change. After additional discussion, the following changes to the TCCC Guidelines were approved by a unanimous vote: (changes in **red text**)

Tactical Field Care

7. Prevention of hypothermia
   a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.
   b. Replace wet clothing with dry if possible. **Get the casualty onto an insulated surface as soon as possible.**
   c. Apply the Ready-Heat Blanket from the Hypothermia Prevention and Management Kit (HPMK) to the casualty's torso (not directly on the skin) and cover the casualty with the Heat-Reflective Shell (HRS).
   d. If an HRS is not available, the previously recommended combination of the Blizzard Survival Blanket and the Ready Heat blanket may also be used.
   e. If the items mentioned above are not available, use dry blankets, poncho liners, sleeping bags, or anything that will retain heat and keep the casualty dry.
   f. Warm fluids are preferred if IV fluids are required.

TACEVAC Care

6. Prevention of hypothermia
   a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.
   b. Replace wet clothing with dry if possible. **Get the casualty onto an insulated surface as soon as possible.**

c. Apply the Ready-Heat Blanket from the Hypothermia Prevention and Management Kit (HPMK) to the casualty's torso (not directly on the skin) and cover the casualty with the Heat-Reflective Shell (HRS).

d. If an HRS is not available, the previously recommended combination of the Blizzard Survival Blanket and the Ready Heat blanket may also be used.

e. If the items mentioned above are not available, use poncho liners, sleeping bags, or anything that will retain heat and keep the casualty dry.

f. Use a portable fluid warmer capable of warming all IV fluids including blood products.

g. Protect the casualty from wind if doors must be kept open.

The updated position paper outlining this change is provided as Attachment (1).

Proposed Change – Fluid Resuscitation in TACEVAC **CAPT Jeff Timby**

CAPT Timby presented modifications to his proposed changes stemming from yesterday's discussion. After further consideration, the Committee unanimously approved the following changes to the TCCC Guidelines: (changes in **red text**)

Tactical Field Care:

6. Fluid resuscitation

Assess for hemorrhagic shock; altered mental status (in the absence of head injury) and weak or absent peripheral pulses are the best field indicators of shock.

a. If not in shock:
   - No IV fluids necessary
   - PO fluids permissible if conscious and can swallow

b. If in shock:
   - Hextend, 500-mL IV bolus
   - Repeat once after 30 minutes if still in shock.
   - No more than 1000 mL of Hextend

c. Continued efforts to resuscitate must be weighed against logistical and tactical considerations and the risk of incurring further casualties.

d. If a casualty with an altered mental status due to suspected TBI has a weak or absent peripheral pulse, resuscitate as necessary to maintain a palpable radial pulse.

TACEVAC Care

5. Fluid resuscitation

Reassess for hemorrhagic shock (altered mental status in the absence of brain injury and/or change in pulse character.) **If BP monitoring is available, maintain target systolic BP 80-90 mmHg.**

a. If not in shock:
- No IV fluids necessary.
- PO fluids permissible if conscious and can swallow.

b. If in shock and blood products are not available:
- Hextend 500-mL IV bolus
- Repeat after 30 minutes if still in shock.
- **Continue resuscitation with Hextend or crystalloid solution as needed to maintain target BP or clinical improvement.**

c. If in shock and blood products are available under an approved command or theater protocol:
- **Resuscitate with 2 units of plasma followed by packed red blood cells (PRBCs) in a 1:1 ratio. If blood component therapy is not available, transfuse fresh whole blood. Continue resuscitation as needed to maintain target BP or clinical improvement.**

d. If a casualty with an altered mental status due to suspected TBI has a weak or absent peripheral pulse, resuscitate as necessary to maintain a palpable radial pulse. If BP monitoring is available, maintain target systolic BP of at least 90 mmHg.

The updated position paper outlining this change is provided as Attachment (2).

Frank K. Butler, M.D.
CAPT, MC, USN (Ret)
Chairman

18 Oct 2010
Date

Attachments:
1) Position Paper for Hypothermia Prevention Change to the TCCC Guidelines
2) Position Paper for Fluid Resuscitation Change to the TCCC Guidelines

Attachment 1

Proposed Change – Hypothermia Prevention

4 August 2010

Mr. Don Parsons

Current Wording (TCCC Guidelines 091104)

Tactical Field Care

7. Prevention of hypothermia
    a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.
    b. Replace wet clothing with dry if possible.
    c. Apply Ready-Heat Blanket to torso.
    d. Wrap in Blizzard Survival Blanket.
    e. Put Thermo-Lite Hypothermia Prevention System Cap on the casualty's head, under the helmet.
    f. Apply additional interventions as needed and available.
    g. If mentioned gear is not available, use dry blankets, poncho liners, sleeping bags, body bags, or anything that will retain heat and keep the casualty dry.

Tactical Evacuation Care

6. Prevention of hypothermia
    a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.
    b. Continue Ready-Heat Blanket, Blizzard Survival Blanket, and Thermo-Lite Cap.
    c. Apply additional interventions as needed.
    d. Use the Thermal Angel or other portable fluid warmer on all IV sites, if possible.
    e. Protect the casualty from wind if doors must be kept open.

Proposed Change

Tactical Field Care

7. Prevention of hypothermia

a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.

b. Replace wet clothing with dry if possible. **Get the casualty onto an insulated surface as soon as possible.**
c. Apply the Ready-Heat Blanket from the Hypothermia Prevention and Management Kit (HPMK) to the casualty's torso (not directly on the skin) and cover the casualty with the Heat-Reflective Shell (HRS).
d. If an HRS is not available, the previously recommended combination of the Blizzard Survival Blanket and the Ready Heat blanket may also be used.
e. If the items mentioned above are not available, use dry blankets, poncho liners, sleeping bags, or anything that will retain heat and keep the casualty dry.
f. Warm fluids are preferred if IV fluids are required.

Tactical Evacuation Care
7. Prevention of hypothermia
a. Minimize casualty's exposure to the elements. Keep protective gear on or with the casualty if feasible.
b. Replace wet clothing with dry if possible. **Get the casualty onto an insulated surface as soon as possible.**
c. Apply the Ready-Heat Blanket from the Hypothermia Prevention and Management Kit (HPMK) to the casualty's torso (not directly on the skin) and cover the casualty with the Heat-Reflective Shell (HRS).
d. If an HRS is not available, the previously recommended combination of the Blizzard Survival Blanket and the Ready Heat blanket may also be used.
e. If the items mentioned above are not available, use poncho liners, sleeping bags, or anything that will retain heat and keep the casualty dry.
f. Use a portable fluid warmer capable of warming all IV fluids including blood products.
g. Protect the casualty from wind if doors must be kept open.

Discussion

Hypothermia in a trauma victim is a much more complicated threat than simple hypothermia in an otherwise healthy person. The primary concern in this setting is hemostasis, since coagulopathy may occur with even mild hypothermia. Hypothermia-induced coagulopathy is well-described, and results from decreases in platelet function, slowing of coagulation cascade enzyme activity, and alterations of the fibrinolytic system. Furthermore, hypothermia is not limited to cold environments – it can occur in warm ambient temperatures. Hypovolemic shock results in a decreased ability to produce heat and to maintain normal body temperature. This predisposes shock victims to hypothermia, and can contribute to worsening of the hypovolemic state as a result of ensuing coagulopathy. (Butler, in press)

The importance of instituting aggressive steps to prevent hypothermia in the field has been emphasized in both an ASDHA Policy Memo and a Joint Theater Trauma System Clinical Practice Guideline (CPG). Simple interventions may be effective in decreasing the incidence of hypothermia during prolonged

evacuations. Because of the physics of heat transfer, it is much easier to *prevent* hypothermia than to *correct* it. Therefore, prevention of heat loss should start *as soon after wounding as the tactical situation permits.*

Current TCCC Guidelines call for the use of the Ready-Heat Blanket, the Blizzard Survival Blanket, and the Thermo-Lite Hypothermia Prevention Cap. This combination of hypothermia prevention measures is also outlined in the current (November 2008) JTTS CPG. Both of these items were found in the Hypothermia Prevention and Management Kit (HPMK).

The most important element of this proposed change is to designate the Heat-Reflective Shell (which is now a component of the HPMK) as the preferred alternative over the previous combination of the Blizzard Survival Blanket and the Thermo-Lite Hypothermia Prevention Cap. The two main advantages of the Heat-Resistant Shell (HRS) over the Blizzard Blanket and the Thermo-Lite cap are that: 1) it allows easy access to the casualty for reassessment and possible interventions by means of the Velcro strips down each side, where the Blizzard Survival Blanket had no openings to expose an IV or tourniquet; and 2) its mummy-type sleeping bag design covers the head and reduces heat loss from this area. Use of the HRS makes using the Thermo-Lite Cap unnecessary, thereby preventing the need to carry the cap as a separate item and eliminating the possibility of the cap being blown off the head by rotor wash, which has been a problem in the past. Both the Ready-Heat Blanket and the HRS are found in the current version of the Hypothermia Prevention and Management Kit, which is a commercially available item. This protective ensemble was shown in ISR studies to very effectively prevent heat loss. (Allen 2010)

If these two devices are not available, alternatives include the previously recommended combination of the Blizzard Rescue Blanket and the Ready Heat Blanket. If this option is not available, then blankets, ponchos, sleeping bags or other expedient items that will help keep the casualty warm and dry should be used. Warming of IV fluids may also be of benefit.

References

Allen PB, Salyer SW, Dubick MA, Holcomb JB, Blackbourne LH: Preventing Hypothermia: Comparison of Current Devices Used by the U.S. Army with an In Viro Warmed Fluid Model. USAISR Institutional Report March 2010.

Butler FK, Giebner S, McSwain N, Pons P, eds: Prehospital Trauma Life Support Manual Seventh Edition (Military); Tactical Field Care; In press.

Joint Theater Trauma System Clinical Practice Guideline 12 Nov 2008 "Hypothermia Prevention, Monitoring, and Management"

Winkenwerder W: Assistant Secretary of Defense Policy Memo on Hypothermia Prevention and Management dated 16 Feb 2006

Attachment 2

Fluid Resuscitation in Tactical Evacuation Care Guideline Revision Recommendation Committee on Tactical Combat Casualty Care

CAPT Jeff Timby
4 August 2010

Purpose: To provide a comprehensive review of the fluid resuscitation guidelines, examine specified and implied actions, apply classification of recommendations and level of supporting evidence, and submit a recommendation for the revision of the guideline for fluid resuscitation in Tactical Evacuation Care.

Background/Discussion:

Medicine is a science of uncertainty and an art of probability. Sir William Osler

The guidelines for Tactical Combat Casualty Care (TCCC), first characterized for special operations forces by Butler in 1996, identifies three stages of care: (1) care under fire; (2) tactical field care; and (3) tactical evacuation care. The guidelines have been revised through a series of regularly scheduled meetings of the Committee on Tactical Combat Casualty Care (CoTCCC), a panel comprised of civilian and military medical personnel with experience in trauma and combat operations. A 2/3 majority vote of full membership of the COTCCC is required to approve a change to the TCCC guidelines. Although the guideline revision process is a rigorous academic endeavor, systematic classification of recommendations and level of supporting evidence has never been performed.The current wording in the TACEVAC section on fluid resuscitation has several perceived deficiencies: 1) it does not call for use of blood pressure measurements where these may be available during TACEVAC; 2) the wording calls for use of only 1000 mL of Hextend when this is not supported in the literature; 3) although it mentions the use of PRBCs where logistically feasible, it does not reflect current theater trauma practice of giving PRBCs and thawed plasma in a 1:1 ratio or, when component therapy is not available, giving fresh whole blood; and 4) the discriminating factor that warrants fluid resuscitation in casualties with TBI is pulse character or hypotension. The changes approved by the Committee below address these deficiencies.

Additionally, for more than 20 years, the American College of Cardiology (ACC) and the American Heart Association (AHA) have released clinical practice guidelines to provide recommendations on care of patients with cardiovascular disease. The ACC/AHA guidelines currently use a grading schema based on level of evidence and class of recommendation. The levels of evidence include:

- Level of evidence A: recommendation based on evidence from multiple randomized trials or meta-analyses;

- Level of evidence B: recommendation based on evidence from a single randomized trial or nonrandomized studies;
- Level of evidence C: recommendation based on expert opinion, case studies, or standards of care.

The classes of recommendation include:

- Class I: conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective;
- Class II: conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment;
- Class IIa: weight of evidence/opinion is in favor of usefulness/efficacy;
- Class IIb: usefulness/efficacy is less well established by evidence/opinion;
- Class III: conditions for which there is evidence and/or general agreement that the procedure/treatment is not useful/effective and in some cases may be harmful.

Of 2711 specific recommendations, only 11% of recommendations are supported by level of evidence A, whereas 48% are level of evidence C. Only 19% of class I recommendations have level of evidence A (Tricoci, JAMA 2009).

There is an absence of level A literature supporting guidelines for fluid resuscitation in combat casualties. The fluid resuscitation literature in trauma patients, primarily level B or C studies, reflects treatment of civilians within large metropolitan areas where medical resources, injuries incurred and transport time to a trauma center do not correlate to those experienced in combat environments. With these limitations in supporting evidence, the TCCC guidelines are dependent on the preponderance of evidence from animal studies, civilian trauma experience and expert opinion from military medical personnel ranging from trauma and orthopedic surgeons, emergency and critical care physicians, as well as corpsmen and medics with experience in managing combat casualties.

This paper utilizes the ACC/AHA grading schema for level of evidence and class of recommendation to support the guideline revision recommendation for fluid resuscitation in Tactical Evacuation Care incorporating recent literature and expert opinion.

Current Recommendations for Fluid Resuscitation in TCCC: The current guidelines for fluid resuscitation during the three phases of care include:

Care under fire: No fluid resuscitation recommended during this phase of care.

Tactical Field Care: Assess for hemorrhagic shock; altered mental status (in the absence of head injury) and weak or absent peripheral pulses are the best field indicators of shock.

a. If not in shock:
   - No IV fluids necessary
   - PO fluids permissible if casualty is conscious and can swallow

b. If in shock:
   - Hextend, 500-mL IV bolus

- Repeat once after 30 minutes if still in shock.
- No more than 1000 mL of Hextend

c. Continued efforts to resuscitate must be weighed against logistical and tactical considerations and the risk of incurring further casualties.

d. If a casualty with TBI is unconscious and has no peripheral pulse, resuscitate to restore the radial pulse.

Tactical Evacuation Care: Reassess for hemorrhagic shock (altered mental status in the absence of brain injury and/or change in pulse character).

a. If not in shock:
- No IV fluids necessary.
- PO fluids permissible if conscious and can swallow.

b. If in shock:
- Hextend 500-mL IV bolus.
- Repeat once after 30 minutes if still in shock.
- No more than 1000 mL of Hextend.

c. Continue resuscitation with packed red blood cells (PRBCs), Hextend, or Lactated Ringer's solution (LR) as indicated.

d. If a casualty with TBI is unconscious and has a weak or absent peripheral pulse, resuscitate as necessary to maintain a systolic blood pressure of at least 90 mmHg.

Approved Revisions:

The committee reviewed the current guidelines for fluid resuscitation during the three phases of care, discussed the supporting literature and revised the guidelines for Tactical Field Care and Tactical Evacuation Care. The approved revisions to the guidelines are in **red text** below:

Tactical Field Care: Assess for hemorrhagic shock; altered mental status (in the absence of head injury) and weak or absent peripheral pulses are the best field indicators of shock.

a. If not in shock:
- No IV fluids necessary
- PO fluids permissible if casualty is conscious and can swallow

b. If in shock:
- Hextend, 500-mL IV bolus
- Repeat once after 30 minutes if still in shock.
- No more than 1000 mL of Hextend

c. Continued efforts to resuscitate must be weighed against logistical and tactical considerations and the risk of incurring further casualties.

d. **If a casualty with an altered mental status due to suspected TBI has a weak or absent peripheral pulse, resuscitate as necessary to maintain a palpable radial pulse.**

Tactical Evacuation Care: Reassess for hemorrhagic shock (altered mental status in the absence of brain injury and/or change in pulse character). **If BP monitoring is available, maintain target systolic BP 80-90 mmHg.**

a. If not in shock:
   - No IV fluids necessary.
   - PO fluids permissible if conscious and can swallow.

b. **If in shock and blood products <u>are not</u> available:**
   - Hextend 500-mL IV bolus
   - Repeat after 30 minutes if still in shock.
   - **Continue resuscitation with Hextend or crystalloid solution as needed to maintain target BP or clinical improvement.**

c. If in shock and blood products <u>are</u> available under an approved command or theater protocol:
   - **Resuscitate with 2 units of plasma followed by packed red blood cells (PRBCs) in a 1:1 ratio. If blood component therapy is not available, transfuse fresh whole blood. Continue resuscitation as needed to maintain target BP or clinical improvement.**

d. If a casualty with an altered mental status due to suspected TBI has a weak or absent peripheral pulse, resuscitate as necessary to maintain a palpable radial pulse. If BP monitoring is available, maintain target systolic BP of at least 90 mmHg.

Classes of Recommendation and Level of Evidence

I. Reassess for hemorrhagic shock (altered mental status in the absence of brain injury and/or change in pulse character). If BP monitoring is available, maintain target systolic BP 80-90 mmHg.

a. Recommendation: Class I

b. Specified/Implied Actions:
- Shock is a common cause of death in combat casualties
- Combat casualties in shock have worse outcomes than those without shock
- Shock onset may be delayed in a subset of combat casualties
- Initial interventions for shock may lose effect with time
- Persistent shock is due to uncontrolled hemorrhage
- Altered mental status in the absence of brain injury and/or change in pulse character is an accurate assessment of shock
- Hypotensive resuscitation improves outcomes
- Sphygmomanometry is available and an accurate end-point of resuscitation

c. Level of Evidence:

Shock is a common cause of death in combat casualties: Several studies have described the incidence of combat mortality from shock (Office of the Surgeon General, Department of the Army 1952; Bellamy, Mil Med1984) (C). The proportion of casualties killed in action has remained constant over many conflicts (Champion, J Trauma 2003; Bellamy, Textbook of Military Medicine 1995) (C). The data for combat casualties from recent conflicts in Mogadishu (Mabry; Holcomb) and Afghanistan (Holcomb, Ann Surg 2007) involving Special Operations Forces have been described (C).

Combat casualties in shock have worse outcomes than those without shock: Several studies have reviewed the outcome of trauma patients in civilian settings demonstrating a high proportion of fatalities from exsanguination and shock (Baker, Am J Surg 1980; Sauaia, J Trauma. 1995; Acosta, J Am Coll Surg 1998) (C). Hemorrhage-induced hypotension in trauma patients is predictive of high mortality and morbidity (Heckbert, J Trauma 1998; Shackford, Arch Surg 2003) (C). Hemorrhage contributes to death during the prehospital period in 33 to 56% of cases, and exsanguination is the most common cause of death among those found dead upon the arrival of emergency medical services (EMS) personnel. Hemorrhage accounts for the largest proportion of mortality occurring within the first hour of trauma center care, over 80% of operating room deaths after major trauma, and almost 50% of deaths in the first 24 hours of trauma care. (Kauvar, J Trauma 2006) (C). Recent studies have demonstrated increased mortality in combat casualties with shock or increased Injury Severity Score (Kragh, Ann Surg 2009; Ritenour, Ann Surg 2010) (C). Several reviews have implicated enhanced shock resuscitation as a critical area for ongoing research to improve the outcome of combat casualties (Butler, Mil Med 1996; Champion, J Trauma 2003; Holcomb, J Trauma 2003; Kauvar, J Trauma 2006) (C).

Shock onset may be delayed in a subset of combat casualties: Extensive hemodynamic and biochemical measurements were made in several hundred seriously wounded combat casualties in the last 6 months of World War II in Italy. Not surprisingly, casualties with the greatest blood loss were most likely to die, and a blood volume reduced to 50% of normal was likely to be fatal (Office of the Surgeon General, Department of the Army 1952) (C). The time interval between injury and casualty evacuation to definitive surgical control of hemorrhage is significantly delayed in combat operations (Mabry, J Trauma 2000; Butler, Mil Med 2000) (C). Casualties with ongoing hemorrhage at a rate that does not result in prompt exsanguination might benefit from resuscitation strategies techniques that aim to stretch the mythical “golden hour” to a 4- to 6-hour window before definitive care can be exercised (Champion, J Trauma 2003) (C).

Initial interventions for shock may lose effect with time: Fluid resuscitation with isotonic crystalloid solutions have a transient effect on repleting intravascular volume and supporting blood pressure. Although current TCCC guidelines recommend initial fluid resuscitation with Hextend for casualties in shock, over 60% of combat fluid resuscitation at point-of-wounding is initiated with isotonic crystalloid solutions, despite the cube weight disadvantage of these fluids in the tactical environment (Kotwal, unpublished data) (C). The physiologic response to fluid resuscitation has been extensively reviewed by three separate expert panels since 1998. The transient effect of fluid resuscitation

strategies in casualties with uncontrolled hemorrhage has been well defined (Committee on Fluid Resuscitation for Combat Casualties, Institute of Medicine, 1999; Combat Fluid Resuscitation 2001, USUHS/Toronto 2001; Prehospital Fluid Conference, Dallas/FT Worth, 2010) (C).

Persistent shock is due to uncontrolled hemorrhage: In a study of civilian trauma patients central nervous system injuries were the most frequent cause of death (42%), followed by exsanguination (39%) and organ failure (7%) (Sauaia, J Trauma. 1995) (C). Hemorrhage-induced hypotension in trauma patients is predictive of high mortality and morbidity. Among the 208 patients with hemorrhagic shock, 31% died within 2 hours of emergency department arrival, 12% died between 2 and 24 hours, 11% died after 24 hours, and 46% survived (Heckbert, J Trauma 1998) (C). Hemorrhage is responsible for 30 to 40% of trauma mortality, and of these deaths, 33 to 56% occur during the prehospital period. Among those who reach care, early mortality is caused by continued hemorrhage, coagulopathy, and incomplete resuscitation (Kauvar, J Trauma 2006) (C). Lack of hemorrhage control is the leading cause of preventable death on the battlefield. Improved hemorrhage control is therefore of paramount importance (Holcomb, J Trauma 2003; Champion, J Trauma 2003; Butler, Mil Med 2007) (C).

Altered mental status in the absence of brain injury and/or change in pulse character is an accurate assessment of shock: Hemorrhagic shock results in altered mental status and changes in pulse character after an estimated blood loss of 1500 ml (McSwain, PHTLS Manual 2006) (C). This is corroborated by The Board for the Study of the Severely Wounded during the last 6 months of World War II which included the categorization of casualties by grade of shock. Those with moderate shock had an average blood pressure 95/58 mmHg, whereas those in severe shock had an average blood pressure 49/25 (Office of the Surgeon General, Department of the Army 1952) (C). Altered mental status in the absence of brain injury and a palpable radial pulse would be expected to discriminate between these two grades of shock. Assessment of mental status and presence of a palpable radial pulse have been accepted as the best field assessment of shock in combat casualties (Butler, Mil Med 1996; Butler, Mil Med 2000 Butler, Mil Med 2007; Champion, J Trauma 2003; Holcomb, J Trauma 2003) (C).

Hypotensive resuscitation improves outcomes: Several lines of evidence have demonstrated improved outcome with hypotensive resuscitation in uncontrolled hemorrhagic shock. A prospective trial comparing immediate and delayed fluid resuscitation in 598 adults with penetrating torso injuries who presented with a prehospital systolic blood pressure less than or equal to 90 mm Hg demonstrated a delay of aggressive fluid resuscitation until operative intervention improved the outcome. Among the 289 patients who received delayed fluid resuscitation, 203 (70 percent) survived and were discharged from the hospital, as compared with 193 of the 309 patients (62 percent) who received immediate fluid resuscitation (P =0.04) (Bickell, NEJM 1994) (B). A study in rats demonstrated that bleeding and mortality were increased with standard resuscitation back to a normal blood pressure and no resuscitation resulted in increased mortality. Animals treated with hypotensive resuscitation had less bleeding and improved survival (Burris, J Trauma 1998) (C). A swine study demonstrated that after uncontrolled hemorrhage caused by liver laceration, hypotensive resuscitation (MAP 60 mmHg) successfully restored both the systemic and splanchnic perfusion, whereas delayed

resuscitation limited blood loss but failed to reestablish gut tissue oxygenation. More aggressive crystalloid resuscitation to a MAP 75 mmHg was associated with both greater blood loss and diminished splanchnic perfusion (Varela, Shock 2003) (C). Further studies demonstrated that among three fluid resuscitation methods, controlled fluid resuscitation effectively decreased hemorrhage, avoided excessive hemodilution and coagulopathy, improved the early survival, and reduced the apoptosis of visceral organs in rats with severe and uncontrolled hemorrhagic shock (Lu, J Trauma 2007) (C). Among experts participating in the USSOCOM-sponsored workshop on the "Management of Urban Warfare Casualties" in 1998, a consensus opinion emerged that fluid resuscitation is indicated for individuals who are unconscious or who have altered mental status as a result of hypovolemic shock (Butler, Mil Med 2000) (C). A consensus was reached in support of hypotensive resuscitation by military and civilian trauma surgeons and medics that attended the Combat Fluid Resuscitation 2001 conference and Prehospital Fluid Conference (Holcomb, J Trauma 2003; Blackbourne, unpublished) (C). A recent review supports either delayed or goal-directed treatment for early hemorrhagic shock as superior to rapid infusion of high volumes of crystalloids. In well-selected patients and in areas with short transport times to definitive care, withholding resuscitation in the field seems safe and will avoid the harm of large-volume crystalloid infusion. In areas with long transport times, it seems that hypotensive resuscitation is a more prudent option (Santry, Shock 2010) (C).

Sphygmomanometry is available and an accurate end-point of resuscitation: Evacuation of the wounded from the battlefield by ground, air, or maritime platforms presents an opportunity to bring in additional medical equipment and personnel, allowing for expanded diagnostic and therapeutic interventions (McSwain, PHTLS Manual 2006) (C). Sphygmomanometry, with either digital blood pressure monitoring or simply systolic pressure measurement by palpation, is likely to be available except in the most rudimentary of lift-of opportunity platforms. A resuscitation systolic blood pressure of 94 mmHg resulted in recurrent bleeding in an animal model of non-compressible vascular injuries (Sondeen, J Trauma 2003) (C). During the Combat Fluid Resuscitation 2001 conference, the consensus with respect to resuscitation endpoints was to use a palpable radial pulse, ability to mentate, and sustained a systolic blood pressure 80–90 mm Hg (Champion, J Trauma 2003) (C). For these reasons, a revision of the current guideline is recommended to utilize a systolic blood pressure of 80-90 mmHg as an acceptable end-point of resuscitation (IIa).

II. If in shock and blood products <u>are not</u> available:

- Hextend 500-mL IV bolus
- Repeat after 30 minutes if still in shock.
- Continue resuscitation with Hextend or crystalloid solution as needed to maintain target BP or clinical improvement.

a. Recommendation: Class IIb

b. Specified/Implied Actions:

- Resuscitation with colloids is better than crystalloids

- Hextend is the best available resuscitation fluid
- The maximum safe dose of Hextend is greater than 1 liter
- Crystalloid solutions following colloid or blood resuscitation is an acceptable alternative for hypotensive resuscitation

c. Level of Evidence:

Resuscitation with colloids is better than crystalloids: Three comprehensive fluid conferences have been convened since 1998 supporting the use of colloid or hypertonic solutions over large volume isotonic crystalloid resuscitation (Committee on Fluid Resuscitation for Combat Casualties, Institute of Medicine, 1999; Combat Fluid Resuscitation 2001, USUHS/Toronto 2001; Prehospital Fluid Conference, Dallas/FT Worth, 2010) (C). As of 2008, a review of 70 trials found no evidence that any one colloid solution is safer or more effective than any other, although they do not exclude clinically significant differences between the various colloids (Bunn, Cochrane Database Syst Rev. 2008) (C). As of 2009, 2 large, multicenter trials were stopped early by the National Institutes of Health because interim results showed that hypertonic saline administered acutely to trauma patients provided no survival benefit relative to normal saline (NIH News, 2009) (B). Fluid resuscitation with colloid solutions has distinct advantages over isotonic crystalloid fluid resuscitation due to reduced cube-weight and duration of effect when evacuation may be delayed. (Butler, Mil Med 1996; Butler, Mil Med 2007; Champion, J Trauma 2003; Holcomb, J Trauma 2003) (C). The effectiveness of this fluid resuscitation strategy is supported by operational experience in OIF/OEF (Tarpey, 2005) (C).

Hextend is the best available resuscitation fluid: The current accepted standard for resuscitation of hemorrhagic shock is transfusion of blood in the form of fresh whole blood or component therapy. Fluid resuscitation in the absence of whole blood or blood component therapy has been the topic of extensive debate. The 1998 Institute of Medicine conference favored the use of 7.5% saline boluses in combat casualties in shock (Committee on Fluid Resuscitation for Combat Casualties, Institute of Medicine, 1999) (C). The consensus of participants at the Combat Fluid Resuscitation 2001 and Prehospital Fluid Conference in 2010 was in agreement with the current TCCC guideline for use of Hextend as the best option for initial fluid resuscitation (Combat Fluid Resuscitation 2001, USUHS/Toronto 2001; Prehospital Fluid Conference, Dallas/FT Worth, 2010) (C). Although 7.5% saline, lyophilized plasma and other agents had theoretical advantages and supporting research, the lack of FDA-approval made these products unsuitable for current use. Of note, the U.S. military personnel who are evacuated to certain coalition forces theatre hospitals, where lyophilized plasma and 7.5% saline are approved for use, may receive these agents during resuscitation. Additionally, coalition forces may receive lyophilized plasma as the initial resuscitation fluid at the point of injury (JTTS, personal communication) (C). A prospective observational study showed an improved initial mortality and overall 22% reduction in mortality from the use of Hextend which was largely related to reduced early death from hemorrhage. There was, however, a late increase in deaths from organ failure, which negated this early advantage of Hextend. The study was limited by non-randomized design and potential selection bias (Olgilvie, J Am Coll Surg 2010) (C). Preliminary data from a subsequent study demonstrate a correlation

between Hextend resuscitation and improved overall mortality, as well as improved blood transfusion requirement, end-tidal CO2, blood pH and lactate levels at the end of surgery in a subset of patients with penetrating trauma (Proctor, unpublished data) (C).

The maximum safe dose of Hextend is greater than 1 liter: The recommended infusion volume for 6% Hetastarch in saline is up to 20 ml/kg/24 hours due to evidence of coagulopathy in higher doses (Stump, Transf 1985; Damon, NEJM 1987; Lockwood, Anes 1988; Cope, Ann Thor Surg 1997; Avorn, Chest 2003; Boldt, Br J Anaesth 2003) (C). The use of 6% Hetastarch in a balanced salt solution (Hextend) has a better safety profile for adverse effects on coagulation parameters. In a Phase III randomized clinical trial by the Hextend Study Group, patients received an average of 1596 mL of Hextend and 42% received >20 mL/kg up to a total of 5000 mL. No Hextend treated patient experienced a related serious adverse event and there was no effect on coagulation based on thromboelastographic (TEG) analysis (Gan, Anesth Analg 1999) (C). Although an adverse of effect of Hextend in doses exceeding 20 ml/kg/24 hours has not been demonstrated, the resources available in combat environments, the potential requirement to resuscitate multiple casualties and the likelihood of mortality in initial fluid non-responders precludes the use of excessive resources in any single casualty during Tactical Field Care (Holcomb, J Trauma 2003) (C). In Tactical Evacuation Care, additonal medical resources may be available on the evacuation platform. Limiting the volume of Hextend infused to 1000 ml is not supported by the in-hospital data above. The approved guideline revision recommends continued resuscitation with either Hextend or crystalloid solutions to maintain target blood pressure or clinical improvement.

Crystalloid solutions following colloid or blood resuscitation is an acceptable alternative for hypotensive resuscitation: Animals studies described above demonstrated that hypotensive resuscitation using isotonic crystalloid solutions had less bleeding and improved survival (Burris, J Trauma 1998; Varela, Shock 2003; Lu, J Trauma 2007) (C). The USSOCOM-sponsored workshop on the "Management of Urban Warfare Casualties" in 1998, produced a consensus opinion that fluid resuscitation is indicated for individuals who are unconscious or who have altered mental status as a result of hypovolemic shock (Butler, Mil Med 2000) (C). Slow infusion rates with crystalloid have been shown to reduce organ injury, cause faster recovery of hemorrhage-suppressed cell-mediated immune function and reduce mortality. Overall, the data suggest that hypotensive resuscitation at a fixed rate of 60 to 80 mL/kg per hour generally maintains controlled hypotension to an SBP of 80 to 90 mmHg and that this empiric control of infusion rates is beneficial in hemorrhagic shock (Santry, Shock 2010) (C). The practical application of controlled infusion rates in combat prehospital scenarios has been questioned (Holcomb, J Trauma 2003) (C).

III. If in shock and blood products are available under an approved command or theater protocol:

- Resuscitate with 2 units of plasma followed by packed red blood cells (PRBCs) in a 1:1 ratio. If blood component therapy is not available, transfuse fresh whole blood. Continue resuscitation as needed to maintain target BP or clinical improvement.

a. Recommendation: Class IIa

b. Specified/Implied Actions:

- Blood transfusion is feasible in Tactical Evacuation platforms
- Early transfusion improves outcome in combat casualties
- Plasma before blood resuscitation improves outcomes
- Fresh whole blood is an alternative to blood component therapy

c. Level of Evidence:

Blood transfusion is feasible in Tactical Evacuation platforms: When logistically feasible, O-positive or O-negative PRBCs should be available in the Tactical Evacuation phase of care. In order to accomplish blood component therapy safely and effectively in situations where transport of the casualty to a medical treatment facility for definitive care will be delayed, the following elements must all be in place: 1) obtaining PRBCs and plasma for transport into prehospital settings must be logistically feasible in the area of operations; 2) a protocol must be in place that has been coordinated with the appropriate blood banking facilities and approved by the unit physician; 3) combat medical personnel must be well-trained in the transfusion protocol; and 4) a high enough probability of a delayed evacuation scenario must be anticipated to warrant planning for prehospital blood component therapy (McSwain, PHTLS Manual 2006) (C). Resuscitation by forward surgical teams utilizing red blood cells before air evacuation or in-flight has been reported (Place, Mil Med 2004) (C). The CoTCCC received a request from Col Warren Dorlac, the Deployed Director of the JTTS, to review a protocol on use of blood products by pararescuemen during air transport of casualties being considered for approval by the JTTS. The topic was discussed extensively during the meeting 03-04 November 2009. The group recommended:

- Blood product administration should be initiated, if feasible, for any casualty who meets the above criteria and is still enroute to the medical treatment facility. There was felt to be no minimum transport time below which blood product therapy should not be initiated if the above criteria are met. Individuals who continue to have absent radial pulse and/or decreased mental status due to hemorrhagic shock after 1000cc of Hextend have a very high expected mortality and are in need of blood products as soon as possible.
- Given that the transport container contains 4 units of thawed plasma and 2 units of Packed Red Blood Cells (PRBCs), 2 units of plasma should be given first, followed by the 2 units of PRBCs, followed by the last 2 units of plasma. The rationale for this is that the first priority is to stop the bleeding and that the coagulation factors in the plasma which may assist in hemostasis are more important initially than the additional oxygen-carrying capacity of the two units of PRBCs. However, RBCs do contribute to clotting and should not be excessively diluted by giving the 4 units of FFP first.

- The end point of resuscitation should be either return of normal mental status or a palpable radial pulse, or in the presence of TBI, a systolic blood pressure of 90 mmHG. Once the end-point has been attained, resuscitation should be stopped and IV access maintained.
- The group emphasized the importance of an ongoing process improvement effort on this issue and strongly recommended that all patients receiving blood component therapy in the prehospital phase of care be flagged for review at the weekly Joint Theater Trauma System process improvement teleconferences (CoTCCC Minutes, Nov 2009) (C).

Early transfusion improves outcome in combat casualties: The major principle of damage control resuscitation is to prevent development of coagulopathy by dilution of factors needed to provide hemostasis. In order to support this goal, the system must provide components at an appropriate ratio throughout the resuscitation process (CPG: Damage Control Resuscitation At Level IIb/III Treatment Facilities, JTTS 2009) (C). To improve survival, these massive transfusions should be composed of not only red blood cells, but also other blood components and plasma factors. The use of platelets in the prehospital setting is not feasible given the current blood banking techniques present in theater (Johnson, Curr Opin Hematol 2007) (C). In a model of uncontrolled hemorrhagic shock in rats, a resuscitation regimen using crystalloids agent alone is not ideal, and even a brief delay in blood administration worsens survival (Takasu, J Trauma 2010) (C). In a study of 211 patients, after controlling for age, sex, mechanism of injury, TRISS and 24-hour blood product usage, there was a 74% reduction in the odds of mortality among patients in the Trauma Exsanguination Protocol (TEP) group (p = 0.001). Overall blood product consumption adjusted for age, sex, mechanism of injury, and TRISS was also significantly reduced in the TEP group (p = 0.015) (Cotton, J Trauma 2008) (C). A prospective study of 806 consecutive trauma patients admitted to the ICU demonstrated no benefit of early plasma infusion, however the low mean number of transfused units, low percentage of patients requiring massive transfusion and a protocol utilizing PRBC:FFP at 1:1 ratio only after transfusion of 5 units of PRBC limit the applicability of the study to combat casualties (Scalea, Ann Surg 2008) (C). Records of 467 massive transfusion trauma patients (≥10 U of PRBCs in 24 hours) at 16 level 1 trauma centers were reviewed. The combination of high plasma and high platelet to RBC ratios were associated with decreased truncal hemorrhage, increased 6-hour, 24-hour, and 30-day survival, and increased intensive care unit, ventilator, and hospital-free days (P _0.05), with no change in multiple organ failure deaths.The largest difference in mortality occurs during the first 6 hours after admission (Holcomb, Ann Surg 2008; Zink, Am J Surg 2009) (C). In patients with combat-related trauma requiring massive transfusion, a high 1:1.4 plasma to RBC ratio was found to be independently associated with improved survival to hospital discharge, primarily by decreasing death from hemorrhage. For practical purposes, massive transfusion protocols should utilize a 1:1 ratio of plasma to RBCs for all patients who are hypocoagulable with traumatic injuries (Borgman, J Trauma 2007) (C). During a symposium held at the U.S. Army Institute of Surgical Research in 2005, general consensus was reached that, in the most severely injured patients, early use of RBC,

plasma, and platelets still offers the best chance of limiting the coagulopathy of trauma in early phases of care (Holcomb, J Trauma 2006) (C).

Plasma before blood resuscitation improves outcomes: The coagulopathy of trauma is a syndrome of nonsurgical bleeding from mucosal lesions, serosal surfaces, and wound and vascular access sites, the tissue oozing that continues after identifiable vascular bleeding has been controlled. Following trauma accompanied by massive hemorrhage, coagulation factors and platelets are lost and consumed, and their activity is reduced by hypothermia, acidosis, and dilution. In addition, clots that are formed may be broken down inappropriately by physical manipulation of wounds and fibrinolysis. The best-case scenario does not take into account the insensible losses of whole blood into tissue compartments, the greater proportional losses of clotting factors and platelets because of low blood volume, the consumption of clotting factors at sites of injury, the inhibitory effects of colloid resuscitation fluids and inactive coagulation factors, and the loss of clotting activity to hypothermia and acidosis. As concentrations of multiple factors decline so that the product of the concentrations fall below the assembly constant, marked instability of the complexes and loss of coagulant activity results. The early addition of plasma and platelets can help prevent the coagulopathy of trauma (Hess, J Trauma 2006; Ketchum, J Trauma 2006) (C). In a swine model of multiple injuries and hemorrhagic shock, infusion of freeze dried plasma and FFP were equally effective in correcting the coagulopathy of trauma (Shuja, J Trauma 2008). During a symposium held at the U.S. Army Institute of Surgical Research in May 2005, general consensus was reached that, in the most severely injured patients, early use of RBC, plasma, and platelets still offers the best chance of limiting the coagulopathy of trauma in early phases of care (Holcomb, J Trauma 2006) (C). During the Committee on Tactical Combat Casualty Care meeting in November 2009, a general consensus was reached favoring the administration of plasma before PRBC (CoTCCC Minutes, Nov 2009) (C). During the discussion for the guideline revision at this meeting, a consensus opinion favoring this approach to blood component therapy was reached by the Committee members.

Fresh whole blood is an alternative to blood component therapy: Fresh whole blood has been used extensively to resuscitate casualties in military conflicts since World War I. To date, there have been no prospective randomized clinical trials comparing FWB to component therapy in the trauma setting. In austere conditions, fractionated blood products are often in limited supply or unavailable. In these settings, fresh whole blood may be the only source of blood components available for the management of hemorrhagic shock and its associated coagulopathy in casualties (JTTS CPG, Fresh Whole Blood Transfusion 2009) (C). A 500 mL unit of FWB has a hematocrit of 38 to 50%, 150,000 to 400,000 platelets per microliter, and 100% activity of clotting factors and 1500 mg of fibrinogen (Beekly, Crit Care Med 2008) (C). In Mogadishu, Somalia, 125 casualties were incurred in less than 24 hours, at a time when the supporting hospital blood bank was out of blood products. Care was sustained by collecting 120 units of fresh whole blood (Mabry, J Trauma 2000) (C). During the first 10 months of OIF, between March and December 2003, a total of 2,349 units of blood products were transfused to 281 patients. Thirty-six of 281 (13%) patients received FWB (Holcomb, J Trauma 2006) (C). Between March 2003 and July 2007, over 6000 units of warm fresh whole blood were transfused in Afghanistan and Iraq according to the Armed Services Blood Program

Organization (Spinella, Crit Care Med 2008) (C). During OIF/OEF, transfusion of fresh whole blood has been performed in far-forward combat scenarios to resuscitate severely injured casualties (CoTCCC Minutes, Aug 2010) (C). In order to accomplish fresh whole blood therapy safely and effectively, combat medical personnel must be well-trained in both the donation:transfusion procedure and adhere to command and theater protocols.

IV. If a casualty with an altered mental status due to suspected TBI has a weak or absent peripheral pulse, resuscitate as necessary to maintain a palpable radial pulse. If BP monitoring is available, maintain target systolic BP of at least 90 mmHg.

a. Recommendation: Class I

b. Specified/Implied Actions:
   - Hypotension worsens outcome in TBI
   - Casualties with TBI and hypotension will have alteration in mental status
   - The optimal resuscitation fluid is uncertain
   - The resuscitation goal in TBI and hypotension is 90 mmHg or greater

c. Level of Evidence:

Hypotension worsens outcome in TBI: The impact of hypotension and hypoxemia on outcome following TBI has been well established (Miller, J R Coll Surg Edinb 1982; Kohi, Injury 1984; Chesnut, J Trauma 1993; Chesnut, J Trauma 1993; Kokoska, J Pediatr Surg 1998) (C). To address life-threatening injuries and begin resuscitation for shock is of paramount importance in casualties with TBI (McSwain, PHTLS Manual 2006; American College of Surgeons Committee on Trauma: Advanced Trauma Life Support, 2003) (C). The end-point of resuscitation in theatre is SBP > 90 mm Hg while maintaing SaO2 > 93% (Guidelines for the Field Management of Combat-Related Head Trauma, Brain Trauma Foundation 2005; CPG - Management of Patients with Severe Head Trauma, JTTS 2009) (C).

Casualties with TBI and hypotension will have alteration in mental status: Combat casualties have multiple potential causes for altered mental status, including shock, TBI, hypoxemia, carbon monoxide poisoning and combat stress. Casualties with TBI may manifest alterations in mental status without coma. The current TCCC guideline recommends fluid resuscitation if a casualty with TBI is unconscious and has a weak or absent peripheral pulse. A guideline revision is recommended for all casualties with TBI with a weak or absent radial pulse: resuscitate as necessary to maintain a palpable radial pulse or a systolic BP of at least 90 mmHg as an end-point of resuscitation to avoid the negative impact of hypotension on outcome.

The optimal resuscitation fluid in TBI is uncertain: Data are insufficient to support a standard for fluid resuscitation in the patient with severe TBI, however hypertonic saline and colloids have logistical benefits (Guidelines for the Field Management of Combat-Related Head Trauma, Brain Trauma Foundation 2005) (C). The Institute of Medicine recommended up to 500 ml boluses of 7.5% saline. The Fluid Resuscitation Conference 2001 and the Prehospital Fluid Conference recommended up to 1000 ml boluses of

Hextend (Committee on Fluid Resuscitation for Combat Casualties, Institute of Medicine, 1999; Combat Fluid Resuscitation 2001, USUHS/Toronto 2001; Prehospital Fluid Conference, Dallas/FT Worth, 2010) (C). Since 7.5% saline is not currently commercially available, alternative regimens of up to 500 ml of 5% hypertonic saline or up to 1000 ml 3% hypertonic saline are suggested (Guidelines for the Field Management of Combat-Related Head Trauma, Brain Trauma Foundation 2005) (C). Despite prior data (Vasser, Arch Surg 1991; Vasser, Arch Surg 1993) (B) supporting the safety and efficacy of either 7.5% saline or 7.5% saline/dextran in hypotensive patients with TBI, a multicenter randomized controlled trial of 7.5% saline was stopped early due to an interim analysis demonstrating no benefit compared to normal saline resuscitation (NIH News, May 2009) (B). While lactated Ringer's is the customary fluid in trauma, normal saline is preferred in the setting of TBI as the sodium content is higher, thus minimizing the potential for resuscitation with a hypotonic solution which could increase cerebral edema (Guidelines for the Field Management of Combat-Related Head Trauma, Brain Trauma Foundation 2005) (C). The current theatre guidelines recommend normal saline as the preferred crystalloid solution for resuscitation of patients who do not require massive transfusion. Blood products are preferred over albumin and Hespan if colloids are necessary (CPG - Management of Patients with Severe Head Trauma, JTTS 2009) (C). A guideline revision to reflect current Brain Trauma Foundation and theatre clinical practice guideline is not recommended due to insufficient evidence to support normal saline, 3% saline or 5% saline over other fluid resuscitation strategies (Prehospital Fluid Conference, Dallas/FT Worth, 2010) (C).

The resuscitation goal in TBI and hypotension is 90 mmHg or greater: Fluid resuscitation can be used to maintain adequate cerebral perfusion pressure and limit secondary brain injury in casualties with TBI. Although there is no clear threshold of systolic blood pressure to assure adequate cerebral perfusion, systolic blood pressure less than 90 mm Hg in casualties with TBI has an association with poor outcome. (Guidelines for the Field Management of Combat-Related Head Trauma, Brain Trauma Foundation 2005; CPG - Management of Patients with Severe Head Trauma, JTTS 2009) (C).