Trauma and Injury Subcommittee Update

Defense Health Board

1 November 2010

Prehospital Fluids - A Look Back: 1993

- **Prehospital fluid resuscitation at the time per ATLS – 2 liters of LR**
- **Special Operations Biomedical R+D project: Trauma care guidelines customized for the battlefield**

Key Premise

- **If we are going to ask a medic or corpsman to perform a medical intervention on the battlefield, we want to be very confident that it will benefit the casualty.**

Fluid Resuscitation

"Despite its widespread use, the benefit of prehospital fluid resuscitation in trauma patients has not been established." (17 references)

"The animal data from a variety of uncontrolled hemorrhage models has clearly established that aggressive fluid resuscitation in the setting of an unrepaired vascular injury is either of no benefit or results in an increase in blood loss and/or an increase in mortality when compared to no fluid resuscitation or hypotensive resuscitation." (12 references)

Fluid Resuscitation

- **The beneficial effect from crystalloid and colloid fluid resuscitation in hemorrhagic shock has been demonstrated largely on animal models where the volume of hemorrhage is controlled experimentally and resuscitation is initiated after the hemorrhage has been stopped.**
- **Controlled hemorrhage**

Fluid Resuscitation: Uncontrolled Hemorrhage

- **World War I combat trauma patients**
- **Concluded that initiating IV fluid replacement without first obtaining surgical hemostasis promoted further hemorrhage.**

Cannon

JAMA 1918

Fluid Resuscitation: Uncontrolled Hemorrhage

- **6855 trauma patients**
- **Found that although hypotension was associated with a significantly higher mortality rate in trauma patients, the administration of prehospital IV fluids did not influence this rate.**
- **Did not address subgroups with controlled versus uncontrolled hemorrhage.**

Kaweski et al
J Trauma 1990

Fluid Resuscitation: Uncontrolled Hemorrhage

- **Retrospective analysis of patients with ruptured abdominal aortic aneurysms and hypotension**
- **Survival rate of 30% in patients treated with aggressive preoperative colloid fluid replacement.**

Crawford

J Vasc Surgery 1991

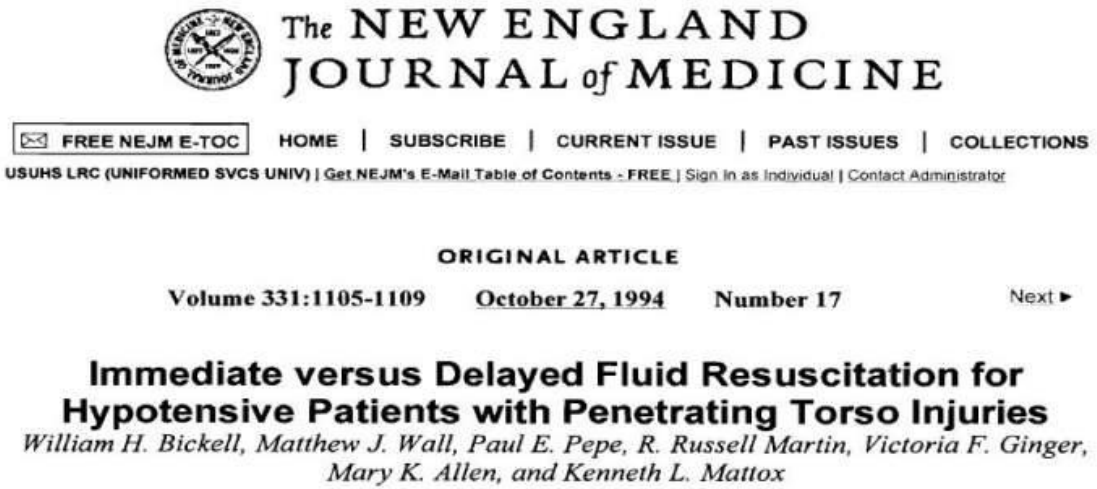
Fluid Resuscitation: Uncontrolled Hemorrhage

- **Survival rate of 46% in hypotensive patients with ruptured abdominal aortic aneurysms given only enough fluid to maintain a systolic blood pressure of 50 to 70 mm Hg until the time of operative repair.**
- **<u>Recommendation</u>: Withhold aggressive fluid resuscitation until the time of surgery in patients with ruptured abdominal aortic aneurysm**

Crawford

J Vasc Surgery 1991

Fluid Resuscitation: Uncontrolled Hemorrhage



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ORIGINAL ARTICLE

Volume 331:1105-1109 October 27, 1994 Number 17 Next ▸

Immediate versus Delayed Fluid Resuscitation for Hypotensive Patients with Penetrating Torso Injuries

William H. Bickell, Matthew J. Wall, Paul E. Pepe, R. Russell Martin, Victoria F. Ginger, Mary K. Allen, and Kenneth L. Mattox

- **Large prospective trial**
- **598 patients with penetrating torso trauma and hypotension**
- **Aggressive fluid resuscitation begun prehospital resulted in a survival rate of 62%.**

Fluid Resuscitation: Uncontrolled Hemorrhage

- **Aggressive fluid replacement withheld until the time of operative intervention resulted in significantly higher survival rate of 70%**
- **Mean transport times to the trauma center:**
  - **12 minutes for immediate resuscitation group**
  - **13 minutes for the delayed resuscitation group.**
- **Transport times from the battlefield to a MTF during an armed conflict are expected to be much longer**
- **A definitive answer to the wrong question?**

Fluid Resuscitation: Uncontrolled Hemorrhage

- **Animal studies of uncontrolled hemorrhage**
- **Observation periods of 60 to 240 minutes**
- **Beneficial effect from withholding fluid replacement are still present (9 references)**

Crystalloids vs Colloids in Controlled Hemorrhage

Address from a battlefield trauma care perspective:

- **Give 1000cc LR**
- **Wait one hour**
- **Only 200cc of infused volume of LR is still in the intravascular space**

Rainey et al

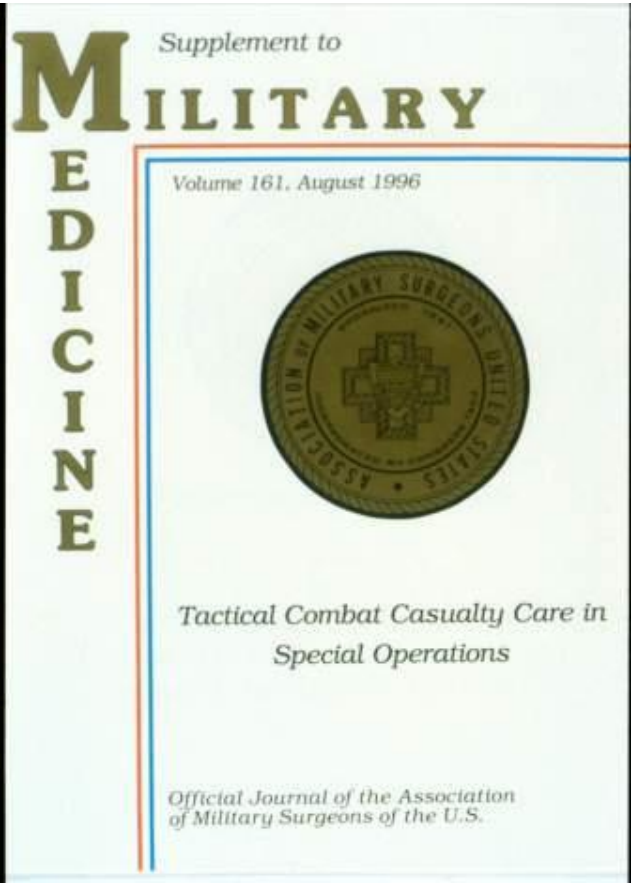
The Pharmacologic Approach to

The Critically Ill Patient. 1988

Crystalloids vs Colloids in Controlled Hemorrhage

- **Typical transport intervals for civilian ambulance systems are 15 minutes or less.**
- **With these very short transport intervals, most of the infused crystalloid is still in the intravascular space by the time of arrival at the trauma center.**
- **Additional volume replacement therapy with blood components can be carried out shortly after the initial crystalloid therapy if necessary.**

Tactical Combat Casualty Care in Special Operations



Military Medicine Supplement August 1996

Trauma care guidelines customized for the battlefield

Fluid Resuscitation TCCC 1996

- **IVs and fluid resuscitation delayed until Tactical Field Care**
- **No IV fluids for casualties not in shock**
- **No IV fluids for casualties in shock resulting from uncontrolled hemorrhage**
- **1000 cc of Hespan initially for casualties in shock as a result on hemorrhage that is now controlled**
- **Limit Hespan to 1500 cc or less**

Mogadishu: The Tactical Medicine Lessons Learned

- **Special Operations Medical Association**

8 December 1999

Loss of Consciousness in Uncontrolled Hemorrhage

- **Clear consensus among the panel members that a casualty with mental status changes due to shock must be fluid resuscitated**
- **Panel members stressed the importance of not trying to aggressively administer IV fluids with the goal of achieving "normal" blood pressure in casualties with penetrating injuries of the chest or abdomen.**

Joint MRMC – ONR Fluid Resuscitation Conferences

- **Held in 2001- 2002**
- **Co-chairs: COL John Holcomb and Dr. Howard Champion**

Fluid Resuscitation 2003

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

Fluid Resuscitation 2003

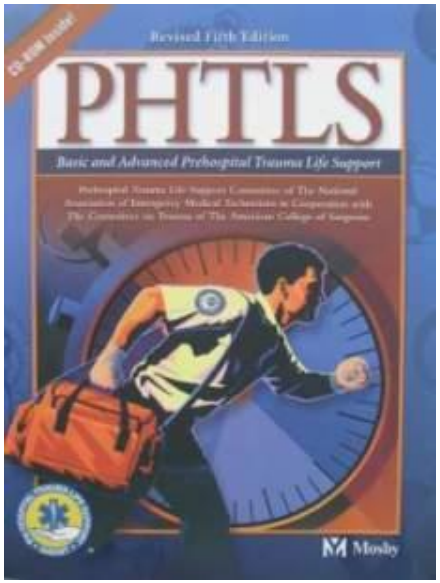
6. Fluid Resuscitation

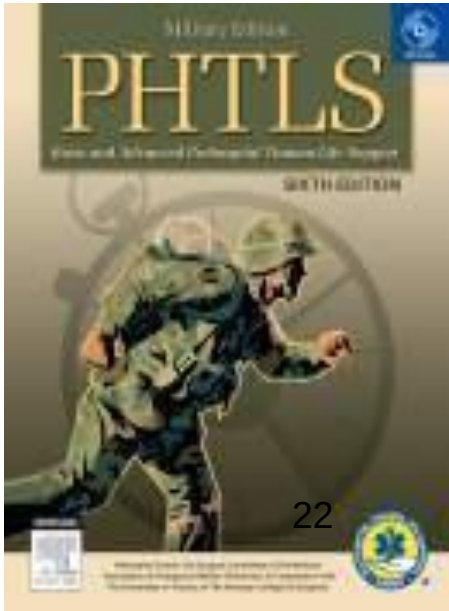
b. If in shock:

- **Hextend, 500ml IV bolus**
- **Repeat once after 30 minutes if still in shock.**
- **No more than 1000ml of Hextend**

TCCC Change - 2003

- Recommended change adopted by Committee on TCCC
- Published in Revised 5th Edition of PHTLS Manual
- Maintained in current Sixth Edition of PHTLS Manual
- PHTLS recommendations are endorsed by ACS Committee on Trauma and NAEMT
- Widely used in U.S. military





Fluid Resuscitation

Tactical Field Care - Current

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 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.

Fluid Resuscitation

Tactical Evacuation Care - Current

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.

Fluid Resuscitation
Guideline Revision

Perceived Deficiencies:

- **Does not call for use of blood pressure measurements where these may be available during TACEVAC**
- **Does not reflect current theater trauma practice of giving PRBCs and thawed plasma in a 1:1 ratio**
- **Calls for Hextend to be used initially instead of plasma and pRBCs when they are available**
- **Decision for fluid resuscitation in casualties with TBI should be based on pulse character or hypotension, not mental status.**

Fluid Resuscitation 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 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.**

Fluid Resuscitation
Tactical Evacuation Care

5. Fluid Resuscitation

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.

Fluid Resuscitation

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 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.

Proposed Change

- **This proposed change was approved unanimously by the CoTCCC on 3 August 2010**
- **It was subsequently approved unanimously by the Trauma and Injury Subcommittee of the DHB on 3 August 2010**

Questions?

Trauma and Injury Subcommittee Update

Defense Health Board
1 November 2010
Supplemental Slides

Supplemental Slides

- TCCC Guidelines - Proposed Fluid Resuscitation Change
- Preliminary Teleconference – 21 Oct 2010
- Dr. Frank Lewis – Executive Director – American Board of Surgery
- Additional information requested from teleconference

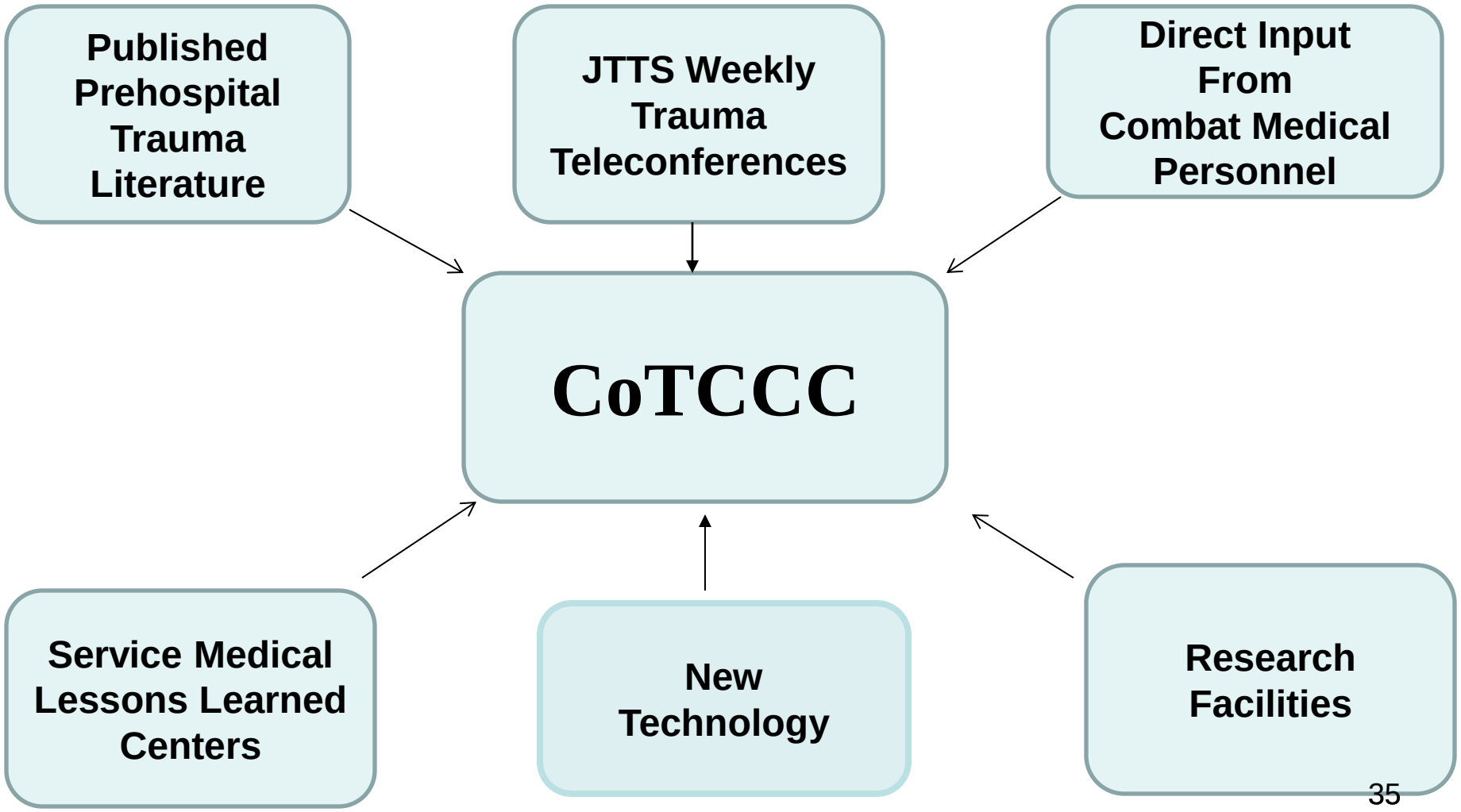
Issues Raised

- Dr. Greg Poland
- Copy of results from USAISR Fluid Resuscitation Conference from Jan. 2010
- CoTCCC membership, decision-making process, information distribution
- Dr. Frank Lewis
- Is Hextend the right fluid?
- Coagulopathy
- Other possibilities, such as LR, dextran or albumin
- Intravascular dwell time of Hextend
- Not all hetastarches are equivalent
- Use of mental status and radial pulse character as indicators of shock in the field

CoTCCC Members – Recent and Present

- U.S. Surgeon General
- Chairman – ACS Committee on Trauma
- Trauma consultants for Army, Navy, and Air Force Surgeons General
- 6 Trauma Directors for Level 1 Trauma Centers
- White House Medical Officer
- 2 Command Surgeons, U.S. Special Operations Command (USSOCOM)
- Command Surgeon for the Army Rangers
- Senior Enlisted Medical Advisor, USSOCOM
- Senior Medic for the Army Rangers

Changes to the TCCC Guidelines



Navy SG Letter on TCCC Changes – 10 March 2010

DEPARTMENT OF THE NAVY
BUREAU OF MEDICINE AND SURGERY
2300 E STREET NW
WASHINGTON DC 20372-5300

IN REPLY REFER TO

6000
Ser M3/5/10UM358106
10 Mar 10

MEMORANDUM FOR COMMANDER, NAVY MEDICINE EAST
COMMANDER, NAVY MEDICINE WEST
COMMANDER, NAVY MEDICINE NATIONAL CAPITAL AREA
COMMANDER, NAVY MEDICINE SUPPORT COMMAND

Subj: POLICY GUIDANCE ON UPDATES TO THE TACTICAL COMBAT CASUALTY CARE (TCCC) COURSE CURRICULUM

"After debate in open forum, CoTCCC members vote on any changes. After being approved by the Committee, proposed changes to the TCCC Guidelines are then reviewed by the Trauma and Injury Subcommittee of the Defense Health Board (DHB) and the Core Board of the DHB. Once approved by all three groups, changes to the TCCC Guidelines are then posted to the Military Health System (MHS) website…..once TCCC curriculum changes have been posted to the MHS website, all Navy medicine training sites are authorized to incorporate the changes as soon as possible to ensure that Navy service members receive the most up-to-date information."

USAF SG Letter on TCCC Changes – 21 Aug 2010

21 August 2010

MEMORANDUM FOR ALMAJCOM/SG

FROM: HQ USAF/SG
1780 Air Force Pentagon
Washington, DC 20330-1780

SUBJECT: Incorporating Tactical Combat Casualty Care (TCCC) Course Curriculum Updates into Air Force Medical Training

- **TCCC is military counterpart to PHTLS**
- **Changes proposed by CoTCCC – approved thru DHB**
- **TCCC Guidelines posted on MHS and USAF websites**
- **“**Effective immediately, all applicable Air Force training courses and programs will incorporate the most current TCCC guidelines consistent with their level of knowledge and proficiency instruction related to battlefield medical care. “

USAISR Fluid Resuscitation Conference

- **State of the Art of Fluid Resuscitation 2010**

Prehospital and Immediate Transition to ED

Dallas/Fort Worth Hyatt
January 8-9, 2010

- **Scheduled for publication in Journal of Trauma in March 2011**
- **Final draft of conference summary obtained courtesy of USAISR**

USAISR Fluid Resuscitation Conference

State of the Art of Fluid Resuscitation 2010

Report prepared by:
Norman McSwain, MD chair
Howard Champion MD
Tim Fabian, MD
David Hoyt, MD
Todd E. Rasmussen
Robert R Roussel
Martin Shreiber, MD
Steven Shackford MD
Lorne H Blackbourne, MD

USAISR Fluid Resuscitation Conference

Excerpts from Conclusions Section

- Most important is restricted use of crystalloids for resuscitation to prevent fluid overload, compartment syndrome in the abdomen, head, and lungs combined with early hemorrhage control ….
- For long term field care and in combat situations, hetastarches such as Hextend have not been found to improve survival but on the other side have not been found to produce coagulopathy or other negative affects either.
- Therefore, in combat and at times when cube/weight ratios are important, this has been found be the correct solution to use.

USAISR Fluid Resuscitation Conference

Excerpt from Conclusions Section

- **TCCC guidelines are supported unchanged.**
- **Hypotensive resuscitation with fluid restriction is supported.**
- **Rapid control of hemorrhage with pressure, tourniquets and hemostatic agents.**

Hextend Issues

Hextend Rationale

"…there are absolutely clear logistic benefits for military medics to carry the smallest volume and weight of resuscitation fluid consistent with effective practice. For the near future, hypertonic saline dextran is not available; thus, Hextend is the next logical choice."

Holcomb
J Trauma 2003

Hextend Intravascular Dwell Time

- Eight healthy volunteers
- 500 cc blood withdrawn
- 500 cc 6% hetastarch infused
- Intravascular volume found to be isovolemic for 8 hours after infusion

Mortelmans
Eu J Anaesthesiology 1995

Hextend vs Albumin

“ Overall, hetastarch is equivalent to 5% albumin as a plasma volume expander. The major difference between these two fluids is cost (hetastarch is less costly) and the risk of altered hemostasis (which is greater with hetastarch).”

Marino
The ICU Book
Third Edition – 2007
p 244

New Generation HES:
Holy Grail or Just Another Starch

“ … the FDA has stated that Hespan use is not recommended during or after CPB because of an increased risk of coagulation abnormalities and bleeding. Similar FDA warnings have not been extended to the administration of Hextend or Voluven in cardiac surgical patients.”

Murphy, Greenberg
J Cardiothor Vasc Anesth
2010; 24: 389-93

Hextend (6% HES, 670/0.75) Primary Resuscitation Fluid

Evidence:

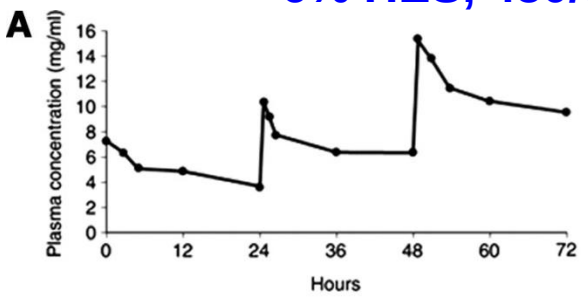
"Although dextrans may attenuate the inflammatory response to CPB, they are rarely used clinically because of the risk of inducing life-threatening anaphylactic reactions."

- **Murphy, J Cardiothorac Vasc Anesth 2010**

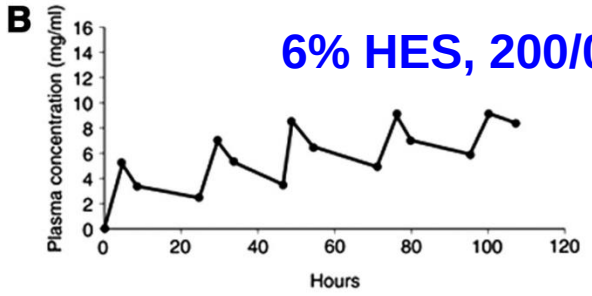
Colloid effect of third generation HES equivalent to Hextend; elimination half-life, tissue deposition, side-effects differ

- **"Notably, the volumes of HES required were not significantly different in cardiac surgery, in orthopedic surgery, and clinical outcomes in all groups were comparable."**
  - Westphal, Anesthes 2009

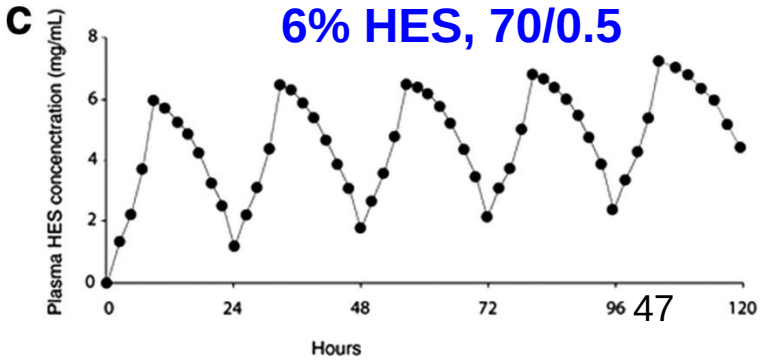
6% HES, 450/0.7



6% HES, 200/0.62



6% HES, 70/0.5



Hextend – The Ryder Study JACS 2010

First Report on Safety and Efficacy of Hetastarch Solution for Initial Fluid Resuscitation at a Level 1 Trauma Center

Michael P Ogilvie, MD, MBA, Bruno MT Pereira, MD, Mark G McKenney, MD, MBA, FACS, Paul J McMahon, BS, Ronald J Manning, RN, MPH, Nicholas Namias, MD, MBA, FACS, Alan S Livingstone, MD, FACS, Carl I Schulman, MD, MSPH, FACS, Kenneth G Proctor, PhD

- 1714 trauma patients at Ryder
- Resuscitation with standard of care +/- Hextend (HET) as initial fluid (max HET dose 1000ml)
- Non-randomized due to Florida law on consent
- " …Initial resuscitation with HET was associated with reduced mortality and no obvious coagulopathy."

Fluid Resuscitation

Shock/Blood Products Not Available

Supporting Evidence:

- **Resuscitation with colloids is better than crystalloids**
  - ✓ **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; Bunn, Cochran Database Syst Rev 2008 (C)**
  - ✓ **NIH News 2009 (B)**
  - ✓ **Butler, Mil Med 1996, 2007; Champion, J Trauma 2003; Holcomb, J Trauma 2003; Tarpey, 2005 (C)**
- **Hextend is the best available resuscitation fluid**
  - ✓ **Support: Combat Fluid Resuscitation 2001, USUHS/Toronto 2001; Prehospital Fluid Conference, Dallas/FT Worth, 2010 (C)**
  - ✓ **Non-support: Committee on Fluid Resuscitation for Combat Casualties, Institute of Medicine, 1999 (C)**
  - ✓ **Olgilvie, J Am Coll Surg 2010; Proctor, Unpub Data 2010; Westphal, Anesth 2009; Boldt, Anesth Analg 2009; Murphy, J Cardiothor Vasc Anesth 2010 (C)**

Indicators of Shock in the Field

Electronic BP Monitoring

- **Combat medics do not currently carry electronic blood pressure monitors onto the battlefield**
- **Reliance on electronic BP monitoring is therefore not part of CUF or TFC**

Fluid Resuscitation
Guideline Revision

Perceived Deficiencies:

- **Does not call for use of blood pressure measurements where these may be available during TACEVAC**
- **Does not reflect current theater trauma practice of giving PRBCs and thawed plasma in a 1:1 ratio**
- **Calls for Hextend to be used initially instead of plasma and PRBCs when they are available**
- **Decision for fluid resuscitation in casualties with TBI should be based on pulse character or hypotension, not mental status.**

Mental Status and Radial Pulse Character as Indicators of Shock in the Field

- " The analysis showed that mortality was 29% in patients with a weak radial pulse when compared with a mortality of only 3% in patients with a normal radial pulse character."

McManus

Prehospital Emergency Care 2005

Mental Status and Radial Pulse Character as Indicators of Shock in the Field

- " In this cohort of patients, predicting the need for an LSI could have been achieved from GCS motor and verbal components and radial pulse character without automated monitors."

Holcomb

J Trauma 2005

Mental Status and Radial Pulse Character as Indicators of Shock in the Field

" In patients with penetrating injuries and short transport times (less than 30 minutes), fluids should be withheld in the pre-hospital setting in patients who are alert or have a palpable radial pulse."

EAST 2008
Practice Management Guidelines
for Prehospital Fluid Resuscitation
in the Injured Patient

Questions/Discussion