MILITARY MEDICINE:
CARING FOR THE WOUNDED WARRIOR AND
HOW IT IMPACTS ON CIVILIAN TRAUMA
CARE

6th Annual McSwain EMS
Trauma Symposium

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DISCLOSURES

I have no financial disclosures

I have no conflicts of interest
Is Military Medicine Really Different?

**Civilian**
- Higher level of care
- Patient stability mandatory
- Transfer agreements
- Logistics of transportation
  - Weather/location dependent
  - Ground
  - Air
  - Training

**Military**
- Higher level of care
- Patient stability a bonus
- AO/Theater evacuation policy
- Logistics of transportation
  - Mission/tactically dependent
  - Weather/location dependent
  - Ground
  - Air
  - Training
  - SECURITY
Military Surgery

- Military or war surgery is a subset of surgery (trauma surgery PLUS…)
- Emergency surgery done on mass production basis, in austere & resource-limited environment
- Do what must be done--not what can can be done
- Care-givers are in danger themselves
  - 10% wounded while giving aid
• Civilian trauma centers and battlefield/military triage situations differ
• Civilian trauma centers
  • small numbers of patients, unlimited resources
• Military setting
  • limited numbers for potentially unlimited patient numbers
MILITARY TRAUMA IS DIFFERENT THAN CIVILIAN TRAUMA
THE CHALLENGE

• AMEDD Motto: “To Conserve Fighting Strength”
• Provide advanced medical/surgical care as far forward as possible
• Preserve life, limb, eyesight
• Return the wounded to his/her unit
• Return the wounded to his/her family
Medical/Surgical Needs for a Combat Surgeon

- Pre-hospital stabilization & care
- Emergency surgery:
  - “Trunkey Trauma Training”
    - Thoracic
    - Abdominal
    - Vascular
    - Urologic
    - Orthopedic
    - Neurosurgical
    - Critical care
Medical/Surgical Needs for an Acute Care Surgeon

- Pre-hospital stabilization & care
- Emergency surgery:
  - “Trunkey Trauma Training”
    - Thoracic
    - Abdominal
    - Vascular
    - Urologic
    - Orthopedic
    - Neurosurgical
    - Critical care
“Traditional” Battlefield Medicine

- Linear movement of troops – “slogging it out”
- Combat support
  - Long range fire
  - Heavy air support
  - Close air support
  - Tactical situation dictates medical capabilities
- Emphasis on Bde, Bn, Corps, Divisional assets
Continuous En Route Care

Historical Route From Injury to Definitive Care

CASUALTY EVAC
- Evac Policy - 1 Day

TACTICAL EVAC
- Evac Policy - 7 Days

Field Hospital "Level 2"

Battalion Aid Station "Level 1"

In Theater Hospital "Level 3"

STRATEGIC EVAC
- Evac Policy - 15 Days

Definitive Care "Level 4"
Recent Conflicts Present Changing Paradigm

• Non-linear nature of conflict presents major issues with security
  ➢ No clear “front line”
  ➢ Green zones interspersed between “hot zones”
  ➢ Force protection a major concern during transport
  ➢ Geneva Convention prohibits vehicles marked with “Red Cross” from carrying offensive weapons
  ➢ Geneva Convention prohibits firing on vehicles marked with “Red Cross”…..YEAH RIGHT!
• Medical units cannot execute MEDEVAC convoys
Recent Conflicts Present Changing Paradigm

• Unprecedented “non-linear” rapid movement of FLOT
• Battlefield changes daily
• AMEDD mission changes daily
  ➢ Tactical issues
  ➢ Medical needs
  ➢ Logistical support
  ➢ Evacuation capabilities
• Specter of “non-conventional” warfare
OIF/OEF Dilemma: Non-linear/Asymmetrical Warfare

The Challenge:
Create lightweight, lean and mobile capability
Austere but adequate within a meaningful distance to the injured
The FST- Forward Surgical Team

- Self-sufficient surgical team
- 1-10 stabilization procedures
- 72 hrs without resupply
- Extend Survivability
  - Laparotomy
  - Hemorrhage control
  - Bowel closure
  - Vascular shunts
  - Ortho fixation
  - Craniectomy
Mission of Forward Surgical Team

- Far-forward surgical presence in areas of most intense conflict
- Life-saving operations for highly lethal wounds
  - laparotomy
  - thoracotomy
  - craniotomy
- “Damage Control” Surgery
  - vascular repairs
  - amputation
  - external fixation
What is “Damage control” surgery?

- Situation: rapid exsanguination, shock
- Avoid lethal triad: hypothermia, acidosis, coagulopathy
- Goals: stop bleeding, seal GI leak, pack, close skin, finish within 30 minutes
- Survival increases from 5% to 25%
- Requirements: more than a fast surgeon
New Problem

• Stabilized, but not stable, patient now sitting in the middle of the desert
• Hard to provide resource intensity and duration of care in austere environment
Solution - CCATT

- Critical Care Air Transport Team
- Intensivist
- ICU R.N
- Respiratory Therapist
Continuous En Route Care

Current Route from Injury to Definitive Care

- **CASEVAC**: 1 Hour
- **TACTICAL EVAC**: 1-24 Hours
- **STRATEGIC EVAC**: 24-72 Hours

- BAS Level 1
- Forward Surgical teams Level 2
- Combat Support Hospital, EMEDS, Fleet Hospital Level 3
- Definitive Care Level 4

Surgical Capability
CCATT Mission Reports

In flight care (OEF/OIF)

- Mechanical Ventilation 58 - 85%
- Vasoactive or sedative drips 54%
- Neuromuscular blockade 4%
- Arterial pressure monitor 27%
- Intracranial monitor 4 - 25%
• MP HMMV on patrol is struck and disabled

• Sgt J.B. lifts the hood to investigate

• He is struck in the mid back by sniper round
Time 45 minutes

- Taken to Level II Army FST in Kirkuk
- Arrival B/P 80 systolic
- Undergoes exploratory laparotomy-
  - Left Nephrectomy
  - Splenectomy
  - Packing of abdomen
  - 8 units PRBC’s
  - B/P 90’s systolic
Time 3 hours

- Air evac to CSH
- Arrives at 332 CSH
- Cold
- Coagulopathic
- Acidotic
- Taken straight to OR
Time 3-6 hours

• Re-explored
• Packed, surgical control gained
• Urgent blood drive for AB+ blood
• Factor VII administered
• Patient warmed to 38
Time 6 hours

- Transported to ICU
- CT scan of spine
- Completion of resuscitation
- “Urgent” evacuation request placed
Time 10 hours

- C-17 arrives from Germany
- Cargo unloaded
- Aircraft reconfigured
- CCATT team alerted
- Patient prepared for transport
Time 10 hours

- CCATT arrives at ICU
- CCATT moves patient to AMBUS to flight line
- Patient loaded for flight
Time 12 Hours

- Patient loaded for flight and takeoff
- 6 hour mission to Germany
- AMBUS transfer to LRMC
Time 18 Hours
Time 24 hours

- Taken to OR PI day 2
- Packing is removed
- Colon continuity restored
- Washed out PI day 5
- Definitive decompression and stabilization of L-2 completed PI day 9
Post-Injury Day 14

- Patient transferred s/p lumbar decompression by CCATT team to WRMC.
Current Equipment Suite

• Good news
  - It works well enough
  - All services have settled on the same equipment

• Bad News
  - It’s old
  - It’s heavy
  - It’s clumsy
  - The pieces are not meant to work together
CCATT Equipment

Equipment Bags
Total Weight: 500+ lbs

- Propaq Monitor
- IVAC IV Pump
- Impact Ventilator
  - AC, SIMV, CPAP, PEEP
- I-STAT Lab device

Total Weight: 500+ lbs
Tactical CCATT

- Light
- Noise
- Vibration
- Altitude
- Duration

Minimal

Lots

High

Long
Autonomous Control Units
Autonomous oxygen control

- In the deployed setting, Oxygen is a critical resource.
- **Assumption**: It is desirable to decrease FiO₂ as long as SaO₂ is maintained.
- Input controller- SaO₂
- Output controller- FiO₂
Closed Loop Clinical Trial

- Clinical trial of up to 50 patients
- Four hours of manual and four hours of automatic FIO₂ control in randomized fashion
- Both sexes, 18-55 years of age
- Multiple trauma patients
- Current FIO₂ > 35%
- Target - SaO₂ 92 – 96%
Results- closed loop control of FiO2

![Graph showing results of closed loop control of FiO2](image)

- Oxygen Use, Liters
- Control
- Closed Loop
- $p = 0.004$
Autonomous Controllers

- Increase Safety?
- Improve Outcomes?
- Compensate for the austere/difficult environment
- Increase Capabilities of provider?
  - Prompts
  - Feedback
  - Suggested treatment(s)
  - Algorithms of care
Future Areas of Autonomous Control

- Mechanical Ventilation
  - APRV, AC, SIMV
  - PEEP
  - Rate/ventilation
  - Weaning
- IV Fluid Control
  - Battlefield prior to hemorrhage control
  - Post-Op resuscitation
  - Burn patients
- Target Controlled infusion
  - Analgesia
  - Sedation
  - Anesthesia
Add-on Modules
- Powered by fire wire
- USB port
- Communicate with/coordinated by central CPU

Communication
- Wireless
- Pt.-caregiver
- Pt.-receiving facility
- Pt.-Regional Control

Monitor
- Ventilator
- O2 Supply
- Fluid Controller
- Limited Power supply

Ultrasound
- ICP/Lycox
- Thermal Control
- Pain Control
- Defibrillator
- Suction module(s)
- Battery Pack
- Labs/ISTAT
Interface Research

- Context Sensitive
  - Provide cues based on monitored parameters
- Access to levels of sophistication
- Variable levels of autonomous control

En-Route Care System

I am a ....
- Medic
- Nurse
- Flight Surgeon
- CCATT doc

PATIENT STATUS: WITHIN NORMAL LIMITS
Master Caution Light!

F-16 panel tells you that something is wrong!

TAKE ACTION QUICKLY!
Master Caution for Shock

This could be our Master Caution light for a patient in trouble
“He who desires to practice surgery must go to war”

Hippocrates

c. 460 BC – c. 377 BC
HAS CIVILIAN MEDICINE BENEFITTED FROM MILITARY MEDICINE?
Combat Surgical Innovations: What has worked in the past?

- Baron D. Larrey - ambulance system (Napoleonic wars)
- Florence Nightingale
  - nursing care (Crimea)
- Battlefield surgical units - US Civil War
Harvey Cushing

- Bovie cautery
- Father of neurosurgery
- WWI France
Combat Surgical Innovations: What has worked in the past?

WWI

• Fluid resuscitation for hemorrhagic shock
• Laparotomy for penetrating abdominal wounds
• Debridement: Depage
Combat Surgical Innovations: What has worked in the past?

**WWII**

- Surgical augmentation teams
- Training of corpsmen in early management of injuries
- Defined theater evacuation policies and echelons of care
- Blood & plasma transfusions
- IV antibiotics
Combat Surgical Innovations: What has worked in the past?

Korea

- Helicopter transport
- MASH Units
- Vascular anastomoses – F.C. Spencer
Combat Surgical Innovations: What has worked in the past?

Viet Nam

- Vascular surgery in combat injuries codified (Norm Rich)
- Helicopter transport of injured dramatically improved
- Rapid surgical intervention => Sicker patients surviving
- Recognition of “Da Nang lung” = ARDS
- Experience in war surgery caused surge in trauma centers and systems in CONUS
Combat Surgical Innovations: What has worked in the past?

OEF/OIF

- Helicopter transport of injured perfected
- Resurgence of (appropriate) tourniquet use
- Hemostatic dressings
- Damage control surgery
  - Abdominal
  - Shunts for vascular injuries
  - Orthopedic – washout & external fixation
- Damage control resuscitation
Combat Surgical Innovations: What has worked in the past? OEF/OIF

- Massive transfusion protocols with 1:1:1 blood product rations
- Autonomous controls translated into critical care protocols
- ACUTE CARE SURGERY
- WELL-TRAINED PREHOSPITAL PERSONNEL
Blood Product Administration

- Use of Whole Blood
  - Change in Philosophy
  - Screening
  - Whole Blood Drives
- Massive Transfusion
- Tracking of Products given
- Thromboelastography
- Guided resuscitation
Fresh Whole Blood Improves Survival Compared To Component Therapy

- 111 patients (55 Fresh Whole Blood [FWB] vs 56 Component Therapy [CT])
- All had a massive transfusion and ISS > 15

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This represents a 15% absolute reduction in mortality or a 39% relative reduction in mortality.

- Variables included in analysis:
  - ISS, admission (HR, SBP, INR, CBC, base deficit) total RBC, FFP, PLT, cryo transfused in 7 days, rFVIIa use
- After adjusting for ISS, p = .09
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Preliminary Experience with Thromboelastography (TEG)

- Over 4 months in 2004 in Iraq
  - >1200 trauma evaluations; >1000 surgical procedures
  - >1700 units blood products administered
  - Only 30 doses of rVIIa given
- Now theater-wide use by protocol
TEG-Guided Resuscitation

Abnormal TEG

- Prolonged R time
  - Transfuse 4 units FFP

- Decreased Maximum Amplitude
  - Transfuse 2-4 units Whole Blood

- Prolonged K time or Decreased $\alpha$-Angle
  - Transfuse 4 units FFP then 4 units Cryoppt/rVIIa if remain abnormal

- Increased LY30
  - Amicar 5 gm IV load over one hour then 1 gm/hr until LY30 normal
TEG-guided resuscitation is now built into the Massive Transfusion Protocols of many civilian trauma centers across the U.S. and Europe.
The (Very Near) Future

- The warfighter/patient deserves the very best
- Improvements in technical capabilities offer a significant opportunity to enhance the care and outcome of the injured soldier
- Implications and applications for civilian trauma care are limited only by our imagination, ingenuity, and the integration of military trauma care into the civilian medical system
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Senior Visiting Surgeon Program

• Initially conceived as a means of sharing information and mentorship
• Presented to the Executive Committee of the ACS COT in 2005
• Jointly sponsored by…
  ➢ ACS
  ➢ ACS COT
  ➢ AAST
SVS Overview

- Two to four week rotation
- Clinical involvement in the ICU, OR and all aspects of care
- Mentorship of military surgeons & staff
- Grand Rounds
- Bring home the lessons learned
A Bold New Mandate

- National Academies of Sciences, Engineering, and Medicine
“If I have seen a little further it is by standing on the shoulders of Giants”

Sir Isaac Newton  1676
If I can see further than anyone else, it is only because I am standing on the shoulders of giants.

Sir Isaac Newton

COL David G. Burris, MD, FACS
1955 - 2010
Jay Johannigman, COL, USAF
“Duty, honor, country -- the motto of West Point. And like the men and women of West Point and all of our military institutions, our physicians in uniform have never failed us. They've been ready when called; ready for hardship and sacrifice, for adventure and exploration; ready to extend the hand of compassion and healing care; ready, if called, to give the last full measure of their devotion”
MAJ Mark D. Taylor, 41
Stockton, CA killed 20 MAR 2004
COL Brian D. Allgood
West Point, NY killed 20 JAN 2007
MAJ John Pryor, 42
Philadelphia, PA killed 25 DEC 2008
".... Seek always to do some good, somewhere. Every man has to seek in his own way to realize his true worth. You must give some time to your fellow man. Even if it's a little thing, do something for those who need help, something for which you get no pay but the privilege of doing it. For remember, you don't lie in a world all your own. Your brothers are here, too."

Albert Schweitzer
THANK YOU!
Questions?
President Ronald Reagan

• “...even while under fire, military physicians developed the use of massive blood transfusions in treating shock and trauma. They pioneered burn research and treatment. And again, of course, ... continues the tradition, leading in such areas as research on vascular surgery and reconstruction”
What Is Coming Down The Line?