Thoracic Surgical Skills from Combat Experience: Lessons from the Iraq and Afghanistan Wars

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Battlefield Challenges

- Limited supplies
- Harsh environment
- Lack of brick and mortar structures
Battlefield Challenges

- Power outages
- Dirty operating rooms
- Unpredictable Evacs
Security

PLEASE CONTACT ONE-STOP IF YOU HAVE ANY ISSUES WITH THIS FACILITY DSN: 851-0314

got weapon?
Living Quarters
Wild Life: Recovery Room
Lay of Land

Please be considerate of others and clean your feces stains from the toilet bowl. Thank you.
“Oh Lord, if I am called to the battlefield, give me the courage to conserve our fighting forces by providing medical care to all who are in need…”  Combat Medic Prayer

TRIAGE
Categories of Triage

- Immediate
- Delayed
- Minimal
- Expectant
- Dead
Immediate

• Life-threatening wounds
• Require quick intervention
• “2 Minutes”
• High likelihood of initial survival with minimal resource use
• Injuries
  – Airway, tension PTX, hemorrhage
  – Limb ischemia, incomplete amputations, circumferential burns
Delayed

- Can tolerate moderate delay before intervention
- “1 hour”
- Injuries
  - Abdomen with visceral injury/minimal bleeding, evisceration
  - Vascular injury with viable extremity
  - Debridement, GU injuries, open/closed fractures, open globe
  - Asymptomatic toxic fumes/phosgene exposure
Minimal or Ambulatory

- Move from triage to separate area
- First aid personnel present

Injuries
- Superficial wounds: Require cleaning, minor debridement, tetanus, first aid
- Burns <15% (non-vital areas), UE fractures, sprains, abrasions
- Early phases of blast/rad exposure, psychiatric
Expectant

- Requires judgment
- Wounds > resources
- Move to separate area with attendant
  - Comfort measures, pain management, chaplain
- Injuries: survival unlikely
  - Unresponsive, penetrating head wounds
  - Mutilating explosive wounds, multiple sites
  - 2\textsuperscript{nd}/3rd degree burns > 80%; inhalation injury
  - Profound shock with multiple injuries
Dead

• Physiologically confirmed by a physician
Expectant: Burns
Expectant: Burns
Vascular Trauma
Delayed Triage
Delayed Triage
Delayed Triage
Burns
Expectant: Burns
Triage: Military vs. Civilian

- Life, Limb, Eyesight
- Hurricane Katrina
  - What comes with experience & training to military physicians does not to civilian physicians
    - Moral consternation
    - Questions of euthanasia
    - Limited resources in hostile environment
- Immediate OR
- Hold
- Expectant
Continuous En Route Care

Point of Injury to Definitive Care

CASEVAC
1 Hour

BAS
Level 1

Forward Surgical Teams
Level 2

Intratheater EVAC
24 Hours

CSH, EMF,
Theater Hospital
Level 3

Intertheater EVAC
48-72 Hours

CONUS/OCONUS MTF
Level 4/5

Surgical Capability

20
MedEvac - Blackhawk
MedEvac Packed & Ready to Go
C-130
CCATT - Patient Loading
Cast/Splint

- Minimal access to soft tissue
- Must be bivalved for evac purposes
- Can be used for temporary documentation
Canine Patient
Afghan Car-jacking
ANA KIA
Burns
Kinetic Energy

- $K_e = \frac{1}{2}MV^2$
- Energy is transferred from the missile to the tissue
- Speed Kills!
High Velocity GSW

- Tissue is stretched by a temporary cavity
- Higher velocity missiles cause greater cavitations
- Higher velocity missiles produce greater energy waves

*Emergency War Surgery, 3rd Edition*
Wounding

$$K_e = \frac{1}{2}MV^2$$
OEF/OIF Mechanisms of Injury

Peake, James B., NEJM, Jan 2005
Explosive Delivery

• Vehicle-borne improvised explosive device (VBIED)

• Improvised explosive device (IED)
Suicide Bomber
Improvised Explosive Device
Armored Vehicles

A Translational blast injury
B Toxic gases
C Blast overpressure
D Missiles

Emergency War Surgery, 3rd Edition
Explosion = Massive Energy
Explosive Mechanisms

Distance From Epicenter

Probability Of Injury

Ballistic

Blast

Thermal

Emergency War Surgery, 3rd Edition
Blast Wave (Primary)

Blast pressure wave – tissue damage at air-fluid interfaces

Total lung barotrauma (blast lung)
- Tympanic membrane rupture
- Bowel perforation
- Severe cerebral contusions

Responsible for death
Penetrating (Secondary)

Penetrating (fragments and debris)

Unprotected torso
Extremity
Eye
Head/neck

Responsible for wounding
No Innocent Wounds
Blunt Displacement (Tertiary)

Blast Wind

Falls

Crush
Thermal (Quaternary)

Thermal / Chemical / Inhalation

All other injuries/illnesses
Exacerbations of pre-existing conditions
Managing the Unimaginable

Note the writing on his abdomen.
Managing the Unimaginable
IED Blast with Facial Trauma
IED Blast with Facial Trauma
IED Blast with Facial Trauma
IED Blast with Facial Trauma
Vascular Trauma
Vascular Trauma
Shunts
GSW to Back and Chest Wall
Chest Wall after AK-47 Glancing Shot
GSW to Chest Wall
Unexploded Ordinance
Unexploded Ordinance
Penetrating Chest
ECMO in Afghanistan
Lessons

• Surgeon and soldier first, and a thoracic surgeon second

• ABCs of trauma
  – Avoid the triad: Hypothermia, coagulopathy, acidosis
  – Emergency airway is not a defeat
    • Just use a 6-0 ET tube and an 11# blade

• Preserve the fighting force
  – Triage, Triage, Triage
Lessons

• Life, limb, eyesight

• Limited resources
  – Blood products
  – Instruments, equipment
    • No right angle

• Pericardium is your friend
  – Big vessel repair not amendable to primary repair
  – Suture reinforcement
Lessons

- Refresh your wound care skills
- Know your muscle flaps - everywhere
- 1 hour to not kill a patient
  - Respect the principles of DAMAGE CONTROL SURGERY
  - Triad of death: Hypothermia, coagulopathy, acidosis
- Understand the mechanism of injuries
  - Velocity and strange projectiles
- IEDs and VBIEDs
  - Have a plan for Mass Casualties
Lessons

• Teach the local families to care for their injured

• Prepare for unexploded ordinance
  – Clear area, minimize team’s exposure

• Trauma thoracotomy
  – 750 cc or 200cc/hr for 2 hours
  – High velocity wounds macerate lung
  – Not your usual gun and knife club

• Trauma incisions
  – Low threshold for a clamshell - reluctance
Lessons

• MedEvac
  – Packaging for transport
    • Everybody is flying
  – Airway and chest tubes must be managed aggressively
  – You cannot hear breath sounds on a Blackhawk
  – Hypotension & hypoxia are not well tolerated in neuro-trauma
    • Partial pressure of O2 is greatly reduced

• You can’t take care of anybody if you are dead
  – Soldiers put their lives on the line knowing that combat surgeon is going to be there for them if they are injured
Lessons

• Beware the lateral decubitus position
  – HIGH VELOCITY rounds/projectiles MACERATE the lung
  – Your patients could drown in their own blood
    • Almost lost a soldier this way
    • You won’t have a rigid scope
    • No double lumen tubes

• No shame in a big clamp on the hilum
  – You don’t have time
  – You don’t have the blood
  – Trauma pneumonectomy

• Blast lung
  – 60yo blast lung from VBIED in Mass Cal
    • Can’t fix him
Lesson: Tractotomies - Friend or Foe

• Simple and relatively peripheral
  – Friend

• Deep and central
  – Beware
    • Could be a foe
  – Be prepared to fix bigger things
    • PA or PA branch
    • Bronchial stumps, tears, lacerations
Lesson: Muscle flaps

• Know your muscle flaps
  – Intercostal muscle
  – Pectoralis
  – Serratus
  – Lattissimus

• Know your extremity flaps as well
  – Gastrocs
  – Ilio-tibial rotation
Lessons

- Whole blood is your friend
  - Make sure you have a type and cross plan

- Tourniquets save lives and limbs
  - Can’t save a limb on a dead person
  - Shunt your vascular injuries; you can fix them later

- Do not “over” resuscitate
  - Increased risk for pulmonary compromise
  - Increased risk for compartment syndrome
    - Limb
    - Abdominal
  - Low threshold for fasciotomies, open abdomen with VAC
Lessons

• Some times you can do something extraordinary
  – Most soldiers are young and healthy
    • You can clamp a lot of things you normally can’t otherwise
  – ECMO in the austere environment

• Your pride cometh before a soldier’s life

• No matter how bad you think you have it, the combat soldier has it worse
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack

- Mass casualty: 4 soldiers, 2 civilians

- Triage:
  - 2 to OR directly
    - 1 with penetrating to extremities
      - Washout, debridement, wound care, Ex-Fix
    - 1 Penetrating to chest, abdomen, and extremity
  - 3 delay/hold - Minor or easily managed
  - 1 expectant - comfort care
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack

- 1 Penetrating to chest, abdomen, and extremity
- 26 yo M 1LT
- Vitals lost on arrival
- Tourniquet on extremity
- Left thoracotomy with clamp on aorta
- Resuscitation with return of vital signs
- OR
  - Exploratory laparotomy
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack

• OR
• Massive transfusion
  – Whole blood drive initiated
• Abdomen packed
  – Liver
  – Multiple enterotomies
    • Rapid control
  – Retroperitoneal bleeding
    • Complete evisceration and mobilization
  – Renal hilum shattered
    • Left nephrectomy with repair of aortic takeoff
  – Splenectomy
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack

- Intra-abdominal hemorrhage controlled
- Small bowel and colonic injuries resected
- Released the thoracic aortic clamp
  - Bleeding!!
  - Missed injury - hole in the aorta near the celiac artery
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack

• How do you fix a hole in the aorta that fits the length of your thumb in a contaminated field in a field hospital in Afghanistan?
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack

• How do you fix a hole in the aorta that fits the length of your thumb in a contaminated field in a field hospital in Afghanistan?

• Chest tube

• Umbilical tape
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack

• Thoracic aortic clamp removed again
  – Bowel pinks up
  – Vital signs stabilize
  – No bleeding!!

• Kick ass surgery - right!
Case: Penetrating Trauma
Indirect Fire from a Rocket Attack

• Kick ass surgery
  – WRONG

• The soldier arrested on the table before we could move him
  – Heart stopped and became stiff/turgid

• Why?

• How did I fail this soldier?
Summary

• How do you manage overwhelming trauma and critical care in a hostile situation with limited resources?
  – Adapt and overcome.
  – Accept your limited resources and get creative
  – They might die with you, but they will definitely die without you.
  – “The truth of the matter is you always know the right thing to do. The hard part is doing it.” - Norman Schwarzkopf
Wall of Heroes
In Memoriam

• 1LT Robert Welch

• CPT Joshua McClinans