Lessons Learned From War

“The Epidemic of Trauma”
Hippocrates....... 

• “He who would learn surgery should join an army and follow it”

• “Destructive as war is, it makes possible quantum leaps in the art of healing”
Vast supplies of wounded men provides opportunities for experimentation and innovation unthinkable in a world at peace

—Unknown
A Brief History of EMS and War

• Our beginnings date back to biblical times
  • 4,000 to 5,000 years ago Sumerians inscribed clay tablets with the earliest medical information, and **PROTOCOLS** were invented then.....
  • 5,000 years later Dr. Banerjee would go on to change them every six months

You’re Welcome!!!
“Book of Wounds”

- A papyrus scroll created by Egyptians in 1500 B.C. contained 48 medical case histories
- The data was arranged from head-to-toe (The Modern Day Patient Assessment)
The Revolutionary War
Weapons Used
The Revolutionary War

- Doctors had a knowledge of anatomy but their ability to heal was extremely limited
- Surgeons were not commissioned
- They were regarded as contract personnel and did not have a rank, they only accompanied a military column
- Doctors, had no specialties, they acted both as primary physicians and surgeons
- They were to be considered only one step above the common barber
The Revolutionary War Lesson Learned

- A growing country needed more skilled professionals to care for the sick and injured
- 4 American medical doctors were signers of the Declaration of Independence
  - used their prominence to create hospitals, stockpile medical supplies, and inoculate soldiers for smallpox
Harvard Med

- Dr. John Warren's **Boston Army Hospital** course on surgical anatomy provided the basis for Harvard College's new medical education department
- Medicine is born and doctors have a new stature
Napoleonic Wars
Jean Larrey, Surgeon

- Ambulance Volante
  - “Flying Ambulance”
- Created by one of Napoleonic’s chief surgeons
- It provided emergency surgery as close to the battlefield as possible
- Larrey is credited with the development of the first pre-hospital triage and transport system
From then on....

Advances in battlefield medicine would be minimal until, the Civil War
Weapons Used
THE CIVIL WAR

- Amputation was the common consequence of wounds in the arms or legs and since nothing was known of antisepsis, infection was almost inevitable.
- Four-wheeled ambulances were a major improvement over the two-wheeled versions issued in larger numbers early in the war.
- Two wheeled were agonizingly uncomfortable for the wounded.
Civil War
The American Red Cross

- The Civil War brought about a new age of battlefield medicine

- Clara Barton, an American nurse, defied army leaders and went to the front lines to treat the sick and injured soldiers

- She used triage techniques to facilitate transport of the injured to improvised hospitals in local homes, barns, and churches

- It was at this time that the first civilian ambulance services began operating out of Bellevue Hospital in N.Y.
THE CIVIL WAR: Lesson Learned

- The greatest medical benefit of the civil war was finding the connection between cleanliness and health
- The causes of infection became known
- Large number of doctors gained valuable surgical experience
- Paved the way for the rapid advances of the next thirty years
World War I
Weapons Used
World War I

• This war saw dramatic improvements in the number and quality of hospitals and in triage however......

• WWI had a high mortality rate that was attributed to an average evacuation time of 18 hours

• Advances in weaponry brought about more traumatic devices (shells and shrapnel) that caused more tissue damage
WWI: Lessons Learned

- Doctors noticed improved recovery rates when the wounded were removed from the front lines before infection had set in.
- It taught us that time is of the essence when it comes to the trauma patient.
- Large numbers of men with wounds of the face and jaw prompted reconstructive surgery that developed a new medical specialty: Plastic surgery.
- Doctors learned that transfusions were useful in treating shock, but they had no system of collecting and transporting sufficient quantities of blood.
Between The Wars

WWI War Memorial

WWII War Memorial
Between the Wars

- Researchers perfected two new techniques
  - First they separated plasma, the liquid part of blood, from the red and white blood cells
    - this made matching blood types unnecessary
  - Second they dried the plasma, which preserved it and made it easier to transport
  - When needed, the plasma was mixed with sterile water and injected into the bloodstream to sustain life until surgery could take place
    - Plasma contains coagulation factor – which aids in clotting
  - The theory of permissive hypotension was first theorized
World War II
Weapons Used
WWII

• Once the war began, the American Red Cross established a system for collecting blood from the civilian population for use on the battlefield

• A system was also created to decrease evacuation times
  • The injured were transported from the frontlines to echelons or different levels of care
  • Problem was that the echelons were too far which created further delays, it often took days from the time of injury to definitive surgery
Military System Echelons of Care

Current Route from Injury to Definitive Care

**CASEVAC**
1 Hour

Battalion Aid Station
Level 1

Forward Surgical Teams
Level 2

TACTICAL EVAC
24 Hours

Combat Support Hospital
Level 3

STRATEGIC EVAC
48-72 Hours

Definitive Care
Level 4
WWII Lessons Learned

- Oxygen systems were developed for patient care and high altitude flying
- Penicillin was created to treat various infections
- Wartime research produced new drugs to combat malaria
- Insecticides were developed which drastically reduced deaths from typhus
- The typhus vaccine was created
  - Typhus killed over 3 million during WWI in Russia and Poland alone
The Korean War
Weapons Used
The Korean War

- At first Korea’s **Mobile Army Surgical Hospital** (MASH) units moved with the Army but…
  - as the war settled down, they tended to remain stationary
- **MASH** units were created so that the injured soldiers could be airlifted for immediate definitive surgery
  - The first Trauma Centers
- Surgical treatment at these units would begin within about 10-20 minutes
- Once stabilized (usually within 24 hours) a patient could be flown to Clark Air Force Base for further treatment
- Mortality rates dramatically decreased
The Korean War Lessons Learned

• Wartime researchers studied wound infection, dehydration, and kidney problems

• A team of highly trained vascular surgeons instructed less specialized MASH doctors in new ways of repairing arterial wounds
  • reducing the need for amputation

• The first artificial kidney machine was used to treat kidney failure in cases of severe shock

• Korea’s severe cold led to advances in the prevention and treatment of frostbite
The Vietnam Conflict
Weapons Used
The Vietnam Conflict

• Helicopter evacuation began in Korea, but land-based ambulances still carried 80 percent of the wounded
• In Vietnam, helicopters touched down on the battlefield and removed the wounded to air-conditioned fixed-facility hospitals
• Due to the speed of evacuation and the quality and proximity of these hospitals, the “died-of-wounds” rate in Vietnam sank to 2.5 percent, the lowest of any war
The Vietnam Conflict Lessons Learned

- Medical evacuation by air was so successful in Vietnam that, by the late 60s and early 70s, helicopters began to transform civilian emergency care.
- Army helicopters piloted by Vietnam veterans flew more than four hundred missions after Hurricane Agnes in June 1972.
- Today air support is a radio call away.
  - and still flown by many pilots trained in the Vietnam Conflict.
The Iraq and Afghanistan Wars
Weapons Used
Major Julio R. Lairet, DO, EMT-P, Maj., USAF, MC

• Biography: Major Lairet, began his EMS career in 1989 after becoming an EMT-B. He continued his training and worked as a Paramedic in the Oklahoma City area on full time basis until 1997, at that time he began his medical studies at the Oklahoma State University College of Osteopathic Medicine. After graduation in 2001 he received his commission into the Medical Corps of the United States Air Force
Major Julio R. Lairet

- Major Lairet completed his Internship at Andrews AFB in 2002 at which time he moved to San Antonio to attend the Emergency Medicine Residency Program at Wilford Hall Medical Center and Brooke Army Medical Center
Major Julio R. Lairet

- He has served as an EMS Medical Director for pre-hospital care within the Air Force. Major Lairet later deployed serving as a Critical Care Air Transport physician. His most current assignment includes being appointed as the Director of the Enroute Care Research Center co-located at the US Army Institute of Surgical Research (Houston, TX)
Points of Interest

• As of March 1st 2010 research has concluded in the Iraq war
• Research will now focus on the Afghanistan war
• 90% of combat deaths occur quickly
  • (in the pre-hospital setting)
• 30% die in the civilian setting from same types of injury
  • (physiology of death is similar)
A Closer Look At Their Studies

• A “New” Mass Casualty Triage System
  S.A.L.T. Triage
• M.A.R.C.H.
• Sucking Chest Wounds
• Chest Decompressions
• Radial Pulse Character and GCS Motor Scale
• C.P.R. vs. C.C.R.
• Tourniquets
• Permissive Hypotension
• HBOC’s and Volume Expanders
SALT Triage
Military Mass Casualty Triage System

- 3rd Priority
- 2nd Priority
- 1st Priority
- No Priority

- This format has been adopted by several associations and agencies, including (American College of Surgeons, NAEMT, and the CDC)
S.A.L.T. Triage System

• S – Sort
• A – Assess
• L – Lifesaving interventions
• T – Treat / Transport
SALT
3rd Priority

• (Walk)
  • Can they walk to a certain area

LSEMS Mass Casualty Triage Equivalent
GREEN
SALT
2nd Priority

• (Wave)
  • This shows that the patient still has capable mental status

LSEMS Mass Casualty Triage Equivalent
  YELLOW
SALT
1st Priority

• (STILL) –
  • Obvious life threats / patient lies still (immediate attention needed)

LSEMS Mass Casualty Triage Equivalent
RED
SALT
No Priority

- Those who have none of the above
- Considered Deceased
Our Traditional Approach
The A, B, C s

- Problem with this:
  - On the battlefield major trauma leads to perfuse bleeding and a rapid death
  - Based on findings of the war, medics are told to first treat the hemorrhage then focus on other injuries

The M.A.R.C.H. Method
M.A.R.C.H.

- Massive Hemorrhage
- Airway
- Respiratory
- Circulation
- Head Injury / Hypothermia
Sucking Chest Wound

Symptoms:
- Sucking noise from chest
- Frothy red blood from wound
- Difficulty breathing

Treatment:
- Look for entry and exit wound
- Cover holes with airtight seal (plastic, tin foil, ID card)
- Tape down all four sides
- Allow casualty to assume position for easiest breathing, preferably on affected side

Make an airtight seal over wound. Tape down all four sides.
DECOMPRESSION OF THE CHEST

• In the recent past we used 2 ½ inch 14 gauge catheter
• Per research from war, if we continue to use the same catheter we will miss 50% of the time
Chest Wall Thickness Study

- CT scans from 100 virtual autopsy cases were used to determine chest wall thickness in deployed male military personnel
- Measurement was made in the second right intercostal space at the midclavicular line
- The mean horizontal thickness was 5.36 cm
- A 5-cm catheter would reliably penetrate the pleural space in only 75% of patients
- An 8-cm catheter would have reached the pleural space in 99% of subjects in this series
Research shows……

- A SBP of <90 and a Motor Scale of < 6 on the GCS will need life saving interventions 95% of the time

- When neither is present only 25% need life saving interventions

- Motor Component of the GCS has strongest association with severe injury
  - (sensitivity 72%, specificity 96.2%)
C.P.R. or is it C.C.R.

- C.P.R. is quickly becoming **Cardio Cerebral Resuscitation**
  - C.C.R. concentrates more on the idea of perfusing the brain and less on ventilations
  - Many services including the military have stopped using PPV altogether
  - Some only use NRB and allow the negative pressure of compressions to supply the lungs with O2
However military research shows that doing too many chest compressions can be a problem.

Data shows that when we compress greater than 130 times per minute the mortality rate increases dramatically.
Tourniquets….The Long Debate
Tourniquets

- They are saving lives (Surgeons and research show that they do work and work very well)
- They should not be the last resort
- Tourniquets per research can stay on for 2-6 hrs, best time frame is 2 hrs
Iraq War Study

• Research was compiled by Colonel Craig an orthopedic surgeon in the Iraq War
• 232 patients had 428 tourniquets applied on 309 limbs
Results

• Best tourniquets were Emergency & Military Tourniquets “EMT” (92%) - however they were found to be cumbersome
• Combat-Application-Tourniquet “CAT” (79%) – Should be used by pre-hospital in civilian setting
• There were no amputations from tourniquet use
• 97% of tourniquets were indicated
• Only 12 tourniquets applied were not indicated
• Time a tourniquet was used: < 2hrs in 91% of patients
Results

• No pulmonary embolisms were noted
• 10 patients had clots in leg (not caused by the tourniquet, rather the injury itself)
• 3% (4 patients) had nerve palsy from the tourniquet site (all function returned after time)
• Tourniquets can go on side by side to help decrease bleeding even more
Improvised tourniquets (belts, straps, BP cuffs, etc) only worked 25% of the time 

(commercial tourniquets were more effective)
Improvised Tourniquets

Not so good....
Recommendations per Colonel Craig

- Tourniquets should be placed on the injured site prior to shock signs and symptoms
- If placed on after, stats show there was a higher mortality rate
- Only clinically validated tourniquets should be used, no improvised tourniquets
Furthermore Colonel Craig states

- Side by side application is useful to stop distal bleed
- Clothes need to be cut off
- For all deaths, the primary cause was the injury
- No deaths were attributed to tourniquet use
Colonel Craig’s Stats:

• 10 patients had tourniquets placed on after shock symptoms arose,
  • 9 died

• 222 patients had tourniquets on prior to shock,
  • 22 died (10%)

• Conclusion
  • Tourniquets prior to shock not after
Just to be sure......

- In 2009 an RN in the war did the same research and found nearly identical statistics

- Tourniquets prior to shock AGAIN was the conclusion
Iraq War vs. Vietnam Conflict

• (Comparison of tourniquet use) Death Rates
  • 2% died in Iraq vs. 9% in Vietnam
  • Tourniquet should be placed 2-3 inches above the wound
  • In the Iraq and Afghanistan Wars every medic carries 2 tourniquets
How Things Change

- If a distal pulse remains make it tighter
- Mark the time the tourniquet goes on (write directly on the patient)
- Tourniquets used by field medics in war Combat Application Tourniquet (CAT)
- Air Force and Army utilized
Civilian Application

• Tactical EMS
• Farm Accidents
• Homeland Security
• Severe injury with massive bleeding
NOTE

- Gravity can drain blood from distal limb even after tourniquet is applied correctly

- If the tourniquet is too loose or distal pulse remains then veins can and will bulge –

THIS IS WHY IMPROVISED TOURNIQUETS DON’T WORK WELL
Compressible vs. Non-Compressible

- Tourniquets are for “Compressible Injuries”
  - Areas like the limbs

- Non-compressible
  - Areas where it is much harder to apply a tourniquet
    - Axilla and Pelvis
    - Tourniquets are being developed for areas of the axilla and pelvis
      - Built into vest and soldiers’ uniforms
Final Thought:

In surgery, tourniquets are applied for 5 to 6 hours without negative outcomes –why then should we think we would have bad outcomes in the field?
PERMISSIVE HYPOTENSION

- Acute hemorrhage accounts for about 50% of battlefield deaths
- Hemorrhage also accounts for 30% of casualties who die from wounds
- The idea of permissive hypotension may have occurred unintentionally
  - Due to limitations of weight and space, medics were unable to give large amounts of fluid to combat blood loss
  - This was recognized as a possible treatment as early as WWI and WWII
Until recently……

• The standard practice in civilian urban setting was to infuse large volumes of fluid to try to normalize blood pressure

• Today the theory is challenged especially when concerning patients in shock due to penetrating injuries
The Argument

- Resuscitation to baseline or normal BP can:
  - Increase bleeding
  - Worsen outcomes due to severe hemodilution
    - Dilute the blood of its coagulation ability
  - Disrupt newly forming blood clots
    - Popping clots out due to high BP
Studies show….

- In lab animals, restoring blood pressure to a MAP of 40 to 60 mmHg resulted in increased survival vs.
- Restoring BP to a MAP of 80 mmHg or higher
- Remember a MAP of about 65 is necessary to perfuse coronary arteries, brain, kidneys
- Fluids used:
  - LR and HBOCs (usually given in the IO route)

\[ \text{MAP} = \frac{2 \times \text{DBP} + \text{SBP}}{3} \]
Hopes of Limited Volume Resuscitation

- Decreased risk of washing out clots
- Decreased rebleeding
- Decreased risk of hemodilution
- Improved likelihood that injured soldiers will make it to higher levels of care
The Future... HBOCs and Volume Expanders

Hemoglobin Based Oxygen Carrying Solutions

• An attempt to provide an oxygen carrying fluid without having the issues of transfusions
  • Availability
  • Typing
  • Reactions
  • Infection
  • Immune suppression
The Science of HBOC’s
Hemoglobin Based Oxygen Carrying Solutions

• HBOC’s don’t last very long, however in the pre-hospital setting it only needs to bridge a gap until transfusions can be done

• During this “bridge” time the body will begin to compensate and create more red blood cells
  • This decreases the amount that is needed for transfusion
Hetastarch
*Hespan, Hextend*

- Volume expanders
  - (basically liquefied corn starch) used to treat hypovolemia
- Provides the ability to circulate red blood cells that deliver oxygen throughout the body
Science of Volume Expanders

Think Osmosis

- Movement of water from a high water concentration to a region of low water concentration **through a semi-permeable membrane**

Now apply it to the patient

- Patient is bleeding out, volume expanders assist in drawing the blood back into the vessels
In Summary

• Today, through the lessons from war, we have achieved the lowest rate of death related to combat injury in history
• The risk of dying has gone down over the past 50 years
  • 22% in WWII
  • 16% in Vietnam
  • < 10% Currently

• All of which is provided by military medicine
Thanks for your attention!

Please complete the post test and return to administration via interoffice mail or fax to: 352-735-4475 attention Scott Temple

This program is worth 2 CEUs in the Trauma, Operations, or Electives categories

Please specify on your post test where you would like the CEUs to be inserted.