Summary of Lessons Learned in Current Conflicts

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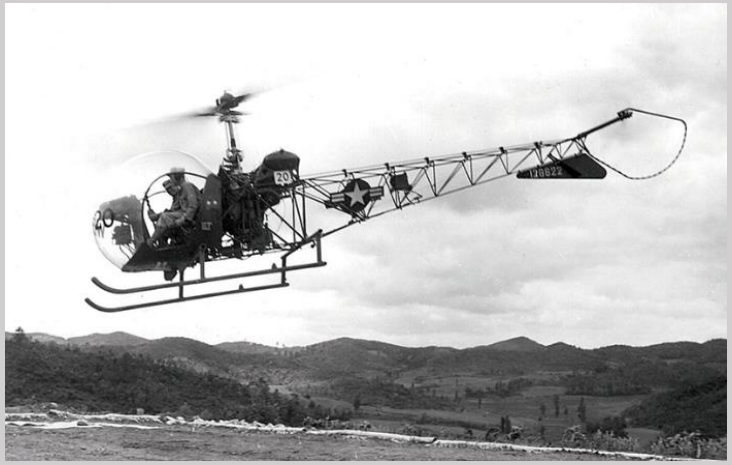
Disclosures

- No COI
- Views are my own

Background

“Medicine is the only victor in war”- Dr. William Mayo

- American Civil War- use of anesthesia during procedures
- World War I- blood transfusions, battalion aid stations, volunteer ambulance attendants
- World War II- antibiotics, fracture treatment and care
- Korean War- helicopter evacuation
- Vietnam War- care during evacuation, burn care



Background

- Global War of Terror (GWOT)
- Began after September 11, 2001
- Spanned multiple conflicts
- Ranging conflict sizes and scopes
- Most recent conflicts where lessons are still being learned

Background

- Various types of mechanisms were seen during conflicts
  - Penetrating fragment wounds
  - Burns
  - Toxic inhalations
  - Blasts
  - Kinetic collisions

Summary of Lessons Learned

- Decades of innovation and experience only a small percentage are represented here
- How we treat patients
- Evolution in care during current conflicts

Blood Administration- Background

- Fresh whole blood (FWB) use was described in WWI
- Cold stored low-titer type O WB (CS-LTOWB) (anti-A and anti-B <1:256) transfusions were first used during the Korean and Vietnam Wars
- Component transfusions (1960) and crystalloid replaced whole blood transfusions over time
- Component blood was used in hospitals more to “give patients just what they needed”
- Red cross began stocking component therapies

Blood Administration- Background

- Studies into the use of crystalloid were often misinterpreted leading to protocols de-emphasizing early use of any form of blood products in the hemorrhaging patient
- Little evidence actually supporting movement away from whole blood
- Crystalloids gained favor in the initial resuscitation of trauma patients (2L) but was found to lead to increased complications and poorer outcomes

Blood Administration- Start of Conflict

- At the time of the start of GWOT
- ATLS guidelines recommended 2L crystalloid administration for hemorrhaging patients
- Then, move on to type specific components

Blood Administration- During Conflict

- During GWOT research into current practice led to significant changes in the way patients are resuscitated
- Shortly after the start of the conflict, research into whole blood administration was conducted
- 2016- US DoD approves WB use
- ROLO program
- Walking blood banks
- Improved patient survival
- Novel ways to supply blood with limited re-supply/storage, FDP
- Civilian applications increasing in hospital and prehospital

Summary of Blood Administration to Present Day

1914-1918	World War I ▪ ABO typing & blood storage developed ▪ Military whole blood (WB) transfusion begins
1939-1945	World War II ▪ WB transfusion continues alongside plasma & albumin ▪ Civilian donation supports war effort
1950-1953	Korean War ▪ Logistical challenges of distant theater hinders blood delivery
1959-1975	Vietnam War ▪ Blood component therapy (BCT) improves supply chain ▪ WB relegated for platelets and coagulopathy treatment
1975-2012	Civilian Transition to BCT ▪ WB eliminated from civilian procurement & therapies
2001-2016	Operations Enduring Freedom & Iraqi Freedom ▪ Platelet logistic challenges renew WB interest ▪ 2/2016: Dept. of Defense approval for LTOWB use
2016-present	Select Civilian Trauma Centers Adopt WB Transfusion ▪ Initial utilization of low titer O- WB ▪ Transition to low titer O+ WB and introduction of prehospital use

Blood Administration Lesson Learned

WB is a safe and effective resuscitation strategy, alternative products may be required to supplement

Tourniquets- Background

- 4th century BC tourniquets (TQ) were used during Alexandar the Great's military campaigns
- Romans used TQ during surgical procedures including amputations
- 1700s led to design innovations to improve efficiency, Royal Navy issued to every sailor
- 1800s reports of "bloodless surgical fields"
- 1904 pneumatic TQ to decrease risk of nerve palsy

Tourniquets- Background

- After WWII, TQ use in military conflicts declined due to observed increased tissue injury and longer transport times
- Some reports of TQ use in Korea and Vietnam
- 1987- IDF emergency TQ use policy during care under fire
- 1993- further evidence for TQ use in hemorrhage control was presented and a systemic approach for TCCC was advocated for
- Limited civilian TQ use due to perceived shorter transport times and concern for risk of complications

Tourniquets- Start of Conflict

- At the time of GWOT there was increasing data and support to increase TQ innovation to minimize complications while using TQ earlier in hemorrhage control to improve outcomes
- Civilian applications were limited

Tourniquets- During Conflict

- With early observance of death due to uncontrolled extremity hemorrhage, TQ use increased by almost tenfold from 2001 to 2010
- TQ saved 2,000 lives between 2005 and 2011
- Mainstream military use early in MARCH
- Civilian agencies increased the use of TQ and some police departments also have TQ in use
- TQ use more recently with prolonged application times, hyperkalemia, tissue damage

Tourniquets Lesson Learned

TQ are effective at preventing death from extremity hemorrhage and require proper training and application

Hemostatic Dressings- Background

- 1909 studies into the use of fibrin in bleeding wounds was studied with powder in an operative field
- WWI form of dry fibrin hemostatic product was used by trauma surgeons
- 1944 combination of fibrinogen and thrombin used in wound healing but with poor adhesion
- During World War II, fibrin glue, fibrin sheet foam, and fibrin powder were mass-produced from pooled plasma, but were withdrawn in 1946 because they transmitted hepatitis

Hemostatic Dressings- Background

- Subsequently, in 1977, all pooled human plasma fibrinogen products, including a commercial liquid FS preparation that was licensed in Europe, were recalled by the FDA because of the high risk of hepatitis transmission
- 1996 no hemostatic agents included in trauma care guidelines
- 2000 increased R&D into novel hemostatic agents and efficacy

Hemostatic Dressings- Start of Conflict

- At the time of GWOT, few hemostatic agents were developed, or researched
- Civilian application was not common practice

Hemostatic Dressings- During Conflict

- Early 2000s- investment into the study of novel hemostatic agents (zeolite, Kaolin, etc)
- 2003 hemostatic dressings become part of TCCC guidelines
- 2003-present- continued research, development, and innovation of products
- 2006 hemostatic agents included in prehospital trauma life support manual
- Research demonstrates less blood loss with the use of hemostatic agents and more favorable outcomes
- Hemostatic dressings increase in civilian prehospital and common in hospital use

Hemostatic Dressings Lesson Learned

Hemostatic dressings are more effective than gauze alone at lessening bleeding

Forward Surgical Support- Background

Where there is conflict, there is injury and the need for treatment

- Egypt 1600 BC texts describe wound care, splinting and hemorrhage control
- Roman military medicine focused on sanitary conditions during procedures
- Lessons from the Romans were lost in the Middle Ages where treatments were based on astrology and humors and medical care was provided by camp followers
- The eighteenth century saw great advances with the invention of tourniquets and forceps to remove bullets and fragments. This period also saw the publication of books on military medicine
- The Napoleonic wars brought the concept of triage and carriages designated for removing the wounded from front lines

Forward Surgical Support- Background

- The hospitals set up immediately behind the lines were often housed in tents during the First World War, including wards and operating theatres. This was also true of Casualty Clearing Stations, with base hospitals further away from the fighting sometimes making use of existing or more permanent buildings
- WWII- At the fighting fronts, a Second World War casualty received specialist treatment more quickly than during the First World War. Specialist surgical facilities were closer to the front line and transport was by motor vehicle, sometimes even by air
- The Korean War saw the use of Mobile Army Surgical Hospitals (MASH)
- Vietnam- Continued surgical support presence
- 1980s and 1990s- training and equipping surgical support for more forward environments

Forward Surgical Support- Start of Conflict

- At the start of GWOT, the presence of trained and equipped forward surgical teams was limited for the new battlefield

Forward Surgical Support- During the Conflict

- At the start of GWOT, truly mobile surgical support for the new battlefield was limited
- Rugged terrain led to delays in hemorrhage control of wounded warfighters
- Oct, 2001- SOCOM recognized the need for forward surgical support and were re-assigned component branches' smaller surgical teams
- 2003- First Air Force SOSTs were operational
- Evidence that troops in Iraq were receiving definitive stabilization faster than those in Afghanistan due to hospital transport times led to investment in additional forward surgical care

Forward Surgical Support- During the Conflict

- Jan, 2009- Secretary of Defense Gates mandated prehospital helicopter transport of critically injured combat casualties in 60 minutes or less
- Proliferation and expansion of forward surgical teams
- Expanded capabilities and expertise led to improved patient outcomes in austere environments
- More recently, surgical teams are operating in contested environments with prolonged transport times and adopting new training and strategies for improving care, integration of civilian health system

Forward Surgical Support Lesson Learned

The presence of adaptable medical elements to conflicts can save lives

Damage Control Interventions- Background

- Damage control is a Navy term defined as “the capacity of a ship to absorb damage and maintain mission integrity”
- In the later part of the 18th century during the Napoleonic campaign, the French surgeon Larrey succinctly alluded to the rationale for expedited battlefield procedures
- Military historical references to the techniques of damage control surgery in the United States appear around the time of the US Civil War
- Reports from WWII on rapid control of bleeding to prevent “the wet lung of war”

Damage Control Interventions- Background

- In the Vietnam War, it was recognized in several case series that temporizing surgical procedures often demonstrated a survival advantage when compared to definitive surgical therapy
- 1983- Stone et al described abbreviated celiotomy in patients with abdominal injury with associated coagulopathy and hypothermia
- 1976- Concepts of damage control procedures described in address to AAST by Lucas and Ledgerwood (packing of major liver injuries)
- 1993 Schwab et al adopts the term “damage control” to the field of traumatology- arresting surgical hemorrhage, containing gastrointestinal spillage, inserting surgical sponges and applying a temporary abdominal closure

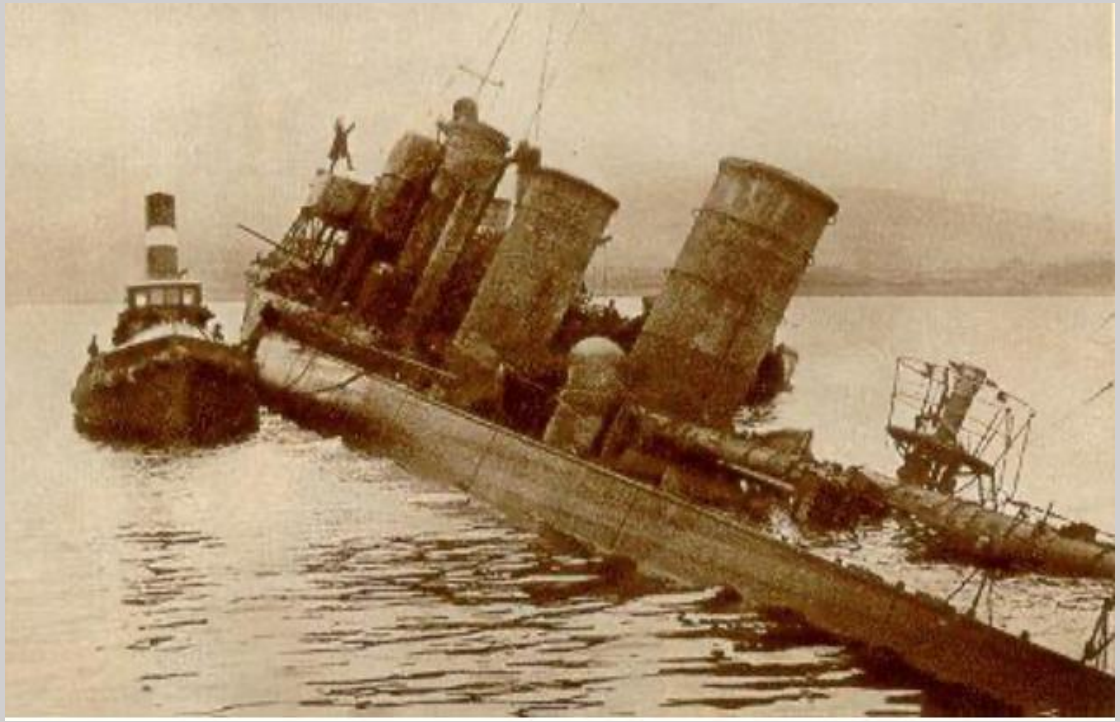
Damage Control Interventions- Start of Conflict

- At the start of GWOT, there was some increased civilian use of DCS mostly in exploratory laparotomy from trauma, however, debates remained on the efficacy and outcomes
- Coagulopathy correction (DCR) in civilian settings was using crystalloid and then component therapy primarily

Damage Control Interventions- During Conflict

- 2006- research into the proliferation of previously described civilian damage control surgery is performed looking specifically at forward surgical teams
- Patients are receiving DCR and DCS in country and then being evacuated for further definitive interventions
- Returning war surgeons and physicians bring DCR and DCS techniques back from the battlefield and rise in use in civilian centers as well as an expanded approach to DCR with the recognition of the importance of calcium
- Changing approaches to surgical techniques in prolonged holding scenarios (second looks, etc)

Damage Control Interventions Lesson Learned



For severely injured patients, DCR and DCS improves outcomes, flexibility in approach required

Evacuation and En Route Care- Background

- Since the earliest conflicts, transporting the wounded off the battlefield has presented unique problems
- The Greeks and Romans had limited evacuation capability if the casualty could not move under their own power
- Napoleonic wars brought about a focus on timely movement of casualties to surgical personnel
- Mid 1800s- most militaries had some form of evacuation system
- Aerial evacuation came to prominence in Korea and Vietnam wars
- 1988- Col. PK Carlton and Maj. Chris Farmer conceptualize critical care air transport teams (CCATT)
- 1992- written conceptualization by Maj Jay Johannigman
- 1990s first CCATT deployments and further refinements of teams and composition

Evacuation and En Route Care- Start of Conflict

- At the beginning of GWOT, CCATT teams were small in number

Evacuation and En Route Care- During Conflict

- CSTARS are developed throughout the US including the CCATT training center at the University of Cincinnati
- Complexity of cases transports increases to include CRRT and ECMO as well as complex burns
- 2012- TCCET utilized for flights requiring more forward critical care
- 2018- increasing numbers of CCATT
- CCATT provides a model for civilian applications of critical care evacuation in disaster areas and austere locations
- CCATTs assist with specialty transports of military and civilian personnel
- Most recent conflicts utilize multi-domain and flexible forms of evacuation

Evacuation and En Route Care Lesson Learned

Medical personnel are capable of performing complex treatments in a variety of moving environments and require training and preparation to do so

Partnerships- Background

- 1939- first meeting of the AAST recognizing the significant role war has played in trauma surgery
- Post WWII- the Excelsior Surgical Society was formed to maintain lessons learned
- 1977 GSACEP founded
- 1987 SOMA founded
- 1992- AAST lecture on the importance of synergy between military and civilian surgeons
- 1993- first meeting that would become MHSRS

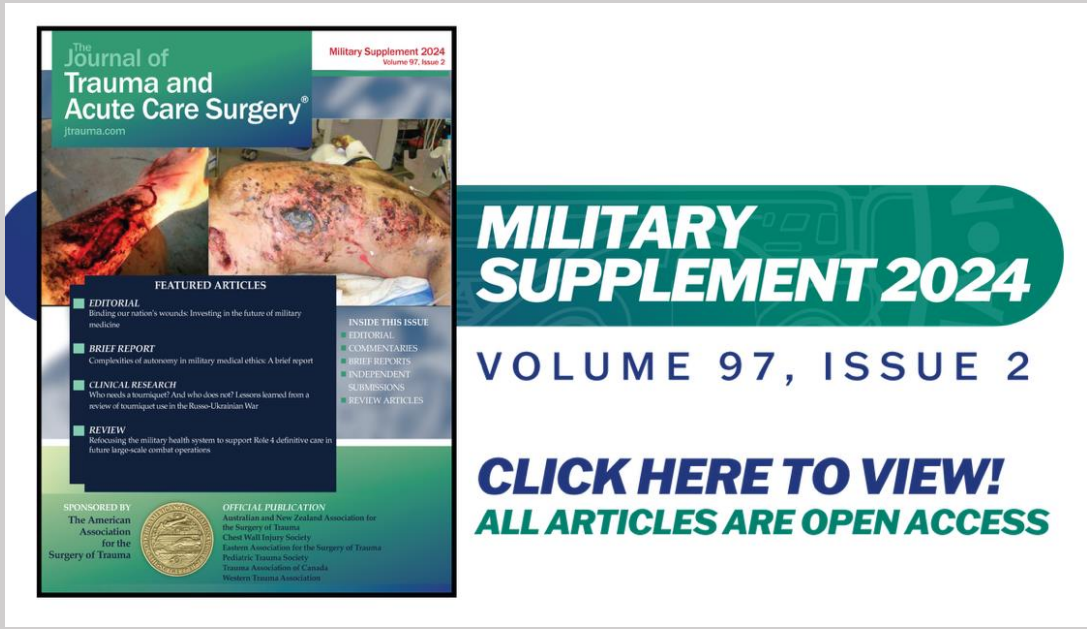
Partnerships- Start of Conflict

- At the start of GWOT, smaller, component meetings and some participation in national “civilian” organizations existed

Partnerships- During Conflict

- GWOT brought about the growth of uniformed chapters within multi-disciplinary organizations
- 2012- Expansion of MHSRS to include international participation and expertise
- 2015- ESS is re-established
- Addition of CSTARS sites across the US along with other expanded military/civilian partnerships
- Military members speak of research, evidence, and experiences at many different conferences and meetings
- Continued advancement in active-duty military members in leadership positions in international societies
- Gatherings and international partnerships expand knowledge and preparation

Partnership Lesson Learned



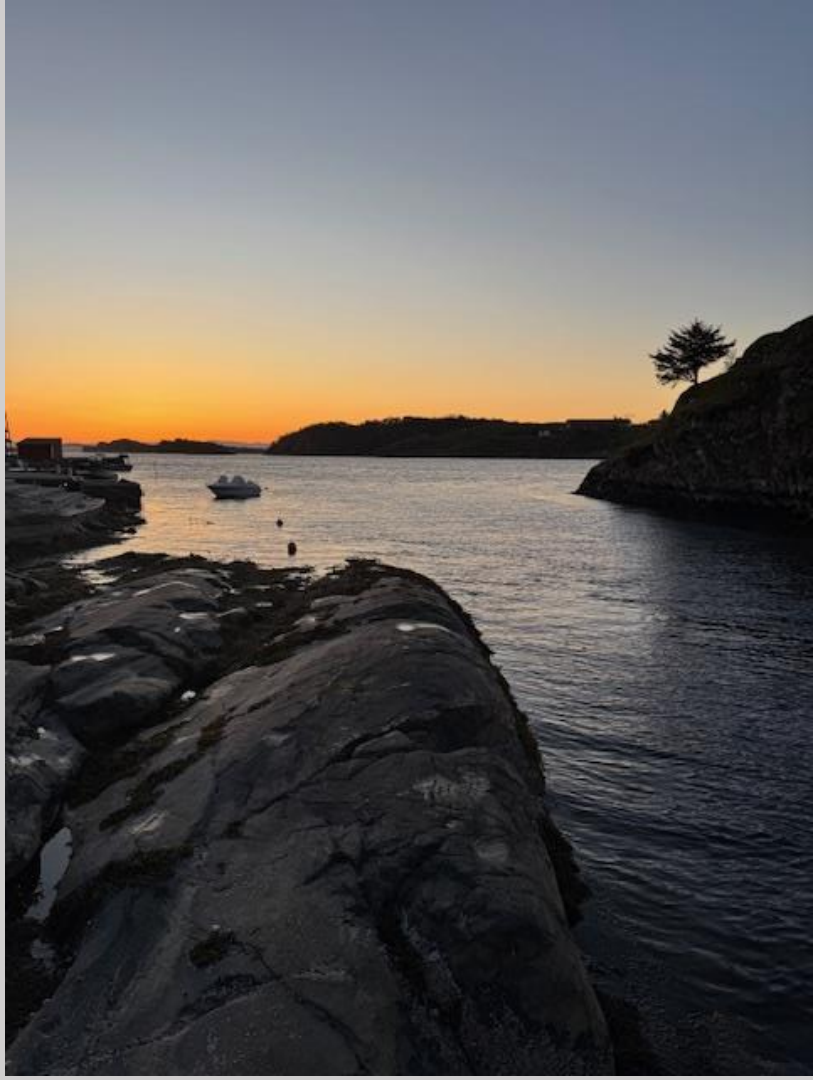
Organizational partnerships pass on lessons learned and facilitate future innovations

A Word on Ongoing Conflicts that Challenge Previous Experiences

- Contested medical operations and prolonged evacuations
- Rise of real time innovation based on experiences
- Flexibility of MEDEVAC capabilities
- Integration of military and civilian healthcare
- Medical support for the morale and effectiveness of the armed forces
- Secondary hyperkalemia and tissue damage from TQ- training and use

The Lessons I Learned

- Question more, write those questions down, and study them
- Take every opportunity to be brave
- Relationships will allow us to learn from previous conflicts and prepare for future conflicts
- All types of clinicians and researchers/developers must work together and learn from each other to innovate for the future battlefield. We all have something to teach and something to learn
- More injured die early in conflict because we forget the lessons of the past as we prepare for the future



"You must give some time to your fellow man. Even if it's a little thing, do something for those who have of help, something for which you get no pay but the privilege of doing it. For remember, you don't live in a world all your own. Your brothers are here, too." Albert Schweitzer

Thank You