Military Trauma Systems in Combat: The Power of Data in Performance Improvement and Clinical Practice Guidelines

David J. Smith, Jr., M.D.
Professor and Director, Division of Plastic Surgery
Department of Surgery
University of South Florida Morsani College of Medicine
CEO, CAMLS (Center for Advanced Medical Learning & Simulation)

Adjunct Professor of Surgery
Department of Surgery at
Uniformed Services University
and
Walter Reed National Military Medical Center
Performance Improvement

- What is Performance Improvement?
  - A process that continuously measures, evaluates, and improves care
- Includes the concept of “patient safety”
  - Institute of Medicine’s 1999 report: “To Err Is Human: Building a Safer Health System”
  - “…errors are caused by faulty systems, processes, and conditions that lead people to make mistakes or fail to prevent them.”
  - Non-system: decentralized fragmented care delivery
    - multiple providers
    - different settings
    - incomplete information
  - At particular risk:
    - Operating Rooms
    - Critical Care Wards
    - Trauma and Emergency Departments
Lessons Learned in Combat

• Nickolay Pirogoff (1810-1881) Russian Army surgeon in the Crimean War.
  “War is an epidemic of trauma.”

• Vladimir Oppel (1872-1932) Russian Army Surgeon.
  • Continental trauma system – “[t]he wounded patient needs to undergo the right operation at the right time and in the right place.”
Brief Evolution of Trauma Care Systems

  – Trauma as a public health concern
  – Development of formal trauma centers

• 1976: American College of Surgeons publishes trauma systems guidelines
  – Optimal Resources for the Care of the Injured Patient
  – Tiered trauma systems

• 1978: Advanced Trauma Life Support
  – Improved standards of care for injured
  – Adopted by ACS 1980
  – Taught internationally today
Brief Evolution of Trauma Care Systems

• 1987: ACS Committee on Trauma
  – Verification and Consultation program

• 1990: US Military Operation Desert Shield and Desert Storm
  – Lessons learned
  – Government Accounting Office critical review of DoD medical response
• Joint Theater Trauma System
  – Development based on trauma care system
  – Created out of principle of “Right Patient, Right Place, Right Time”
  – Initially created May 2004

• Recommend improvements to the trauma system to:
  a) optimize placement of surgical assets
  b) decrease number of surgical sites within the theater.
  c) develop triage criteria for casualty evacuation
  d) develop and implement trauma practice guidelines
• Review and maintain the following:
  a) JTTR
  b) Morbidity and mortality reports shared between institutions
  c) Operative case reports

• Develop clinical information management scheme

• Implement a system of continuous performance improvement
### Table 4: Trauma System Organization

<table>
<thead>
<tr>
<th>Civilian Trauma System Components</th>
<th>Military Trauma System Components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>National/federal level</strong></td>
<td><strong>Department of Defense, Health Affairs, Joint Surgeon’s Office</strong></td>
</tr>
<tr>
<td>American College of Surgeons, Committee on Trauma</td>
<td>- Joint Theater Trauma Registry</td>
</tr>
<tr>
<td>- Registry (NTDB)</td>
<td>- Defense Medical Readiness Training Institute/Combat Trauma Surgery Committee/Committee on Tactical Combat Casualty Care</td>
</tr>
<tr>
<td>- AAST/EAST/WEST (academic organizations influencing trauma care)</td>
<td>- Combatant Command (CENTCOM)</td>
</tr>
<tr>
<td><strong>State/command level</strong></td>
<td></td>
</tr>
<tr>
<td>State Trauma System</td>
<td>- Joint Theater Trauma System (JTTS)</td>
</tr>
<tr>
<td>- State Director (Texas: Governor’s EMS and Trauma Advisory Committee Chair)</td>
<td></td>
</tr>
<tr>
<td>- State registry</td>
<td></td>
</tr>
<tr>
<td>- State Trauma System Plan</td>
<td></td>
</tr>
<tr>
<td><strong>Regional level</strong></td>
<td></td>
</tr>
<tr>
<td>Regional Trauma Areas</td>
<td></td>
</tr>
<tr>
<td>- registry Area of Responsibility (Operation Iraqi Freedom, Operation Enduring Freedom [Afghanistan])</td>
<td></td>
</tr>
<tr>
<td>- JTTR-derived AOR data</td>
<td></td>
</tr>
<tr>
<td><strong>Local level</strong></td>
<td></td>
</tr>
<tr>
<td>Lead Trauma Center</td>
<td></td>
</tr>
<tr>
<td>- trauma registry JTTS Leadership</td>
<td></td>
</tr>
<tr>
<td>- local trauma database, begin capture JTTR data</td>
<td></td>
</tr>
<tr>
<td><strong>Local/regional components</strong></td>
<td></td>
</tr>
<tr>
<td>Regional Advisory Council</td>
<td></td>
</tr>
<tr>
<td>- RAC Chair</td>
<td></td>
</tr>
<tr>
<td>- Rural/Urban Organizations</td>
<td></td>
</tr>
<tr>
<td>- EMS (ground/air)</td>
<td></td>
</tr>
<tr>
<td>- Hospital reps, all Levels</td>
<td></td>
</tr>
<tr>
<td>- PI/Comm/Rehab/Prev</td>
<td></td>
</tr>
<tr>
<td>MEDCOM/CENTAF/MEF Surgeon</td>
<td></td>
</tr>
<tr>
<td>- JTTS director</td>
<td></td>
</tr>
<tr>
<td>- Level II/III facilities</td>
<td></td>
</tr>
<tr>
<td>- Level I/Medevac Battalion</td>
<td></td>
</tr>
<tr>
<td>- Level II/III facilities</td>
<td></td>
</tr>
<tr>
<td>- PI/Comm/Prev</td>
<td></td>
</tr>
</tbody>
</table>

DOD Trauma Registry
Where Does the Data Come From?

Out of Hospital Cell

Role 1

"S&E"

"Web"

In Hospital Care TNCs

Camp Bastion | KAF | BAF

Role 2 & Role 3

Role 4 - OCONUS

Echelon 5 - CONUS

TMDS
AARs
PHTR
PECC
PCRs

Courtesy LTC(P) Jennifer Gurney, JTS Chief, Trauma Systems Development
DOD Trauma Registry

- Information captured
  - demographics
  - injury-producing incident
  - diagnosis and treatments outcomes of injuries
  - US/Non-US military and US/Non-US civilian personnel
  - Includes point of wounding to final disposition

- DODTR Reports:
  - Epidemiology of injury
  - Injury scoring reports
  - Mechanism of injury
  - Complication rates, systems events
  - Unique injury populations
  - Patient movement thru system
• DODTR enables:
  – Injury prevention
  – Community outreach
  – Training and education priorities
  – Performance improvement activities
  – Research
Maughon – *Mil Med* 1970 – Vietnam:
• 193 Extremity Hemorrhage Deaths / 2600 Battlefield Deaths = 7.4%

Kelly – *J Trauma* 2008 – Afghanistan and Iraq:
• 77 Extremity Hemorrhage Deaths / 982 Battlefield Deaths = 7.8%

Eastridge – *J Trauma* 2012 – Afghanistan and Iraq:
• 119 Extremity Hemorrhage Deaths / 4596 Battlefield Deaths = 2.6%
• CPG Evolution: Dismounted Complex Blast Injury:

Figure 8. Monthly OEF massive transfusions. Left axis represents # units of blood. (DEC01 – DEC10)

Dismounted Complex Blast Injury
High Bilateral Amputations and Dismounted Complex Blast Injury

BACKGROUND

The Discounted Complex Blast Injury (DCBI) injury pattern consists of (generally proximal) bilateral lower extremity amputations with associated pelvic/perineal injuries and frequently also includes upper extremity injuries which may be bilateral but most commonly involve the left side due to weapon carrying stance at the time of injury as well as frequent thoracoabdominal or neurovascular injuries. DCBIs represent one of the most challenging cohorts of surgical patients from management of the initial injury through definitive reconstruction. These injuries are associated with a high incidence of both morbidity and mortality. Survival is initially dependent upon hemorrhage control and massive transfusion and resuscitation protocols. A coordinated team approach is essential to provide simultaneous, multiorgan management, volume resuscitation (ideally with Whole Blood (WB) or RBC transfusion), and immediate control of life threatening hemorrhage. Later risks for mortality include sepsis and multisystem organ dysfunction. These injuries can broadly be divided into two categories; those with a pelvic/pelvic floor injury and those without. Counterparts or similar injuries in civilian trauma remain rare. An organized aggressive continuum of care from the Point of Injury (POI) onwards by medics, anesthesiologists, general and orthopedic surgeons and intensivists is critical to optimize outcomes.

EVALUATION AND TREATMENT

INITIAL RESUSCITATION

These patients typically arrive in extremis shortly after injury. Tourniquets are often in place on all injured extremities. Due to profound shock and associated upper extremity amputations, IV access may not be obtained in the field. Rapid placement of infra-Osseous (IO) lines is sometimes useful adjacent to skin resuscitation prior to venous access. Large bore central venous access should be considered early and placed by an experienced proceduralist. This injury pattern mandates immediate activation of massive transfusion protocols, the preferential use of fresh packed red blood cells (< 21 days old), minimal use of crystalloid products, and early consideration for the use of WB if blood resources are limited. Refer to the Damage Control Resuscitation (DCR) and WB Transfusion CPG for specific recommendations.

ROLE OF RESUSCITATIVE THORACOTOMY

Occasionally these patients arrive with CPR in progress. When signs of life are present, consideration of resuscitative thoracotomy should be given according to established CPGs. Outcome data from Orr suggest a reasonable survival rate in properly selected patients. Another alternative described with exsanguination in civilian extremity injuries is the use of a brief period of CPR with concomitant massive blood product resuscitation before resorting to a resuscitative thoracotomy. A review of the Department of Defense Trauma Registry (DoDTR) in 2011, suggests the mortality associated with bilateral high amputations, pelvic injury and emergency department thoracotomy is very high (≈90%). Experienced military surgeons doubt the optimal approach to prevent ongoing hemorrhage in this population – thoracic, distal aortic or bilateral iliac proximal vascular control. Endovascular aortic balloon occlusion may offer an elegant alternative for proximal vascular control in the future.

TRIAGE CONSIDERATIONS

These patients can consume massive amounts of blood products and utilize multiple surgical tools to include operative teams, equipment and operating hours. In multiple casualty scenarios, a prudent assessment of resource allocation should be done prior to proceeding with resuscitative thoracotomy.
Outcomes

Images from the Borden Institute’s “Care of the Combat Amputee”, Chapter 21, 2017.
- Surgical training still a dilemma
  - Progressive responsibility still the norm
  - Chronology emphasized over performance
- Need to consider evaluation of proficiency of those already in practice
Benefits of Metrics-Based Approach in Establishing a Framework for Surgical Education

- Requires definition of measurable observable performance criteria
- Standardizes performance across learners
- Learners progress based on accomplishment of specific performance measures
- Allows deliberate practice with feedback for self-correction of errors
- Shorten training time for learners and more effective transfer of learning
- Potential use in summative evaluation for high-stakes assessment
The medical education system 100 years out of date

- Halstedian system cannot survive the contemporary pressures on graduate surgical education

Service vs. education

- Huge increase in service load
- Surgical divisions have increased in size - was 2-3 attending's, now 7-10 are normal
## Structure vs. Competency Based Education

<table>
<thead>
<tr>
<th>Variable</th>
<th>Educational Program Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Structure/Process</td>
</tr>
<tr>
<td>Driving force for curriculum</td>
<td>Content-knowledge acquisition</td>
</tr>
<tr>
<td></td>
<td>Teacher</td>
</tr>
<tr>
<td></td>
<td>Hierarchical</td>
</tr>
<tr>
<td></td>
<td>(Teacher → student)</td>
</tr>
<tr>
<td>Driving force for process</td>
<td>Outcome-knowledge application</td>
</tr>
<tr>
<td>Path of learning</td>
<td>Learner</td>
</tr>
<tr>
<td>Responsibility for content</td>
<td>Non-hierarchical</td>
</tr>
<tr>
<td>Goal of educ. encounter</td>
<td>(Teacher ↔ student)</td>
</tr>
<tr>
<td>Typical assessment tool</td>
<td>Student and Teacher</td>
</tr>
<tr>
<td>Assessment tool</td>
<td>Knowledge application</td>
</tr>
<tr>
<td>Setting for evaluation</td>
<td>Multiple objective measures</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Authentic (mimics real tasks of profession)</td>
</tr>
<tr>
<td>Timing of assessment</td>
<td>“In the trenches” (direct observation)</td>
</tr>
<tr>
<td>Program completion</td>
<td>Criterion-referenced</td>
</tr>
<tr>
<td></td>
<td>Emphasis on formative</td>
</tr>
<tr>
<td></td>
<td>Variable time</td>
</tr>
</tbody>
</table>
Proficiency-Based Progression

- Focus on skillset and documenting proficiencies
- Determines what proficiency measures are necessary to complete a curriculum
- Challenge is to develop proficiency-based measures
- There is a difference between proficiency and competency
Developed by a tri-service team of 14 military surgeons with deployment experience facilitated by the ACS

Educationally based methodology exportable to all critical specialties
• Four Key Elements
  – Periodic assessment of knowledge and abilities aligned with a relevant curriculum;
  – Pre-deployment assessment of procedural skills;
  – Appropriate remediation when necessary focused by the above assessments;
  – Development of a measurable “readiness” value of pre-deployment practice.
• Offsets:
  – Reduced need for pre-deployment trauma training if surgeon is deemed proficient
  – Standardizes requirement for existing Tier 3 trauma preparation courses
  – Provides majority of self assessment CME
A NATIONAL TRAUMA CARE SYSTEM
Integrating Military and Civilian Trauma Systems to Achieve ZERO Preventable DEATHS After Injury