Defense Health Board

Combat Trauma Lessons Learned from Military Operations of 2001-2013

March 9, 2015

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
HEALTH AFFAIRS
7700 ARLINGTON BOULEVARD, SUITE 5101
FALLS CHURCH, VA 22042-5101

DEFENSE HEALTH BOARD

March 9, 2015

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE (PERSONNEL AND READINESS)

SUBJECT: Combat Trauma Lessons Learned from Military Operations of 2001-2013 Report

The Defense Health Board (DHB) is pleased to submit its report on Combat Trauma Lessons Learned from Military Operations of 2001-2013, attached.

On May 18, 2012, the Acting Under Secretary of Defense for Personnel and Readiness requested that the DHB develop a Theater Trauma Lessons Learned document summarizing lessons learned from the conflicts in Iraq and Afghanistan and recommend strategies for preserving these lessons in future conflicts. The DHB tasked its Trauma and Injury Subcommittee with conducting a review, summarizing the key lessons, and developing a strategy for their preservation for the Board's consideration.

The Subcommittee examined the findings and recommendations of other expert groups that have reviewed lessons learned in the delivery of trauma and injury care over the past two conflicts. The Subcommittee also reviewed relevant peer-reviewed literature and conducted panel discussions with the Surgeon Trauma Consultants.

On behalf of the DHB, I appreciate the opportunity to provide the Department of Defense with this independent review of combat trauma lessons learned.

Nancy W. Dickey, M.D.
President, Defense Health Board

Attachments:
As stated

cc:
ASD(HA)

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EXECUTIVE SUMMARY

The survival rate of Service members injured in combat has significantly improved during the recent decade of military conflict due to advances in trauma care and knowledge gained by medical personnel in the pre-hospital far forward environment. As the wars in Iraq and Afghanistan wind down, the Department of Defense (DoD) recognizes the importance of learning from these conflicts and preserving the advances in trauma care achieved in both theaters. On May 18, 2012, the Acting Under Secretary of Defense for Personnel and Readiness (USD(P&R)) requested that the Defense Health Board (DHB) develop a Theater Trauma Lessons Learned document summarizing lessons learned from the conflicts in Iraq and Afghanistan and recommend strategies for preserving these lessons in future conflicts. The DHB tasked its Trauma and Injury Subcommittee with conducting a review, summarizing the key lessons, and developing a strategy for their preservation for the Board's consideration. Combined, the members of the DHB Trauma and Injury Subcommittee have decades of experience in the fields of civilian and military emergency, trauma, and casualty care.

The Subcommittee noted that several expert groups have already been convened to review lessons learned in the delivery of trauma and injury care over the past two conflicts. It examined the findings and recommendations of these groups, reviewed the relevant peer-reviewed literature, and conducted panel discussions with the Trauma Consultants to the Surgeons General. The assessments and recommendations of these groups provided useful guideposts and a foundation for this review, which provides additional recommendations. The DHB endorses and repeats many of the conclusions drawn by these expert groups. The Subcommittee formed its recommendations based on available information and its expert judgment. The report is organized around the themes of DoD systems for trauma care, communications, informatics, performance improvement, training, and research and clinical investigation.

Members initiated the review by discussing an overarching goal for DoD in any theater, as described by the Joint Trauma System:

"Right patient, right place, right time, right care"[1 (p.5)]

Department of Defense Trauma System

Early in the recent conflicts, deploying U.S. forces included the embedded medical response and footprint specific to each Service. This reflected the organization of trauma care in prior conflicts. Individual Service medical missions, leadership, and support needed to mature, as the rest of the theater had, but no Joint plan had been developed to create and support this environment. In 2004, U.S. Central Command (CENTCOM) created a formal military trauma care system in its theater of combat operations, designated as the Joint Theater Trauma System (JTTS). JTTS originally focused on care of the injured within the theater and at the primary out-of-theater receiving military

treatment facility, located at Landstuhl Regional Medical Center, Germany. The system was ultimately expanded to include Continental U.S. and Department of Veterans Affairs facilities.

Lesson 1: *Despite vast improvements in the military trauma care system over the past decade, there is no unifying agency with oversight over all aspects of the combat casualty care system.*

The DHB concurs with the assessment of the U. S. Military Joint Trauma System Assessment team regarding the need for a lead agency for the combat casualty care system.

> **Recommendation 1.1:** Establish a senior level organization, such as the Defense Health Agency (DHA), as the lead agency for oversight of trauma care.

A single lead agency of the trauma system should have oversight of trauma care. This agency should also continually assess the system's structure, function, resources, and outcomes, and be enabled to recommend policy or guidelines based on analysis of these assessments, thereby standardizing trauma care across DoD. The lead agency must assure optimal system function through the measurement of both system and component performance against established benchmarks through a verification process that provides objective, external review of capability and performance.

In addition, the influence of the Joint Trauma System (JTS) should be more clearly and visibly articulated as the overarching system of trauma care across all combatant commands. Lessons learned through JTTS or any subsequent combatant command (COCOM) efforts should be fed up to JTS and disseminated to all global operations. A lead agency would facilitate multi-directional communication across the Services and COCOMs.

> **Recommendation 1.2:** Establish the JTS, in its role as the Department of Defense Trauma System (DoDTS), as the lead agency for trauma in DoD with authority to establish and assure best-practice trauma care guidelines to the Director of the DHA, the Services, and the Combatant Commanders.

Lesson 2: *At the onset of the current conflicts, communication, coordination, and command and control of and among levels of care and personnel across the Services under Combatant Command control were not well coordinated, trained for, or implemented consistent with practices in civilian centers and systems.*

The Surgeons General have primary oversight of health care policy in their respective Services, while combatant unit commanders control the time, budget, personnel, training, and equipment for trauma care. Each line commander has a medical advisor. However, the advisor to the line commander may have variable experience in combat casualty care and may not be current in either tactical combat casualty care (TCCC) or clinical practice guidelines (CPGs).

The patient load and capabilities of military treatment facilities which are primary receiving centers for wounded Service members may vary over time with the level and duration of sustained combat operations and geographic proximity to a combat theater. Thus, relationships with civilian medical facilities are essential to maintain the trauma care skills of military medical personnel during the interwar periods of decreased trauma patient load. These relationships will help ensure military medical facilities have the inherent capability to rapidly respond to changing trauma care demands when needed.

Recommendation 2: Responsibilities of the Service Command:

a. Unit surgeons* or the medical advisor for the line commander shall be fully competent in the recommended professional and practice standards as promulgated by the proposed DoDTS (at the writing of this report, it would be the TCCC Guidelines and DoDTS CPGs).
b. Combatant Command Surgeons shall report their expectations, including evacuation times, CPGs, and integration to JTS and the DoD Trauma Registry (DoDTR).

This capability and readiness should endure during times of both war and peace. Knowledge gathered, assessed, and reported out by DoDTS will ensure that state-of-the-art practices are disseminated to COCOMS in a timely manner. Conversely, COCOMs should ensure that data and experiences in theater are communicated in a systematic way to DoDTS.

Communications

Lesson 3: *At the beginning of the conflicts, communication and specifically clinical patient information was difficult to transmit among levels of care.*

Lack of or poor communication can lead to a less than ideal state in which treatment facilities become overwhelmed due to inadequate information about incoming medical needs and current facility capabilities. Insufficient access to basic information pertaining to the number, severity, and types of injured can result in suboptimal care following transport. As such, sharing lessons learned is an essential step toward maintaining the trauma advances achieved during the recent conflicts. For example, as a conflict begins in a new theater, communication of this type may be immature, and every effort to mitigate poor communication should be undertaken.

Recommendation 3.1: DoD shall establish and promote a Joint Trauma Medical Communications and Information Director to work with the JTS, who has the authority and resources to develop, test, acquire, and implement a communication system focused on meeting medical needs.

* For example, a battalion surgeon.

Recommendation 3.2: DoD shall develop, test, and implement a dedicated medical communications and information system that:

a. Provides the global positioning system (GPS) location of the medic in theater or garrison when the mission allows.
b. Enables audiovisual telecommunications among military treatment facilities to support situational awareness across Level I through IV facilities.
c. Supports a user-friendly electronic medical documentation system from the field through the various treatment facilities. This system should be portable, have biometric and tracking capabilities, allow accessibility to pertinent medical records, contain audiovisual capabilities, and enable viewing of radiographs in the medical record. Further, the system should be standardized across the Services.
d. Supports collaborative performance improvement (PI) (see Section 5, beginning on page 27).

Recommendation 3.3: DoD should continue to expand its partnerships with civilian trauma organizations to share information, preserve lessons learned, and improve trauma care. For example, a close partnership with a civilian medical center would help to ensure rapid stand up capability if necessary, and in peacetime, could allow for additional trauma experience, maintaining the skills and competency of military medical personnel.

Recommendation 3.4: DoD should ensure the sustainment of effective and targeted communication, distributing important combat casualty care information in a timely manner (such as the committee on Tactical Combat Casualty Care (CoTCCC) system in use at the publication of this report).

Informatics

Embracing current and future technologies is essential to improving care, through identifying opportunities for improvement in current levels of care and planning for future care. Informatics provides an opportunity to advance all aspects of trauma care in theater, both during and after the conflict. The increased use of informatics will allow for tracking of casualties and their injuries, but also tracking treatment methods and outcomes. This information is vital to research and quality improvement.

Lesson 4: *In the context of trauma care, informatics equates to the use of electronic medical records (EMRs), which are vital to clinical care across the continuum and to performance improvement and research.*

Uniform and interoperable databases of medical information can promote more effective and efficient medical capabilities, as well as provide the information needed for implementing training platforms that ensure the highest level of training for medical personnel.

Recommendation 4: To establish a uniform registry that encompasses all aspects of trauma care, from the field to rehabilitation and to the degree possible, beyond rehabilitation to community reintegration, DoD shall take the following actions:

a. Develop a high-fidelity online, tiered database as well as enhanced communications capability through all levels of care.
b. Increase research and development funding for new, automated live-patient tracking and identification, including biometrics.
c. Develop an expeditionary, deployable EMR, which is easy to use, readily taught, increases productivity, secure, web-based, instantly visible from all levels including the Veterans Health Administration, compatible with existing databases and registries, and built by established experts in information systems with input from practicing military providers.
d. Increase system-wide support for concurrent data collection across the continuum to include tactical combat casualty care and Levels I-III, en route care/Critical Care Air Transport (CCAT).
e. Expand the DoDTR platform to provide data and information which can be used in conjunction with the Armed Forces Medical Examiner System (AFMES) in continuous real-time performance assessment and validation of best practices.

Performance Improvement

PI has been incorporated as a routine and ongoing activity across most aspects of health care delivery. It is part of a broader system of quality improvement, certification, and accreditation, and in the case of trauma centers, verification. In a 2011 report, *United States Military Joint Trauma System Assessment: A Report Commissioned by the U.S. Central Command Surgeon, Sponsored by Air Force Central Command, A Strategic Document to Provide a Platform for Tactical Development*, the authors made four recommendations: 1) JTS should develop an overarching PI and Patient Safety Plan; 2) the plan should encompass a system-wide process for identifying events, taking corrective actions, monitoring, evaluating and benchmarking; 3) As the lead agency for the system, JTS and the JTTS leadership in theater must possess the infrastructure and authority and systems accountability over the contuum of care for the PI process; and 4) a robust and system-wide informatics platform is needed to support the process.

Lesson 5: *Ongoing improvement of outcomes for the combat wounded requires a robust ability to monitor the care rendered to combat casualties and to measure casualty outcomes as a function of the various elements of trauma care provided along the continuum in theaters of conflict. The Services are attempting to track and analyze outcomes, but compared to JTTS/JTS/DoDTS oversight of the same, there is significant opportunity to codify the PI process. Codifying the PI process will allow DoD to benchmark practices and outcomes and initiate near real-time corrective measures not possible outside the DoDTS today.*

Recommendation 5.1: The DHB concurs with the recommendations from *United States Military Joint Trauma System Assessment* listed below, and encourages DoD to act on these recommendations:

a. JTS should develop an overarching PI and Patient Safety Plan;
b. The PI and Patient Safety Plan should encompass a system-wide process for identifying events, taking corrective actions, monitoring, evaluating, and benchmarking;
c. As the lead agency for the system, JTS and the JTTS leadership in theater must possess the infrastructure and authority and systems accountability over the continuum of care for the PI process; and
d. A robust and system-wide informatics platform is needed to support the process.

Recommendation 5.2: DoD shall establish a formal and system-wide process for event identification and prioritization, determination of root causes, and development of possible countermeasures for PI. Such analysis and evaluation would improve the entire spectrum of trauma care and allow DoD to document casualty outcomes to demonstrate that the right care was provided under the right circumstances. Specifically, this requires the following:

a. Improved documentation including pre-hospital care and evacuation care and times.
b. Ongoing analysis of combat injuries to identify potentially preventable adverse events in conjunction with the AFMES.
c. Submission of timely and focused case reports from the unit level, prepared by field level personnel who are trained, resourced and designated as responsible and who have deployed with all medical units. These reports should be linked, in a timely manner, to the larger JTS.
d. Adherence to the cycle of PI including data acquisition, information analysis, and application of advances back into the larger trauma system.

Training

Successful training requires adhering to a training standard as well as successful pre-identification of desired outcomes. Training is a key component of the performance improvement cycle that includes delivery of care, documentation, data abstraction and analysis, development of clinical practice guidelines, proper staffing and equipment, and adequate training to implement the changes. Military medical, trauma, and operational rescue training should be considered part of the mission essential task list (METL) for all operational units.

Lesson 6: *A robust PI system is required to link trauma training to patient outcomes and validate training methodology.*

Recommendation 6: To ensure a systems approach to trauma training, DoD shall take the following actions:

a. Support the development of a formal link between the JTS and military medical training centers (e.g., Joint training centers, enlisted schoolhouses, Uniformed Services University of the Health Sciences (USUHS), medical proficiency training sites).
b. Provide military medical leaders with formal training in PI operations.
c. Ensure line commanders are aware of current casualty response system and best practice recommendations (such as those found on JTS website at the time of this report).
d. Establish a joint electronic repository for medical lessons learned, supporting scientific evidence, relevant DoD and Service operational documents, and existing Service-training efforts.
e. Establish a high-level battlefield care directorate staffed with personnel possessing appropriate and relevant clinical expertise (at the time of this report that directorate may be in the DHA).
f. Enable oversight, as currently performed by the U.S. Army Institute of Surgical Research and potentially the DHA.

Lesson 7: *Medical and trauma knowledge must flow freely between the civilian and military medical communities and be coupled with rapid training integration strategies.*

Recommendation 7: To standardize and harmonize trauma training across the Services, DoD shall take the following actions:

a. Sustain and expand initiatives to train and support all tactical evacuation medics to a common and high standard (at the writing of this report that standard would be Critical Care Flight Paramedics) (e.g., 160th Special Operations Aviation Regiment [Airborne] model, Air Force Special Operations Command model, newly implemented Army Medical Department model).
b. Develop an initiative to train and sustain combatant unit senior ground medics to a common and high standard.
c. Support the development of CCAT and the Center for the Sustainment of Trauma & Readiness Skills (C-STARS) by the Air Force for development of best practices and common standards for en route care.
d. Review Service trauma training center programs (Army Trauma Training Centers, Navy Trauma Training Centers, C-STARS) and consider creating Joint Trauma Training Centers (JTTCs) making sure training occurs in a team based environment, ideally with a team that will deploy together.
e. Ensure best practices and procedures are cross-leveled and standardized across all military medical simulation training centers (MSTCs), which should receive central certification.
f. Ensure MSTC trainers are subject matter experts, regardless of military versus civilian status, and are trained to a standard, not to a time.
g. Train military tactical evacuation (TACEVAC) personnel to, at a minimum, civilian critical care transport standards (see Recommendation 7c.).

Lesson 8: *The lack of comprehensive, standardized training for military health care providers creates an operational gap that affects unit-level training as well as effective utilization of the military system to reduce combat mortality.*

Recommendation 8: USUHS, as DoD's joint military medical school, shall take the following actions:

a. Continue to expand and institutionalize its direct participation, research, and training in trauma and combat casualty care delivery across Services and throughout the continuum of care.
b. Develop and formalize a partnership with the JTS.
c. Systematically train and develop clinical experts in pre-hospital battlefield care.
d. Involve the DHB Trauma and Injury Subcommittee in setting the curriculum.
e. Develop a trauma care curriculum that would be required by all health care providers before deployment.

Lesson 9: *Effectively trained TCCC has a demonstrable effect on reducing potentially preventable causes of death on the battlefield.*

Recommendation 9: TCCC shall continue to form the basis for battlefield trauma care and be integrated as the minimal accepted standard of training for all military members, initial enlisted medical training, and specialized enlisted medical training. In addition, TCCC sustainment training programs must occur on a regular basis, as the TCCC Guidelines are a "living" document and are regularly updated.

Lesson 10: *TCCC and combat trauma training, aimed at achieving core competencies in combat casualty care, must be provided in a tiered fashion to all personnel operating in the battle space.*

Recommendation 10: DoD shall require that all military personnel deploying in support of combat operations be trained in TCCC. This training shall be carried out at a minimum on initial entry into the service and within six months of deploying. This training should be scaled to the skill set of the personnel. The unit commander should be accountable for accomplishment of this training task in a fashion similar to any other training standard of their unit. Personnel shall not deploy until they demonstrate and document mastery of this training.

Lesson 11: *Effective knowledge acquisition and retention requires multi-modal educational strategies that include appropriate balance of didactics, practical application, scenario-based learning, distance learning, live tissue training (LTT), human role models, clinical experience, and high-fidelity simulation.*

Recommendation 11: To ensure multi-modal educational strategies are used in trauma training, DoD shall take the following actions:

a. Prioritize medical and trauma training as components of the METL and fund efforts to develop distance learning, virtual reality, and high-fidelity simulation training.
b. Support enduring sustainment hands-on trauma training for all pre-hospital medical personnel including, but not limited to LTT and Trauma Center Rotations (e.g., U.S. Special Operations Command [USSOCOM] Directive 350-29 model; U.S. Army Special Operations Command Regulation 350-1 model).
c. Investigate partnerships with the Defense Advanced Research Projects Agency and private industry developers of popular combat video games (e.g., "Halo ©," "Call of Duty ©," "Gears of War ©") to create integrated, accurate first responder treatment protocols for casualties in the game, based on injuries and injury requirements.[2]
d. Upgrade the medical simulation training centers to serve as the medical range for every division-sized post.
e. Develop a surgical skills course, including war surgery skills.
f. Develop a national certified trauma course, standardizing CPGs across the spectrum of trauma training.

Lesson 12: *Medical and trauma training must be integrated into operational and tactical training.*

Recommendation 12: To integrate trauma training into operational and tactical training, DoD shall take the following actions:

a. Train all combatant unit personnel in basic TCCC and combat trauma management initially, annually, and within six months of combat deployment (e.g., USSOCOM Directive 350-29 model); this shall be a requirement for deploying to a combat theater.
b. Include demanding, realistic, scenario-based exercises in training, identifying basic critical tasks and training those to mastery, not merely familiarization.
c. Leverage the opportunity for field medical operations and training.
d. Establish Service training under the newly established DHA in order to standardize training across the Services.

Lesson 13: *LTT has an important, tailored role in trauma training for life saving interventions (LSI) on the battlefield.*

Recommendation 13: LTT should be combined with high-fidelity simulation and integrated operational medical training across the force. DoD should continue to fund research efforts to compare cost, efficacy and sustainability of LTT programs compared to high fidelity simulation for training LSI.

Lesson 14: *Commanders can only accept full responsibility for risk assumption or mitigation when they understand the inherent risk as well as their options as commanders to mitigate that risk. Medicine, medical, and medical training are terms conveying specialty training or education and have no tactical relevance. Accordingly, casualty*

response training for first responders and combatant leaders is often not incorporated into unit battle drills. This trauma training for leaders is an essential component of battlefield trauma care.

Recommendation 14: To ensure command accountability for trauma training, the following shall occur:

a. Battlefield trauma training must be a reportable item and receive command attention.[2]
b. Medical training and readiness shall be measured before deployments and considered a go or no go item with commander attention.
c. DoD shall provide a structure and foundation for casualty response systems and trauma care training. Combatant non-commissioned officers provide first responder continuity for casualty response systems.
d. DoD shall change all references to tactical life-saving tasks/equipment from medical to casualty.

Research and Clinical Investigation

Although great progress has been made in combat casualty care in recent decades, much more can be done to save lives and reduce disabling medical conditions. Trauma and injury research is the essential link between making sense of the lessons learned to inform improved care. Systematic review of retrospective data as well as carefully designed clinical trials creates the evidence base on which to train personnel and ensure clinical practice that is state-of-the-art.

DoD medical research enabled significant advances in combat casualty care in areas such as TCCC, selection and optimal use of extremity tourniquets, topical hemostatic dressings, damage control resuscitation, management of burn casualties, improved outcomes in casualties with traumatic brain injury, and the use of tranexamic acid in combat casualties. However, gaps remain. The Subcommittee makes detailed recommendations to advance the trauma and injury research agenda.

Lesson 15: *Since the start of Operation ENDURING FREEDOM in 2001 and subsequently Operation IRAQI FREEDOM in 2003, numerous advances have been made in battlefield trauma care but more research is needed to fill critical gaps.*

Recommendation 15: To advance the trauma and injury research agenda, DoD shall take the following actions:

a. Continue to fill the research gaps remaining from the 2008 *Guidance on Development of the Force*.
b. Continue to support trauma care research during the interwar years in order to address existing TCCC gaps identified by the CoTCCC in the following areas:
    i. non-compressible hemorrhage.
    ii. hemostatic dressings and resuscitation strategies.

iii. lyophilized plasma product.
iv. fluid resuscitation.
v. combat casualty care monitoring devices.
vi. junctional hemorrhage control.
vii. training and evaluation methods for TCCC skills.
viii. airway management.

c. Embed deployable research teams within deployed commands or deployed hospitals.
d. Work to ensure a clinicopathological review of every U.S. combat fatality, including preventable death analyses from combat units.
e. Support the continued use and analysis of the DoDTR in order to identify areas of potential improvement and measurement of implemented mitigation strategies.
f. Implement a transition initiative to procure, field, train, and track new TCCC devices and medications.
g. Establish an interagency mechanism with the Food and Drug Administration to approve proposed projects and indications for use by the Services in deployed combat environments.
h. Recommend the sustainment of the annual Military Medical Health Research Symposium, which is meant to link the clinical questions to the future funding.

Conclusions

For much of U.S. military history, after each conflict ends, the focus of care for military medical corps transitioned to less acute care and the lessons learned were not systematically preserved or formally passed on to inform military medicine during the next conflict. In the recent conflicts in Afghanistan and Iraq, many lessons have been learned in trauma and injury care, providing an opportunity to amend past missed opportunities by documenting, validating, and disseminating this knowledge as well as by developing a platform to sustain and continue its development. It is critically important to document not only the individual clinical lessons learned, but also the systems lessons learned, particularly the development of the JTS and its many activities, which parallel and keep pace with civilian trauma systems. If history is an indicator, it is inevitable that another conflict will occur. As such, a cadre of trained and available military medical personnel must be available for deployment and patient care in the event of isolated actions throughout the world. Validating and archiving lessons learned from prior conflicts allows that cadre to be trained in, leverage, and build on previous advances.

Executive Summary References

1. Bailey J, Spott MA, Costanzo G, Dunne JR, Dorlac W, Eastridge B. Joint Trauma System: development, conceptual framework, and optimal elements,. U.S. Department of Defense, U.S. Army Institute for Surgical Research; 2012:51.
2. U.S. Central Command, Pre-Hospital Trauma Care Assessment Team. *Saving lives on the battlefield: a Joint Trauma System review of pre-hospital trauma care in Combined Joint Operating Area-Afghanistan (CJOA-A) final report.* January 30, 2013.

CHARGE TO THE DEFENSE HEALTH BOARD

On May 18, 2012, the Acting USD (P&R) requested the DHB develop a Theater Trauma Lessons Learned document summarizing lessons learned from the conflicts in Iraq and Afghanistan and recommend strategies for preserving these lessons in future conflicts. The DHB tasked its Trauma and Injury Subcommittee with conducting a review, summarizing the key lessons, and developing a strategy for their preservation for the Board's consideration (see Appendix A).

The Subcommittee examined the findings and recommendations of other expert groups that have already convened to review lessons learned in the delivery of trauma and injury care over the past two conflicts, reviewed the relevant peer-reviewed literature, and conducted panel discussions with the Surgeon Trauma Consultants. The Subcommittee formed its recommendations based on available information and its expert judgment. Appendix C contains a complete list of meetings and briefings received.

ABOUT THIS REPORT

The report is organized around the themes of DoD systems for trauma care, communications, informatics, performance improvement, training, and research and clinical investigation. Section 2 focuses on the Department of Defense Trauma System, examining the role of a lead agency and Service command. Section 3 reviews the need for communication among all levels of trauma care and between the Services. Section 4 covers informatics, including electronic medical records. Section 5 examines performance improvement, particularly in the deployed setting. Section 6 reviews trauma care training and education. Section 7 discusses trauma care research and clinical investigation.

1. BACKGROUND AND INTRODUCTION

> "If any good can be said to become of war, then the Second World War must go on record as assisting and accelerating one of the greatest blessings that the twentieth century as conferred on man—the huge advances of medical knowledge and surgical techniques. War, by producing so many and such appalling casualties, and by creating such widespread conditions in which disease can flourish, confronted the medical profession with an enormous challenge and the doctors of the world rose to the challenge of the last war magnificently."[3(pp 89)]
>
> Brian J. Ford, British Scientist

The survival rate of Service members injured in combat has significantly improved during the recent decade of military conflict due to advances in trauma care and knowledge gained by medical personnel in the pre-hospital far forward environment.[4,5,6,7] It is important that the advancements resulting in these increased survival rates not be lost but, rather, sustained and expanded with research so immediate re-implementation is possible in the event of future conflict.

Since the beginning of recorded time, war has had the effect of advancing medicine—in both military and civilian settings—particularly in trauma surgery, emergency care, and control and treatment of infectious diseases.[8] For example, it is significant that many aspects of the civilian trauma system regarding the need for care within the first hours of injury were advanced by lessons learned from the Vietnam War and its focus on rapid evacuation.[9] Wartime trauma and injury care experience continues to inform and improve civilian trauma care.[10,11,12,13] Thus, military expertise advances not only the health and survival of the Force but also of those injured in civilian and mass casualty settings.

For much of U.S. military history, after each conflict ends, the focus of care for military medical corps transitioned to less acute care and the lessons learned were not systematically preserved or formally passed on to inform military medicine during the next conflict. In the recent conflicts in Afghanistan and Iraq, many lessons have been learned in trauma and injury care, providing an opportunity to amend past missed opportunities by documenting, validating, and disseminating this knowledge as well as by developing a platform to sustain and continue its development. It is critically important to document not only the individual clinical lessons learned, but also the systems lessons learned, particularly the development of the Joint Trauma System (JTS) and its many activities, which parallel and keep pace with civilian trauma systems. If history is an indicator, it is inevitable that another conflict will occur. As such, a cadre of trained and available military medical personnel must be available for deployment and patient care in the event of isolated actions throughout the world. Validating and archiving lessons learned from prior conflicts allows that cadre to be trained in, leverage, and build on previous advances.

As the wars in Iraq and Afghanistan wind down, the Department of Defense (DoD) recognizes the importance of learning from these conflicts and specifically preserving the advances in trauma care achieved in both theaters. On May 18, 2012, then Acting Under Secretary of Defense (Personnel and Readiness) requested that the Defense Health Board (DHB) develop a Theater Trauma Lessons Learned document summarizing lessons learned from the conflicts in Iraq and Afghanistan and recommend strategies for preserving these lessons in future conflicts (see Appendix A). The DHB tasked its Trauma and Injury Subcommittee with conducting a review, summarizing the key lessons, and developing a strategy for their preservation for the DHB's consideration.

The importance of preserving lessons learned was reinforced in a June 18, 2014 communication from Dr. Jonathan Woodson, Assistant Secretary of Defense, Health Affairs, and others to the entire Military Health System (MHS) following a visit with medical and combat leaders in Afghanistan (see Appendix B).

> With the war winding down, it is critical that we remain dedicated to gathering the lessons learned from this experience. The MHS has been exemplary in rapidly learning about what works and what does not work in our care to wounded service members, and turning that knowledge around into clinical practice in the real world. Processes for triage, patient flow, trauma care, and aeromedical evacuation have been refined and continuously improved – and now serve as the standard for our medical colleagues around the world.
>
> As the war concludes, it is important that we codify those innovations and embed them in our education and training systems worldwide. Every one of us – whether serving overseas today or serving here at home – has a role in this effort. We need to ensure actions and instincts that are in the forefront of our thoughts today are not lost.[14]

1.1 Overview of Progress in Trauma and Injury Care

Throughout the course of U.S. military history, each new conflict leads to advances in medical care, particularly in cases of traumatic injuries. These advances are tied to the medical capabilities available at the time of the conflict and the various mechanisms of injury and have been well documented in trauma and injury literature.

Wounding patterns seen during Operation ENDURING FREEDOM (OEF) and Operation IRAQI FREEDOM (OIF) are markedly different than those experienced in earlier conflicts, including World War II (WWII), Korea, Vietnam, and the Persian Gulf War.[15] Earlier conflicts saw a high rate of thoracic and head injuries, particularly from gun shots; however, there has been a decreased incidence in thoracic wounds since that time.[15, 16] Rates of blast-related injuries have increased, with the dominant mechanism of injury being overwhelmingly penetrating, with 75 percent of casualties associated with explosive fragmentation and gunshot wounds.[15, 17] These injuries are also correlated with

a greater proportion of wounds to the head and neck and are often associated with penetrating traumatic brain injury (TBI).[18] As such, TBI, transfusion, and limb salvage have been areas of significant focus in trauma care and research during the current conflicts.

Despite their differences, some similarities remain between OEF/OIF and earlier conflicts. Isolated extremity wounds resulting in exsanguination have been consistently seen throughout military operations. In 1970, in a cohort of 2,600 casualties, 7.4 percent of fatalities were found to have resulted from extremity wounds.[6,16] In 2004, an analysis of potentially preventable deaths by Kelly et al found that of 232 potentially preventable deaths, 33 percent showed failure to use a tourniquet. Although use of tourniquets remained an issue early on in the current engagements, recent studies have documented a marked increase in lives saved due to the use of tourniquets.[6] A 2012 analysis by Eastridge et al found a rate of 23.3 deaths per year in pre-tourniquet years of the OEF/OIF and a rate of 3.5 deaths per year after fully fielding tourniquets.[17] Noncompressible hemorrhage also remains a dominant cause of death among potentially survivable casualties, as overall hemorrhage approaches 90 percent of potentially survivable injuries.[6, 17]

In a 2006 analysis of U.S. military ground troops, in both WWII and the Vietnam war, of those Soldiers that died in combat, 88 percent were killed in action (KIA) before reaching a military treatment facility and 12 percent died of their wounds after reaching care (DOW).[19] Comparatively, considering Iraq and Afghanistan together, these rates are approximately 77 percent KIA and 23 percent DOW. The overall case fatality rate and rates of those KIA are decreasing as Soldiers survive longer after injury and reach higher levels of medical care.[19, 18] Eastridge et al conducted an analysis based on historical data captured by individual observers, compilations of administrative information, and retrospective studies, which showed that the overwhelming majority of battlefield casualties died before reaching medical care.[17]

Progress in medical evacuation and transport has had a significant impact on survival rates of casualties injured in battle. Transport time from battlefield to definitive care in WWII was less than four hours.[7] With the introduction of helicopter evacuation during the Korean conflict, evacuation times were decreased to two to four hours. This time was further cut down with the advent of forward surgical hospitals, including the Mobile Army Surgical Hospital .[7] Transport time in Vietnam established the modern evacuation time of the "golden hour," with definitive care delivered to injured patients in less than one hour after injury.[7, 20] At the onset of hostilities in both Iraq and Afghanistan, evacuation times from both conflicts were often delayed, though the impact of such delays is unknown.[21] However, in 2009, the median evacuation time in Afghanistan was 90 minutes.[21] With the standard that evacuation times be 60 minutes or less within Iraq and Afghanistan,[22,23] the median evacuation dropped further, and was 42 minutes as of 2013.[21] Current evacuation and transport can move an injured Service member from the battlefield to the continental U.S. (CONUS) for definitive care within 24 to 48 hours, depending on the severity of the injury.[24] This rapid evacuation from point of injury to definitive care, while maintaining ongoing medical care, has created a complex system of

levels of care as shown in Table 1. Levels of care were previously referred to as *echelons* and denote differences in capability and not quality of care. These levels should not be confused with the levels of trauma care centers used by the American College of Surgeons.

Table 1. Levels of Trauma and Injury Care[24, 25, 26]

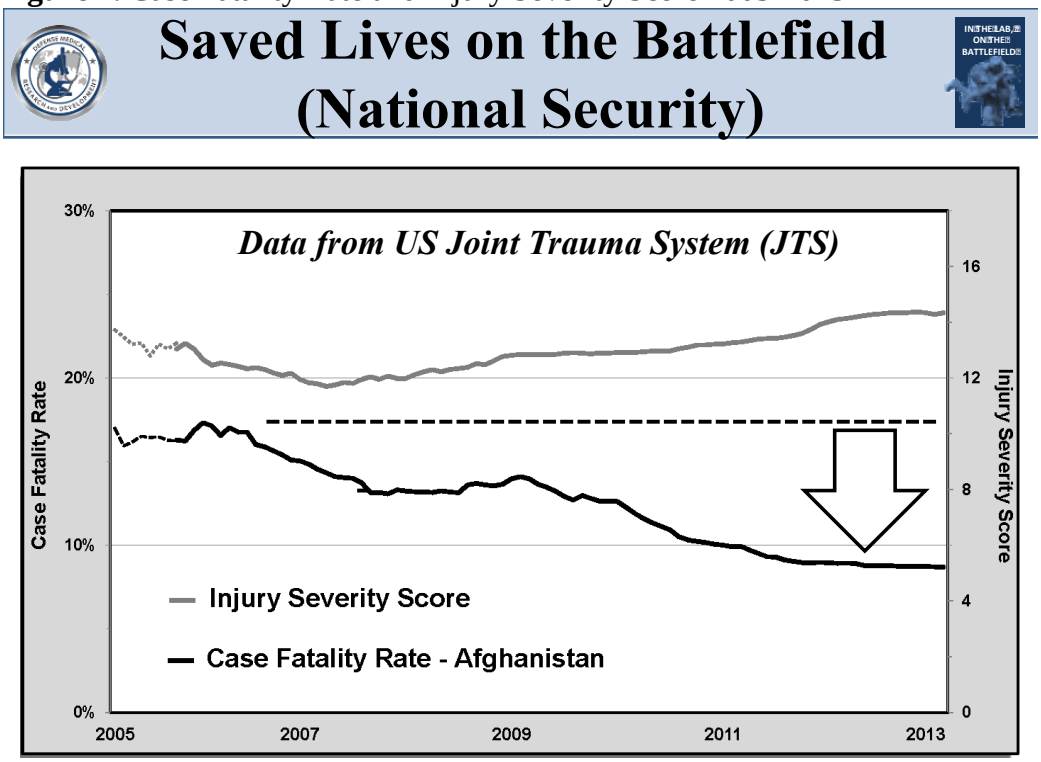
Current Levels of Care	Function
Level I **Battlefield Care to Battalion Aid Station**	Initial level of care/immediate lifesaving measures. Emphasis on stabilizing casualty for evacuation to next level of care. Similar to civilian first responders. Also includes: Battlefield Care (Self-Aid/Buddy Aid, Combat Lifesaver and Combat Medic). Battalion Aid Station (far forward aid station with at least one physician available).
Level II **Forward Surgical Team**	Small, highly mobile, austere surgical team. Provides life-and-limb saving surgical care and typically the first level of surgery available. Limited capabilities, some laboratory, X-ray, mental health and dental services may be available.
Level III **Combat Surgical Hospital** **Air Force Theater Hospital**	High volume trauma center. Highest level of treatment within the area of military operations. Provides full range of surgical, medical, laboratory, and radiology capability. Care also includes dental, physical therapy, mental health, obstetrics/gynecology, and primary care services.
Level IV **Example: Landstuhl Regional Medical Center**	Definitive medical and surgical care. Outside of area of military operations or combat, but not within CONUS. Stabilization point before evacuation to CONUS.
Level V **Examples:** **Walter Reed National Military Medical Center, Brooke Army Medical Center**	Definitive medical and surgical care CONUS.

Adapted from: Horne et al, 2014; Silva; Cubano, 2013

Advancements in body armor, tactics, a deployed trauma system and medical response have led to improvements in both morbidity and mortality rates in combat[15, 17] (see Figure 1). Together the progress made in trauma and injury care has resulted in an unprecedented survival rate of 90 percent. This rate compares with a historical rate of 84 percent in Vietnam and 80 percent during WWII.[15,17] Efforts to identify, preserve, and disseminate lessons learned—particularly using the Tactical Combat Casualty Care (TCCC) Guidelines and the Department of Defense Trauma Registry (DoDTR)—have

been influential in the progression of trauma and injury care in theater (see Table 2 for examples).

Figure 1. Case Fatality Rate and Injury Severity Score 2005-2013[14,27†]



From: Rasmussen TE, Rauch TM.; 2014.

† The dotted line is a reference mark illustrating the high case fatality rate (CFR) documented early in the conflict, in 2008. This line is meant to provide context to the decreased CFR documented later in the conflict, in 2013.

Table 2. Current State of Battlefield Trauma and Injury Care[28]

Current State of Battlefield Trauma and Injury Care
Tactical Combat Casualty Care Guidelines, include: - Phased care in the tactical environment, including care under fire, tactical field care and tactical evacuation care. - Use of blood or blood components for resuscitation from hemorrhagic shock when feasible. - Needle decompression to treat tension pneumothoraces, with a 14-guage, 3.25 needle/catheter. - Use of vented chest seals to treat open pneumothoraces. - Use of fluoroquinolones and ertapenem or cefotetan for battlefield antibiotics. - Use of fluid resuscitation and supplemental oxygen to maintain high oxygen saturation when treating moderate/severe TBI. - Use of tourniquets, including junctional tourniquets, to control life-threatening external hemorrhage from sites amenable to tourniquet placement. - Use of Combat Gauze to control external hemorrhage from sites not amenable to tourniquet placement. - Use of tranexamic acid if there is an anticipated need for significant blood transfusion. - Use of intraosseous techniques when vascular access is difficult to obtain. - Use of the Ready-Heat Blanket/Heat-Reflective Shell and warm fluids if intravenous fluids are required. - Use of nasopharyngeal airways, protective airway positioning (including sitting up and leaning forward), and surgical cricothyroidotomies for airway management. - Use of oral analgesics, ketamine, morphine, and fentanyl citrate lozenges as described in the TCCC "triple-option analgesia" plan. - Documentation of care by using TCCC Casualty Cards and TCCC electronic After-Action Reports. - Tactical, scenario based combat training.

Adapted from: Committee on Tactical Combat Casualty Care, 2014

1.2 Overview of the Recent Evolution in Systems of Trauma Care

U.S. military medical forces deployed in support of the Global War on Terror have provided continuous casualty care for subsequent combat operations in Iraq and Afghanistan. This care initially lacked a cohesive and structured approach as well as standardized documentation of the care, such as a trauma registry.[6] In 2004, the U.S. Central Command (CENTCOM) implemented the Joint Theater Trauma System (JTTS) across DoD, an inclusive system of trauma care in its theater of combat operations. The initial focus was CONUS and Veterans Affairs (VA) facilities, but later included larger trauma centers including Landstuhl Regional Trauma Center and major trauma hospitals in CONUS.[29] As the conflict was expanded to include trauma care provided across the Services, individual and smaller trauma systems within each Service or location were integrated into the JTS.[30] JTTS continues to serve CONUS and is embedded at the U.S. Army Institute of Surgical Research (USAISR) in San Antonio, Texas.

The goal of JTTS is to enable data-driven performance improvement across the continuum of trauma care within the MHS, beginning at the point of injury to include evacuation and treatment through all levels of care, concluding with definitive treatment in the United States.[31] Eventually, the system evolved to include Level V and VA facilities. It is important that this standardization and unification process be maintained, and research efforts added as current in-theater operations are downsized.

The creation of the JTTR—a database of all military casualties from the wars in Iraq and Afghanistan—has facilitated in-depth analyses and research of wartime injuries and deaths. In 2012, the JTTR was renamed the DoDTR to reflect the "true nature" of the data.[1] The registry permits reviews of types and severities of injuries so that potential survivable injuries can be identified and quality improvement measures implemented.

By establishing a robust JTS and a Combat Casualty Care Research Program (CCCRP), supported by the academic and medical leadership platform that is the Uniformed Services University of the Health Sciences (USUHS), the MHS has developed and implemented a continuously learning health system in trauma. Coined by the Institute of Medicine, continuously learning health systems integrate medical education, medical research, clinical practice, and performance improvement to assure best patient outcomes.[32] Evidence-based process improvement is guided and informed by the JTS, DoDTR, and dynamic clinical process guidelines. In the MHS, these elements are military-specific and aimed at military-specific gaps or requirements. Trauma care supported by the JTS, in both current and future conflicts, is guided and informed by the CCCRP, which relies on the JTS as a main input to its requirements-based medical research and development. Both the JTS and the CCCRP are supported and sustained by the academic foundation and long-term Joint medical leadership that is provided by USUHS.

In addition to systemic issues, when the recent conflicts began there was a lack of experienced trauma providers in the active duty ranks. The experience was provided by Reserve and Guard physicians and care providers. Much of the education was on-the-job training for those whose prior experience was elective patient care.[30, 2] Writing about the state of training at the beginning of the Afghanistan conflict, Butler et al (2012) stated: "In the absence of a Department of Defense (DoD) level group with a charter to provide the services with updated best practice battlefield trauma care guidelines, the prehospital trauma care techniques being taught to U.S. combat medical personnel at the start of the war were based on courses developed for management of trauma in noncombat settings." [6] Now, several years later, in CENTCOM there are well-trained trauma surgeons providing start-of-the-art trauma care. This experience and knowledge must be preserved for conflicts in the future and for other commands as current conflicts change locations.[33]

1.3 SUMMARY OF EXISTING REVIEWS OF LESSONS LEARNED

Several expert groups have already been convened to review lessons learned in the delivery of trauma and injury care over the past two conflicts. The assessments and recommendations of these groups provided useful guideposts and a foundation for this review. In fact, the DHB endorses and repeats many of the conclusions drawn by these expert groups.

The 2008 Guidance on Force Development involved a comprehensive review that identified 69 gaps regarding Joint Force Health Protection requiring medical research and development (R&D), of which 28 fell within the purview of the CCCRP, which is requirements driven, programmed medical research directed at the spectrum of combat casualty care research, include the point of injury, en route care, and facility based care. (See Section 7 of this report, *Research and Clinical Investigation*, for further discussion).

In 2012, USAISR conducted a comprehensive review of the JTS, specifically its development, conceptual framework, and optimal elements.[1] That report, which will not be repeated here, provides a comprehensive description of the evolution and development of the JTS since 2002.

In addition, in 2011, at the invitation of the CENTCOM Surgeon and sponsored by Air Force Central Command, a group of nationally recognized trauma experts visited and evaluated U.S. and the North Atlantic Treaty Organization military medical facilities and the trauma system in Germany and Afghanistan.[30] The report of this group contains detailed strategic recommendations for the future direction of the JTS, inclusive of the U.S. CENTCOM JTTS, its optimal elements, integration, and sustainment in order to improve performance. A 2013 JTTS and JTS review of pre-hospital trauma care in Afghanistan captured additional lessons learned, with a follow up in 2014.[2,34]

DoD has supported several educational efforts to record and share lessons learned in military medicine. For example, an educational program was developed through the Small Business Innovative Research program in partnership with civilian industry and the Office of the Assistant Secretary of Defense for Health Affairs. A panel of civilian and military trauma experts compiled lessons learned from OEF and OIF, fortified with evidence-based recommendations for improving casualty care. Thirteen peer-reviewed and referenced chapters provide explanations of the latest advances in combat casualty care, ranging from damage control resuscitation and surgery, to trauma to various parts of the body and acute burn care. The resulting textbook, *Combat Casualty Care: Lessons Learned from OEF and OIF*, was published in 2012.[15]

Lessons learned have also been maintained and distributed by the Committee on Tactical Combat Casualty Care (CoTCCC). Originally developed through a Special Operations medical research program in the mid 1990's, the Committee works to improve combat casualty outcomes through the development and implementation of the TCCC Guidelines, a set of pre-hospital trauma care guidelines customized for use on the battlefield. Though not universally followed at the onset of the recent conflicts, the

guidelines are widely adopted in the U.S. military and by many coalition partners. CoTCCC updates the guidelines and corresponding curriculum as new evidence becomes available, releasing a new set of guidelines yearly. Additionally, the CoTCCC develops and delivers TCCC courses, compiling peer-reviewed journal articles of importance to and emanating from military trauma care. The group has developed strong partnerships with other organizations in the field of pre-hospital care, including the American College of Surgeons and the National Association of Emergency Medical Technicians.[6] The CoTCCC is currently located within JTS, allowing access to trauma surgery leaders, participation in JTTS activities, and representation in critical trauma care performance improvement efforts such as the weekly theater trauma conferences and the monthly Armed Forces Medical Examiners System case reviews.

1.4 METHODOLOGY

Combined, the members of the DHB Trauma and Injury Subcommittee have decades of experience in the fields of civilian and military emergency, trauma, and casualty care. Armed with their knowledge and experience, they examined the findings and recommendations of other expert groups, reviewed the relevant peer-reviewed literature, and conducted panel discussions with the Trauma Consultants to the Surgeons General. They formed their recommendations based on available information and their expert judgment. The report is organized around the themes of DoD systems for trauma care, communications, informatics, performance improvement, training, and research and clinical investigation.

1.5 OVERARCHING GOAL

Members initiated the review by discussing an overarching goal for DoD in any theater, as described by the Joint Trauma System:

"Right patient, right place, right time, right care"[1 (p.5)]

To achieve this goal, this report offers lessons learned and recommendations in the areas of the trauma system, communications, informatics, performance improvement, training, and research. Appendix D provides a comprehensive list of lessons learned, which are also found in each section of this report.

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2. Department of Defense Trauma System

Early in Operation ENDURING FREEDOM (OEF) and subsequently in Operation IRAQI FREEDOM (OIF), deploying U.S. forces included the embedded medical response and footprint specific to each Service. This reflected the organization of trauma care in prior conflicts. However, as the wars progressed, OEF/OIF involved more joint Service efforts than previous engagements, with personnel from all Services co-located and operating together in theater. Once field positions were attained and the battlefield space changed from one of invasion to stabilization, more traditional medical support elements were brought into theater. It became apparent that communication, coordination, and command and control among levels of care and personnel across the Services under combatant command (COCOM) control had not been well planned, exercised, or implemented to the level that U.S. civilian trauma centers and systems had developed over the preceding 30 or more years. The early lack of integration reportedly resulted in numerous events in which multiple casualty incidents were managed in an uncoordinated fashion. Moreover, single system injuries in a single casualty, requiring sub-specialty care, resulted in less-than-optimal triage and coordination.

During the early years of the conflicts, overall deployed medical authority within the military system and individual centers of care were not keeping pace with development and maturation of events in theater. Geographic factors, surges in casualty volume, delivery of care in austere environments, and constantly changing conditions presented additional challenges to accomplishing defined trauma system goals.[30] Furthermore, finding the appropriate trauma system authority proved challenging for those providing care. Individual Service medical missions, leadership, and support needed to mature, as the rest of the theater had, but no Joint plan had been developed to create and support this environment.

In 2004, U.S. Central Command (CENTCOM) created a formal military trauma system of trauma care in its theater of combat operations, designated as the Joint Theater Trauma System (JTTS). JTTS originally focused on care of the injured within the theater and at the primary out-of-theater receiving military treatment facility, located at Landstuhl Regional Medical Center, Germany. The system was ultimately expanded to include Continental U.S. (CONUS) and Department of Veterans Affairs facilities.

Although the JTTS is a U.S. CENTCOM organization headquartered in Tampa, Florida, its functionality is based at the U.S. Army Institute of Surgical Research (USAISR) in San Antonio, Texas where a continual directorship and support is maintained (see Figure 2). A Joint Theater Trauma Registry (JTTR), now Department of Defense Trauma Registry (DoDTR) was developed concurrently to support JTTS operations and data collection in theater.

Subsequently, a USAISR-imbedded organization was designated the Joint Trauma System (JTS), as an official program of record within USAISR in 2011, to distinguish it from the JTTS. The JTTS is limited to the U.S. CENTCOM theater of operations, whereas JTS is aligned to support a continuous deployable global trauma systems

capability for the entire U.S. military.[30]

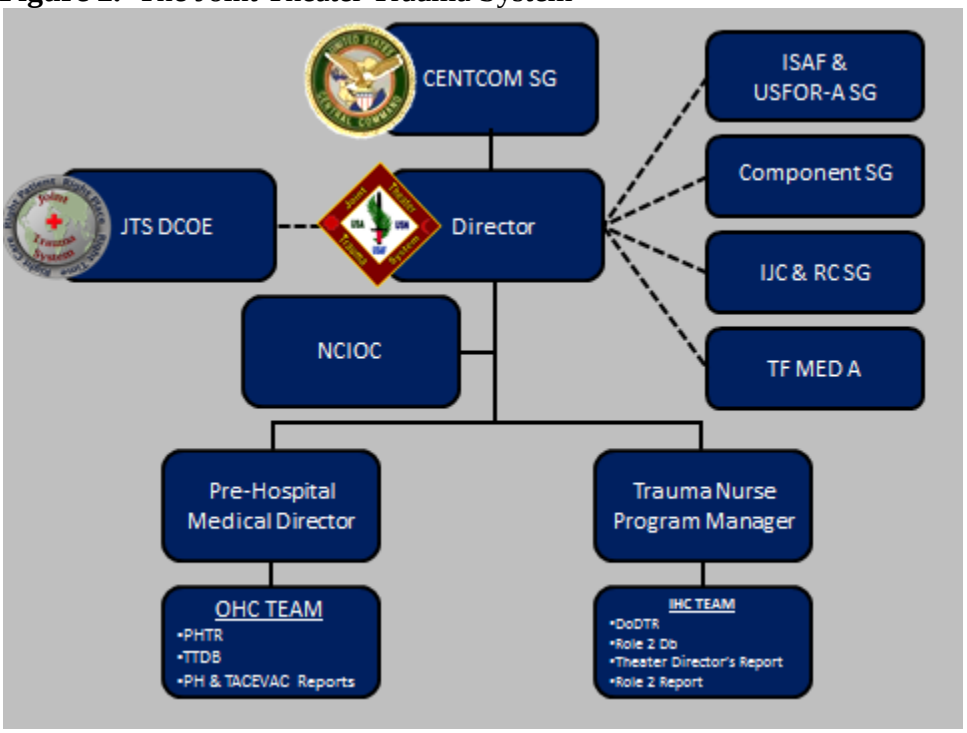
The JTS was tasked to develop a systematic and integrated approach to organize and coordinate combat casualty care. Although JTS has a global scope, the JTS Director reports to the USAISR Commander[30] (see Figure 3). With regard to the current organizational status of JTS and JTTS, the 2012 United States Military Joint Trauma Assessment report noted:

> While the current JTTS demonstrates, for the most part, excellent elemental function, its integrative function is still somewhat limited. This is manifest by suboptimal performance at the component interfaces, a lack of understanding by the individual components of the function of other components and less than optimal understanding of the system overall. Moreover, due to a lack of doctrinal authority, the Joint Trauma System (JTS) functions in a very limited capacity as a lead agency for the system and therefore, at best functions as a finite infrastructure element only.[30(p.9)]

The report went on to say that the lead agency of a trauma system should conduct continuous assessment of the system's structure, function, and outcomes. Performance should be assessed against benchmarks and a verification process involving objective external review. An assurance process includes education at all levels and "coalition building with leaders and participants across the system to foster cohesion and collaboration,"[30(p.9)] as well as the use of analytical tools to assess performance, and the capacity to evaluate and verify that the system is meeting standards and requirements. The 2012 United States Military Joint Trauma Assessment report further noted:

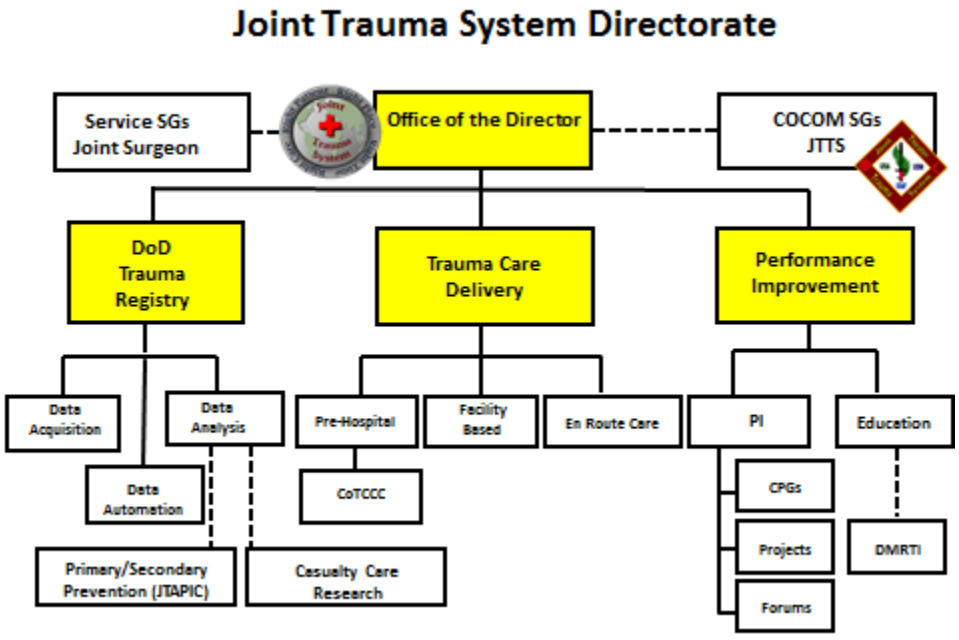
> While assessment data is generated at the component level of the JTTS, the assessment, subsequent analysis, guideline development and assurance should take place at the JTS level in conjunction with JTTS leadership and other JTTS leadership system components. At the moment, the limited in theater infrastructure to support the data assessment function, the divergence of the combat command and the medical command structure, and the multiservice multinational composition of the health care provider force prevent optimal system functionality. While the immediate solution to this complex problem is unclear, the goal should be that the JTS function as a lead agency in support of the JTTS through these three critical functions: assessment – policy/guideline development – assurance.[30(p.10)]

Figure 2. The Joint Theater Trauma System[35]



From: U.S. Army Institute of Surgical Research, 2012.

Figure 3. The Joint Trauma System[35]



From: U.S. Army Institute of Surgical Research, 2012.

2.1 NEED FOR A LEAD AGENCY

Lesson 1: Despite vast improvements in the military trauma care system over the past decade, there is no unifying agency with oversight over all aspects of the combat casualty care system.[2]

The Defense Health Board concurs with the assessment of the U.S. Military Joint Trauma System Assessment team regarding the need for a lead agency for the combat casualty care system. According to the American College of Surgeons, the public health system model provides a useful framework for trauma system development, management, and continuous performance improvement.[36] It includes three functions that are essential to an effective trauma care system: 1) assessment, 2) policy development, and 3) assurance.[36] A single agency best carries out these three core functions.

Optimal characteristics of assessment include the ability to thoroughly describe the epidemiology of injury within the theater jurisdiction and facilitate concurrent access to databases across the continuum of system care to scrutinize efficacy and identify opportunities for improvement.

Ideal characteristics of policy development (to include guidelines) include: comprehensive authority to maintain trauma system infrastructure, planning, oversight, and future development; and authority to create and enforce policy and guidelines on behalf of the welfare of the injured.

Additionally, an effective trauma system should include education and coalition building with leaders and participants across the system to foster cohesion and collaboration, the use of analytical tools to monitor performance and promote injury prevention, and the ability to evaluate and verify that system components meet agreed upon criterion or clinical requirements. This process of assurance relies on agreed-upon goals that are achieved either through policy and guidance or through the actions of others.

Recommendation 1.1: Establish a senior level organization, such as the Defense Health Agency (DHA), as the lead agency for oversight of trauma care.

A single lead agency of the trauma system should have oversight of trauma care. This agency should also continually assess the system's structure, function, resources, and outcomes, and be enabled to recommend policy or guidelines based on analysis of these assessments, thereby standardizing trauma care across the Department of Defense (DoD). The lead agency must assure optimal system function through the measurement of both system and component performance against established benchmarks through a verification process that provides objective, external review of capability and performance.

In addition, the influence of JTS should be more clearly and visibly articulated as the overarching system of trauma care across all combatant commands. Lessons learned through JTTS or any subsequent COCOM efforts should be fed up to JTS and disseminated to all global operations. A lead agency would facilitate multi-directional communication across the Services and COCOMs.

Recommendation 1.2: Establish the JTS, in its role as the Department of Defense Trauma System (DoDTS), as the lead agency for trauma in DoD with authority to establish and assure best-practice trauma care guidelines to the Director of the DHA, the Services, and the Combatant Commanders.[2]

The DoDTS should be assured by a facility and systems verification process, with a JTS established within each COCOM. As a Center of Excellence, JTS/DoDTS should provide additional influence and guidance, leading the provision of combat casualty care from prevention through rehabilitation. DoDTS would coordinate all phases of care in conjunction with the Services, COCOMs, and the Department.

2.2 SERVICE COMMAND

Lesson 2: At the onset of the current conflicts, communication, coordination, and command and control of and among levels of care and personnel across the Services under Combatant Command control were not well coordinated, trained for, or implemented consistent with practices in civilian centers and systems.

Currently, each Service is "designated to provide scalable and tailorable medical command and control modules for early and expeditionary operations"[23] in theater until an operational health care infrastructure is developed. Thus, the Services are required to be structured and resourced to support the combat mission regardless of tactics, terrain, distance, or environmental conditions. However, in their go-to-war platforms, each Service addresses its individual identity, highlighting the fact that the injuries of Soldiers and Marines differ from those of Sailors and Airmen. Service differences in deployed medical care, especially Level II and Level III medical centers, are confusing and often not interoperable.[‡15] The engagement of additional Services and changes in mission require a change in medical authority, recognizing that authority should change with operational stability and the phase of operations. The Surgeons General have primary oversight of health care policy in their respective Services, while combatant unit commanders control the time, budget, personnel, training, and equipment for trauma care.[2] Each line commander has a medical advisor. However, the advisor to the line

[‡] Level II medical centers consist of small, highly mobile surgical teams, with limited capabilities to provide life and limb saving surgical care. Level III facilities however, are full trauma centers, providing the highest level of treatment within the military area of operations. These centers provide a full range of surgical, medical, laboratory and radiology capability. Service differences exist in the specific care and staffing capabilities present within each Level.[6]

commander may have variable experience in combat casualty care and may not be current in either tactical combat casualty care (TCCC) or clinical practice guidelines (CPGs).

As individual military treatment facilities (MTFs) experience varying patient loads due to proximity to nearby theaters, capabilities of these MTFs will also change. One such example is Landstuhl Regional Medical Center (LRMC). Verified as a Level I trauma center by the American College of Surgeons in 2011, LRMC has experienced significantly low patient loads since the drawdown of recent combat operations, "no longer meeting the minimum number of patients required to be considered for Level I verification."[37] Relationships with civilian medical facilities are essential in providing an additional source of trauma experience, contributing to the maintenance of the skills and competency of military medical personnel during lulls in military patient loads. These relationships will ensure the rapid initial operational capability of medical facilities if necessary.

Recommendation 2: Responsibilities of the Service Command:

a. **Unit surgeons[§] or the medical advisor for the line commander shall be fully competent in the recommended professional and practice standards as promulgated by the proposed DoDTS (at the writing of this report, it would be the TCCC Guidelines and DoDTS CPGs).**
b. **Combatant Command Surgeons should report their expectations, including evacuation times, CPGs, and integration to JTS and DoDTR.**

In all cases, each Service must be immediately responsive, adaptable, and fully capable of achieving the mission in all aspects of U.S. military actions including combat, humanitarianism, and contingency operations. This capability and readiness should endure during times of both war and peace. Knowledge gathered, assessed, and reported out by DoDTS will ensure that state-of-the-art practices are disseminated to COCOMS in a timely manner. Conversely, COCOMs should ensure that data and experiences in theater are communicated in a systematic way to DoDTS.

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3. COMMUNICATION

> "High quality communication is essential for efficient care and optimal outcomes. Without it, system elements function in isolation."[30(pp12)]

During the early years of Operation ENDURING FREEDOM and Operation IRAQI FREEDOM, communication, specifically of clinical patient information, was difficult among the different levels of care.[38] As a basic workaround, surgeons wrote brief narratives directly on patient dressings in order to pass along clinical information. Additionally, military treatment facility (MTF) trauma medical directors rotated every six months, which could lead to a loss in institutional knowledge. Without a solid understanding of current communication systems or opportunities to interact with their peers, systems are often redesigned with each new director.[30] Systems assessments suggested several factors influenced this lack of effective communication including operational tempo, patient movement, immature theater infrastructure, and casualty load. Additionally, the collection of pre-hospital data remains a problem.[1,15,30,38] Multiple methods of record keeping were tried in theater including handheld portable dictaphones, memory sticks with digital images, and paper records.[15] Recognizing the need for a developed communication system, assessments of the Joint Trauma System (JTS) called for integrated communication infrastructure between facilities and during medical transport.[1] Mature theaters are now able to establish communication using the Joint Patient Tracking Application. The Internet-accessible electronic medical record allows users to obtain real-time information including email and direct phone contact to transfer information between facilities and throughout the system.[15,38]

NEED FOR COMMUNICATION AMONG ALL LEVELS OF CARE AND AMONG THE SERVICES

Lesson 3: At the beginning of the conflicts, communication and specifically clinical patient information was difficult to transmit among levels of care.

Although the Armed Forces in theater are well equipped on the battlefield with state-of-the-art equipment, the ability of medical personnel to communicate to receiving treatment facilities and from facility to facility was almost non-existent. The ability to communicate from a Level III facility to Levels IV and V has improved greatly, but still has room for improvement. The vehicles in the battle zone are equipped with state-of-the-art secure laptop computers, which have global positioning system (GPS) capability, and headquarters commanding the mission can track vehicles and personnel. Service members can communicate among themselves, with commanders, as well as with rotary and fixed wing aircrafts. With the availability of these continually improving capabilities, the medical community, from the medic through the various treatment facilities, should have access to the requisite communications technologies.

In addition to the communication void that existed on the battlefield, there were gaps in the ability of the Services to communicate with each other. Services may be operating in individual spheres without reliable and succinct communication, focusing on immediate patient care over effective communication. When an injury occurs, if the medic does not have the ability to communicate with higher levels of care, critical direction of care could be impeded. Inadequate levels of communication can also extend to the method of evacuation, which may prevent dispatch of the appropriate evacuation vehicle. The battlefield experiences of some members of the Subcommittee included situations in which Service members knew the exact nature of injuries and the needs for transport of the injured but the medic/corpsman was not able to communicate with the receiving treatment facility, thereby preventing ideal levels of preparation for receiving the casualties.

Lack of or poor communication can also lead to a less than ideal state in which treatment facilities become overwhelmed, due to inadequate information about incoming medical needs and current facility capabilities. Insufficient access to basic information pertaining to the number, severity, and types of injured can result in suboptimal care following transport. Technology currently exists that can be implemented in theater to monitor and track patient data.[39] Future capability could also provide location and even audiovisual communication of the state of affairs at the point of wounding. Audiovisual communications would be ideal if possible, but are currently inadequate in theater.

Finally, clinicians in different facilities do not consistently engage in communication with each other, due to a lack of contact information or difficulty reaching colleagues. Without knowledge of currently deployed personnel or a common communication portal, clinicians may be left without contact information for other providers. In the perspective of the Subcommittee, this poor communication is especially apparent between the Services. The resultant lack of engagement may prevent collaboration and the exchange of ideas.[30] Additionally, information flow is often unidirectional up to the Joint Theater Trauma System (JTTS) and JTS, as there are limited mechanisms for the transmission of information down to the clinicians from both the JTTS and JTS.[30] As cited by Rotondo et al at a 2011 trauma conference, new data on multi-drug resistant bacteria was presented that would likely change patient care and improve outcomes.[30] Instead of waiting to hear a report of the data at a conference, medical centers could have shared relevant information and influenced patient care immediately upon receiving positive study results.

Beyond the battlefield, adequate communication between Department of Defense (DoD) and civilian trauma organizations advances the timely exchange of ideas and advancements. Improved communication and the sharing of lessons learned could benefit patients as well as providers. As an example, the weekly Theater Casualty Care teleconference/webinar provides a platform for Tri-Service health care providers across the spectrum of care, including deployed units in theater to definitive care within the continental U.S. (CONUS), to discuss recent casualties.[40] This capability has advanced sharing of lessons learned, which has improved the care of the wounded warrior.[2,17,41,42]

Another example of sharing lessons learned is the Tactical Combat Casualty Care (TCCC) Guidelines, developed and distributed by the Committee on Tactical Combat Casualty Care (CoTCCC). Their strategy to disseminate TCCC guidance and best practices, informed by 15 years of feedback from stakeholders, is based on a seven-tiered system, as described below:

- TCCC Guidelines explicitly state the recommended elements of trauma care.
- Position papers are written to provide evidence-based changes to the guidelines. Once approved by a two-thirds majority of voting CoTCCC members, the position paper is published in the Journal of Special Operations Medicine, as an enduring and available reference. Changes to the guidelines are incorporated on a yearly basis.
- The TCCC curriculum, composed of PowerPoint slides, supporting video components, and skill sheets, is used to train health care providers in the TCCC Guidelines. The CoTCCC Developmental Editor provides updated copies of the TCCC curriculum to all of the combat medic schoolhouses in DoD.
- The TCCC chapters in the Prehospital Trauma Life Support (PHTLS) also provide a supplement to the TCCC curriculum, including a discussion for each recommended intervention. The PHTLS textbook includes a variety of related TCCC topics including blast injury burns, the JTS, and casualty response training and is updated every three to four years. Recommendations included in the text are endorsed by the American College of Surgeons Committee on Trauma and the National Association of Emergency Medical Technicians (NAEMT).
- Once changes to the TCCC Guidelines are approved, change packages are sent out via email to the TCCC distribution list. Each change package contains the updated TCCC Guidelines, the position paper that supports the change, and a set of PowerPoint slides designed to provide a training aid for military units in order to implement the recommended change. These change packages were sent out as soon as the change paper was published, but at the request of the U.S. Central Command Surgeon, are now sent out as soon as the change paper has been cleared for publication by the JTS and the U.S. Army Institute of Surgical Research, improving the distribution time from months to weeks.
- TCCC communications such as top performance issues, article abstracts, and TCCC related directives from the Service medical departments, combatant commands, Defense Health Agency, and the Office of the Assistant Secretary of Defense for Health Affairs are also distributed via the TCCC email distribution list.
- All of the above information is also posted to TCCC websites including the Military Health System website, the JTS website, the NAEMT website, and the Special Operations Medical Association website.

Together, such a process is an example of effective and targeted communication, distributing important combat casualty care information in a timely manner. Sharing lessons learned, such as this, is an essential step toward maintaining the trauma advances achieved by the recent conflicts.

Recommendation 3.1: DoD shall establish and promote a Joint Trauma Medical Communications and Information Director to work with the JTS, who has the authority and resources to develop, test, acquire, and implement a communication system focused on meeting medical needs.

Recommendation 3.2: DoD shall develop, test, and implement a dedicated medical communications and information system that:

- **a. Provides GPS location of the medic in theater or garrison when the mission allows.**
- **b. Enables audiovisual telecommunications among military treatment facilities to support situational awareness across Level I through IV facilities.**
- **c. Supports a user-friendly electronic medical documentation system from the field through the various treatment facilities. This system should be portable, have biometric and tracking capabilities, allow accessibility to pertinent medical records, contain audiovisual capabilities, and enable viewing of radiographs in the medical record. Further, the system should be standardized across the Services.**
- **d. Supports collaborative performance improvement (see Section 5, beginning on page 27).**

Recommendation 3.3: DoD should continue to expand its partnerships with civilian trauma organizations to share information, preserve lessons learned, and improve trauma care. For example, a close partnership with a civilian medical center would help to ensure rapid stand up capability if necessary and in peacetime, could allow for additional trauma experience, contributing to the maintenance of the skills and competency of military medical personnel.

Recommendation 3.4: DoD should ensure the sustainment of effective and targeted communication, distributing important combat casualty care information in a timely manner (such as the CoTCCC system in use at the publication of this report).

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4. INFORMATICS

The lack of a unified, contiguous electronic health record across the military continuum of care has led to great difficulties in the communication of clinical information. Significant progress in medical informatics has been integral in the treatment of injured Service members.[43] At the beginning of Operation ENDURING FREEDOM (OEF) in 2001, the 75th Ranger Regiment initiated a basic pre-hospital database using information captured through after action reports and the Ranger Casualty Card.[43] This basic database expanded into the web-based Pre-Hospital Trauma Registry, allowing basic statistical analysis, trends, and reports.[43] In 2003, the Joint Theater Trauma Registry (JTTR) was approved as a demonstration project at Landstuhl Regional Medical Center. Shortly after its inception, the JTTR was expanded, with a deployed team working to capture data in theater.[1] While the JTTR, now renamed the Department of Defense Trauma Registry (DoDTR), has improved the capture of information and proven to be a major source of trauma data, the lack of an electronic medical record (EMR) remains.[29] In a 2013 Joint Trauma System (JTS) review of pre-hospital trauma care in Afghanistan, it was cited that few medical records were being received from Level I medical facilities. This lack of documentation was seen as a major obstacle to documenting and tracking medical care.[2] Medical informatics will continue to be important data sources as biometrics and other monitoring devices are moved into the deployed setting.[44]

Lesson 4: In the context of trauma care, informatics equates to the use of electronic medical records, which are vital to clinical care across the continuum and to performance improvement and research.

Embracing current and future technologies is essential to improving care, through identifying opportunities for improvement in current levels of care and planning for future care. Informatics provides an opportunity to advance all aspects of trauma care in theater, both during and after the conflict. The increased use of informatics will allow for tracking of casualties and their injuries, but also treatment methods and outcomes. This information is vital to research and quality improvement.[43,45] Uniform and interoperable databases of medical information can promote more effective and efficient medical capabilities, as well as provide the information needed for implementing training platforms that ensure the highest level of training for medical personnel.[46] As noted by Rigby, "computer-based record systems have a major potential to improve quality of care by enabling integrated care delivery through multi-professional electronic patient records, whilst also providing quality assurance processes."[46] It is important to note however, that the value of information gathered from EMRs is only as good as the quality of the information initially collected.

Many data registries have been developed over the course of Operation ENDURING FREEDOM and Operation IRAQI FREEDOM, including:

- JTTR, now included in the DoDTR
- 75th Ranger Regiment Pre-Hospital Trauma Registry
- Tactical evacuation database and Level II database
- Navy/Marine Corps Expeditionary Medicine Registry
- Armed Forces Medical Examiner System (AFMES)
- Medical Communications for Combat Casualty Care

However, these registries are not part of a global medical database. A uniform database should encompass all aspects of medical care, from the field to rehabilitation. The benefits of such a complete database would be significant. Similarly, there is no contiguous EMR across all military treatment facilities.[30] This deficiency, in addition to inconsistencies in communication, can make the transfer and capture of clinical information unnecessarily difficult.[30] Most notably, several sources have cited challenges in capturing pre-hospital data, from point of injury to Level III care.[6,30,43] This lack of documentation represents a lost opportunity for data capture and feedback.

Recommendation 4: To establish a uniform database that encompasses all aspects of trauma care, from the field to rehabilitation and to the degree possible, beyond rehabilitation to community reintegration, the Department of Defense (DoD) shall take the following actions:

a. Develop a high-fidelity online, tiered registry as well as enhanced communications capability through all levels of care.
b. Increase research and development funding for new, automated live-patient tracking and identification, including biometrics.
c. Develop an expeditionary, deployable EMR, which is easy to use, readily taught, increases productivity, secure, web-based, instantly visible from all levels including the Veterans Health Administration, compatible with existing databases and registries, and built by established experts in information systems with input from practicing military providers.
d. Increase system-wide support for concurrent data collection across the continuum to include tactical combat casualty care and Levels I-III, en route care/Critical Care Air Transport.
e. Expand the DoDTR platform to provide data and information which can be used in conjunction with the AFMES in continuous real-time performance assessment and validation of best practices.

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5. PERFORMANCE IMPROVEMENT

Performance improvement (PI) has been incorporated as a routine and ongoing activity across most aspects of health care delivery.[47] It helps providers advance their practice using evidence-based analysis and intervention strategies. Individuals or groups of health care providers learn a specific method to improve their performance, assess their current practice, apply the new measures over a useful and informative time interval, and reevaluate their performance at the end of the interval.[48, 49] PI is a continuous cycle of improvement beginning with data acquisition leading to the development of information that can be analyzed and results in actions which are incorporated into the systems of practice resulting in care that is more effective, efficient, and safe. PI is part of a broader system of quality improvement, certification, and accreditation, and in the case of trauma centers, verification.[47]

Trauma system development in the U.S. civilian sector has evolved over the past three decades as a central aspect of any single trauma center's quality program. Beginning with trauma center development following the Vietnam War, quality of care became a central focus of the American College of Surgeons (ACS), which took responsibility for trauma center development and verification.[***] Quality care rendered quickly became a primary focus and the first major program to standardize the initial approach to the evaluation and resuscitation of trauma victims was the Advanced Trauma Life Support course developed by ACS.

Several activities evolved over time to measure and monitor outcomes of trauma care, including hospital-wide quality improvement; standard setting, certification, and accreditation through the Joint Commission; development of trauma-specific quality measures focused on preventable and potentially preventable death reviews, eventually to become ACS's Trauma Quality Improvement Program; and development of trauma-specific morbidity and mortality efforts. Many of these processes focus on root cause analysis and loop closure.

As the Department of Defense (DoD) had only two ACS trauma centers, both located in San Antonio, Texas, many of these national developments went largely unnoticed. Furthermore, the formalization of the process of ACS verification of trauma centers and subsequent PI processes, which began in the late 1980s, rapidly expanded in a disorganized fashion. Many centers around the country sought and received initial verification only to realize 10 years later that there was a required re-verification process and that they were no longer verified. It is not clear that DoD was cataloguing these events and planning to adopt these standards and processes into a deployable environment. As ACS improved the verification process, hundreds of trauma centers were verified across the United States, and DoD was left behind.

[***] The designation of trauma facilities is a geopolitical process. ACS does not designate trauma centers; instead, it verifies the presence of the resources listed in *Resources for Optimal Care of the Injured Patient*. This is a voluntary process. See the ACS website at http://www.facs.org/trauma/verified.html.

Dr. Michael Rotondo, a trauma surgeon, helped ACS develop and lead the regionalization effort in trauma systems of care, and went on to lead the ACS Committee on Trauma, responsible for ACS's PI and verification activities. In 2011, Dr. Rotondo and other nationally recognized trauma experts were sent by U.S. Central Command (CENTCOM) to review and comment on the current system of trauma care in place in U.S. and North Atlantic Treaty Organization military medical facilities in Germany and Afghanistan. The group was asked to focus on opportunities for improvement, a staple of the ACS approach to center and system development, with a specific focus on quality of care that has become the signature achievement of the trauma verification and system development process that has taken place in this country over the past three decades.

In the final report of that committee, *United States Military Joint Trauma System Assessment: A Report Commissioned by the U.S. Central Command Surgeon, Sponsored by Air Force Central Command, A Strategic Document to Provide a Platform for Tactical Development,* the following observations were made about PI.

- The trauma PI and patient safety process is fragmented. The awareness, implementation and integration of structured PI processes vary by level of care, branch of Service and coalition partners. This less than desirable state results in a loss of transparency, creates difficulty in performing concurrent, multidisciplinary PI, and stifles the communication and learning between and amongst levels of care.
- Efforts to implement rudimentary trauma related PI varied widely from no review, to an exclusionary physician only review with little documented analysis or corrective actions, to a casual multidisciplinary verbal debriefing with no recorded corrective actions or loop closure documented in any of these observed systems.
- Effective communication of PI events or trends forward or backward to allow for analysis, corrective action and sustained resolution is lacking.
- There is no clear metric by which commanders or the trauma directors can be held accountable for the suboptimal outcomes of the injured.[30(p.14)]

In brief, the committee made four recommendations: 1) The Joint Trauma System (JTS) should develop an overarching PI and Patient Safety Plan, 2) the plan should encompass a system wide process for identifying events, taking corrective actions, monitoring, evaluating, and benchmarking; 3) JTS, as the lead agency for the system, and the Joint Theater Trauma System (JTTS) leadership in theater, must possess the infrastructure and authority, and systems of accountability over the continuum of care for the PI process; and 4) a robust and system-wide informatics platform is needed to support the process.

Lesson 5: Ongoing improvement of outcomes for the combat wounded requires a robust ability to monitor the care rendered to combat casualties and to measure casualty outcomes as a function of the various elements of trauma care provided along the continuum in theaters of conflict. The Services are attempting to track and analyze outcomes, but compared to JTTS/JTS/ DoD Trauma System (DoDTS) oversight of same, there is significant opportunity to codify the PI process. Codifying the PI process will allow DoD to benchmark practices and outcomes and initiate near real-time corrective measures not possible outside the DoDTS today.

Recommendation 5.1: The Defense Health Board (DHB) concurs with the recommendations from the *United States Military Joint Trauma System Assessment,* and encourages DoD to act on these recommendations.

a. **JTS should develop an overarching PI and Patient Safety Plan;**
b. **The PI and Patient Safety Plan should encompass a system wide process for identifying events, taking corrective actions, monitoring, evaluating and benchmarking;**
c. **JTS, as the lead agency for the system, and the JTTS leadership in theater, must possess the infrastructure and authority, and systems of accountability over the continuum of care for the PI process; and**
d. **A robust and system-wide informatics platform is needed to support the process.**

In addition to PI undertaken by JTS, the Armed Forces Medical Examiner System (AFMES) also maintains its own registry, the Department of Defense Medical Mortality Registry. As all U.S. combat casualty deaths from theater move through AFMES, the registry has the broad mission of analyzing all active duty deaths for trends and preventable or modifiable risk factors.[17] These trends or risk factors can be used to drive improvements in equipment, tactics, and trauma care techniques. An effective PI program that leads to robust primary and secondary systems based prevention of mortality and morbidity includes gathering and analyzing data regarding all deceased Service members, not just those who died of wounds. Linkage with AFMES is a vital part of the PI cycle.

TRAUMA PERFORMANCE IMPROVEMENT IN THE DEPLOYED SETTING

PI activities at traditional military treatment facilities (MTFs) are generally geared toward meeting accreditation requirements for intermittent external civilian review, and therefore might not be specific to or relevant to either combat trauma or a deployed environment. Moreover, deployed PI personnel require different training and skill sets compared to their MTF counterparts, who currently are not included in any pre-deployment medical training platform except for the training specifically developed by the JTS DoDTS for its deploying CENTCOM JTTS teams, and therefore not available in a contingency situation with a short lead time.

The Subcommittee offers the following observations regarding PI in the deployed setting.

1. **Data acquisition is critical to PI.** Improving casualty care relies on a cycle of data acquisition related to casualty care, followed by analysis-which can often require more than simply reviewing spreadsheets, and then implementation of necessary changes to improve subsequent casualty care based on that analysis. Done in real time, PI personnel at JTTS/DoDTS have been able to remain relevant with very tight decision-making cycles. For example, within one month, in most cases, a problem surfaces, data are acquired and analyzed, and a corrective action is created and disseminated in an effective manner, such as through a Notice to Airmen or All Army Action message. Real-time PI requires accurate data acquisition and deposit into a central data repository (i.e., a trauma registry). These requirements were not recognized and acted on until late 2004, several years into the current conflicts.

2. **Data acquisition is not standardized and centralized across the continuum of care.** Data acquisition at Level III and above (see Introduction, Table 1) was standardized by 2005 through use of the Joint Theater Trauma Registry (JTTR) form and uploading of data into what is now the Theater Medical Data Store .[†††] However, at Level II and below, data acquisition was lacking and not standardized until the 2013 fielding of the Level II, pre-hospital and tactical evacuation (TACEVAC) data store. The JTTR form, despite eight years of use, is still not a Department of Defense form. Furthermore, a standardized field Tactical Combat Casualty Care (TCCC) card was accepted as a DoD form only after two years of concerted effort. The Navy-Marine Corps Combat Trauma Registry, which contains more than 10 years of data from Level II and below, remains a completely separate entity from and does not communicate with the DoD Trauma Registry (DoDTR).

3. **PI is also local.** While a global or theater system can and does support PI processes, the implementation of changes must occur locally. This requires dedicated or at least designated staff at deployed MTFs to acquire data and implement changes driven by analysis, although the analysis itself can be, and is, done elsewhere. Those personnel with the appropriate expertise and available time should be organic within the MTFs regardless of size. This is true in times of both peace and war.

4. **PI within a system requires the existence of a system.** A robust system for patient transportation through the evacuation chain exists, some aspects by design, and some by circumstances. However, there is no robust system for the flow of medical data. For example, caring for casualties sometimes occurs in an environment in which documentation on bandages is the norm in every command except CENTCOM. The Pacific Command is standing up a JTS for its area of responsibility.

[†††] Levels of care are further described in Background and Introduction.

5. **PI within a system requires bidirectional flow of information**. Lessons learned and new guidance must be disseminated in a coordinated fashion to all levels of care to achieve PI. The current leadership paradigm in theater is coordinated centrally above Level II (Levels III and IV to evacuation) but is completely under local guidance at Levels I and II. In the current construct there is limited or no ability to communicate effectively to all levels with authority in the current construct, resulting in poor data collection and communication of lessons learned.

6. **PI requires clearly defined guidance and central leadership.** The JTTS PI leader interfaces with the local units but remains outside their chain of command. This lack of direct reporting allows the JTTS Director to act as an "honest broker" with support of the combatant command (COCOM) leadership. Whether that model should be maintained or whether full authority should be given to enact PI endeavors is to be debated. Similarly, guidance delivered to improve performance has been clear, evidence-based, and formalized through the development of 38 CENTCOM JTTS clinical practice guidelines (CPGs) that are, in themselves, a treasure trove of lessons learned that are neither currently adopted nor endorsed in any other COCOM. This lack of standardization across all COCOMs demonstrates the lack of a systems-based approach to delivering consistent high quality and safe care to warfighters.

7. **Trauma System leadership requires core PI support staff to provide oversight of the theater system.** With a DoD practice setting that crosses COCOM boundaries, the DoD-level JTS leadership again provides global "honest broker" leadership in support of uniform effective and in near real time system-wide PI across COCOMs, while respecting the autonomy of those COCOMs in advancing PI. The role of the Defense Health Agency and the Joint Staff Surgeon's offices role in PI across the continuum of multiple COCOMs is yet to be defined.

8. **PI must always remain relevant at the local level.** PI recommendations should always be relevant to the individual units. This requires a coordinated communication plan such that PI endeavors are transmitted to the proper level(s)/role(s) and not miscommunicated to improper level(s)/role(s) as 'noise' that could cause future communications to be inadvertently ignored.

Based on its experience and expert judgment, the Subcommittee developed examples of best practices in PI to be considered in a more systematic enterprise-wide effort, as displayed in Table 3 and in accordance with the TCCC Guidelines as posted on the Military Health System and JTS websites.

Table 3. Current Examples of Best Practices

Current Examples of Best Practices

Performance and Process Improvement
• Development of CPGs
  ○ Continuously reviewed and updated by subject matter experts current in combat casualty care.
• Robust monitoring of combat casualty care, extending from Level II/III facilities to definitive continental U.S. (CONUS) and Veterans Affairs care; expanding towards point of care, TCCC and Level I and II.
• Rapid implementation of data driven improvements, to allow for agility and real time course corrections.
Performance and Process Improvement (Continued)
• Establishment of the Committee on TCCC.
  ○ Production and Revision of TCCC guidelines to share new and improved tactics, techniques, procedures, medication (use) and equipment.
• Allows for leadership to make truly informed decisions.

Staffing Capabilities
• Involvement of civilian experts in PI.
• Visiting surgeons program at Level IV Landstuhl Regional Medical Center (LRMC) (ACS Visiting Surgeons Program).
• Redesign of forward surgical teams.
• Critical Care physicians in theater (in place of doctrinal 'generic' internal medicine physicians to provide critical care which has drastically advanced over the past 40 years since doctrine initiated).
• Use of surgeons and emergency medicine trained physicians in triage versus historic doctrinally derived use of dentists in this role (in training 40+ years ago, dentists received same medical training as physicians which has not been carried forward for at least 20 years but is still in doctrine).
• Use of paramedic-level providers or higher in TACEVAC platforms.[50]
• Formation of specific teams in theater
  ○ Lung injury teams.
  ○ Extra corporeal membrane oxygenation teams.
  ○ U.S. Army Institute of Surgical Research (USAISR) Rapid Response Burn Transport Team.
  ○ Joint Research Team devised by USAISR and augmented by U.S. Air Force.

Evacuation Techniques and Infrastructure
• Advanced capability (Medical Emergency Response Team -like) evacuation platforms save lives versus traditional U.S. and military platforms.
• Improved staffing and support saves lives.
  ○ En route critical care nurses specifically trained in Center for the Sustainment of Trauma & Readiness Skills (C-STARS) programs.
  ○ Critical Care Air Transportation Teams trained in C-STARS programs.
  ○ Tactical Critical Care Air Transportation Teams (should be trained in C-STARS programs).
  ○ Tranexemic acid on TACEVAC platforms.
• Streamlining evacuation processes and communication.

- Single Level IV air evacuation hub from each theater.
- Early evacuation of all casualties to a Central Level IV facility.
- Early evacuation of all casualties to a CONUS Level V facility.

Infrastructure Improvements

- Trauma Center (TC) Verification changes, in order to better serve patient populations.
  - LRMC verified as a Level I TC by the ACS, will re-verify as a Level III.
  - San Antonio Military Medical Center re-verified as a Level I TC.
  - Walter Reed National Military Medical Center - verified as a Level II TC.
  - Tripler Army Medical Center to be verified as a Level III for Pacific Command.
  - ACS acceptance of MTF use of DoDTR as registry participation requirement for TC verification.
  - Need Level II/III verification process similar to ACS verification process and create combat trauma centers prior to their deployment.

Communication

- Feedback communication mechanisms across all Roles of care must be codified.
  - Trauma mortality and morbidity conferences at unit level through MTF's and standard reporting mechanism up through trauma system.
  - Improved documentation.
    - Direct feedback from Service members in the field.
    - Improved documentation of point of injury care using TCCC casualty cards and After-Action Report.
    - Improved documentation of TACEVAC care using aviation run sheets.
    - Improved deployed hospital documentation endeavor and communicating same along the continuum.

Equipment

- Expanded personal protective equipment and preventative techniques using data from DoDTR and clinical pathologic conferences between DoDTS and Armed Services Coroner's Office.
  - To prevent injury:
    - Rigid eye shields and antibiotics for eye injuries.
  - To stabilize or prevent further injury:
    - Avoidance of platelet-inhibiting nonsteroidal anti-inflammatory drugs in combatants and in casualties. Hypothermia prevention in casualties.
    - Fluid resuscitation.
    - Hemorrhage control.
      - Physical-tourniquets and junctional devices.
      - Medical- TXA, plasma, etc.

Recommendation 5.2: DoD shall establish a formal and system-wide process for event identification and prioritization, determination of root causes, and development of possible countermeasures for PI. Such analysis and evaluation would improve the entire spectrum of trauma care and allow DoD to document casualty outcomes to demonstrate that the right care was provided under the right circumstances. Specifically, this requires:

a. **Improved documentation including pre-hospital care and evacuation care and times.**
b. **Ongoing analysis of combat injuries to identify potentially preventable adverse events in conjunction with the AFMES.**
c. **Submission of timely and focused case reports from the unit level, prepared by field level personnel who are trained, resourced and designated as responsible and who have deployed with all medical units. These reports should be linked, in a timely manner, to the larger JTS.**
d. **Adherence to the cycle of PI including data acquisition, information analysis, and application of advances back into the larger trauma system.**

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6. TRAINING

Successful training requires adhering to a training standard as well as successful pre-identification of desired outcomes. Training is a key component of the performance improvement (PI) cycle that includes delivery of care, documentation, data abstraction and analysis, development of clinical practice guidelines, proper staffing and equipment, and adequate training to implement the changes. Military medical, trauma, and operational rescue training should be considered part of the mission essential task list (METL) for all operational units.

Theater trauma care presents numerous high-level challenges. In the view of the Subcommittee, there is a lack of Joint service training requirements and role-based training requirements. Furthermore, there has been difficulty in adequately training physicians in how to support military operations as well as in determining which skills are required to become an effective military medical provider. Another challenge is the standardization and sustainment of initial training across the Services. For example:

- Defining "who owns battlefield medicine" and by extension who is accountable for training providers;
- Determining where the military physician providers should be trained;
- Defining and creating accountability for the METL required of medical personnel serving in operational units;
- Systemic lack of outcomes data regarding pre-military treatment facility (MTF) trauma interventions, knowledge retention, and training modality efficacy;
- Importance of currency of skills beyond pre-deployment training; and
- Variance between active duty and National Guard/Reserve component training.

This section focuses on the training lessons learned related to provision of battlefield and operational medical support. It organizes the lessons learned as follows:

- Training systems
- Educational content
- Educational format
- Civilian/military collaboration

6.1 TRAINING SYSTEMS

Lesson 6: A robust PI system is required to link trauma training to patient outcomes and validate training methodology.[2]

Advancements in medical/trauma training are intimately linked to field data collection, analysis, and outcomes measurement. The Joint Trauma System (JTS) and the U.S. Central Command (CENTCOM) Joint Theater Trauma System (JTTS) have proved instrumental in acquisition of injury and outcomes data through the Department of Defense Trauma Registry (DoDTR). The DoDTR has captured more than 100,000 casualty records and has resulted in more than 100 peer-reviewed medical publications.

The implementation and study of tactical combat casualty care (TCCC) life-saving interventions (LSI) such as tourniquets, damage control resuscitation (DCR), tactical evacuation (TACEVAC), and decreased emphasis on intravenous access are clear examples of successful implementation of the Plan, Do, Study, Act cycle based on mortality data. However, the translation of these data to training requirements has had mixed results. While TCCC application has moved from U.S. Special Operations Command to the general force, conventional medical training schoolhouses[‡‡] were slow to adopt these lessons in a systematic fashion. Early engagement of schoolhouses and empowering them to quickly adjust training programs is critical to meeting the needs of combatant commands.

Recommendation 6: To ensure a systems approach to trauma training, the Department of Defense (DoD) shall take the following actions:

a. **Support the development of a formal link between the JTTS and military medical training centers (e.g., Joint training centers, enlisted schoolhouses, Uniformed Services University of the Health Sciences (USUHS), medical proficiency training sites).**
b. **Provide military medical leaders with formal training in PI operations.**
c. **Ensure line commanders are aware of current casualty response system and best practice recommendations (such as those found on the JTS website at the time of this report).**
d. **Establish a joint electronic repository for medical lessons learned, supporting scientific evidence, relevant DoD and Service operational documents, and existing Service-training efforts.**
e. **Establish a high-level battlefield care directorate staffed with personnel possessing appropriate and relevant clinical expertise (at the time of this report that directorate may be in the Defense Health Agency (DHA)).**
f. **Enable oversight, as currently performed by the U.S. Army Institute of Surgical Research and potentially the DHA.**

Lesson 7: Medical and trauma knowledge must flow freely between the civilian and military medical communities and be coupled with rapid training integration strategies.

The civilian sector is historically a repository for knowledge during the inter-war period. However, during the past 12 years, it has also served as an innovator and validator of military medical experience, as well as a source of critical training best practices. Though originated in combat, supporting research and training in DCR has largely come from the civilian trauma centers. Additionally, Mabry et al clearly demonstrated that implementing civilian critical care/flight paramedic standards for TACEVAC in Afghanistan reduced mortality.[51] Finally, all Services work jointly in theater. Home trauma rotations at civilian trauma centers and health care systems offer a variety of

[‡‡] Schoolhouses are the specified training locations within the Services.

unique training opportunities. Training should be done to a standard, with Service members continuing to train as they fight. Military engagement with these centers has increased (Army Trauma Training Centers (ATTC), Navy Trauma Training Centers (NTTC) Center for the Sustainment of Trauma and Readiness Skills (C-STARS)); however, no standardization exists. Best practices from current service trauma training center programs should be cross-leveled.

One of the most definitive examples of the critical nature of the civilian/military relationship is the collaboration between the Committee on Tactical Combat Casualty Care, the Prehospital Trauma Life Support (PHTLS) Committee and the American College of Surgeons Committee on Trauma .[52] This relationship allowed the TCCC guidelines to garner validation and accreditation by the civilian leaders in trauma care and allowed the military to capitalize on existing training infrastructure. The Defense Medical Readiness Training Institute, in conjunction with JTS, has developed an operational emphasis module to the Advanced Trauma Life Support training program (ATLS).

Recommendation 7: To standardize and harmonize trauma training across the Services, DoD shall take the following actions:

- **a. Sustain and expand initiatives to train and support all tactical evacuation medics to a common and high standard (at the writing of this report that standard would be Critical Care Flight Paramedics) (e.g., 160th Special Operations Aviation Regiment (Airborne) model, Air Force Special Operations Command model, newly implemented Army Medical Department model).**
- **b. Develop an initiative to train and sustain combatant unit senior ground medics to a common and high standard (e.g., U.S. Army Special Operations Command (USSOCOM) model).**
- **c. Support the development of the CCAT and C-STARS by the Air Force for the development of best practices and common standards for en route care.**
- **d. Review Service trauma training center programs (ATTC, NTTC, C-STARS) and consider creating Joint Trauma Training Centers (JTTCs), making sure training occurs in a team based environment, ideally with a team that will deploy together.**
- **e. Ensure best practices and procedures are cross-leveled and standardized across all military medical simulation training centers (MSTCs), which should receive central certification.**
- **f. Ensure MSTC trainers are subject matter experts, regardless of military versus civilian status, and are trained to a standard, not to a time.**
- **g. Train military TACEVAC personnel to, at a minimum, civilian critical care transport standards (see Recommendation 7c.).[53,51,54]**

6.2 EDUCATIONAL CONTENT

Lesson 8: The lack of comprehensive, standardized training for military health care providers creates an operational gap that affects unit- level training as well as effective utilization of the military system to reduce combat mortality.

The 2013 CENTCOM Pre-Hospital Trauma Care Assessment Team identified a variety of challenges related to physician knowledge.[2] Specifically regarding TCCC, the report notes that physicians were not reliably trained in TCCC.[2] Therefore, while combat medics/corpsmen serving at Level I were generally very familiar with TCCC principles, the supporting medical element and medical direction were not. Efforts to address this challenge include the Combat Casualty Care Course, offered by all Services and usually attended by military physicians in training; the two-week Field Medical Service Officer Course at one of the two Field Medical Training Battalions for Navy physicians serving with the Marine Corps; and the Marine Expeditionary Force requirement for all medical officers to go to the Naval Trauma Training Center prior to deployment.

Though a variety of programs were developed with a focus on trauma training, there is a systems gap in training military physicians to effectively support combat operations.[55, 56, 57] As a result, military physicians are not universally prepared to understand and operate within the military medical system. Military health care providers are trained to the highest civilian standards.[58] Their training takes place in a fixed-facility hospital or clinic environment. Physicians should be trained in epidemiology and military operational principles including evacuation, pre-hospital medical direction, logistics, and process improvement.

Recommendation 8: USUHS, as DoD's joint military medical school, shall take the following actions:

a. **Continue to expand and institutionalize its direct participation, research, and training in trauma and combat casualty care delivery across Services and throughout the continuum of care.**
b. **Develop and formalize a partnership with the JTS.**
c. **Systematically train and develop clinical experts in pre-hospital battlefield care.**
d. **Involve the Defense Health Board Trauma and Injury Subcommittee in setting the curriculum.**
e. **Develop a trauma care curriculum that would be required by all health care providers before deployment.**

Lesson 9: Effectively trained TCCC has a demonstrable effect on reducing potentially preventable causes of death on the battlefield.[59, 19, 60,]

In 2001, the training for medical personnel was primarily based on a civilian course not designed for combat situations. Integration of the TCCC guidelines into special operations forces medical protocols began in earnest in 1998 and expanded to the broader military starting in 2003. The U.S. Army 68W training program[§§] and the Combat Casualty Care Course both moved from civilian-based trauma training (PHTLS/ATLS) toward TCCC-focused training. In 2004, the Navy and Marine Corps began to integrate TCCC into the forces; however, formal integration into the Field Medical Service Schools did not begin until 2005-2006. In 2009, the DHB recommended TCCC training to all combat medical personnel. Multiple retrospective studies demonstrate that implementation of TCCC was one of the primary reasons for lowering preventable deaths in the Global War on Terror. [59,19,61]

Recommendation 9: TCCC shall continue to form the basis for battlefield trauma care training and be integrated as the minimal accepted standard of training for all military members, initial enlisted medical training, and specialized enlisted medical training. In addition, TCCC sustainment training programs must occur on a regular basis, as the TCCC Guidelines are a "living" document and are regularly updated.

Lesson 10: TCCC and combat trauma training, aimed at achieving core competencies in combat casualty care, must be provided in a tiered fashion to all personnel operating in the battle space.

TCCC is not a medical skill set; it is a tactical skill set. The success of TCCC requires integration into the medical and operational training pipelines. The best example of this practice is the Casualty Response Training for Ranger Leaders course and noted reduction in preventable battlefield death from training non-medical personnel in TCCC. True success requires integrating TCCC and rescue training into the METL and holding line commanders responsible for execution. In order to reach all DoD components, the training should also include Reserve and Guard components.

Recommendation 10: DoD shall require that all military personnel deploying in support of combat operations be trained in TCCC. This training shall be carried out at a minimum on initial entry into the service and within six months of deploying. This training should be scaled to the skill set of the personnel. The unit commander should be accountable for accomplishment of this training task in a

[§§] 68W is the Military Occupational Specialty (MOS) for the Army's healthcare specialist, also known as the combat medic.

fashion similar to any other training standard of their unit. Personnel should not deploy until they demonstrate and document mastery of this training.[***]

6.3 EDUCATIONAL FORMAT

DoD faces several fundamental questions regarding training format: how to most effectively provide initial training; where to provide it—schoolhouse, medical school, or individual unit; who provides the training—private vendors, individual units, or designated training centers; and how does the military most effectively sustain skill sets?

Lesson 11: Effective knowledge acquisition and retention requires multi-modal educational strategies that include appropriate balance of didactics, practical application, scenario-based learning, distance learning, live tissue training (LTT), human role models, clinical experience, and high-fidelity simulation.

National trauma courses exist which could be augmented to incorporate military specific, including mass casualty or blast response training, such as the Advanced Trauma Operative Management course and the Advanced Surgical Skills for Exposure in Trauma course, both from the American College of Surgeons.[62,63]

Recommendation 11: To ensure multi-modal educational strategies are used in trauma training, DoD shall take the following actions:

a. **Prioritize medical and trauma training as components of the METL and fund efforts to develop distance learning, virtual reality, and high-fidelity simulation training.**
b. **Support enduring sustainment hands-on trauma training for all pre-hospital medical personnel including, but not limited to LTT and Trauma Center Rotations (e.g., USSOCOM Directive 350-29 model; USASOC Regulation 350-1 model).**
c. **Investigate partnerships with the Defense Advanced Research Projects Agency and private industry developers of popular combat video games (e.g., "Halo©," "Call of Duty©," "Gears of War©") to create integrated, accurate first responder treatment protocols for casualties in the game, based on injuries and injury requirements.**[2]
d. **Upgrade the medical simulation training centers to serve as the medical range for every division-sized post.**
e. **Develop a surgical skills course, including war surgery skills.**
f. **Develop a national certified trauma course standardizing clinical practice guidelines across the spectrum of trauma training.**

[***] Current TCCC Guidelines can be found on the Military Health System (https://mhs.health.mil/References/REF_TCCC.cshtml) and the JTS (http://www.usaisr.amedd.army.mil/joint_trauma_system.html) websites.

Lesson 12: Medical and trauma training must be integrated into operational and tactical training.

Some units may only be training first responders in TCCC to a level of familiarization versus conditioning first responders to a level of proficiency or a level of mastery. Casualty response training should be repetitious hands-on training commensurate to marksmanship, physical training, and small unit tactics. Unit casualty response rehearsals should be conducted routinely. A medical equipment pre-combat check and pre-combat inspection should be conducted prior to every mission.[2]

Recommendation 12: To integrate trauma training into operational and tactical training, DoD shall take the following actions:

a. **Train all combatant unit personnel in basic TCCC and combat trauma management initially, annually, and within six months of combat deployment (e.g., USSOCOM Directive 350-29 model); this shall be a requirement for deploying to a combat theater.**
b. **Include demanding, realistic, scenario-based exercises in training, identifying basic critical tasks and training those to mastery, not merely familiarization.**
c. **Leverage the opportunity for field medical operations and training.**
d. **Establish Service training under the newly established DHA in order to standardize training across the Services.**

With regard to computer-based simulations, power-point presentations and static in-doors exercises have a role in knowledge transfer, but do not replicate performing critical tasks under an evoked sympathetic nervous system response.

Lesson 13: LTT has an important, tailored role in trauma training for life saving interventions (LSI) on the battlefield.

There is strong opinion from deployed medical forces that LTT is "paramount and saves lives."[2] Though Kotwal's *Saving Lives on the Battlefield* cited, "unanimous agreement that LTT is very helpful in preparing corpsmen to manage combat casualties," there remains controversy regarding the utility of isolated LTT for all procedural training.[2] Discussions with tri-Service senior medics support the value of LTT for line personnel and inexperienced medics. However, many feel that integrating trauma training into routine operational training is more critical. LTT remains an important component of a full spectrum trauma-training program.

Recommendation 13: LTT should be combined with high-fidelity simulation and integrated operational medical training across the force. DoD should continue to fund research efforts to compare cost, efficacy, and sustainability of LTT programs compared to high fidelity simulation for training LSI.

6.4 COMMAND ACCOUNTABILITY FOR TRAINING

Lesson 14: Commanders can only accept full responsibility for risk assumption or mitigation when they understand the inherent risk as well as their options as commanders to mitigate that risk. Medicine, medical, and medical training are terms conveying specialty training or education and have no tactical relevance. Accordingly, casualty response training for first responders and combatant leaders is often not incorporated into unit battle drills. This trauma training for leaders is an essential component of battlefield trauma care.

Casualty, first responder, combat lifesaver, and combat casualty care are terms commanders can identify and/or understand. A recent study of combat casualties from the 75th Ranger Regiment, U.S. Army Special Operations Command, between 2001 and 2010 documented that 0 percent of their pre-MTF fatalities and 3 percent of their total fatalities were potentially preventable. This is largely attributable to the Ranger Casualty Response System, a TCCC based program that is aggressively taught to all unit personnel. The 75th Ranger Regiment Regimental Command Inspection program tracks and evaluates 100 percent Ranger First Responder achievement.[2] In August 2010, the Headquarters of the U.S. Marine Corps mandated TCCC-based trauma training for all medical providers deploying into theater.[64]

Recommendation 14: To ensure command accountability for trauma training, the following shall occur:

a. **TCCC training and all other elements of the unit's casualty response plan are the responsibility of the unit commander and shall be a reportable item on the Unit Status Report.[2]**
b. **Medical training and readiness shall be measured before deployments and considered a go or no go item with commander attention.**
c. **DoD shall provide a structure and foundation for casualty response systems and trauma care training. Combatant non-commissioned officers provide first responder continuity for casualty response systems.[2]**
d. **DoD shall change all references to tactical life-saving tasks/equipment from medical to casualty.**

In sum, culture and strategy follow structure. DoD should prioritize resources and training based on structure and then master and reinforce the basics. Personnel achieve confidence through competence on the basics. However, the Department should not just train the basics; it must condition the basics through repetition. Akin to marksmanship, physical training, and small unit tactics, first responders must become the masters of the basics of pre-hospital casualty response and the command held accountable for such response training.

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7. RESEARCH/CLINICAL INVESTIGATION

> "Fiscal challenges including indiscriminate funding reductions, withdrawal of troop formations from Afghanistan, and bureaucratic inertia threaten to diminish the military's core mission of trauma research. The wars in Afghanistan and Iraq and events on U.S. soil have laid bare the essential link between military research and advances in trauma care. Even in austere times, the military remains uniquely obligated to maintain its commitment to trauma research as a matter of national security and well-being."[33]
>
> Col Todd E. Rasmussen, Deputy Director, U.S. Combat Casualty Care Research Program, Fort Detrick

Although great progress has been made in combat casualty care in recent decades, much more can be done to save lives and reduce disabling medical conditions. Trauma and injury research is the essential link between making sense of the lessons learned to inform improved care. Systematic review of retrospective data as well as carefully designed clinical trials create the evidence base on which to train personnel and ensure clinical practice that is state-of-the-art.

Within the Department of Defense (DoD), the Combat Casualty Care Research Program (CCCRP) of the U.S. Army Medical Research and Materiel Command (MRMC) located at Fort Detrick, Maryland, focuses on reducing the mortality rate of American troops, reducing morbidity of combat injuries, and reducing the medical footprint on the battlefield. It conducts and supports research on hemorrhage and resuscitation, traumatic brain injury, forward surgical/intensive care, and treatments for tissue injury. Particular focus is placed on improving the first responder's capability to provide effective treatment more rapidly and as close to the place of the injury as possible.[65] The program is composed of individual Service medical research and development funding and the joint Defense Health Program.

CCCRP collaborates with the Office of Naval Research's Casualty Care and Management Group and U.S. Air Force research efforts through the Biomedical Initiative Steering Committee, the Committee on Tactical Combat Casualty Care (CoTCCC), and the Joint Program Committee. In addition, CCCRP collaborates with the National Institutes of Health, the Defense Advanced Research Projects Agency, and other organizations in seeking improvements in care of combat casualties through research.

DoD's 2008 Guidance on Development of the Force included an assessment of military trauma research gaps. Joint Force Health Protection Joint Capability Documents or Functional Needs Assessments were reviewed to identify capability gaps.[66] Of the 69 gaps requiring medical research and development, 28 fell within CCCRP's purview in the areas of Joint Casualty Management (24 gaps) and Joint Patient Movement (4 gaps).[27]

In 2013, the U.S. Government Accountability Office (GAO) issued a report saying that DoD, through the Office of the Assistant Secretary of Defense for Health Affairs (OASD(HA)) and MRMC had completed 44 research projects since the 2008 assessment. However, no assessment had been conducted of whether the results of the research fill the gaps identified in 2008.[67] In response to the GAO report, the Senate Report of the 2014 National Defense Authorization Act directed CCCRP to brief the Staff of the Senate Armed Services Committee on whether CCCRP is meeting its goals. On February 3, 2014, Colonel Todd E. Rasmussen accompanied Dr. Terry M. Rauch from OASD(HA) to brief Senate staff on the resolution of military trauma research gaps defined in the 2008 *Guidance on Development of the Force*. Colonel Rasmussen provided results from a broad, qualitative assessment of gap closure that found that although significant progress has been made, the gaps were less than 50 percent resolved.[27,68] In conducting its assessment, the Defense Health Board Subcommittee reviewed the CCCRP portfolio and the gaps remaining, as identified in the February 2014 Senate briefing.

Lesson 15: Since the start of Operation ENDURING FREEDOM in 2001 and subsequently Operation IRAQI FREEDOM in 2003, numerous advances have been made in battlefield trauma care but more research is needed to fill critical gaps.

DoD medical research enabled significant advances in combat casualty care in areas such as tactical combat casualty care (TCCC), selection and optimal use of extremity tourniquets, topical hemostatic dressings, damage control resuscitation, management of burn casualties, improved outcomes in casualties with traumatic brain injury, and the use of TXA in combat casualties.[6,69] DoD researchers, in conjunction with the Armed Forces Medical Examiner System, greatly increased the understanding of the causes of combat mortality and how to decrease potentially preventable deaths from wounds sustained in combat.[17] Data captured by the DoD Trauma Registry (DoDTR), military medical research, and development efforts directly contributed to the U.S. military achieving the highest casualty survival rate in the history of warfare during the conflicts in Afghanistan and Iraq.[17]

It is important to sustain both the valuable research and clinical investigations that have developed these advances, as well as the Joint Trauma System (JTS) and CoTCCC, which have operationalized the advances. As the current military conflicts end and the volume of combat injuries decreases, the focus of military medicine will likely shift away from trauma care. Translational and collaborative research between the civilian and the military sectors will continue to be essential to maintaining and continuing to develop trauma care research.[70] As noted by Rasmussen and Baer, "[l]ed and funded by the military, civilian institutions must continue to play the role of expert partner and mentor with…expertise for basic research as well as a larger capacity for clinical trials."[33] The Uniformed Services University of the Health Sciences and the Military Health System Research Symposium (MHSRS) provide appropriate venues to present this research to partners both within and outside of DoD. Promoting communication between military

and civilian sectors, at events such as the MHSRS will also help to ensure the translation of these TCCC advancements to these other sectors of care.

Recommendation 15: To advance the trauma and injury research agenda, DoD shall take the following actions:

a. **Continue to fill the research gaps remaining from the 2008 *Guidance on Development of the Force*.**
b. **Continue to support trauma care research during the interwar years in order to address existing TCCC gaps identified by the CoTCCC in the following areas:**
    i. **non-compressible hemorrhage**
    ii. **hemostatic dressings and resuscitation strategies**
    iii. **lyophilized plasma product**
    iv. **fluid resuscitation**
    v. **combat casualty care monitoring devices**
    vi. **junctional hemorrhage control**
    vii. **training and evaluation methods for TCCC skills**
    viii. **airway management.**
c. **Embed deployable research teams within deployed commands or deployed hospitals.**
d. **Work to ensure a clinicopathological review of every U.S. combat fatality, including preventable death analyses from combat units.**
e. **Support the continued use and analysis of the DoDTR in order to identify areas of potential improvement and measurement of implemented mitigation strategies.**
f. **Implement a transition initiative to procure, field, train, and track new TCCC devices and medications.**
g. **Establish an interagency mechanism with the Food and Drug Administration to approve proposed projects and indications for use by the Services in deployed combat environments.**
h. **Recommend the sustainment of the annual MHSRS which is meant to link the clinical questions to the future funding.**

CONCEPTS INTO ACTION

New technology and trauma care research findings will continue to present additional opportunities to improve the care of combat wounded Service members, but implementation of these advancements requires the support of the military leadership. Each unit should have available state-of-the art advances in medical care; however, the implementation of advancements is sometimes leadership dependent. As such the implementation of battlefield trauma care has evolved unevenly in the U.S. military over the last 12 years.[6] Newly recommended TCCC devices and medications are transitioned into use by combat forces largely based on unit initiative. Likewise, presently there is no transition of the JTS Clinical Practice Guidelines, implementation of the DoDTR, or consistent use of the TCCC Guidelines throughout the geographic combatant commands

outside of the U.S. Central Command. There is considerable variability among the Office of the Secretary of Defense, the Services, the Geographic Combatant Commanders, and individual combat units with respect to training and equipping troops in evidence-based battlefield trauma care. Previous recommendations by the Assistant Secretary of Defense for Health Affairs to train all combatants and physicians in TCCC, in particular, remain unimplemented throughout DoD.[2] As discussed in the training section of this report, the JTS, with a DoD-wide and international team of collaborators, should help ensure that these new advancements are quickly translated into lives saved.

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APPENDICES

APPENDIX A: LETTER OF REQUEST

UNDER SECRETARY OF DEFENSE
4000 DEFENSE PENTAGON
WASHINGTON, DC 20301-4000

PERSONNEL AND READINESS

MAY 18 2012

MEMORANDUM FOR PRESIDENT, DEFENSE HEALTH BOARD

SUBJECT: Request to the Defense Health Board to Provide Theater Trauma Lessons Learned from the Conflicts in Iraq and Afghanistan

As the conflicts in Iraq and Afghanistan wind down, the Department recognizes the importance of learning from these experiences and the advanced trauma care systems developed in these theaters. I request that the Defense Health Board develop a Theater Trauma Lessons Learned document summarizing lessons learned from the conflicts in Iraq and Afghanistan, and a strategy for preserving these lessons in future conflicts. Please provide the requested review and Lessons Learned document to the Assistant Secretary of Defense for Health Affairs as soon as possible.

Jo Ann Rooney
Acting

APPENDIX B: MEMO FROM THE ASSISTANT SECRETARY OF DEFENSE FOR HEALTH AFFAIRS

From: Assistant Secretary of Defense for Health Affairs
Sent: Wednesday, June 18, 2014 10:56 AM
Subject: Global Health/Afghanistan

Good morning MHS Team,

Last month, the five of us embarked on a visit with medical units and combat leaders in Afghanistan. In the austere environment of this country, the Military Health System is an actor in two major missions – our combat medicine mission and the sustainment of host-nation health capacity in the era following our drawdown this summer.

With the war winding down, it is critical that we remain dedicated to gathering the lessons learned from this experience. The MHS has been exemplary in rapidly learning about what works and what does not work in our care to wounded service members, and turning that knowledge around into clinical practice in the real world. Processes for triage, patient flow, trauma care, and aeromedical evacuation have been refined and continuously improved – and now serve as the standard for our medical colleagues around the world.

As the war concludes, it is important that we codify those innovations and embed them in our education and training systems worldwide. Every one of us – whether serving overseas today or serving here at home – has a role in this effort. We need to ensure actions and instincts that are in the forefront of our thoughts today are not lost.

In looking at host-nation health capacity and capability, it is clear that the contributions of US military medical personnel have also been immense. We were moved by the commitment of not only the U.S. military, but NATO partners, non-NATO nations, the non-government organizations and – above all – the Afghan people, who have come together to support the singular mission of improving the health and system of medical care in this war-ravaged nation.

Although the principal purpose of our visit was focused on medical support to operational forces, we also had the opportunity to visit with our Afghan colleagues and witness the great strides they have made in advancing health in their own society. We visited a local Afghanistan hospital that Dr. Woodson had visited in a previous visit to the country. The singular advances of that one institution exemplified the progress being made across the nation – progress that includes remarkable reductions in maternal mortality, infant and child mortality, and increases in life expectancy. And this visit highlighted the important work that embedded U.S. medical forces have made in supporting these advances.

Our work with the people of Afghanistan will not end this summer. We will continue to have a role, in a model that brings "whole of government" resources and expertise in sustaining and expanding their capacity to care for their citizens. This mission, as part of our global health engagement strategy, is important to our overall national security strategy and goals – and will be an important component of continuing to help Afghanistan grow and thrive.

To visit our medical personnel on the ground is always uplifting for us. Witnessing the pride and professionalism of these men and women reminds each of us of the MHS's contributions as a global force for good.

Jonathan Woodson, M.D.

Assistant Secretary of Defense (Health Affairs)

Forrest Faison, RADM, MC, USN

Deputy Surgeon General

Mark Ediger, Maj Gen, USAF, MC

Deputy Surgeon General

Nadja West, MG, MC, USA

Joint Staff Surgeon

Joseph Caravalho, MG, MC, USA

Commander, US Army Medical Research and Material Command

APPENDIX C: MEETINGS AND BRIEFINGS

November 8, 2012

On this teleconference, members discussed the tasking and relevant publications and reports. There were no briefings at this meeting.

December 14, 2012

On this teleconference, members discussed the tasking, relevant publications and reports, and a potential way forward. There were no briefings at this meeting.

January 29, 2013
Falls Church, VA

Members discussed the tasking, relevant publications and reports, and broke into groups to formulate draft findings and recommendations. There were no briefings at this meeting.

October 29, 2013
Teleconference

MRMC Research Initiatives
Dr. Terry Rauch, Director of the Defense Medical Research and Development Program, Force Health Protection and Readiness

December 20, 2013
Teleconference

Joint Trauma System as a Defense Center of Excellence
Col Jeffrey Bailey, Director, Joint Trauma System, U.S. Army Institute of Surgical Research (USAISR), and COL Michael Weber, Commanding Officer, USAISR

February 25-26, 2014
Falls Church, VA

Roundtable Discussion
- Col Jeffrey Bailey, Director, Joint Trauma System, U.S. Army Institute of Surgical Research (USAISR)
- Dr. Eric Elster, Department of Surgery, Uniformed Services University of the Health Sciences, Naval Medical Research Center
- Col Matthew Martin, Trauma Medical Director, Madigan Army Medical Center; Army Chair, American College of Surgeons Committee on Trauma

- Col Todd Rasmussen, Deputy Director, U.S. Combat Casualty Care Research Program, Fort Detrick
- Lt Gen Douglas Robb, Director, Defense Health Agency
- CDR Carlos Rodriguez, Division Chief Trauma Surgery/Surgical Critical Care, Walter Reed National Military Medical Center

July 15, 2014

On this teleconference, members reviewed and continued to finalize the draft report. There were no briefings at this meeting.

July 30, 2014

On this teleconference, members discussed and reviewed the draft report. There were no briefings at this meeting.

August 11, 2014
Defense Health Board Meeting
Falls Church, VA

Col (Ret) Donald Jenkins, Subcommittee chair, presented the deliberative predecisional draft of the report. Defense Health Board members requested additional edits to the report.

October 6, 2014

On this teleconference, members discussed and reviewed the draft report. There were no briefings at this meeting.

November 6, 2014
Defense Health Board Meeting
Dayton, OH

Col (Ret) Jenkins presented the revised deliberative pre-decisional draft of the report. The Board unanimously approved the recommendations with revisions.

APPENDIX D: LIST OF INDIVIDUAL ADVANCES

Department of Defense Trauma System

- Development and implementation of a Joint Trauma System
  - Now designated as the Defense Center of Excellence (DCoE) for Trauma
- Who Owns Combat Trauma Care in the DoD?
- Secretary of Defense and Under Secretary of Defense for Personnel and Readiness may set Department of Defense (DoD) policy
- Health Affairs has primary oversight of health care policy in DoD
- Service Chiefs train and equip in their services
- Surgeons General have primary oversight of health care policy in their services
- U.S. Army Special Operations Command trains, equips, and sets policy for Special Operations (SOF) Forces
- Geographic Combatant Commands establish policy in their area of responsibility
- Must preserve resourcing of DCoE for Trauma
- DCoE for Trauma must incorporate lessons learned from civilian sector
  - During the peace interval
- DCoE for Trauma must include regulatory specialists to facilitate effective
  - Investigation of trauma registries

Communications

- Rapid publication of clinical and research results
- Need a published paper in the medical literature on military trauma care
  - Lessons learned from Afghanistan and Iraq
- Mechanism for exchanging best practice guidelines between DoD and civilian sector
- Military trauma system experts establish formal relationship with American College of Surgeons (ACS)
- Weekly Performance Improvement Trauma video-teleconferences and teleconferences.

Informatics

- Development of a DoD Trauma Registry (DoDTR)
- Ranger Pre-Hospital Trauma Registry at first
  - Later tactical evacuation (TACEVAC) database and Level II database
- Also a Navy/Marine Corps Expeditionary Medicine Registry
- DoDTR extended registry capability to entire continuum
- TACEVAC database usability enhanced

Performance Improvement

- Development of Clinical Practice Guidelines (CPGs)
- Continuous review and update of CPGs
- Robust performance improvement monitoring
- Performance improvement extension from facilities to point of injury (POI)

- Rapid implementation of data-driven improvements
- Monthly Killed in Action Preventable Death Reviews
  - Armed Forces Medical Examiner System (AFMES) recognized as a valuable member of team
  - AFMES data critical to improving combat casualty care
- Deliberate involvement of civilian experts
- Visiting Surgeons program at Level IV
- ACS verification of Landstuhl Regional Medical Center (LRMC) as a Level I trauma center
- LRMC will re-verify as a Level III Trauma Center
- ACS re-verification of San Antonio Military Medical Center as Level I trauma center
- ACS verification of Walter Reed National Military Medical Center as Level II trauma center
- ACS acceptance of military treatment facility use of DoDTR as registry participation
- Requirement for Trauma Center verification
- Tripler to be verified as a Level III Trauma Center for Pacific Command
- Increased frequency of blood delivery to theater
  - Newer red blood cells
- Redesign of Forward Surgical Teams
- Establishment of the Committee on Tactical Combat Casualty Care (CoTCCC)
- CoTCCC Guidelines based on phased care on the battlefield
- Aggressive use of tourniquets for life-threatening extremity hemorrhage
- Hemostatic agents for external hemorrhage control not amenable to
  - tourniquet application
- Combat Ready Clamp, Junctional Emergency Treatment Tool, SAM Junctional Tourniquet for junctional hemorrhage control
- Nasopharyngeal airways for unconscious casualties
- Sit up and lean forward airway positioning for maxillofacial trauma
- Surgical airways for maxillofacial trauma with obstructed airway
- Supraglottic airways
- Aggressive needle thoracostomy for suspected tension pneumothorax
- Longer needle for needle decompression
- Lateral approach for needle decompression
- Vented chest seals for open pneumothorax
- Intravenous (IV) access obtained only when needed
- Intraosseous (IO) access if vascular access needed but IV cannot be started
- Multiple IO options
- Tranexamic acid (TXA) for casualties at risk of significant hemorrhage
- Fluids by mouth (PO) for casualties able to do so.
- Hypotensive resuscitation with Hextend for casualties in shock
- Freeze-Dried Plasma for fluid resuscitation in SOF
- Hypothermia prevention in casualties
- Avoidance of nonsteroidal anti-inflammatory drugs in combatants and in casualties
- Rigid eye shields and antibiotics for eye injuries

- Battlefield antibiotics (PO and IV)
- Improved fluid resuscitation for burn casualties
- Triple-Option battlefield analgesia
  - Meloxicam/acetaminophen
  - Oral transmucosal fentanyl citrate
  - Ketamine
- Modified tactical combat casualty care (TCCC) measures to optimize pre-hospital care for traumatic brain injury (TBI)
- Direct feedback from combat medics on TCCC equipment
- Improved documentation of POI care using TCCC casualty cards and
  - After-Action Reports
- Joint Individual First Aid Kit
- Use of paramedic-level providers or higher in TACEVAC platforms
- Early availability of 1:1 plasma:packed red blood cells (PRBCs) when feasible
- Guidelines for use of fresh whole blood when needed
- Freeze-Dried Plasma in SOF units
- TXA on TACEVAC platforms
- Advanced capability (Medical Emergency Response Team-like) evacuation platforms
- Improved documentation of TACEVAC care using aviation run sheets
- Overfly Level II's when Level III facility is close
- Damage Control Resuscitation
- Damage Control Surgery
- 1:1:1 plasma:platelets:PRBCs transfusion ratio for hemorrhagic shock
- Guidelines for use of fresh whole blood when needed
- Thawed plasma at Level II and III
- Platelet teams in theater
- Ultrasound at all Level II and III
- Computed Tomography scans at all Level III
- Aggressive decompressive craniectomy in TBI
- Aggressive monitoring of intracranial pressure in TBI
- Temporary vascular shunting at all Level II and above
- Delayed removal of intraocular foreign bodies
- Aggressive use of fasciotomy in extremity injuries
- Development of TBI protocols
- Improved fluid resuscitation strategies for burn casualties
- TXA
- Coagulation monitoring using thrombelastography or thromboelastometry
- Negative pressure wound therapy
- Improved management of wound infections
- Critical Care physicians in theater
- Trauma mortality and morbidity conferences
- Improved treatment of invasive fungal infections
- Robust performance improvement monitoring
- Surgical capability at Level II B's
  - U.S. Marine Corps
- Enroute Critical Care Nurses
- Tactical Critical Care Evacuation Teams
- Critical Care Air Transportation Teams
- Critical Care Air Transportation Teams
- Single Level IV air evacuation hub from each theater

- Early evacuation of all casualties to a Central Level IV facility
- Early evacuation of all casualties to CONUS Level V facility
- Use of wound vacs in strategic evacuation
- Lung injury teams
- Extra corporeal membrane oxygenation teams
- U.S. Army Institute of Surgical Research Rapid Response Burn Transport Team
- Tripler to be verified as a Level III Trauma Center for Pacific command

Research/Clinical Investigation

- Dedicated research teams in theater
- Institutional Review Board approval system in theater
- Focused research at DoD labs on combat casualty care issues
- Increased funding of trauma-related research
- Lessons Learned in the Drawdown
- What mistakes made in medical drawdown in Iraq?
- What mistakes made in medical drawdown in Afghanistan?
- TCCC maintain interface with U.S. Special Operations Command biomedical research and development programs
- DoD combat casualty care program should provide for thorough analysis
  - of the data in the DoDTR to examine trauma injury patterns, trauma
  - care interventions, and their association with clinical outcomes

Training

- Service trauma training centers
- DoD-wide adoption of TCCC concepts and training

APPENDIX E: SUMMARY OF LESSONS LEARNED

Department of Defense Trauma System

1. Despite vast improvements in the military trauma care system over the past decade, there is no unifying agency with oversight over all aspects of the combat casualty care system.
2. At the onset of the current conflicts, communication, coordination, and command and control of and among levels of care and personnel across the Services under Combatant Command control were not well planned, trained for, and implemented consistent with practices in civilian centers and systems.

Communication

3. At the beginning of the conflicts, communication and specifically clinical patient information was difficult to transmit among levels of care.

Informatics

4. In the context of trauma care, informatics equates to the use of electronic medical records, which are vital to clinical care across the continuum and to performance improvement and research.

Performance Improvement

5. Ongoing improvement of outcomes for the combat wounded requires a robust ability to monitor the care rendered to combat casualties and to measure casualty outcomes as a function of the various elements of trauma care provided along the continuum in theaters of conflict. The Services are attempting to track and analyze outcomes, but compared to JTTS/JTS/DoDTS oversight of the same, there is significant opportunity to codify the PI process.

Training

6. A robust performance improvement (PI) system is required to link trauma training to patient outcomes and validate training methodology.
7. Medical and trauma knowledge must flow freely between the civilian and military medical communities and be coupled with rapid training integration strategies.
8. The lack of comprehensive, standardized training for military health care providers creates an operational gap that affects unit- level training as well as effective utilization of the military system to reduce combat mortality.
9. Effectively trained tactical combat casualty care (TCCC) has a demonstrable effect on reducing potentially preventable causes of death on the battlefield.
10. TCCC and combat trauma training, aimed at achieving core competencies in combat casualty care, must be provided in a tiered fashion to all personnel operating in the battle space.
11. Effective knowledge acquisition and retention requires multi-modal educational strategies that include appropriate balance of didactics, practical application,

scenario-based learning, distance learning, live tissue training (LTT), human role models, clinical experience, and high-fidelity simulation.

12. Medical and trauma training must be integrated into operational and tactical training.
13. LTT has an important, tailored role in trauma training for life saving interventions on the battlefield.
14. Commanders can only accept full responsibility for risk assumption or mitigation when they understand the inherent risk as well as their options as commanders to mitigate that risk. Medicine, medical, and medical training are terms conveying specialty training or education and have no tactical relevance. Accordingly, casualty response training for first responders and combatant leaders is often not incorporated into unit battle drills. This trauma training for leaders is an essential component of battlefield trauma care.

Research/Investigation

15. Since the start of Operation IRAQI FREEDOM and Operation ENDURING FREEDOM in 2001, numerous advances have been made in battlefield trauma care but more research is needed to fill critical gaps.

APPENDIX F: ACRONYMS

ACS	American College of Surgeons
ACS COT	American College of Surgeons, Committee on Trauma
AFMES	Armed Forces Medical Examiner System
AMEDD	Army Medical Department
ATLS	Advanced Trauma Life Support
ATTC	Army Trauma Training Centers
CCAT	Critical Care Air Transport
CCCRP	Combat Casualty Care Research Program
CENTCOM	U.S. Central Command
CENTCOM SG	U.S. Central Command Surgeon General
COCOM	Combatant Command
CONUS	Continental U.S.
CoTCCC	Committee on Tactical Combat Casualty Care
CPG	Clinical Practice Guideline
C-STARS	Center for the Sustainment of Trauma & Readiness Skills
DCR	Damage control resuscitation
DHA	Defense Health Agency
DHB	Defense Health Board
DMRTI	Defense Medical Readiness Training Institute
DoD	Department of Defense
DoDTR	Department of Defense Trauma Registry
DoDTS	Department of Defense Trauma System
DOW	Died of wounds
ECMO	Extra corporeal membrane oxygenation
EMR	Electronic Medical Record
FMSO	Field Medical Service Officer
FMSS	Field Medical Service School
GAO	U.S. Government Accountability Office
GPS	Global Positioning System
IHC	In-hospital
IJC	International Joint Command
ISAF	International Security Assistance Force
JFHP	Joint Force Health Protection
JTAPIC	Joint Trauma Analysis and Prevention of Injury in Combat
JTR	Joint Trauma Registry
JTS	Joint Trauma System
JTS DCOE	Joint Trauma System Defense Center of Excellence
JTTC	Joint Trauma Training Centers
JTTR	Joint Theater Trauma Registry
JTTS	Joint Theater Trauma System

KIA	Killed in action
LRMC	Landstuhl Regional Medical Center
LSI	Life-saving interventions
LTT	Live tissue training
MERT	Medical Emergency Response Team
METL	Mission essential task list
MPT	Medical proficiency straining
MRMC	Medical Research and Materiel Command
MSTC	Medical simulation training centers
MTF	Military Treatment Facility
NAEMT	National Association of Emergency Medical Technicians
NATO	North Atlantic Treaty Organization
NCIOC	Non-Commissioned Officer in Charge
NTTC	Navy Trauma Training Centers
OEF	Operation ENDURING FREEDOM
OHC	Out of hospital
OIF	Operation IRAQI FREEDOM
PACOM	Pacific Command
PH	Pre-hospital
PHTLS	Prehospital Trauma Life Support
PHTR	Pre-Hospital Trauma Registry
PI	Performance Improvement
RC	Regional Command
SAMMC	San Antonio Military Medical Center
SG	Surgeon General
TACEVAC	Tactical evacuation
TBI	Traumatic brain injury
TCCC	Tactical Combat Casualty Care
TF MED A	Task Force Medical-Afghanistan
TMDS	Theater Medical Data Store
TTDB	Theater Tactical Evacuation Database
TXA	Tranexamic acid
USAFOR-A SG	U.S. Forces - Afghanistan Command Surgeon General
USAISR	U.S. Army Institute of Surgical Research
USASOC	U.S. Army Special Operations Command
USD (P&R)	Under Secretary of Defense for Personnel and Readiness
USSOCOM	U.S. Special Operations Command
USUHS	Uniformed Services University of the Health Sciences
VA	Department of Veterans Affairs
WWII	World War II

APPENDIX G: SUPPORT STAFF

Allen Middleton, S.E.S.
Deputy Director, Defense Health Agency
Defense Health Board
Designated Federal Officer

Christine Bader, M.S., B.S.N., R.N.-B.C.
Defense Health Board Executive Director and
Independent Review Panel on Military Medical
Construction Standards

Col Douglas Rouse, M.C., S.F.S.
Defense Health Board Executive Secretary

Camille Gaviola, M.B.A.
Defense Health Board Deputy Director and
Independent Review Panel on Military Medical
Construction Standards

Kathi E. Hanna, M.S., Ph.D.
Lead Writer
Creative Computing Solutions, Inc. (CCSi)

Katrina Badger, M.P.H., G.S.W.
Task Lead, Grant Thornton, LLP
(Until October 2014)

Lisa Austin, M.S.H.A., M.B.A.
Task Lead, Grant Thornton, LLP

Elizabeth Ribeiro, M.S.P.H., C.P.H.
Analyst, CCSi

Sara Higgins M.P.H.
Analyst, Grant Thornton, LLP

Ariel Markowitz-Shulman, M.S.
Analyst, Grant Thornton, LLP

Marianne Coates
Communications Advisor, CCSi

Kendal Brown, M.B.A.
Management Analyst, CCSi

Margaret Welsh
Management Analyst, Grant Thornton, LLP

Jean Ward
Defense Health Board Staff Assistant