Implementing and preserving the advances in combat casualty care from Iraq and Afghanistan throughout the US Military

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ABSTRACT: Thirteen years of continuous combat operations have enabled the US Military and its coalition partners to make a number of major advances in casualty care. The coalition nations have developed a superb combat trauma system and achieved unprecedented casualty survival rates. There remains, however, a need to accelerate the translation of new battlefield trauma care information, training, and equipment to units and individuals deploying in support of combat operations. In addition, the US Military needs to ensure that these advances are sustained during peace intervals and that we continue to build upon our successes as we prepare for future conflicts. This article contains recommendations designed to accomplish those goals. For the proposed actions to benefit all branches of our armed services, the direction will need to come from the Office of the Secretary of Defense in partnership with the Joint Staff. Effective translation of military advances in prehospital trauma care may also increase survival for law enforcement officers wounded in the line of duty and for civilian victims of Active Shooter or terrorist-related mass-casualty incidents. (*J Trauma Acute Care Surg*. 2015;79: 321–326. Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.)

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Debakey[1] observed that, "Had certain problems in World War I been recognized and addressed, their repetition in World War II could have been avoided. The end of hostilities brings such a sense of relief that we are inclined to want to put the experience behind us." This observation proved true in the aftermath of World War II as well. We knew that the tourniquets fielded and used by US forces in World War II were largely ineffective at stopping arterial blood flow.[2] We knew that morphine as fielded and used by US forces in that war was slow to relieve pain and was reported to cause life-threatening overdoses.[3] We knew the benefits of hypotensive resuscitation in resuscitating casualties in shock from noncompressible hemorrhage[4] and freeze-dried plasma.[5,6] None of these opportunities to improve combat casualty care had, however, been effectively translated to modern combat medicine at the onset of the recent wars in Afghanistan and Iraq. Turning lessons learned in combat casualty care into lives saved in future conflicts requires definitive action and strong leadership to ensure that these lessons are incorporated into improved best-practice trauma care guidelines. Since advances in military trauma care often result in a survival benefit for trauma victims in the civilian sector as well,[7,8] a dual benefit may be realized by improving the implementation and preservation of combat casualty care lessons learned.

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Combat Casualty Care, 2001

The US Military had not effectively sustained many of the lessons learned from past conflicts and went to war in Afghanistan without wide availability of tourniquets, without modern battlefield analgesics, without prehospital plasma, and without trauma care guidelines designed specifically for use on the battlefield. Hemostatic dressings had not yet been developed and fielded. There was no military deployed trauma system, no Department of Defense trauma registry (DoDTR), no weekly worldwide trauma teleconferences to review treatments and outcomes for all casualties occurring in the preceding week, and no Committee on Tactical Combat Casualty Care (CoTCCC).[9–12]

Combat Casualty Care, 2015

All of these challenges were met during the 13 years of conflict that followed the attacks of September 11, 2001. This prolonged interval of continuous combat operations allowed the US Military and its coalition partners to make major advances in trauma care and to achieve unprecedented casualty survival rates.[13] The standards of care have been redefined in prehospital hemorrhage control, transfusion medicine, and care during casualty transport.[11] The United States and its coalition partner nations have now developed a Joint Trauma System (JTS) that works closely with the combat theater medical leadership to establish and ensure standards for battlefield, evacuation, and in-hospital trauma care.[11] Forty-five evidence-based clinical practice guidelines (CPGs) are presently used on our evacuation platforms and in our deployed military hospitals to preserve trauma care lessons learned.[14] Some of these advances have transitioned rapidly to the civilian sector. The military's damage-control resuscitation strategy, for example, which is designed to promote hemostasis as well as to restore intravascular volume and tissue perfusion in casualties being resuscitated from hemorrhagic shock,[15] has been shown to

TABLE 1. Tactical Combat Casualty Care, 2015

US combat medics, corpsmen, and pararescuemen are now taught battlefield trauma care techniques based on the TCCC guidelines. These guidelines are reviewed on an ongoing basis and updated as needed by the CoTCCC. Once approved by the JTS, updated versions of the TCCC guidelines are posted on the JTS Web site, as well as those sponsored by the Military Health System, the National Association of Emergency Medical Technicians, the Special Operations Medical Association, and the *Journal of Special Operations Medicine*. At 3-year to 4-year intervals, the TCCC guidelines are also published in new editions of the *Prehospital Trauma Life Support* textbook. TCCC training is now provided to all US combat medical personnel and includes the following:[12,34]

- Phased care in the tactical environment to ensure that good medicine is combined with good small-unit tactics. The three defined phases of care are as follows:
  - Care under fire
  - Tactical field care
  - Tactical evacuation (TACEVAC) care
- Casualty and medic actions during the care under fire phase reflect the imperative to gain and preserve the tactical advantage, with only tourniquets currently recommended as standard medical care in this phase
- The aggressive use of CoTCCC-recommended tourniquets for the initial control of life-threatening extremity hemorrhage, followed by removal of the tourniquet when feasible in the tactical field care or TACEVAC phases of care
- The use of CoTCCC-recommended hemostatic dressings to control life-threatening external hemorrhage from sites that are not amenable to tourniquet use
- The use of junctional tourniquets as an adjunct to external hemorrhage control at junctional bleeding sites (e.g., axilla and groin)
- Initial management of the airway in casualties with maxillofacial trauma that consists of having the casualty sit up and lean forward if possible, thus allowing blood to simply drain out of the oropharynx and thus clear the airway
- The use of nasopharyngeal airways to protect the airway in unconscious casualties when there is no airway obstruction from direct maxillofacial or neck trauma
- Surgical airways for airway obstruction in casualties with maxillofacial or neck trauma in whom the use of the sit-up and lean-forward position is not feasible or not successful
- Aggressive needle thoracostomy with a 14-gauge, 3.25-in needle for suspected tension pneumothorax
- Vented chest seals for casualties with open pneumothoraces
- A different approach to spinal immobilization: the use of this technique is not emphasized for casualties with penetrating trauma only but is still recommended for use as tactically feasible when blunt trauma is present
- Intravenous access only when required for medications or fluid resuscitation
- The preferential use of a saline lock for intravenous access instead of having to have intravenous fluids running to keep the vein open
- The use of intraosseous techniques when intravenous vascular access is needed but difficult to obtain
- Early use of tranexamic acid in the prehospital phase of care (before fluid resuscitation) for casualties in or at risk of hemorrhagic shock
- Prehospital fluid resuscitation that emphasizes the use of damage-control resuscitation with whole blood or blood components in a 1:1 red blood cell–plasma ratio as soon as logistically feasible, even in the prehospital environment
- Hypotensive resuscitation with Hextend when blood products are not available
- Casualties with traumatic brain injury are treated with more aggressive fluid resuscitation and supplemental oxygen as needed to avoid hypotension and hypoxia
- Safer, faster, and more effective relief of pain from combat wounds through the use of the "triple-option" approach to battlefield analgesia that emphasizes the use of ketamine and oral transmucosal fentanyl citrate lozenges rather than intramuscular morphine
- Ondansetron for trauma or opioid-related nausea and vomiting
- Prevention of hypothermia and secondary coagulopathy with improved technology to prevent heat loss in casualties
- The prehospital use of moxifloxacin or ertapenem to reduce preventable deaths and morbidity from wound infections
- Tactical scenario-based combat trauma training to help combat medical providers grasp that battlefield trauma care must be consistent with good small-unit tactics and the particulars of each combat situation
- The use of the DD Form 1380 (TCCC casualty card—June 2014) and electronic TCCC Medical After-Action Reports to improve the documentation of prehospital care

The uses as described here for fentanyl lozenges, tranexamic acid, moxifloxacin, and ertapenem are off-label, but all four medications are FDA-approved medications.

improve casualty survival[16] and is now used in more than 70% of US civilian trauma centers.[17]

In the area of prehospital care for combat casualties, the lack of high-quality evidence, organizational and doctrinal complexities, and divided responsibilities in the military structure have historically combined to make improvements in this phase of care difficult to achieve. Maughon[18] observed in 1970 that few real advances in battlefield trauma care had been made in the last 100 years. Prehospital combat casualty care has now been transformed by the concepts of Tactical Combat Casualty Care (TCCC).[12] TCCC is the product of a joint US Special Operations Command and Uniformed Services University of the Health Sciences biomedical research effort. The TCCC guidelines are evidence-based trauma care guidelines designed specifically for use on the battlefield. They are reviewed and updated frequently by the CoTCCC, which is the prehospital arm of the JTS. The JTS is a directorate within the US Army Institute of Surgical Research (a component command of the US Army Medical Research and Materiel Command).[12] The TCCC guidelines include tourniquets, hemostatic dressings, new prehospital fluid resuscitation and analgesic strategies, and many other advances over prehospital care as it was practiced in 2001.[12] The use of TCCC-recommended interventions has been shown to improve outcomes for combat casualties[19–24] and to be well-suited for use on the battlefield.[20] They have been adopted widely throughout the US Military and by our coalition partner nations.[22–31] Although conducting well-designed prospective randomized studies on the impact of specific interventions on casualty outcomes in the inherent chaos of the tactical combat environment is not feasible, this challenge can largely be overcome by making optimal use of the available evidence and a clear understanding of the differences between civilian prehospital trauma care and care as it is provided on the battlefield[32,33] (Table 1).

Improving Performance in Combat Casualty Care

The JTS now monitors outcomes in US and coalition casualties to identify opportunities to improve combat casualty care. Advances throughout the continuum of care produced a steady decline in the case-fatality rate among US casualties in Iraq and Afghanistan despite progressively increasing injury severity.[35] Another important metric in trauma care is fatalities that occur in casualties whose injuries were potentially survivable.[36] Eastridge et al.[10] reviewed all 4,596 US combat fatalities during a 10-year period in the recent conflicts. This

study found that 24% of our prehospital combat fatalities succumbed to wounds that were potentially survivable. The study of Eastridge et al. determined the survivability of wounds based on a predefined set of anatomic injuries that were considered nonsurvivable and labeled all other injuries as potentially survivable. Tactical information relating to these fatalities such as prolonged engagements with hostile forces or other unavoidable delays in evacuation to medical treatment facilities with an emergency surgery capability was not available to the investigators and was therefore not considered. Injury survivability was determined based on anatomic autopsy findings alone. Many of these fatalities might have been avoided if lifesaving surgery had been immediately available for all seriously injured casualties, but the exigencies of combat usually preclude the availability of immediate surgical care. Noncompressible hemorrhage, which presently can only be controlled with surgery, was the cause of death in 67% of the potentially preventable fatalities identified in the study of Eastridge et al. It should be noted that this study spans a decade throughout which many advances in trauma care such as extremity and junctional tourniquets, hemostatic dressings, and damage-control resuscitation were introduced into use by US and coalition forces. The incidence of death from some types of injuries was therefore progressively reduced as the wars continued. The impact of increasing tourniquet use alone was striking. Death from extremity hemorrhage in US casualties (as a percentage of the 982 combat fatalities reviewed) was 7.8% in the period 2003 through 2006,[37] a period during which many US units did not use extremity tourniquets. Extremity tourniquets began to be more widely used by the military in 2005, and by the end of 2010, the incidence of potentially preventable death from extremity hemorrhage had been reduced to 2.6%, a decrease of 66%.[10,37]

While opportunities to improve in deployed hospital-based care have been documented by Martin et al.,[38] the study of Eastridge et al. found that the large majority of combat fatalities (87%) occur in the prehospital environment. This finding highlights the need to focus on battlefield trauma care in the effort to further improve casualty survival.[10] As West et al.[36] pointed out three decades ago, preventable deaths in trauma patients should not be regarded as acts of God and accepted as inevitable; they should rather be approached with careful, systematic review of the care provided and implementation of corrective action where needed.

The 75th Ranger Regiment has demonstrated that an unprecedented decrease in potentially preventable deaths can be achieved through command ownership and responsibility for the unit's prehospital trauma care program and by training all unit personnel—nonmedical combatants and medics—to perform TCCC.[24] There were 196 casualties (7.4% of fatalities) who died of exsanguination from extremity wounds in the prehospital phase of care in the Maughon study[18] and 77 deaths from this cause (7.8%) in the study of Kelly et al.[37] As a result of the establishment of the TCCC-based Ranger First Responder program, with its strong emphasis on control of external hemorrhage, before the conflicts in Afghanistan and Iraq, there were no Ranger deaths from extremity hemorrhage in the 8.5 years of conflict included in this study.[24] TCCC was implemented in the Canadian Armed Forces in 1999. The article by Savage et al.[22] noted that, despite the increasing severity of the injuries sustained by Canadian Forces (CF) in the recent conflicts, "… the CF experienced the highest casualty survival rate in history. Though this success is multifactorial, the determination and resolve of CF leadership to develop and deliver comprehensive, multileveled TCCC packages to soldiers and medics is a significant reason for that and has unquestionably saved the lives of Canadian, Coalition and Afghan Security Forces."

Performance improvement methodology now used by the JTS includes weekly worldwide trauma teleconferences, focused reviews of information contained in the DoDTR to determine the impact of specific interventions on casualty outcomes,[39] and monthly conferences with the Armed Forces Medical Examiner System to discuss the causes of death in combat fatalities and how they might have been prevented. Opportunities to improve in prehospital care are addressed by ongoing updates to the TCCC guidelines;[34] similar opportunities for in-hospital and en route care are addressed by periodic changes to the JTS CPGs.[14] The ongoing updates to the JTS CPGs and the TCCC guidelines also help to identify evidence gaps in the trauma care literature and highlight the need for research projects designed to address these gaps. A prioritized list of proposed battlefield trauma care research efforts is currently being addressed by the JTS in a separate publication.

Challenges to Effecting Change in Battlefield Trauma Care

In 2012 and 2013, two assessments of prehospital care in Afghanistan were conducted by the JTS at the request of the US Central Command (USCENTCOM). These assessments found that TCCC concepts, medications, and equipment had been implemented unevenly and incompletely across the battle space.[40,41] The failure to effectively implement these best-practice battlefield trauma care guidelines occurred despite the endorsements by senior combat commanders and medical leaders in the US Military noted previously. These findings emphasize the point made by Mabry and DeLorenzo[42] that divided and overlapping responsibilities and authorities create challenges to optimizing trauma care across an enterprise as large and complex as the DoD. Just as the United States has hundreds of trauma centers and thousands of autonomous prehospital care systems, which can potentially slow the transition of advances in military prehospital trauma care into use in the civilian sector, the US Military has four armed services, six Geographic Combatant Commands, the US Special Operations Command and the US Transportation Command, all of which play a role in the care of combat casualties. Each of these organizations is authorized to operate autonomously with respect to combat casualty care unless directives are issued at the highest level of the military chain of command, which is the Secretary of Defense (SecDef) acting on the advice of his or her chief medical advisor, the Assistant Secretary of Defense for Health Affairs. Lacking direction in the form of SecDef rule and Joint Staff doctrine, there is no assurance that advances in trauma care will be implemented consistently throughout the various components of the US Military. Secretary of Defense Robert Gates used his authority as the senior leader in the DoD to great effect in 2009, when he mandated a 60-minute maximum evacuation time in

Afghanistan.[43] Because of his position as SecDef, Secretary Gates' directive was implemented quickly throughout all US forces in Afghanistan. An analysis of JTS data to determine the resulting impact on casualty survival is currently pending.

Based on recommendations of the Defense Health Board (the senior external advisory body to the DoD on medical issues) and the JTS, the Assistant Secretary of Defense for Health Affairs and the Service Surgeons General have all endorsed and promulgated TCCC concepts for battlefield trauma care,[23,27,28,44,45] but ensuring that combat units are trained to respond properly to combat casualty scenarios is the responsibility of combat unit commanders. Combat commanders typically act on the advice of their unit surgeons, but most military physicians have limited training in administering a prehospital trauma care system, and many have little or no knowledge of TCCC concepts.[40] It is clearly not optimal to have physicians who have not been trained in TCCC supervising corpsmen, medics, and pararescuemen who have had this training.

The analyses performed by the two DoD survey teams described earlier also found that there may be prolonged delays in translating newly recommended trauma care techniques and technologies to combat units.[40,41] There is an urgent need to accelerate the implementation of advances in trauma care in deployed and deploying military units. Timely updates in newly recommended training, medications, and equipment are required if the US Military is to be successful in optimizing outcomes for our country's combat casualties through ongoing medical research and performance improvement efforts. Identifying opportunities to improve in prehospital trauma care, acting rapidly on these opportunities, and documenting the success of these innovations may also be of great benefit to civilian law enforcement officers and to victims of Active Shooter incidents, terrorist bombings, and victims of other types of noncombat trauma.[33,46,47] The need for an increased focus on tourniquet use in prehospital trauma care, as pioneered by TCCC, has been recognized as one of the lessons learned from the Boston Marathon bombing.[48,49]

Preserving the Advances in Combat Casualty Care

In light of the discussion earlier, how can we assure that the US Military will effectively capture the lessons learned in Afghanistan and Iraq and use them to save lives in the next war? As previously noted, lessons learned in previous wars have often been lost. There is at present no assurance that the casualty care lessons learned from our most recent conflicts will be translated into sustained improvements in care. We need to be resolute in capturing not just the clinical advances in trauma care that have been made in these wars but in preserving the process and infrastructure changes that were instrumental in effecting these clinical advances. The following proposed actions would codify the DoD's newly developed system for the production and implementation of ongoing, evidence-based improvements in combat casualty care:

1. Commanders at every level in the US Military should mandate TCCC as the standard for battlefield trauma care and ensure that all combatants and medical personnel are trained in the current version of TCCC as developed by the DoD's trauma experts, the JTS, and posted on the JTS Web site. Combat units should be fully prepared to use TCCC concepts to treat casualties on the battlefield.
2. Combatant commanders should adopt the JTS CPGs as the standard of care for deployed military hospitals and evacuation platforms in their commands. All in-hospital and en route care trauma care providers should be trained in these CPGs before deployment.
3. The JTS should be a permanent entity within the Military Health System. Responsibility for managing and overseeing the JTS should rest at a senior and joint position within the DoD. The JTS should be empowered and resourced to act as the DoD's lead organization for trauma care. The JTS should serve as a direct resource for the battlefield trauma care provider, senior military medical leaders, the military Services, and the Combatant Commands.
4. All battle and nonbattle injury data, to include prehospital care, should be entered into the DoDTR, which should be managed by the JTS to support continuous performance improvement across the continuum of prevention and care.
5. Continuous learning is essential to a high reliability organization. Deaths that occur as a result of potentially survivable injuries and other major adverse outcomes should be identified and tracked by the JTS and the Armed Forces Medical Examiner System at established intervals as dictated by the number of US combat casualties sustained. The Assistant Secretary of Defense for Health Affairs and senior Service leadership should closely monitor these potentially preventable deaths and take action as needed to close the performance improvement loop.
6. No DoD-wide program exists at present to ensure that newly recommended technology, techniques, and medications in combat casualty care are quickly and reliably made available to those who care for our casualties. A medical Rapid Fielding Initiative program should be established to expedite delivery of newly recommended combat casualty care equipment and training to deployed and deploying forces and to gather feedback on the initial experience with this newly fielded equipment.
7. Military medical research should maintain a sharp focus on addressing the root causes of combat fatalities that result from potentially survivable injuries. Furthermore, a DoD-FDA Military Use Panel should be established and empowered to grant military-specific indications for products of compelling need to the military, such as dried plasma, fentanyl lozenges, tranexamic acid, and ketamine.
8. Training on TCCC guidelines and the JTS CPGs must be ongoing, even in peacetime, for all medical department personnel who may be entrusted with the lives of our country's wounded in the next armed conflict. This training, coupled with strong partnerships with civilian trauma centers to ensure sustainment of essential trauma skills, will ensure that our military's combat trauma care capability does not languish in times of peace.

Military medicine has progressively improved combat casualty care throughout the last 13 years of war. The US Military, in concert with its coalition partners, has now established a proven

combat trauma system that has achieved the best casualty outcomes in the history of modern warfare. It is now imperative that we sustain those advances and build upon our successes in preparation for future conflicts. Knowing the right things to do in combat casualty care will not result in lives saved unless we act on this knowledge. For the actions proposed earlier to benefit the US Military as a whole, the direction will need to come from the Office of the Secretary of Defense in partnership with the Joint Staff. As a recent Associated Press article on combat trauma care noted, "The currency of change in trauma medicine remains the blood of Soldiers."[50] Let us not re-pay this price again.

DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

1. Debakey ME. History, the torch that illuminates lessons from military medicine. *Mil Med*. 1996;161:711–716.
2. Wolff LH, Adkins TF. Tourniquet problems in war injuries. *Bull US Army Med Dept*. 1945;37:77–84.
3. Beecher H. Delayed morphine poisoning in battle casualties. *JAMA*. 1944;124:1193–1194.
4. Cannon W, Fraser J, Cowell E. The preventative treatment of wound shock. *JAMA*. 1918:618–621.
5. Lee L, Moore EE, Hansen KC, Silliman CC, Chandler JG, Banerjee A. It's not your grandfather's field plasma. *Surgery*. 2013;153:857–860.
6. Kendrick DB. *Blood Program in World War II (Supplemented by Experiences in the Korean War)*. Washington, DC: Office of the Surgeon General, Department of the Army; 1989.
7. Pruitt B, Rasmussen T. Vietnam (1972) to Afghanistan (2014): the state of military trauma care and research, past to present. *J Trauma Acute Care Surg*. 2014;77:S57–S65.
8. Carmona R. The paradox of military trauma and emergency care. *JAMA*. 1991;266:217.
9. Holcomb JB. The 2004 Fitts Lecture: current perspective on combat casualty care. *J Trauma*. 2005;59:990–1002.
10. Eastridge BJ, Mabry R, Seguin P, Cantrell J, Tops T, Uribe P, Mallett O, Zubko T, Oetjen-Gerdes L, Rasmussen T, et al. Prehospital death on the battlefield: implications for the future of combat casualty care. *J Trauma Acute Care Surg*. 2012;73:S431–S437.
11. Blackbourne LH, Baer DG, Eastridge BJ, Butler FK, Wenke JC, Hale RG, Kotwal RS, Brosch LR, Bebarta VS, Knudson M, et al. Military medical revolution: military trauma system. *J Trauma Acute Care Surg*. 2012;73:S388–S394.
12. Butler FK, Blackbourne LH. Battlefield trauma care then and now: a decade of tactical combat casualty care. *J Trauma Acute Care Surg*. 2012;73:S395–S402.
13. Holcomb JB, Stansbury LG, Champion HR, Wade C, Bellamy RF. Understanding combat casualty care statistics. *J Trauma*. 2006;60:1–5.
14. JTS Clinical Practice Guidelines. Joint Trauma System Web site. Available at: http://usaisr.amedd.army.mil/cpgs.html#CCAT. Accessed January 4, 2015.
15. Holcomb JB, Jenkins D, Rhee P, Johannigman J, Mahoney P, Mehta S, Cox ED, Gehrke MJ, Beilman GJ, Schreiber M, et al. Damage control resuscitation: directly addressing the early coagulopathy of trauma. *J Trauma*. 2007;62:307–310.
16. Cap A, Spinella PC, Borgman MA, Blackbourne LH, Perkins JG. Timing and location of blood product transfusion and outcomes in massively transfused combat casualties. *J Trauma Acute Care Surg*. 2012;73:S89–S94.
17. Langan NR, Eckert M, Martin MJ. Changing patterns of in-hospital deaths following implementation of damage control resuscitation practices in US forward military treatment facilities. *JAMA Surg*. 2014;149(9):904–912.
18. Maughon JS. An inquiry into the nature of wounds resulting in killed in action in Vietnam. *Mil Med*. 1970.
19. Kragh JF, Walters TJ, Baer DG, Fox CJ, Wade CE, Salinas J, Holcomb JB. Survival with emergency tourniquet use to stop bleeding in major limb trauma. *Ann Surg*. 2009;249:1–7.
20. Tarpey MJ. Tactical Combat Casualty Care in Operation Iraqi Freedom. *US Army Medical Dept J*. 2005:38–41.
21. Butler FK, Holcomb JB, Giebner SG, McSwain NE, Bagian J. Tactical combat casualty care 2007: evolving concepts and battlefield experience. *Mil Med*. 2007;172(Suppl):1–19.
22. Savage E, Forestier C, Withers N, Tien H, Pannel D. Tactical Combat Casualty Care in the Canadian Forces: lessons learned from the Afghan War. *Can J Surg*. 2011;59:S118–S123.
23. Wilensky G, Jolcomb JB. Defense Health Board Memo on Tactical Combat Casualty Care and Minimizing Preventable Fatalities; 2009.
24. Kotwal RS, Montgomery HR, Kotwal BM, Champion HR, Butler FK Jr, Mabry RL, Cain JS, Blackbourne LH, Mechler KK, Holcomb JB. Eliminating preventable death on the battlefield. *Arch Surg*. 2011;146:1350–1358.
25. Richards TR. Tactical Combat Casualty Care Training. Commander, Naval Special Warfare Command Letter 1500 Ser 04/0341 of April 9, 1997.
26. Fox RC. Tactical Combat Casualty Care (TCCC) guidelines and updates. Marine Corps Administrative Message 016/11 dated January 10, 2011.
27. Robinson AR. Policy guidance on updates to the Tactical Combat Casualty Care (TCCC) course curriculum. BUMED Letter Ser M3/5/10UM35810 dated March 10, 2010.
28. Green CB. Incorporating Tactical Combat Casualty Care (TCCC) course curriculum updates into Air Force medical training. Air Force Surgeon General, Letter dated August 21, 2010.
29. Dempsey ME. Improvements to Tactical Combat Casualty Care (TCCC) and the Combat Lifesaver Course; TRADOC ltr; 2010.
30. US Special Operations Command Message. Tactical Combat Casualty Care Training and Equipment. 2005.
31. Amor SP. ABCA Armies' Program Chief of Staff Letter dated 22 February, 2011.
32. Butler FK, Hagmann J, Butler EG. Tactical Combat Casualty Care in Special Operations. *Mil Med*. 1996;161(Suppl):3–16.
33. Elster EA, Butler FK, Rasmussen TE. Implications of combat casualty care for mass casualty events. *JAMA*. 2013;310:475–476.
34. Butler FK, Giebner SD, McSwain N, Pons P. *Prehospital Trauma Life Support Manual; Eighth Edition—Military Version*. 2014.
35. Bailey JA, Morrison JJ, Rasmussen TE. Military trauma system in Afghanistan: lessons for civil systems? *Curr Opin Crit Care*. 2013;19:569–577.
36. West JG, Cales RH, Gazzaniga AB. Impact of regionalization. The Orange County experience. *Arch Surg*. 1983;118:740–744.
37. Kelly JF, Ritenhour AE, McLaughlin DF, Bagg KA, Apodaca AN, Mallak CT, Pearse L, Lawnick MM, Champion HR, Holcomb JB. Injury severity and causes of death from Operation Iraqi Freedom and Operation Enduring Freedom: 2003–2004 versus 2006. *J Trauma*. 2008;64:S21–S26.
38. Martin M, Oh J, Currier H, Tai N, Beekley A, Eckert M, Holcomb J. An analysis of in-hospital deaths at a modern combat support hospital. *J Trauma*. 2009;66(4 Suppl):S51–S60.
39. Mazzoli RA, Gross KR, Butler FK. The use of rigid eye shields (Fox shields) at the point of injury for ocular trauma in Afghanistan. *J Trauma*. 2014;77:S156–S162.
40. Kotwal RS, Butler FK, Edgar EP, Shackelford SA, Bennett DR, Bailey JA. Saving lives on the battlefield: a joint trauma system review of prehospital trauma care in combined joint operating area–Afghanistan (CJOA-A) executive summary. *J Spec Oper Med*. 2013;13(1):77–80.
41. Sauer SW, Robinson JB, Smith MP, et al. Saving Lives on the Battlefield (Part II) – One Year Later. A Joint Theater Trauma System & Joint Trauma System Review of Pre-Hospital Trauma Care in Combined Joint Operating Area – Afghanistan (CJOA-A). *USCENTCOM Report*. 2014.
42. Mabry RL, DeLorenzo R. Challenges to improving combat casualty survival on the battlefield. *Mil Med*. 2014;179:477–482.
43. Gates R. *Duty: Memoirs of a Secretary at War*. New York: Alfred A. Knopf; 2014.
44. Kiley K. Army Surgeon General Executive Order 096–09: Mandatory Pre-Deployment Trauma Training (PDTT) For Specified Medical Personnel. 2009.

45. Woodson J. Tactical Combat Casualty Care. Assistant Secretary of Defense for Health Affairs Memorandum. 2011.
46. Jacobs L, Wade D, McSwain N, Butler FK, Fabbri W, Eastman A, Conn A, Burns KJ. Hartford Consensus: a call to action for THREAT, a medical disaster preparedness concept. *J Am Coll Surg*. 2014;218: 467–475.
47. Butler FK, Carmona R. *Tactical Combat Casualty Care: From the Battlefields of Afghanistan and Iraq to the Streets of America*. The Tactical Edge; 2012.
48. Gates J, Arabian S, Biddinger P, Blansfield J, Burke P, Chung S, Fischer J, Friedman F, Gervasini A, Goralnick E, et al. The initial response to the Boston marathon bombing: lessons learned to prepare for the next disaster. *Ann Surg*. 2014;260:960–966.
49. King DR, Larentzakis A, Ramly EP; The Boston Trauma Collaborative. Tourniquet use at the Boston Marathon bombing: lost in translation. *J Trauma Acute Care Surg*. 2015;78:594–599.
50. Collier R. *Wartime Advance in Trauma Care Are Coming Back to Help Civilians*. Associated Press Article; 2015.