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STATEMENT OF FINANCIAL DISCLOSURE

To reveal any potential bias in this publication, and in accordance with Accreditation Council for Continuing Medical Education guidelines, Dr. Dietrich (editor in chief), Dr. Springer (author), Dr. Verbillion (author), Dr. Schwartz (peer reviewer), Ms. Behrens (nurse reviewer), Ms. Mark (executive editor), Ms. Coplin (executive editor), and Ms. Hatcher (managing editor) report no relationships with companies related to this field of study.

AHC Media

Tactical Emergency Medicine

Mass casualty shooting events in the United States, although rare, appear to be increasing in frequency. Active shooter attacks have become a favored means of inflicting terror attacks. This has been a growing trend overseas for some time, with active shooter terrorist teams (often carrying explosive devices or explosive suicide vests) attacking targets of opportunity. This article has the purpose of speeding the transition of military medical lessons learned from the battlefield to civilian medical response to high-risk situations.

— Ann M. Dietrich, MD, Editor

Introduction

Trauma care is an evolving specialty that has seen its greatest advances during times of war. The battlefield is an unpleasant arena that pushes the medical community to its limits to decrease the number of casualties. The combat environment brings many challenges, including hostile fire, impaired visibility, limited resources, widely variable evacuation times, and complex wounds, that make providing quick, efficient, and appropriate medical care difficult.[1,2] Advanced Trauma Life Support (ATLS), although appropriate in the civilian trauma setting, lacks a mission-oriented focus and means of negotiating tactical hazards while providing medical care. Over time, it became apparent that ATLS could prove detrimental in the combat setting to both the casualty and medical personnel. Tactical Combat Casualty Care (TCCC) changed the face of care during combat with guidelines based on the hostility of the environment. New emphasis was placed on hemorrhage cessation, simplified airway control, and rapid evacuation. Tourniquets were re-popularized, and damage-control resuscitation was born. Despite the severity and complexity of combat injuries, survival rates for combat casualties now are equal to or better than those for civilian trauma.[1]

Special Weapons and Tactics (SWAT) and other law enforcement special operations teams routinely find themselves in hostile environments. Terrorist acts in the United States have given a whole new meaning to the phrase "mass casualty incident," and our law enforcement personnel teams are on the front lines in these cases. Until recently, emergency medical services (EMS) providers were kept in "safe zones" outside the hostile perimeter and only brought to the scene after it was deemed safe, a strategy that cost lives due to delay of treatment. It was quickly realized that the guidelines of TCCC could be used in the civilian setting for Tactical Emergency Medical Support (TEMS). Like TCCC, TEMS addresses differences between the civilian and military tactical environment. The primary goals of TEMS are mission accomplishment, minimizing injury potential, providing care in unsecured environments, and facilitating evacuation to definitive care. TCCC and TEMS have changed the face

EXECUTIVE SUMMARY

- Advanced Trauma Life Support does not take into consideration factors such as enemy fire, equipment limitations, delayed evacuation times, temperature and weather extremes, mission considerations, and transport challenges in hostile environments.
- Tactical Combat Casualty Care divides treatment into three phases of care, based on the combat environment. Care under fire is rendered by the medic or corpsman at the scene of the injury while both provider and casualty remain under hostile fire. Tactical field care is rendered once the medic and casualty are no longer under direct hostile fire. CASEVAC is the care rendered once the casualty has been picked up by an aircraft, vehicle, or boat and is transferred to the medical treatment facility.
- Tactical Combat Casualty Care and its phases of care represent a huge paradigm shift in the treatment of combat casualties because they initiate treatment of combat casualties starting at the point of injury, and it provides a seamless continuity of medical support all the way to definitive care without any decrease in the level of care.
- Tactical Emergency Medical Support is an out-of-hospital EMS system that focuses on medical support for law enforcement special operations missions.
- Physicians can assist with resource allocation by understanding what is available in the community in terms of trauma center locations and capabilities, best methods for casualty transport to definitive care, and relevant contact numbers for local EDs and other medical resources.
- The three phases of Tactical Combat Casualty Care have been augmented to fit the needs of the civilian tactical environment and include the hot zone, warm zone, and cold zone.
- Tactical primary survey is a sequential series of assessments and interventions designed to provide optimal care to those suffering injury in a tactical environment.
- Care addresses three major causes of mortality in the combat environment: exsanguinating hemorrhage (particularly from the extremities), tension pneumothorax, and airway obstruction.

of trauma care on the battlefield and in the law enforcement environment, with lessons learned now shaping traditional civilian EMS. This article will discuss the origins of TCCC, TEMS, the tactical primary survey, and how TEMS has affected current prehospital care and is adapting to address hybrid targeted violence.

Origins of Tactical Emergency Medicine

Tactical Combat Casualty Care

Short periods of intense warfare tend to bring about the greatest advances in surgical and trauma medicine compared to long intervening periods of peace.[3] To fully appreciate the development of TCCC and TEMS, it is prudent to understand the history of warfare medicine and developments that led to the creation of the Triservice Committee on TCCC (CoTCCC). The current global war on terrorism has seen survival rates that are equal to or better than civilian trauma care. This would not have been possible without the ultimate sacrifice that many made, the dedication of the military medical community, and the continued research allowing for innovation and advancement of casualty care.

In the mid-1990s, using ATLS for treating combat casualties was called into question. While successful in the civilian setting, ATLS does not take into consideration factors such as enemy fire, equipment limitations, delayed evacuation times, temperature and weather extremes, mission considerations, and transport challenges in hostile environments.[6] In 1993, Capt. Frank Butler, the Commander of the Naval Special Warfare Command, led a two-year study supported by the United States Special Forces Operation Command. They compiled a thorough literature review and ran workshops with special operations physicians, corpsmen, and medics. The result was what is now considered to be the birth of TCCC.[2] The core principles of TCCC were conceptualized into a framework focusing on treating life-threatening battlefield injuries while dealing with tactical considerations.[6,7] In 1996, Butler et al wrote the first article to detail specific guidelines for TCCC.[6] There were three basic objectives: treat the patient, prevent additional casualties, and complete the mission.[6,8] At the time of the article publication, up to 90% of combat deaths occurred before the casualty ever reached the medical treatment facility (MTF). TCCC policies outlined in Butler's article focused special attention on three major but potentially survivable causes of death during war: exsanguination, tension pneumothorax, and airway obstruction. The most common mechanism for injury in modern-day warfare is penetrating trauma from explosions and gunshot wounds. A sobering thought from a study conducted by Holcomb et al found a 15% incidence of potentially preventable fatalities after reviewing all special operations deaths in Iraq and Afghanistan since November 2004.[2] Based on this research, 25% of fatalities might have been saved with the application of a tourniquet. Another astounding statistic from Kelly et al is that exsanguination from isolated extremity wounds caused 7.8% of combat-related deaths during Operation Iraqi Freedom and Operation Enduring Freedom.[6] Ultimately, TCCC focuses on point-of-injury intervention to stabilize casualties. TCCC divides treatment into three phases of care based on the combat environment: care under fire, tactical field care, and combat casualty evacuation care. The phases below are updated with the most recent TCCC guidelines as of June 2016.

Care Under Fire: Care under fire is rendered by the medic or corpsman at the scene of the injury while both provider and casualty remain under hostile fire. Little medical equipment is available, limited to what can be

Table 1. Tactical Field Care: MARCHE

Massive hemorrhage
Airway
Respirations
Cardiac (pulses)
Head injury/Hypothermia
Everything else

carried on the individual. Medical care is limited, and obtaining fire superiority needs to be prioritized. The medic or corpsman should focus on returning fire and maintaining cover, with the goal of keeping the casualty from being wounded further. The only medical care provided during this phase is control of life-threatening hemorrhage with a tourniquet or direct pressure, applied by the casualty if able. Airway management and spinal immobilization are both deferred. Very few injuries (approximately 1.4%) sustained during combat result in clinically significant cervical spine trauma. Spinal immobilization is time-consuming and likely to be more hazardous to the provider and the casualty than any potential injury.[6,9]

Tactical Field Care: Tactical field care is rendered once the medic and casualty are no longer under direct hostile fire. The amount of time available to provide medical care is variable, and the tactical field care phase easily can degrade into care under fire. Therefore, situational awareness must be maintained. The primary survey in tactical field care is MARCHE: Massive hemorrhage, Airway, Respirations, Cardiac (pulses), Head injury/hypothermia, Everything else.[10] (*See Table 1.*) It is critical to avoid undertaking futile therapeutic measures, such as cardiopulmonary resuscitation (CPR), during this phase. Combat casualties who are in cardiac arrest rarely survive, and CPR diverts resources and care from others with greater likelihood of survival.

Major external bleeding sources should be addressed first, and tourniquets, direct pressure, and the use of hemostatic agents are appropriate. Care should be taken to reassess tourniquets applied during care under fire.

Airway interventions such as chin-lift and jaw-thrust are used. If the patient is conscious, allow the patient to assume whatever position allows him or her to best protect the airway.[5] If the patient is unconscious with spontaneous respirations, the airway can be maintained with a nasopharyngeal airway (NPA). NPAs are tolerated better than oral airways in patients who regain consciousness and are less likely to be dislodged during transport. After initial interventions, place the casualty in recovery position. In the event of complete airway obstruction or severe respiratory distress requiring a definitive airway, surgical cricothyroidotomy is preferred. This is in contrast to civilian EMS and emergency department (ED) management in which cricothyroidotomy is a last resort following failed intubation. Most corpsmen and medics are inexperienced with endotracheal intubation, a technically difficult procedure. White light emitted by the laryngoscope can give away one's position to the enemy. Maxillofacial injuries can complicate the potential visibility of the larynx, and esophageal intubations are difficult to recognize in the combat setting.

Oxygen often is not available in this phase of care because of the equipment needed to make it a feasible option. If available, it should be given to casualties with moderate to severe traumatic brain injury (TBI). Pulse oximetry monitoring should be used if available. Needle decompression should be considered in any unstable casualty with unilateral chest trauma. The diagnosis of tension pneumothorax on the battlefield is difficult, and the trauma caused by needle decompression is less detrimental to the casualty than an unrecognized tension pneumothorax. Penetrating chest injuries should be covered with commercial vented chest seals or other occlusive dressing.

Intravenous or intraosseous access should be obtained. If a casualty is anticipated to need massive transfusion, has a severe penetrating torso injury, or likely will require major amputation, tranexamic acid (TXA) should be given within 1-3 hours of injury. Fluid resuscitation should be limited to casualties in hemorrhagic shock. Whole blood is preferred first line, followed by plasma, packed red blood cells, and platelets in a 1:1:1 ratio. Crystalloids are considered a last-resort resuscitative fluid. Attempts should be made to prevent hypothermia, and analgesia should be given. During Operation Iraqi Freedom and Operation Enduring Freedom, combat pill packs were created and distributed to all combatants. In the event of injury, conscious combatants were instructed to take the entire contents of the package: Tylenol 1,000 mg, Mobic 15 mg, and moxifloxacin 400 mg. When additional pain control in the form of narcotics is required, the casualty should be disarmed first. Severe pain can be controlled with transmucosal fentanyl citrate lozenges, which contain an 800 mcg dose. The lozenge can be placed between the cheek and gum or taped to the casualty's finger and placed in the mouth. The latter option allows for self-titration; if the casualty loses consciousness, the finger will fall from the mouth. Casualties in respiratory distress or shock should be given ketamine or morphine. Narcan and zofran should be available as needed for severe respiratory depression and vomiting.

Fractures should be splinted and assessed for neurovascular patency. Penetrating eye trauma should be addressed by obtaining visual acuity, administering antibiotics, and applying a rigid eye shield. All wounds should be dressed, and the patient should be checked for missed wounds. Antibiotics should be prioritized to casualties with abdominal trauma, grossly contaminated wounds, open fractures, and massive soft tissue injuries. Burns present an additional concern in the combat environment. Total body surface area (TBSA) should be estimated to the nearest 10%. Burns should be covered with a dry, sterile dressing, and fluid resuscitation with lactated Ringers or normal saline should be used for all burns > 20% TBSA with an initial rate of %TBSA × 10 mL/hr. Casualties with burns who are also in hemorrhagic shock should be treated with blood products first.[6,9]

Combat Casualty Evacuation Care (CASEVAC): CASEVAC is the care rendered once the casualty has been picked up by an aircraft, vehicle, or boat and is transferred to the MTF. Additional medical personnel and equipment usually are available during

this stage. The time between tactical field care and CASEVAC can vary, but usually falls somewhere between 30 minutes and four hours. Much of the care provided mirrors tactical field care, but a few advanced techniques now are recommended based on safety of the environment, available medical personnel, and equipment. All interventions done prior to receiving the casualty should be reassessed. This includes looking for new bleeding, checking dressings and splints, and providing additional analgesia and antibiotics. Endotracheal intubation and supraglottic airways are options if experienced personnel are available. Cricothyroidotomy remains an appropriate option if endotracheal intubation fails or cannot be accomplished. Physical examination such as lung or cardiac auscultation is difficult during transport, so electronic monitoring should be applied to track blood pressure, heart rate, pulse oximetry, and capnography during transport. Oxygen should be provided as needed. Chest tubes should be considered in casualties with continued distress following needle decompression and when long transport times are anticipated. Casualties in hemorrhagic shock should have volume resuscitation, preferably with whole blood. Permissive hypotension, in which fluids are withheld in individuals without signs of shock and only given until restoration of mental status or systolic blood pressure between 70-90 mm Hg, is encouraged. TBI casualties should undergo frequent neurologic checks for signs of deterioration; if concerns arise for increasing intracranial pressure, hypertonic saline, elevation of the head of the bed, and hyperventilation are options. CPR can be considered during CASEVAC if the casualty does not have obviously fatal wounds and arrival time to the MTF is short.[6,9]

Navy SEALs and Army Rangers were the first to adopt TCCC, and after a decade of war in the global war on terrorism, TCCC is used by all services in the U.S. military as the standard for training corpsmen and medics for combat. Variations of TCCC also have been adopted by the Israeli defense force, British army, and Canadian forces. TCCC has been updated since mid-1990s with the formation of the CoTCCC in 2001, which ensures that emerging technology and information are incorporated into the TCCC policies on an ongoing basis.[2] Guidelines are updated quarterly. Partnerships with other military organizations to assist in advancing TCCC include the Joint Trauma System (JTS), which reviews all combat casualties, provides clinical practice guidelines, and provides evidence-based recommendations for trauma care. JTS also has created the Joint Theater Trauma Registry, which is the world's largest combat data set. JTS was established by the United States Army Institute of Surgical Research, which represents another critical partnership for the advancement of TCCC.[1]

TCCC and its phases of care represent a huge paradigm shift in the treatment of combat casualties because they initiate treatment of combat casualties starting at the point of injury, and provides a seamless continuity of medical support all the way to definitive care without any decrease in the level of care. As previously stated, up until the initiation of TCCC, the majority of combat deaths occurred prior to treatment at the MTF. Now the United States has achieved unprecedented survival rates, as high as 98% for casualties arriving alive to combat hospitals.[7]

Tactical Emergency Medical Support

One of the most significant civilian effects that resulted from TCCC and the modernization of military medicine is the creation of tactical emergency medical support (TEMS). TEMS is an out-of-hospital EMS system that focuses on medical support for law enforcement special operations missions. Current TEMS standards are based on the principles espoused in TCCC.[11] The primary goals of TEMS are to minimize the potential for injury and illness and to provide care from the point of injury in the tactical field to arrival at a definitive care facility. TEMS was designed to fit the distinct needs of high-risk law enforcement operations.[12] Like their military counterparts, TEMS providers are faced with many unique challenges. They always must maintain situational awareness while simultaneously caring for patients with significant penetrating trauma. They also must function with limited medical equipment, often in cramped and low-light environments, while burdened with personal protective equipment such as body armor, helmets, and gas masks. Medical decision-making is based on risk vs. benefit not only to the patient but also to the entire tactical team and innocent civilians. Ultimately, the law enforcement mission supersedes all medical missions, and, at times, lifesaving medical care is denied to achieve mission success.[13]

SWAT teams have been placing men and women in austere and hazardous environments since the 1960s. Initially created to handle riots, civil unrest, and increasingly violent and better-armed criminals, the use of SWAT has dramatically increased since the 1980s. The war on drugs and the war on terrorism have placed law enforcement in increasingly hazardous environments, and the integration of TEMS personnel has become a key component of special operations efforts. Prior to the development of specific TEMS personnel, these special operations missions were carried out without on-scene medical coverage. EMS units were available in a designated "safe zone," often miles from the mission site. EMS providers were unable to access the tactical environment until it had been deemed safe for them to enter. By the time they arrived, many patients had died from potentially survivable injuries, most notably penetrating trauma and hemorrhage.[14] Traditional EMS protocols were not practical nor safe in the tactical environment, which is one of many reasons TEMS was created. SWAT team members sustain an injury rate of 33 per 1,000 missions and bystanders at a rate of 3.2 per 1,000 missions.[12] Effective tactical medicine support must enable law enforcement to operate more efficiently and effectively, and with reduced risk. Just as with TCCC, it is critical to provide point-of-injury care in tactical operations, as the most common cause of mortality from penetrating trauma is hemorrhage requiring immediate treatment.

One of the unique challenges of TEMS is that despite 20 years of research and proven benefit, there still is a lack of standardized training and

Table 2. National TEMS Initiative and Council Core Competency Domains

1. Tactical Emergency Casualty Care Methodology and Threat-based Trauma Interventions
- Hemostasis
- Airway
- Respiration/breathing
- Circulation
- Medication administration
- Damage control resuscitation
- Casualty immobilization and packaging

2. Mass casualty triage
3. Medical planning
4. Remote medical assessment and surrogate treatment
5. Force health protection
6. Legal aspects of TEMS
7. Hazardous materials management
8. Tactical familiarization
9. Less lethal injuries
10. Operational rescue and casualty extraction

Source: Pennardt A, et al. Integration of Tactical Emergency Casualty Care Into the National Tactical Emergency Medical Support Competency Domains. *J Spec Oper Med* 2016;16:62-66.

care recommendations. This leads to multiple protocols, training abilities, and levels of integration into law enforcement special operations. Efforts are being made to rectify this situation. In 2009, TEMS experts identified core competencies required for successful tactical medical support of civilian law enforcement operations. In 2011, the National TEMS Initiative and Council (NTIC) was established under a grant from the Centers for Disease Control and Prevention-Terrorism Injuries Information, Dissemination, and Exchange (CDC-TIIDE) Project. Since then, the NTIC has reviewed and modified the core competencies, assisted in establishing a common language and better communication among TEMS providers, and integrated tactical emergency casualty care (TECC) into the competency domains. (*See Table 2.*) TECC, discussed later in the paper, is a reworking of TCCC guidelines that reflects best evidence and practice for reducing potentially preventable mortality in the high threat civilian environment.[15,16]

Physician involvement in TEMS is highly encouraged, although actual participation varies greatly based on the specific law enforcement agency and TEMS unit. Physicians provide advanced medical training and skills that can assist in patient care when treatment exceeds paramedic protocols. In addition to on-scene medical expertise, physicians can keep the team operating in peak condition by providing preventive medical knowledge through yearly physical exams, management of chronic conditions, and encouraging immunizations and tobacco cessation. Physicians also can assist with resource allocation by understanding what is available in the community in terms of trauma center locations and capabilities, best methods for casualty transport to definitive care, and relevant contact numbers for local EDs and other medical resources.[11,12] Physicians involved in tactical medicine should undergo additional training to better understand mission operations and risks, including unconventional weapons, distraction and less-lethal devices, weapons management, and team and individual movement.

The three phases of TCCC have been augmented to fit the needs of the civilian tactical environment and include the hot zone, warm zone, and cold zone.[17,18] Situational awareness should be maintained throughout all zones, as even a cold zone can degrade to a hot zone as a situation unfolds.

Hot Zone (Care Under Fire): This zone is characterized by an active hostile environment and priority should be placed on neutralizing the existing threat. If a casualty can move to safety, he or she should do so; if the patient is unconscious or unable to move, the scene commander will determine if a rescue effort should be pursued. Medical care provided here is focused on life-threatening bleeding only, with the use of tourniquets or direct pressure provided by the casualty if able to do so. The TEMS provider needs to prevent self-injury, casualty harm, and public harm. Patients who cannot move themselves are moved to cover in a "scoop and run" manner. There is no role for CPR in this setting, as it is more likely to expose providers than benefit the casualty.

Warm Zone (Tactical Field Care): In the warm zone, there is no immediate threat; however, potential threats exist. Care provided in the warm zone should be based on the tactical primary survey, described below. Goals of care here should focus on maintaining tactical supremacy and completion of the overall mission. To ensure safety, disarm casualties with altered mental status. Medical care should include tourniquet application, hemostatic agents for compressible hemorrhage not amenable to tourniquets, needle decompression, nasopharyngeal airway placement, possible advanced airway placement, and basic care of remaining wounds. Chest wounds should be covered with a vented chest seal or other occlusive dressing. intravenous or intraosseous fluid resuscitation can be considered. Fractures should be splinted and assessed for neurovascular stability. Analgesia and antibiotics, if available, can be given in the warm zone. The casualty should be reassessed frequently and prepared for extrication. There is no indication for CPR unless the injury is due to electrocution or drowning, and even then, the risk to providers must be considered.

Cold Zone (CASEVAC): The cold zone is an area of relative safety and provides a staging area/casualty collection point for transport to definitive care. All casualties should be reassessed at regular intervals. A formal triage system, such as the START protocol, should be initiated. A secondary survey should take place in the cold

zone to ensure proper triage category and maximal casualty stabilization. All patients should be connected to monitors, and vitals should be obtained. All wounds should be inspected and dressed. Analgesia and antibiotics should be provided as needed. Spinal immobilization can be considered in casualties with a high risk of unstable spinal injury. Chest tubes can be placed and oxygen administered as needed. Prevention of hypothermia should be prioritized. Depending on resource availability and likelihood of survival, CPR can be considered in the cold zone if transport times are short and there is a good likelihood of achieving return of spontaneous circulation. Ultimately the goal of the cold zone is to transport the casualty to a definitive care facility.

The TEMS zones of care are similar to the TCCC phases of care, with subtle differences that help distinguish care in the tactical vs. combat setting. TEMS has provided law enforcement with medical protection and resources allowing for improved mission success and fewer casualties.

Tactical Primary Survey

A defining feature of TEMS is the use of the tactical primary survey (TPS). TPS is a sequential series of assessments and interventions designed to provide optimal care to those suffering injury in a tactical environment. It is essentially the law enforcement tactical medical provider's version of the TCCC tactical field care primary survey. Like its military equivalent, the TPS differs from the civilian primary survey by considering unique aspects of tactical situations, including hostage-taking, active shooter scenarios, and terrorist incidents. Threats unique to the TPS include blast trauma, complex penetrating wounds, toxic contamination, and austere conditions. The TPS uses the zones of care concept. TPS is most fully applied within the warm zone. While different mnemonics have been used for the TPS over the years, the TCCC tactical field care acronym MARCHE is readily applicable in the TEMS warm zone. (*See Table 1.*)[10]

Potentially Survivable Injury

Much like the military, law enforcement tactical medicine is governed by an overall emphasis on mission accomplishment. Although military and law enforcement missions often differ, basic concepts (tactical superiority, protection of innocent lives, minimizing threats to the individual) are the same. As such, the medical mission must reflect the tactical mission and focus on threats that can be addressed readily in the field while not compromising mission success. Resource expenditures should focus on injuries that can be treated successfully in a dangerous environment where further casualties must be avoided. As such, TEMS has adopted the military focus on addressing potentially survivable injuries. In the tactical environment, the diversion of medical resources to treating futile cases or initiating interventions that require extensive resources must be avoided to prevent mission failure and further loss of life.

The classic terms encountered in the civilian literature are "preventable death," "potentially preventable death," and "nonpreventable death." However, delivery of care on the battlefield and in law enforcement operations is dictated as much by the tactical situation as by medical necessity. If a patient dies from a treatable injury because the tactical situation prohibits care from reaching him or her, categorizing the death as "preventable" is erroneous. The term "preventable" implies that something should have been done to alter the outcome of the casualty. Tactical reality acknowledges that this may not always be the case; the mission may take priority over an individual life. Therefore, it is more accurate to describe injuries sustained in the tactical environment as "potentially survivable" or "nonsurvivable."[2]

As previously noted, TCCC emphasizes addressing three major causes of mortality in the combat environment: exsanguinating hemorrhage (particularly from the extremities), tension pneumothorax, and airway obstruction. The warm zone tactical primary survey endorsed by TECC prioritizes injury treatment that derives from military experience, with an up-front emphasis on hemorrhage control through use of tourniquets on the extremities, and pressure, wound packing, and junctional tourniquets on so-called "junctional hemorrhage."[17] Junctional hemorrhage occurs when penetrating trauma damages large vessels that sit at the junction of the extremities and the torso where tourniquets cannot be applied, i.e., femoral and axillary arteries.[19] The neck also remains an area relatively unprotected by body armor, containing large vessels that can lead to rapid exsanguination, and is not amenable to tourniquet application. Given the benefits of time, recent studies have looked at the patterns of preventable deaths in the civilian law enforcement population and found significant differences from the military experience.

Sztajnkrycer looked at law enforcement data from the Federal Bureau of Investigation's Uniform Crime Reporting Law Enforcement Officers Killed and Assaulted (LEOKA) database. (*See Table 3.*) He selected cases in which the casualty died immediately and where no life-saving interventions were undertaken. He defined potentially preventable deaths as those amenable to a TCCC skill set intervention or immediate airway management. During a 10-year time period (1998-2007, with deliberate exclusion of officer deaths in the terror attacks of Sept. 11, 2001), narrowing the field down from more than 500 line-of-duty deaths, he found 123 met his criteria for dying from a potentially preventable cause. The majority suffered from chest wounds and neck wounds; only two officers (0.6%) died from isolated extremity hemorrhage. Of note, the most common causes of death overall were head and chest wounds.[20]

A recent paper examining casualties in "civilian public mass shooting incidents" also found injury patterns that differed from combat operations.[21] The authors examined the autopsy reports for all victims in 12 incidents, looking at injury sites, probable site of fatal injury, and presence of potential survivable injury. All injuries were gunshot wounds, with each victim sustaining an average of 2.7 gunshots. Fatality rates were higher than those reported by the military, with low rates of victims (7%) having survivable wounds. The most common fatal wounds were to the head

Table 3. Law Enforcement Officers Feloniously Killed: Type of Weapon, 2006-2015

Type of Weapon	Total	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number of victim officers	491	48	58	41	48	56	72	49	27	51	41
Total firearms	454	46	56	35	45	55	63	44	26	46	38
Handgun	330	36	39	25	28	38	50	34	18	33	29
Rifle	88	8	8	6	15	15	7	7	5	10	7
Shotgun	34	2	8	4	2	2	6	3	3	3	1
Type of firearm not reported	2	0	1	0	0	0	0	0	0	0	1
Knife or other cutting instrument	2	0	0	0	0	0	1	1	0	0	0
Bomb	2	0	0	2	0	0	0	0	0	0	0

Source: Law Enforcement Officers Killed and Assaulted (LEOKA) 2015; Available at: http://bit.ly/2kmYN8h. Accessed Jan. 31, 2017

and chest; no head wounds were survivable, but 89% of survivable wounds identified were to the chest. No victims died from extremity hemorrhage.

Differences in civilian injury patterns from the military should not be surprising. Both military and law enforcement violence tend to stick with established patterns; recent trends in civilian violence (increased use of long guns, improvised explosive devices [IEDs]) have not modified these patterns significantly. The typical military fighter, when entering into a combat zone, will be equipped with body armor with rifle-resistant plates, ballistic helmet, eye protection, and often supplemental armor to shield the groin, axillae, and neck. Engagements ranging from close quarter battle to long distance consist of threats from long guns such as assault rifles and automatic weapons, grenades (both thrown and rocket propelled), and IEDs, most often using military-grade high explosives. The vulnerability of areas not protected by body armor accounts for the high rates of extremity hemorrhage seen on the battlefield and the high rates of success secondary to emphasis on rapid self-, buddy-, or medic-application of commercial tourniquets. Law enforcement gun battles tend to occur suddenly and often without forewarning. Engagements tend to occur at close range in low light conditions; the most commonly used firearms are "low velocity" weapons (handgun, shotgun).[22] Engagements tend to end quickly, with most shootouts lasting seconds to minutes. Body armor worn by patrol officers is lighter that military armor and designed to defeat handgun threats; areas such as the neck, groin, and axillae are not protected by most patrol vests.

Differences in casualty rates and types in civilian mass shootings and combat operations are affected by similar factors: lack of personal protective equipment, low-velocity weapons fired at close range, and compressed time frame of the events themselves. Unique to civilian mass shootings is the higher fatality rate compared to military operations. Here, an armed individual deliberately targets an unarmed and vulnerable population (schools, malls, places of worship) and engages targets at close range, with resulting higher numbers of non-survivable injuries such as head wounds.[21]

There is concern that law enforcement may misinterpret the conclusions of the above articles to mean that practicing self-aid/buddy-aid skills are not necessary, and tourniquets and other hemorrhage control devices are of little benefit. These same concerns apply to recommendations for active shooter and other hybrid targeted violence issues such as terrorism and bombings. The Hartford Consensus (discussed later) ongoing recommendations for improving survival in active shooter incidents places a strong emphasis on extremity hemorrhage control.

However, neither study calls for a revamping of the MARCHE tactical primary survey. There is no debate that massive hemorrhage will result in morbidity and mortality quicker than other preventable deaths, and so it must remain the priority when present. However, emphasis on hemorrhage control at the exclusion of other options (such as emphasis on rapid evacuation when operating within the civilian environment) may be detrimental. Of note, by looking at deceased casualties, "survivor bias" may be present.[20] We do not have as robust of a "near miss" database to explore. In other words, in casualties who survive, what are the most common injuries and what life-saving interventions have been attempted?

Hemorrhage Control

One of the most striking and readily visible influences of tactical medicine on civilian medical care has been the prioritization of hemorrhage control as a means of treating potentially survivable injury. The tactical primary survey (MARCHE) has begun to replace the traditional mantra of ABC. Massive hemorrhage and its resulting physiological derangements portends significant morbidity and mortality, and must be addressed in a timely manner, especially in the field or ED. Within the field of civilian trauma management, damage control surgery and resuscitation reflect this paradigm shift. The lethal triad of acidosis, hypothermia, and coagulopathy may preclude definitive surgical repair of all injuries; it is in this subset of patients that damage control surgery (DCS) is advocated. DCS prioritizes physiological recovery over anatomical repair, and is associated

with dramatically increased survival of the most seriously injured casualties. Damage control resuscitation (DCR) is a newer development within the damage control paradigm, and describes strategies designed to limit physiological derangement associated with traumatic injury. DCR originated in the military management of major hemorrhage during the conflicts in Afghanistan and Iraq. DCR recognizes the primacy of hemorrhage control in the prehospital environment. DCR uses the "<C>ABC" paradigm (similar to the tactical primary survey) from point of wounding to definitive treatment to minimize blood loss, maximize tissue oxygenation, and optimize outcome.[23]

Once considered a last resort, tourniquets play a key role as the primary means of hemorrhage control in the tactical environment. Tourniquets have been used successfully on the battlefield for centuries, with the first documented use in 1674 by a French army surgeon.[24] Until the past decade, concern for limb ischemia, reperfusion injury, and pain made providers hesitant to apply tourniquets in the field. The use of commercial tourniquets in Iraq and Afghanistan demonstrated a remarkable safety record, with almost no loss of limbs secondary to a properly applied tourniquet. The benefit from lives saved far outweighed any risk of limb ischemia. While certainly painful, appropriate use of analgesics in the field can mitigate discomfort from both the tourniquet and underlying wounds. Improperly applied tourniquets (particularly improvised tourniquets) actually may increase bleeding from soft tissues by occluding low pressure venous outflow but not arterial flow. Following the Boston Marathon bombings, many improvised tourniquets were found to be venous-only, lacking hemostasis and causing paradoxical bleeding.[25] Proper equipment, training, and use are imperative.

While direct pressure often is adequate to control hemorrhage, tourniquets remain the first-line intervention in tactically dangerous environments. Examples include:

1. Self-application or application to an injured partner or civilian by police officers following gunshot wounds, stabbings, or other penetrating injury;

2. Terror incidents in which blasts create multiple casualties with amputations and near-amputations;

3. Rural/wilderness incidents where resources are severely limited and transport to higher level of care is delayed.

Prevalence of tourniquet use by EMS agencies in civilian settings is low but is increasing. Prehospital protocols increasingly include tourniquet application for hemorrhage. Lower rates of use in the civilian environment likely result from better access to more conventional methods of hemorrhage control. Despite the increased interest in tourniquet use in mass casualty situations, most cases are reported to be routine EMS incidents. However, documented cases of successful tourniquet use by law enforcement continue to grow.[26,27]

Vulnerability of military and law enforcement personnel to junctional hemorrhage also has influenced tactical medical care. The junctions of the extremities and torso contain large blood vessels (femoral, axillary) that may be injured by penetrating injury or blast. These areas also tend to be susceptible to injury because of gaps in body armor. Injury too close to the torso for tourniquet application can be particularly problematic, as ongoing direct pressure may not be practical in the tactical environment. For compressible hemorrhage that is not amenable to tourniquet use, tactical medical providers will pack the wound with either cotton or hemostatic gauze. Hemostatic gauze is cotton gauze impregnated with chemicals meant to enhance hemostasis, usually by promoting clotting. They are a step above previous granular hemostatic agents that had to be poured or packed into a wound, generated heat when in contact with blood and body fluids, and were associated with development of pathologic clots away from the injury site. Commonly seen hemostatic gauze includes QuikClot Combat Gauze, which uses the mineral kaolin, and Celox Gauze, which uses chitosan polymer derived from shrimp shells. While showing a moderate advantage over plain cotton gauze when tested in animal models, hemostatic gauze is expensive. There seems to be little difference in efficacy between the most commonly used hemostatic agents.[28-30]

Junctional tourniquets are specialized devices that either apply direct pressure to the site of junctional injury or, in some cases, compress the aorta to slow lower extremity junctional bleeding. These devices are now part of TCCC guidelines and also are being advertised and sold to non-military tactical medical providers.[19] Literature regarding efficacy of these devices is lacking, and they are often bulky, expensive, and require time to apply.[31] Wound packing remains the first-line intervention for compressible hemorrhage not amenable to tourniquet application.

Acknowledging that external hemorrhage increasingly is being recognized as a major cause of potentially preventable death following severe injury, and looking closely at the plethora of military data from the United States, United Kingdom, and Israel regarding tourniquet and hemostatic agents, the American College of Surgeons Committee on Trauma published Guidelines for External Hemorrhage Control in 2014. It found large and consistent benefits to tourniquet use across several studies and recommended tourniquet use in the prehospital setting if direct pressure is ineffective or (as is often the case in the tactical environment) impractical. While evidence was low, it also recommended the use of topical hemostatic agents in anatomic areas where tourniquets could not be applied.[32]

Contemporary Issues in Tactical Emergency Medicine

TECC. In May 2011, the Committee for Tactical Emergency Casualty Care held its inaugural meeting for the purpose of speeding the transition of military medical lessons learned from the battlefield to civilian medical response to high-risk situations. As noted, military experience and doctrine was being applied to the civilian setting. While similarities exist in the wound patterns and tactics necessary, significant differences affect casualty care. As TECC is quick to note on its own website: Just as ATLS failed to address many of the unique factors of the battlefield, TCCC does not address the unique features of tactical medicine in the civilian

setting.[33] These factors include:

• Unlike military providers, the civilian medical responder scope of practice is bound by state and local protocols and subject to liability and negligence.

• TCCC data and experience predominantly are based on an 18- to 30-year-old patient population, and do not address all age groups seen in civilian operations, such as pediatric and elderly patients. The baseline TCCC combatant population tends to be relatively healthy and physically fit and without a high incidence of chronic medical illness. Effects of chronic medication use, such as beta-blockers and anticoagulants, also are not addressed. Other special populations, such as pregnant patients and those with mental and physical disabilities, also need to be considered in civilian scenarios.

• Time, distance, and availability of resources for definitive care are different in the civilian environment; there often are multiple medical facilities within a given region, with trauma centers among them. Asset availability, such as ground and air transport (as well as transport in law enforcement or civilian vehicles), is an option.

• Once in the cold zone, concern for secondary dangers (such as further attack) are considered negligible in the civilian environment.

• Wounding patterns differ between military and civilian scenarios. As noted earlier, this is multifactorial and includes differences in weapons, IED use and strength, and ballistic protective gear prevalence and protection levels. Recent studies confirm these observations.

TECC has become an increasingly popular resource for guidance of protocols for TEMS providers. The National Association of Emergency Medical Technicians (NAEMT) now offers a 16-hour course covering core TECC topics such as hemorrhage control, surgical airway, treatment of wounded responders in hostile environments, and pediatric patient care. For its core text, NAEMT uses the military version of Prehospital Trauma Life Support (the same text tused for TCCC).

Like TCCC, TECC recognizes phases of care in which the tactical situation determines what medical aid can be rendered.[17] Direct threat/hot zone care goals are mission accomplishment with minimum casualties, prevention of additional casualties, and minimization of all-hazards threats and public harm. Unlike TCCC's care under fire, direct threat care hazards include not only armed assailants but also civilian considerations such as unstable buildings, fires, and HAZMAT. Indirect threat/warm zone care goals are directed toward care within a hostile perimeter but out of direct potential harm. Emphasis is on maintaining tactical supremacy and completing the mission, while stabilizing casualties to permit safe extraction and evacuation. This section contains tactical medical skills (tourniquet application, hemostatic agents, surgical airways) designed to extend survivability in the field until casualties can be evacuated to higher levels of care. Evacuation/cold zone care emphasizes maintenance of interventions applied in the warm zone, with rapid evacuation to an appropriate treatment facility. A major difference from TCCC's tactical evacuation is that in most civilian settings, once they are in the cold zone, both the casualties and providers can assume to be safe from further tactical hazard, a luxury not afforded to military personnel in hostile terrain.

Active Shooter Response and the Hartford Consensus

Mass casualty shooting events in the United States, though rare, appear to be increasing in frequency.[34] These tend to be very high-profile events that capture the attention of the public because of their horrific nature. Attacks on soft targets, such as schools or places of worship, create multiple casualties in rapid succession, with the potential to overwhelm medical resources. Active shooter attacks have become a favored means of inflicting terror. This has been a growing trend overseas for some time, with active shooter terrorist teams (often carrying explosive devices or explosive suicide vests) attacking targets of opportunity. Examples include the attacks in Paris in 2015 on the Charlie Hebdo offices and the Bataclan theater, and the 2008 Mumbai, India attacks. Recent active shooter events in the United States (Fort Hood, Orlando, San Bernardino) are linked to international terrorist organizations. Although the average time of these attacks is brief, it can take hours for law enforcement to evaluate a scene for additional threats and render the area "safe." Thus, warm zone care, a hallmark of tactical medicine, has become a predominant focus of active shooter response. Since the attack on Columbine High School, law enforcement has altered tactics in response to an active shooter from surround and contain to immediate movement to contact with the threat, even in the case of single officer response. Although dangerous, the risk to the public to allow the shooting to continue unopposed is too great, and officers now are trained to head "toward the sound of gunfire" and address the threat. EMS response, burdened with the concept of "scene safety" has been slower to alter tactics, but this now is changing. Cooperation between law enforcement and EMS has become the new norm, with the goal of providing care to the wounded in the warm zone and facilitating rapid evacuation to higher levels of care.[35]

In 2013, the American College of Surgeons and the Federal Bureau of Investigation brought together leaders from the medical, law enforcement, fire/rescue, and EMS communities to produce a document to stimulate discussion and ultimately lead to strategies to improve survival for the victims of mass casualty shooting events. Experts convened at a one-day meeting in Hartford to provide input based on data from military and civilian experiences with active shooters. The result was a concept paper, "Improving Survival from Active Shooter Events," released by the Hartford Consensus Conference.[36]

The members noted a segmented and linear response to shooting events initially focused on law enforcement (stop the shooting). This was followed by the remainder of the incident response and recovery, to include rendering of medical care and casualty evacuation. They recognized that maximizing survival requires an integrated system allowing initiation of medical care while simultaneously achieving tactical goals. Lessons learned from military and civilian tactical medicine provided a framework:

mission accomplishment (stopping the threat, either through isolation or neutralization) while simultaneously mobilizing a medical element capable of addressing survivable injuries in an unsecured area. Given that law enforcement likely will be the first to come in contact with casualties, they noted that initial actions to control hemorrhage should be part of the law enforcement response and a core law enforcement skill. The Consensus recommends an integrated response addressing critical actions described in the acronym THREAT:

1. Threat suppression;
2. Hemorrhage control;
3. Rapid Extrication to safety;
4. Assessment by medical providers;
5. Transport to definitive care.

The Consensus members further recommended that to create a truly integrated response, members of law enforcement, fire, and EMS need to work together beforehand to ensure they are using shared terminology, and to develop protocols jointly for active shooter response. Subsequent meetings of the Consensus members have been used to develop strategies to achieve the objectives of the first Hartford Consensus and to focus on bleeding control techniques for all levels of responders, including civilian bystanders, to active shooter events.[37] Coordinated response strategies such as the Rescue Task Force Concept share similar goals: Use a tactical medical model to initiate care of casualties as quickly as possible in an unsecured environment.

Hybrid Targeted Violence

Here in the United States, we are beginning to see mass casualty attacks that do not readily fit into the patterns of the past. The label "active shooter" does not adequately describe for first responders or the public the dynamic incidents that may involve a variety of lethal weapons, mobile attackers, and multiple locations. Frazzano and Snyder define the term hybrid targeted violence as "an intentional use of force to cause physical injury or death to a specifically identified population using multifaceted conventional weapons and tactics."[38] This definition better captures the range of hazards confronting public safety and tactical medical response. Assaults increasingly use a combination of lethal conventional weapons and well-planned tactics. Individual responders must have well-crafted strategies to address active threats involving firearms, improvised explosives, fire as a weapon, and military style barricading and maneuvering techniques. These strategies blur lines between traditional law enforcement, fire, and EMS duties and responsibilities. Medical providers must be prepared for casualties that may come in multiple waves and involve multiple mechanisms, including penetrating trauma, blast, and burns. Such incidents may become protracted; the Orlando shootings began as an active shooter event before becoming a hostage barricade.

Successful response to hybrid targeted violence will require a mind-set change among first responders. Scenes of fire and EMS staging outside a perimeter while lives are being extinguished no longer will be tolerated. Nor can law enforcement personnel, faced with a critically wounded individual, simply stand by and wait for medics while the casualty bleeds out. Lessons learned from tactical medicine need to be integrated into our medical response to these active threats. Officers need to be trained and equipped to provide point-of-wounding care to critically injured civilians through use of tourniquets, wound packing, and basic airway control. EMS must be equipped to move into warm zones and initiate triage and treatment long before a scene is considered secure. Medical directors must train their agencies on these techniques, and be prepared themselves to manage patients who have been treated with extremity and junctional tourniquets, chest seals, and hemostatic gauze. Hard-learned lessons from the battlefield and the streets will influence our management of traumatic injury and enhance our ability to save lives. With proper tactics and training, life-saving care increasingly will be rendered at the point-of-wounding in unsecured scenes, maximizing chances of reaching higher levels of care.

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CME/CE Questions

1. Which of the following interventions is *not* appropriate in the hot zone?
   a. Application of a tourniquet for exsanguinating hemorrhage
   b. Return fire if fired upon
   c. Evacuation to warm zone
   d. Supraglottic airway insertion
2. You have just evacuated a 30-year-old male bystander with multiple stab wounds to the warm zone. He is responsive to sternal rub with an intact gag reflex; he has multiple stab wounds present over the chest wall with decreased breath sounds on the right. He is tachycardic, tachypneic, and hypotensive. Which of the following interventions is *not* appropriate?
   a. Hemostatic agent application to any profusely bleeding wounds
   b. IO access for resuscitation
   c. Tube thoracostomy for presumed hemothorax
   d. Tranexamic acid administration
3. Compared to military combat operations, civilian mass shootings have:
   a. lower fatality rates.
   b. higher incidence of exsanguinating extremity wounds.
   c. higher fatality rates.
   d. lower incidence of chest and head wounds.
4. Commercial tourniquets are the first-line intervention for extremity hemorrhage in all the following situations *except*:
   a. terrorist bombing with multiple casualties with amputations and near amputations.
   b. junctional wound in which bleeding is not controlled with direct pressure.
   c. self-application by law enforcement officer after being shot by suspect and getting to cover.
   d. severe bleeding from a deep forearm laceration in a hiker who fell into a gulley and requires complex extrication/extraction.
5. You are treating an officer who was shot during a SWAT-callout for a barricaded subject. The officer was struck in the groin by a handgun bullet and is bleeding profusely. You decide to pack the wound with hemostatic gauze. You are aware that:
   a. hemostatic gauze uses granular agents to promote clotting.
   b. kaolin is the active ingredient in Celox Gauze.
   c. hemostatic gauze has been shown to reduce mortality from junctional wounds.
   d. hemostatic gauze shows a moderate advantage over cotton gauze in animal model testing.

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