TACTICAL EMERGENCY CASUALTY CARE VS TACTICAL COMBAT CASUALTY CARE

InfoBrief

International Public Safety Association

May 2018

About

The ***International Public Safety Association's Tactical Emergency Casualty Care vs Tactical Combat Casualty Care InfoBrief*** is authored by members of the IPSA's Tactical Emergency Medical Support (TEMS) Committee.[i]

The IPSA is a 501(c)3 non-profit public safety association that represents all public safety disciplines: law enforcement, fire service, EMS, telecommunications, public works (water, sanitation, transportation), public health, hospitals, security, private sector, and emergency management. Our vision is for a stronger, more integrated public safety community capable of an effective joint response to all public safety incidents.

The IPSA's TEMS Committee includes public safety practitioner, subject matter experts and trauma-care physicians from around the globe. This committee is dedicated to advancing the IPSA mission and contributing to the professional development of the public safety community.

Emerging tactical medicine trends derived from TCCC & how they relate to TECC

After almost two decades since its inception, the evolution of Tactical Combat Casualty Care (TCCC) has resulted in a dramatic drop in the rate of preventable combat deaths in modern combat settings. In the civilian realm, the Committee for Tactical Emergency Casualty Care (C-TECC) has used military battlefield guidelines as an evidenced based starting point in the development of civilian specific medical guidelines for high threat operations. Each phase and medical recommendation of the military TCCC guidelines was examined and discussed by the C-TECC, and then was re-written, annotated or removed through consensus voting of the Guidelines Committee to create civilian specific, civilian appropriate guidance. Additionally, the C-TECC added and/or put specific emphasis on several medical recommendations not included in TCCC to address high threat operational aspects unique to civilian operations.

Today, TCCC and TECC guidelines continue to evolve in parallel to improve battlefield and tactical prehospital medical care, respectively. What follows is a succinct review of the latest updates in the TCCC guidelines[ii] and how these trends in military medicine may translate into the civilian trauma systems of care paradigm.

For purposes of consistency, major changes and highlights will be presented in the three phases of TCCC/TECC and in keeping with the established M.A.R.C.H.E. format (Massive Hemorrhage, Airway, Breathing/Respirations, Circulation, Head & Hypothermia and Everything else).

Care Under Fire/Direct Threat Phase/Hot Zone

- There are no major changes in the 2017 TCCC update in this phase of care.

Tactical Field Care/Indirect Threat Phase/Warm Zone

- It is accepted that the best medicine in a combat environment is fire-power superiority, and furthermore, good medicine can be bad tactics and bad tactics can get everyone killed. It follows naturally that tactical priorities take precedence over medical ones. Though this is implicit in any SWAT or tactical operations, it was recognized that it should be made explicit in the TCCC guidelines. Theses common sense principles equally apply in any civilian SWAT paradigm. Thus, the following changes were made in the preamble to M.A.R.C.H.E. in the CUF/DTP phases of care:

    1. Establish a security perimeter in accordance with unit tactical standard operating procedures and/or battle drills. Maintain tactical situational awareness.
    2. Triage casualties as required. Casualties with an altered mental status should have weapons and communications equipment taken away immediately.

- **MASSIVE HEMORRHAGE**: X-Stat has gained some traction in the latest iteration of the TCCC guidelines. However, definitive evidenced-based science is lacking to prove (or disprove) its role in tactical medicine. Based on the mechanism of deployment and action, it has plausibility for efficacy, and as such, should be considered a treatment adjunct in the TFC/ITP phase of care, provided all other interventions with greater evidence (e.g. tourniquet application) have been deployed, if applicable.

  Within the context of the penetrating injury, it was further noted in the 2017 TCCC updates that *"X-Stat is not to be removed in the field, but additional X-Stat, other hemostatic adjuncts, or trauma dressings may be applied over it."* This too follows a gradient of plausibility and would equally translate to the civilian TECC context.

- **AIRWAY/RESPIRATION:** We have increasing evidence of the morbidity associated with hypoxemia and relative or absolute hypotension in severe traumatic brain injury (TBI). In the 2017 TCCC update, it is suggested to *"initiate pulse oximetry in individuals with moderate/severe TBI.*" The only caveat to this recommendation are the tactical implications of a light-signal from the pulse oximeter, and caution with the use of pulse oximetry as a trigger for the administration of supplemental oxygen, i.e. compressed gas, in a potentially kinetic environment.

  In the civilian SWAT context, individual teams need to weigh the risk/benefit of having compressed air in their armoured rescue vehicles versus deferring this treatment adjunct to EMS colleagues in the cold zone. Otherwise, pulse oximetry may play a role as a stimulus for airway or breathing interventions, notwithstanding the issue of supplemental oxygen.

- **CIRCULATION:** There are numerous additions in this section, which for the most part, are self-explanatory and immediately transferrable to civilian applications. Some items worth noting include the following:

  - **Use of pelvic binders for confirmed or suspected pelvic fractures:** Criteria articulated by the 2017 TCCC updates include *severe blunt force trauma with any of: pelvic pain, evidence of pelvic facture, shock, unconsciousness, and the presence of any lower limb amputation (or near amputation).*

    The last criteria was a derivation specific to the experience from the U.S. Joint Trauma Theatre in Afghanistan. On the surface one might be cautious to generalize to civilian wound patterns, but given the increase use of improvised explosive devices and bombs in domestic acts of terror, this inclusion criteria renders the principle immediately applicable.

  - **Intravenous (IV) or intraosseous (IO) access:** *IV or IO access is indicated if the casualty is in hemorrhagic shock or at significant risk of shock (and may therefore need fluid resuscitation), or if the casualty needs medications, but cannot take them by mouth. An 18-gauge IV or saline lock is preferred. If vascular access is needed but not quickly obtainable via the IV route, use the IO route.*

    Though new in its articulation in the 2017 TCCC guidelines, this is arguably already considered standard of care in conventional civilian EMS realms.

  - **Tourniquet removal and/or de-escalation**: The 2017 TCCC Update state that if *during the reassessment of tourniquet application, it is determined that the tourniquet was not needed, then one can remove the tourniquet and note time of removal on the TCCC Casualty Card.*

This recommendation may stimulate more heated discussion, and in truth, context will determine its broader applicability. More specifically, current dogma appropriately emphasizes early deployment of tourniquets, high and tight. But in battle (or civilian) scenarios with prolonged field time, there are conceivably risks with this more aggressive paradigm. Thus, the committee for TCCC suggests that after the CUF/DTC phase has passed and one has cover, concealment, and more situational awareness, one might take the time to reassess and reconsider the necessity of the tourniquet, thus potentially avoiding unnecessary loss of limb due to ischemia.

In theory, this makes total sense. In civilian practice, however, though the concept of tourniquet removal or de-escalation has merit, in most civilian settings where the prehospital time is lower, individual tactical medical teams will have to weigh the relative risk/benefit of espousing this practice, given that most causalities in civilian trauma can be transported to a trauma center well within a safe limit of limb ischemia in the setting of tourniquet application.

- **Tranexamic Acid:** The 2017 TCCC updates recommend *"administration of 1 gm of tranexamic acid in 100 ml Normal Saline or Lactated Ringer's as soon as possible but NOT later than 3 hours after injury. When given, TXA should be administered over 10 minutes by IV infusion."*

  Though not addressed in the TCCC update, there are numerous SWAT teams in Canada now using IM TXA as a treatment option. This treatment modality was adopted reflecting the ease administration, the sense of time urgency for administration prior to shock setting in, to optimize medic situational awareness, and to allow medics to treat more victims in less time, especially in mass causality scenarios.

  Again, individual SWAT programs will have to consider the relative evidence for this intervention within the context of their medics' skills and operational context. If possible, IV or IO would still be the preferred route.

- **Fluid Resuscitation:** The topic of fluid resuscitation in combat medicine represents likely the greatest differentiating practice versus what is seen today in most civilian trauma. More specifically, "*the resuscitation fluids of choice for casualties in hemorrhagic shock, listed from most to least preferred, are: whole blood; plasma, red blood cells (RBCs) and platelets in a 1:1:1 ratio; plasma and RBCs in a 1:1 ratio; plasma or RBCs alone; Hextend; and crystalloid (Lactated Ringer's or Plasma-Lyte A). NOTE: Hypothermia prevention measures should be initiated while fluid resuscitation is being accomplished."*

  This detailed and thoughtful recommendation likely has one of the greatest potentials to mitigate the morbidity and mortality associated with hemorrhagic shock; however, there are several significant and complex operational issues to consider with pre-hospital blood programs.

  To date, there are probably less than two dozen programs in North America that are using pre-hospital blood. Scientific data is increasingly convincing that whole-blood or 1:1(:1) transfusion is optimal in hemorrhagic shock, based on the restoration of effective circulating fluid volume, mitigation of acute coagulopathy of trauma shock, and the optimization of acid:base status and organ perfusion.

  Some of the challenges faced by many civilian care providers have to do with cost, consent, storage and licensure requirements for the pre-hospital administration of blood products. However, these barriers are not insurmountable. As the paradigm of early, balanced blood-

product resuscitation takes hold across North America, perhaps barriers to its uptake will start to fall.

- **Communication:** *Communicate with the casualty if possible. Encourage, reassure and explain care. Communicate with tactical leadership as soon as possible and throughout casualty treatment as needed. Provide leadership with casualty status and evacuation requirements to assist with coordination of evacuation assets. Communicate with the evacuation system (the Patient Evacuation Coordination Cell) to arrange for TACEVAC. Communicate with medical providers on the evacuation asset if possible and relay mechanism of injury, injuries sustained, signs/symptoms, and treatments rendered. Provide additional information as appropriate.*

- **Preparation for Evacuation:**

  a) *Complete and secure the TCCC Card to the casualty.*
  b) *Secure all loose ends of bandages and wraps.*
  c) *Secure hypothermia prevention wraps/blankets/straps.*
  d) *Secure litter straps as required. Consider additional padding for long evacuations.*
  e) *Provide instructions to ambulatory patients as needed.*
  f) *Stage casualties for evacuation in accordance with unit standard operating procedures*
  g) *Maintain security at the evacuation point in accordance with unit standard operating procedures.*

- **Analgesia:** *For moderate to severe pain in casualties in hemorrhagic shock or respiratory distress or at significant risk of developing either condition: Ketamine 50 mg IM or IN, or Ketamine 20 mg slow IV or IO (Ketamine concentration dose of 100 mg/ml). Repeat doses q30min prn for IM or IN, or repeat doses q20min prn for IV or IO. End points: Control of pain or development of nystagmus (rhythmic back-and-forth movement of the eyes).*

  The use of Ketamine is gaining increased traction in both emergency and prehospital care literature. Beyond its favorable hemodynamic and respiratory pharmacodynamic profile, it has multiple potential civilian police applications including procedural sedation for painful procedures or prolonged tourniquet application, pain control, and as a sedative for the management of excited delirium syndrome.

  Local and federal regulatory laws regarding the possession, transport and administration of Ketamine must be considered as it is classified as a controlled substance in many, if not most states and provinces.

Evacuation (CASEVAC/TACEVAC)/Cold Zone:

- There are numerous additions in this section which, for the most part, are self-explanatory and immediately transferrable to civilian applications. Items worth noting include the following:

  - **Transition of Care:** *a) Tactical force personnel should establish evacuation point security and stage casualties for evacuation; b) Tactical force personnel or the medic should communicate patient information and status to TACEVAC personnel as clearly as possible. The minimum information communicated should include stable or unstable, injuries identified, and treatments rendered; c) TACEVAC personnel should stage casualties on evacuation platforms as required; d) Secure casualties in the evacuation platform in accordance with unit policies, platform configurations and safety requirements; e) TACEVAC medical personnel should re-assess casualties and re-evaluate all injuries and previous interventions.*

- **Transport:** With regard to casualty transport, non-trauma preferred Hospitals in the civilian context should be capable and willing to accept traumatically injured casualties as a result of an intentional mass-casualty incident. Taking patients to the closest hospital will help to not overload the Level 1 Trauma centers and will get more trauma patients to surgeons in a timely manner.

Though there have been several modification and additions to the 2017 TCCC guidelines, the clear majority have immediate applicability to civilian SWAT operations. But as with everything we do, everything must be put into context. The TCCC guidelines, like the TECC guidelines must be adapted and contextualized to the environment in which any individual SWAT team operates, and tactical medical principles are applied.

Moving forward, it will be of great interest to see the uptake of prehospital balanced blood product resuscitation has on outcomes and how readily or aggressively it can adopt into civilian tactical medicine.

Similarly, the potential for Ketamine as a single-agent analgesic/sedative hypnotic with a favorable cardiorespiratory profile makes it an ideal agent for various applications in civilian policing and tactical medicine.

TECC vs TCCC courses: What's the difference?

When considering which class to teach, TECC or TCCC, it is important to consider the background of the students attending. TECC and TCCC classes are very similar and provide valuable information for both the civilian and military provider. Instructors already tailor their presentations toward their audience, but there is a push to minimize instructor drift.

According to C-TECC, "When discussing the differences between the two, it is important to emphasize that TECC and TCCC are not in competition with each other; although, as the pictures from the recent Boston Marathon bombing demonstrate, the bullets and explosives may be similar in civilian settings as in military combat, this does not make the military guidelines directly applicable for civilian applications."[iii]

TECC is more adapted to the civilian environment than TCCC. TECC omits certain aspects of TCCC that do not apply to the civilian setting including use of a 9-line and specific threats in a combat environment. TECC focuses more on law enforcement/TEMS response and threats that would likely be encountered in this setting.

"The TECC guidelines place more emphasis on interagency communication, integrated operations between EMS, fire and law enforcement, casualty extraction and evacuation, and care of non-combatant civilians."[iv]

Scenarios in this class include response to a barricaded subject, hostage rescue, active assailant and officer down scenarios, all of which are likely encountered for TEMS medics and law enforcement. TECC also covers areas of active assailant response including the Rescue Task Force concepts and establishing Casualty Collection Points, none of which are covered in TCCC.

Overall, information is very similar in that the three phases of care are essentially the same and include the same skills and material. Both courses use PHTLS, military edition as their textbook for the course.

Patient population and baseline health

As devastating as active shooter/hostile events and mass casualty incidents are, none leave a mark as much as when they involve pediatric and/or geriatric patients. The following section will look at these events regarding patient population and baseline health as it pertains to each.

When we investigate these population segments in relation to health, the main considerations at both ends is the patient's lack of being able to compensate from the insult. In other words, with our pediatric population, their compensatory mechanism may not be as well developed as adults. In the geriatric population, their compensatory mechanisms may not be able to compensate as well due to age, health and pre-existing medical conditions. Let's begin with looking at what is "normal" for pediatrics in relation to vital signs, as we should all be aware of the saying "children are not just little adults" and what may be considered abnormal in the adult world may not be so for the pediatric patient.

Group	Age	Respiratory Rate per Minute	Heart Rate per Minute	Blood Pressure
Newborn	Birth – 6 weeks	30 – 50	120 - 160	74 – 100 50 – 68
Infant	6 weeks – 1 year	20 – 30	80 – 140	84 – 106 56 - 70
Toddler	1 – 2 years	20 – 30	80 – 130	86 – 106 42 - 63
Preschooler	2 – 6 years	20 – 30	80 – 120	89 – 112 46 – 72
School Aged	6 – 13 years	12 – 25	60 – 110	97 - 115 57 - 76
Adolescent	13 – 16 years	12 - 20	60 - 100	118 - 132 70 - 82

In relation to the adult TECC guideline, pediatric patients have a few distinctions. As with all ages, rapid hemorrhage control is paramount and addressed as the priority. If the exsanguination is not obvious a "blood sweep" from head to toe may help determine the location of the insult.

Application of a tourniquet or emergency trauma dressing with direct pressure (where a tourniquet is not applicable) is the choice for hemorrhage control; note that the TECC pediatric guidelines specifically recommend a use of a tourniquet in pediatric patients[v]. A recommendation of which type of tourniquet though is not given. A CAT tourniquet may be most applicable, but a secondary tourniquet should definitely be considered, especially in the smaller pediatric patients. A possibility would be an "elastic" type or R.A.T.S. (Rapid Application Tourniquet System) as they may be better suited for application in this population. Further studies are warranted for the use of these tourniquets.

Pediatric airway

The pediatric airway is addressed next. Depending on location of care (direct care, indirect care or evacuation phase) basic airway maneuvers such as positioning, basic airway devices, bag valve mask, intubation and surgical airway may be recommended. With pediatric basic airway considerations, due to a larger occipital area a, 1-inch pad or blanket placed under an infant's torso can lesson acute flexion of the neck and help keep the airway patent[vi]. This may help to easier facilitate a "sniffing position." Once an airway is established, the goal should be prevention of hypoxia. This may be accomplished using a bag valve mask in conjunction with basic airways. Advanced or surgical airways may be considered if other means are unsuccessful.

Respirations and breathing

Respirations and breathing are now addressed. With known or suspected torso trauma or worsening respiratory distress, consider the use of needle decompression for relief of a tension pneumothorax. Cather size and landmark location may be protocol directed. Any open chest wounds should be immediately covered with a vented chest seal, patients must be monitored for possible development of a tension pneumothorax. Circulation, tourniquet and/or wound packing reassessment is warranted here. If major bleeding has been controlled. The major concern here is the pediatric patient moving from compensated shock to decompensated shock. Areas to look at in the pediatric patients would be changes in respiratory effort, alteration in LOC, changes are skin perfusion (temperature, color, delayed cap refill).

Field treatment consists of Intravascular IV/IO access with fluid administration, 20cc/kg of normal saline or lactated ringers. If blood pressure monitoring is available maintain a target systolic blood pressure of, (Age x2) +70 = BP, for children 10 and younger.

> *Note that these patients have lost red blood cells – the oxygen carrying capacity. IV fluids will increase the circulating volume but at the same time will dilute the remaining circulating volume of RBC's. The definitive treatment would include plasma and packed red blood cells.*

Treatment modalities for our geriatric population, in relation to TCCC/TECC, are the same as the general adult treatment. Massive Hemorrhage, Airway, Breathing/Respirations, Circulation, Head & Hypothermia and Everything else (M.A.R.C.H. E.).

Geriatric population

There are special considerations for our geriatric population that must be addressed. This population has changes that are both anatomical and physiological. The period of old age is generally characterized by frailty, slower cognitive processes, impairment of psychological functions, diminished energy, the appearance of chronic and degenerative diseases and a decline in sensory acuity.[vii]

The alterations in vision and hearing thus may lead to difficulty with understanding and/or following directions. Simple directions that can be clearly understood would be best for both age groups. With the aging process also comes the ability to not perceive pain normally. Their vital signs may vary from that which is considered normal.

In addition to age, medications need to be considered (e.g. beta blockers, calcium channel blockers, blood thinners) will all influence the patient's ability to compensate from an insult, such as inhibiting heart rate increases or clotting factors to compensate for blood loss.

A factor to further consider is the use hemostatic agents on patients that are on blood thinners. Controlling blood loss can be a major problem for some individuals, particularly those who take blood thinners, and those who suffer from inherited or acquired bleeding or clotting disorders. The blood in these individuals does not clot quickly. Even the smallest cut can be a real problem. Again, hemostatic agents may be a valuable addition to controlling bleeding in these patients. [viii]

A key fact to remember is that hemostatic agents need to be used in conjunction with wound packing and direct pressure applied to the wound site for three minutes to control hemorrhage.

For compressible (external) hemorrhage not amenable to limb tourniquet use or as an adjunct to tourniquet removal, use of a hemostatic impregnated gauze f (Kaolin or chitosan) wound packing is preferred. Hemostatic adjuncts: Combat Gauze, Celox Gauze, chitoGauze or XStat (Best for deep, narrow-tract junctional wounds).

Hemostatic dressings should be applied with at least 3 minutes of direct pressure (optional for XStat). Each dressing works differently, so if one fails to control bleeding, it may be removed and a fresh dressing of the same type or a different type applied. (Note: XStat is not to be removed in the field, but additional XStat, other hemostatic adjuncts, or trauma dressings may be applied over it.)".[ix] All of the above factors may come into play and make assessment and treatments of our geriatrics patients more challenging.

Hypothermia

For any age group, another important consideration is the prevention of hypothermia as it relates to blood loss. In all age cases hypothermia can lead to coagulopathy, effecting the bodies' ability to stop bleeding due to impaired platelet function or inhibition of clotting factors, thus leading to cardiovascular collapse. Prevention of heat loss should begin as soon possible with ready heat blankets or heat reflective shields to help maintain body heat.

Emotional distress

Emotional distress of any age group needs to be considered, more so within our pediatric and geriatric age groups. A lack of understanding, as addressed above, may be a challenge to the provider. The combination of parental absence, slower cognitive ability, emotional distress and unfamiliarity with surroundings may make information gathering difficult in the pediatric patient.

TECC guidelines have suggested that first responders or care providers plan operationally, not only for a child friendly space, but for an individual or group of individuals dedicated specifically to interaction with pediatric casualties[x]. A goal should be to help reconnect families, thus helping to reduce stress and improving communication with health care providers.

These types of events are probably the most challenging calls for any first responder to deal with. By understanding differences in age population and differences in treatments to these populations, first responders have the best hope to provide the greatest good to the greatest number. It is important to remember that everyone who is exposed to these types of events will need some sort of support system.

Special populations

The military and law enforcement agencies have widely adopted the TCCC guidelines due to their success during the Global War on Terror and methodology for dividing patient care by threat and risk.[xi] The difference between the civilian or law enforcement high threat environment compared to the military combat environment is the addition of special populations.

In the battlefield environment the military fighter is predominantly 18-30 years of age, male, in good physical condition with no chronic medical history.[xii] The combatants are outfitted in ballistic gear that gives them a level of protection to the head, chest abdomen and groin from blast and penetrating injury.

The law enforcement tactical environment includes a multitude of different patient subsets. This includes the tactical officers, which closely represent the same physical health and protection as the military combatant, but may also consist of children, the elderly and special populations. Special populations include the

chronically ill, the pregnant patient, physically disabled patients and those who are having mental health emergencies. The tactical medic must be prepared to address all the different needs of the special population; a patient having a diabetic crisis, assisting a mother in delivering a baby or treating an excited delirium patient.

Further, TEMS teams have a legal and moral obligation of making sure every person within that scene is treated and cared for in the law enforcement tactical environment[xiii]. Civilians that have penetrating trauma injuries from violent attacks do not have the ballistic armor to protect their vital organs. Further, law enforcement officers' protection is usually lighter than that worn by military personnel which could lead to a higher percentage of thoracic injuries.

Validity of TCCC in the civilian sector

Medical and tactical experts have questioned direct applicability of the TCCC guidelines in the civilian sector on the basis that law enforcement injury patterns do not match those seen in the military.[xiv] Additionally, the authors of the TCCC guidelines do not suggest methods or formatting for civilian tactical medicine training. The C-TECC puts specific emphasis on medical recommendations to assist TEMS teams with the variety of patients within the special population that are not included in TCCC. [xv] However, a gap remains in the available literature and evidenced based research describing the application of these principles to special populations.

The TEMS medical threat assessment is a vital tool during the tactical mission briefing that differs from the military and civilian environments. It allows the tactical medic to gather medical intelligence based on the civilian setting, resources available and additional equipment needs for the special population. The civilian setting could include an apartment block, a drug house or an ASHE. The resources that may be utilized could include a mental health team, staging ambulances on stand-by or calling in mutual aid. The medical equipment that may need to be added for a special population could include additional medications (naloxone, glucose or salbutamol) or special diagnostic equipment (cardiac monitor, SPO2, portable ultrasound).

TCCC guidelines represent current and evidence based best practices collected from lessons learned on the battlefield for reducing potential preventable trauma mortality. TECC is the civilian translation of TCCC. TECC has created an all hazards approach in a whole-of-community format that allows the tactical medic to provide trauma care and medical care for special populations in the civilian environment.[xvi] The C-TECC sought to establish a set of peer-reviewed guidelines to serve as a foundation describing current best practices in the absence of an evidence-based set of guidelines for pre-hospital care of the special population.[xvii]

Military vs civilian wounding patterns

When considering the type of medical training in which to provide first responders who will be responding to MCIs, one critical factor in the decision-making process ought to be the type of wounds most likely to be encountered.

Ideally, we should strive to train medical professionals to respond to the types of wounds they will see most frequently in these events. But we should also add in the additional layer of complexity of encouraging medical providers to first treat the types of wounds where treatment can be rendered rapidly and effect the greatest impact on overall survival. Thus, the issues that needs to be addressed is not the types of wounds medical providers will see, but instead the types of wounds they will likely see where their treatment may have the greatest impact.

This is a challenging issue to address for both military and civilian medical providers. In the interest of comparison, it is perhaps best to look first to the area with the most data.

Joint Theater Trauma Registry

The military has researched the types of wounds seen throughout the most recent conflicts including Vietnam, Operation Desert Storm, Operation Enduring Freedom and Operation Iraqi Freedom. Indeed, access to the Joint Theater Trauma Registry has proven invaluable in assessing the types of wounds encountered in combat as well as the efficacy of the medical treatments rendered.

One of the strongest descriptions of combat wounds from the recent conflicts was published in 2008 in the Journal of Trauma. In this article, the Joint Theater Trauma Registry was queried for all U.S. service members who received wounds from October 2001 through January 2005, including those that died-of-wounds. In reviewing 6,609 wounds inflicted on 1,566 combatants, the authors found 54 percent extremity wounds, 11 percent abdominal wounds, 10 percent face wounds, 8 percent head wounds, 6 percent thorax and eye wounds, and 3 percent ear and neck wounds.

The percentage of extremity wounds is consistent with prior historical conflicts. The proportion of head and neck wounds was found to be higher and thoracic wounds lower ($p<0.0001$) than World War II and Vietnam. The proportion of gunshot wounds was 18 percent while the proportion of explosive wounds was found to be 78 percent. The authors note that this is the highest percentage of explosive wounds seen in any large-scale conflict to date.[xviii]

Journal of Trauma

While there are several publications from single units, smaller cohorts and individual medical centers, the only other comparable data was published in The Journal of Trauma in 2012. These authors again analyzed the Joint Theater Trauma Registry, this time looking at data from 2005-2009. They found 29,624 combat wounds in 7,877 combatants. They found injury patterns reflecting 51 percent extremity wounds, 28 percent head and neck, 10 percent abdomen and 9.9 percent thorax. Again, they noted explosive injury mechanism to account for over 70 percent of all combat casualties, consistent with the article from 2008.[xix] In sum, both articles demonstrate consistent and important historical trends in the U.S. combat casualties sustained between 2001 and 2009.

Limited data, limited empirical research

To accurately compare combat wounds with the wounding patterns seen in man-made mass-casualties, we would need to have similar data from the civilian realm. Unfortunately, little such data exists to date. There are publications from single countries relating the civilian injury patterns from penetrating trauma in general. In the U.S., the data is limited and derives from single events.

The Boston Trauma Collaborative pooled data in an effort to evaluate prehospital management of severely bleeding extremity injuries. The focus of this article was to evaluate whether tourniquets were used and were effective. However, it did not include a description of the wounding patterns of all injured patients.[xx]

There have been other publications following single events in the U.S., but the trend of these articles has been a discussion of how to prepare for man-made mass-casualties or what lessons were learned from the medical response. There is currently no existing research that reflects a global picture of the wounding patterns seen in a single mass-casualty event or a national effort to pool data from all recent events to evaluate wounding patterns or evaluate trends in preventable death.

While the National Trauma Data Bank (NTDB) reflects the largest aggregation of U.S. trauma registry data ever assembled, as of 2017 no articles have been published analyzing this database for the types of wounds sustained in civilian man-made mass-casualties. The reasons for this gap in evidence are numerous and complex.

As highlighted by the FBI active shooter data collection efforts, the definition of what constitutes an active shooter event has evolved over the last 10 years making data analysis for even an isolated type of man-made mass-casualty challenging at best. This is true of all varieties of man-made mass casualties in the sense that the definitions have evolved over the last two decades.

Given that these events are often complex and involve weapons beyond just handguns or rifles, nailing down a definition of what types of patients we would need to identify in the NTDB is fraught with difficulty. Submitting data to the NTDB is voluntary and generally only endeavored by hospitals designated as trauma centers. What we have seen with many of the recent man-made mass-casualties is that they occur increasingly in small towns that lack verified trauma centers.

Particularly with large mass-casualty events, there is a trend toward patients accessing non-EMS transport and arriving via privately owned vehicles (POV) to local hospitals. There are national, state and local laws that restrict access to personal health information. These circumstances inadvertently create a situation where information about the wounding patterns seen at large-scale events such as the Las Vegas Shooting, where some victims were transported by POV to non-verified trauma centers, is not collected or disseminated for analysis on a national level.

Determining trends with limited data sets

There is no existing reliable data on which to draw conclusions about what types of trends are arising in wounding patterns and preventable death in civilian man-made mass-casualties. In the absence of evidence, we are left to extrapolate from other data sets that are available.

One option is to look at the types of weapons used in the most lethal man-made mass-casualties over the last century. This information can be extrapolated from a list of disasters in the U.S. by death toll. Excluding natural disasters, accidents and military strikes (e.g. Pearl Harbor), what is left behind is a decent starting point for examination.

The remaining incidents of interest in order of number of fatalities includes:

- 9/11 terrorist attacks (2001)
- Oklahoma City Bombing (1995)
- 1993 Fire in Waco Texas (1993)
- 2017 Las Vegas shooting (2017)
- 1992 Los Angeles riots (1992)
- Pulse Nightclub shooting (2016)
- Bath School mass murder in 1927
- Wall Street Bombing (1920)
- Sandy Hook school shooting (2012)
- Sutherland Springs church shooting (2017)
- Luby's shooting in Kileen, Texas (1991)
- Los Angeles bombing (1910)
- Shooting at University of Texas, Austin (1966)
- Beltway Snipers who killed 17 (2002)
- San Bernadino attack (2015)
- Boston Marathon bombing (2013)[xxi]

Looking at these incidents, there is a broad mixture of wounding mechanisms including bombings, blast injuries and gunshot wounds. While it is extremely unlikely that the percentage of civilian man-made mass-casualty wounds secondary to explosions would approximate the 78 percent seen in recent military conflicts, there is still likely to be many deaths related to blast injury. It is reasonable to assume that for the same

weapon type, there will be a higher percentage of head and thoracic wounds in the civilian population due to the lack of body armor.

Though there is not extensive data on the civilian wounding patterns seen man-made mass-casualties, we do know what kind of weapons have been used in recent mass shooting events. The ALERRT active shooter data reveals some insight as to type of weapons used. Specifically, between 2000 and 2015, multiple weapons were used in close to 40 percent of active shooter events. The most powerful weapon used in ~ 55 percent of these events was a pistol. Rifles were the most powerful weapon used in ~ 27 percent.[xxii]

Still, this data set has limitations. It only covers one type of man-made mass-casualty, extends only from 2000-2015, and it does not include the resulting wounding patterns.

The only attempt to describe wounding patterns from recent civilian mass shooting events was an article published in Journal of Trauma in 2016. The authors performed a retrospective study of autopsy reports from 12 public mass shooting events. Based on this review, they estimated that 58 percent of the victims had gunshot wounds to the head and chest with only 20 percent having extremity wounds.[xxiii]

However, the methodology and conclusions drawn are deeply flawed, making it nearly impossible to draw any meaningful or statistically valid conclusions from this article. It differs so vastly from comparable data analysis from the military realm that it is impossible to draw any useful comparison or conclusions about civilian man-made mass-casualty wounding patterns or preventable deaths as compared to combat wounds.

Active interest and a strong, accessible data set have resulted in ample evidence of wounding patterns seen in distant and recent military conflict. More importantly, that data has been utilized to evaluate where medical response and training need to focus to decrease the rate of preventable death. With this data analysis, the leaders in military medicine have been able to focus their efforts on eliminating preventable death on the battlefield by training medical responders with a consistent, evidence-based curriculum in the form of TCCC.[xxiv, xxv]

Some of the limitations to accessing similar data in civilian trauma have been discussed above. These limitations leave us without strong evidence to guide our medical response and training for civilian man-made mass casualties. In the absence of appropriate evidence, we are left little option but to translate the wounding patterns and lessons learned from the military setting. Until there is a stronger evidence base to guide the medical response to civilian man-made mass-casualties, the IPSA recommends that we should continue to extrapolate military combat medical principles to the civilian environment in an effort aimed at eliminating preventable deaths.

Barriers to tactical evacuation

Pre-hospital medical providers are aware that TECC is simply the civilian counterpart of TCCC, but how does that relate to the daily duties of providing patient care?

Combat medical care had historically been modelled after civilian trauma care (PHTLS and ATLS); as battlefield medicine had not drastically changed in decades. That was true until 1996 when a Special Operations Medical research project developed the initial guidelines of TCCC. In the following years, TCCC was adopted by all branches of the U.S. military and became the mainstream medical standard for battlefields around the world.[xxvi]

As positive results increased, and the numbers of our fighting force lives were saved, these guidelines began to surface in the public sector. It wasn't long before subtle difference between the military and civilian

implementation of these guidelines (i.e. liability, patient population, transport times and wound patterns) began to become a factor in patient care. In 2011, the C-TECC was formed to massage these guidelines into a civilian model. As the differences between TCCC and TECC are continually assessed and improved upon, here we will examine some of the differences in barriers to evacuation and care within the two.[xxvii]

In the tactical environment, evacuation may be a two-pronged process including evacuation of the victim from the direct-threat zone to transporting the patient to definitive care. Initial and on-going hostility is usually the main barrier to the evacuation. In TCCC, the answer to this problem would be superior firepower.[xxviii]

In the TECC realm, however, the use of an evacuation corridor – in-where law enforcement officers secure the pathway of movement – might be necessary. In either modality, the use of a CCP might be used and certain considerations must be taken in choosing a location for the CCP. The CCP should be located away from choke points, but it is required to be accessible to the evacuation assets. Additionally, the CCP should be capable of expanding if the situation warrants, while still providing passive security to those in the area.

Transport barriers

Once medical personnel are ready to transport victims off the scene and to definitive care, they must consider the condition of the casualty, the treatment facility best suited (if there are multiple options) for that patient and the mode of transportation; ground, air or even boat.[xxix]

Regardless of the module, casualties need to be transported as soon as feasible after a significant injury. In TCCC, terrain and environment are usually the first factors in determining the mode of transportation. In urban-centric operations, ground transportation is considered the norm. Remote and austere environments typically lean toward aircraft evacuation, however, there are multiple considerations for air evacuation including altitudes, capacity, weather and time of day/night.

These same barriers exist in the TECC setting albeit in different capacities.

In the urban environment, aircraft usage can be limited by lack of suitable landing zones. And those tend to be under-utilized. Altitude can be a factor with both response availability and effects on patient care, especially in mountainous locations. Military medical aircraft, except for the Lakota, usually have a much larger patient capacity than civilian aircraft, but in the tactical setting, availability may be limited.[xxx] Civilian medical helicopters have less capacity, but most jurisdictions have multiple resources that are capable to respond.

Weather is also a major factor with aviation medicine and military aircraft tend to fly in more adverse conditions, including night operations than their civilian counterparts. All these barriers must be taken into account and evaluated for proper and adequate evacuation to take place.

Medical supplies

Barriers to patient care between TCCC and TECC mainly focus on the use of tourniquets and hemostatic dressings. Military personnel are not subject to state and local protocols, nor are they subject to negligence and liability claims; thus, these barriers are punctuated by scope of practice and liability limitations placed on them by local EMS.

Both civilian and military medicine frowned upon tourniquet use for several years. After the introduction of TCCC, civilian use of the tourniquet was still delayed. Some resistance was based on the beliefs of civilian physicians relating to the risk of complications from tourniquet usage. Subsequent studies proving the benefits of tourniquet use without risk of extensive vascular damage have all but debunked these old beliefs. In

addition, with the increase in training of their actual application through multiple trauma courses, the use of commercially available tourniquets has increased as have the number of lives saved.

Hemostatic agents posed yet another barrier for civilian use. The original powdered form was messy, hard to apply and occasionally caused physical burns to the patient. As impregnated materials became the norm, again wound patterns was a major factor in the reluctance of civilian EMS to adopt these products.[xxxi] As with tourniquets, the increase of education in the use of hemostatic agents also increased their use. Thus, the glaring barrier of all medical care, cost, rose to the forefront. Sadly, the dollars spent on these esteemed yet not often used products is difficult for many jurisdictions to absorb.

Caregivers understand the value of these life saving devices, and this is especially true when the patient is a member of our own team. However, cost is a huge obstacle for many organizations when implementing their programs.

Language barriers

One last barrier, not usually mentioned in care and evacuation of patients both in TCCC and TECC, is the language barrier. TCCC, although originates in the care of our troops, it also encompasses allied troops, civilian casualties and enemy combatants. Not all of these individuals will speak a language that allows us to communicate effectively.

In TECC, language barriers can be even greater. From incidents involving large crowds made up of multiple ethnicities and an even greater number of languages, to a school shooting with students speaking a multitude of languages, practitioners must learn to adapt and overcome to provide great patient care.

Regardless of the setting, military, SWAT or purely civilian EMS, trauma care and evacuation will always have barriers. Today's EMS providers must learn to work around those barriers and provide the best care possible. This will be done with education, practice and tenacity.

The world continues to be a violent place and those front line medical providers continue to expand and improve as the lives they save, build our worlds foundation.

References

[i] This InfoBrief was developed by members of the International Public Safety Association's TEMS Committee. Members included Dr. Eric Vu; Dr. Kari Jerge (and IPSA Board Member), Todd Kerfoot (and IPSA Board Member), David Murray, Al Duncan, TEMS Committee Chair Shane Fitzpatrick and Executive Director/Founder Heather R. Cotter.
[ii] TCCC Guidelines for Medical Personnel – 31 January 2017.
[iii] http://www.c-tecc.org/about/faq.
[iv] TCCC Guidelines for Medical Personnel – 31 January 2017.
[v] Tactical Emergency Casualty Care Pediatric Guidelines, TECC Appendix, 2014.
[vi,] PHTLS – Military Eight Edition, Jones & Bartlett, 2016.
[vii] PHTLS – Military Eight Edition, Jones & Bartlett, 2016.
[viii] Hemostatic Agents for Tactical Use – Hendon Publishing.
[ix] TCCC Guidelines for Medical Personnel – 31 January 2017.
[x] Tactical Emergency Casualty Care Pediatric Guidelines, TECC Appendix, 2014.
[xi] Butler, Captain Frank K, LTC John Hagmann, and Ensign E George Butler. 1996. "Tactical Combat Casualty Care in Special Operations." Military Medicine 161 (Supplement): 3–16.; Gerold, Kevin B, Capt Mark Gibbons, and Sean Mckay. 2009. The Relevance of Tactical Combat Casualty Care (TCCC) Guidelines to Civilian Law Enforcement Operations. http://ntoa.org/site/images/stories/tccc_guidelines_ntoa.pdf; Matthew D. Sztajnkrycer, MD, PhD, FACEP. Winter 2010. "Learning from tragedy: Preventing officer deaths with medical interventions." http://valorproject.org/uploads/Sztajnkrycer_W10_NTOA.pdf. http://www.ncbi.nlm.nih.gov/pubmed/8772308.
[xii] Committee of Tactical Emergency Casualty Care: Overview. http://www.c-tecc.org/images/content/C-TECC-Overview.pdf.
[xiii] IPSA InfoBrief: Legal Aspects of TEMS
[xiv] Gerold, Kevin B, Capt Mark Gibbons, and Sean Mckay. 2009. The Relevance of Tactical Combat Casualty Care (TCCC) Guidelines to Civilian Law Enforcement Operations. http://ntoa.org/site/images/stories/tccc_guidelines_ntoa.pdf; Matthew D. Sztajnkrycer, MD, PhD, FACEP. Winter 2010. "Learning from tragedy: Preventing officer deaths with medical interventions." http://valorproject.org/uploads/Sztajnkrycer_W10_NTOA.pdf.
[xv] Andre M. Pennardt, MD, FACEP; David W. Callaway, MD, MPA, FACEP; Richard Kamin, MD, FACEP; Craig H. Llewellyn, MD, MPH, FACPM, FRSM; Geoffrey L. Shapiro, BSHS, EMTP; Richard H. Carmona, MD, MPH, FACS; Richard Schwartz, MD, FACEP "Integration of Tactical Emergency Casualty Care Into the National Tactical Emergency Medical Support Competency Domains." https://www.jsomonline.org/FeatureArticle/2016262Pennardt.pdf.
[xvi] Andre M. Pennardt, MD, FACEP; David W. Callaway, MD, MPA, FACEP; Richard Kamin, MD, FACEP; Craig H. Llewellyn, MD, MPH, FACPM, FRSM; Geoffrey L. Shapiro, BSHS, EMTP; Richard H. Carmona, MD, MPH, FACS; Richard Schwartz, MD, FACEP "Integration of Tactical Emergency Casualty Care Into the National Tactical Emergency Medical Support Competency Domains" https://www.jsomonline.org/FeatureArticle/2016262Pennardt.pdf.
[xvii] Bobko J, Lai TT, Smith ER, Shapiro GL, Baldridge RT, Callaway DW. J Spec Oper Med. 2013 Winter; 13(4):94-107."Tactical emergency casualty care? pediatric appendix: novel guidelines for the care of the pediatric casualty in the high-threat, prehospital environment." https://www.ncbi.nlm.nih.gov/pubmed/24227567.
[xviii] Owens BD, Kragh JF Jr, Wenke JC, Macaitis J, Wade CE, Holcomb JB. Combat wounds in operation Iraqi Freedom and operation Enduring Freedom. J Trauma. 2008 Feb; 62 (2):295-9.
[xix] Belmont PJ Jr, McCriskin BJ, Sieg RN, Burks R, Schoenfeld AJ. Combat wounds in Iraq and Afghanistan from 2005 to 2009. J Trauma. 2012 Jul; 73(1):3-12.
[xx] King DR, Larentzakis A, Ramly EP, Boston Trauma Collaborative. Tourniquet use at the Boston Marathon bombing: Lost in translation. J Trauma. 2015 Mar; 78(3):594-9.
[xxi] https://en.wikipedia.org/wiki/List_of_disasters_in_the_United_States_by_death_toll.
[xxii] http://www.activeshooterdata.org/the-event.html.
[xxiii] Smith ER, Shapiro G, Sarani B. The profile of wounding in civilian public mass shooting fatalities. J Trauma. 2016 Jul; 81(1): 86-92.
[xxiv] Eastridge BJ et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. J Trauma. 2012 Dec; 73 (6 Suppl 5):S431-7.
[xxv] Kotwal RS et al. Eliminating preventable death on the battlefield. Arch Surg. 2011 Dec; 146(12): 1350-8.
[xxvi] Butler, Captain Frank K. R (Ret) MC, USN Association of Military Surgeons of the United States. Tactical Combat Casualty Care in Special Operations, A supplement to Military Medicine, 1996.
[xxvii] David W. Callaway, MD et al: The Committee for Tactical Emergency Care (C-TECC): Evolution and Application of TCCC Guidelines to Civilian High Threat Medicine. Journal of Special Operations Medicine Volume 11, Edition 2/Spring 2011.
[xxviii] TCCC, February 2011.
[xxix] Prehospital Trauma Life Support 8th Edition.
[xxx] Joshi MC, Sharma RM, Med J Armed Forces India 2010, Aero-medical Considerations in Casualty Air Evacuation (CASAEVAC).
[xxxi] Hadi Khoshmohabt, et al: Trauma Monthly, Journal of Trauma and Emergency Medicine. February 2016.
Additional sources: National Association of Emergency Medical Technicians, Tactical Combat Casualty Care February 2011, Care Under Fire Slide 17 and National Association of Emergency Medical Technicians, Prehospital Trauma Life Support 8th Edition, Tactical Emergency Casualty Care, Evacuation Care.