Combat Casualty Care and the Development of Tactical Emergency Medicine

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Introduction

This essay is a compilation of current knowledge available on the historical development of Combat Casualty Care, and its evolution into Tactical Emergency Care. With the conflicts in the Middle East and the resurgence of Active Shooter events and I.E.D. usage worldwide, there is a great deal of interest and training occurring in the topics of rapid casualty care methods under active combat conditions, especially in the civilian setting.

Historical developments are placed in context within the essay for the interest of the reader, and include content on ballistic injury, blast injury, weapons and tactics development, combat psychological conditioning, tactical patient assessment, field treatment, and commonly available casualty care equipment.

Editing of original documents has been performed to simplify, shorten, or target the information to a broader audience.

Contents

Surgical Experience From Warfare

There are Egyptian medical documents surviving from 1600BC, describing care for war injuries. In Greece, as reported in the Homeric poem The Iliad, composed in the 700s B.C., provides what some consider to be the first written description of the treatment of battle wounds.

Wound care depicted on early Greek pottery, dated 500 BC.

Hippocrates (460–377 B.C.) authored a number of medical texts on combat injuries. His writings on surgery recommended using only wine to moisten a wound, giving little food and no drink but water for all injured patients including those with abdominal wounds, prohibition of walking, standing, and even sitting, and making pus form in the wound as soon as possible for the counterintuitive reason of reducing inflammation. Insertion of a tube in the chest wall for pus drainage and the use of traction for fracture alignment are described. The oath attributed to Hippocrates is considered to be the earliest codification of medical ethics.

The shift of the center of medical progress to Rome over the next 4 centuries was accelerated by Galen, 130–200 A.D., who began his practice as physician in Rome. His success in treating the wounds of gladiators attracted the attention of the emperor, Marcus Aurelius, who made Galen his personal physician. Galen was the author of some 400 works in which he describes trepanning of the skull, and intestinal or abdominal wall suture of penetrating abdominal wounds of gladiators. He was also a proponent of assuring that pus forms in wounds, which was ultimately detrimental to the health of the casualty.

Surgical progress was impeded in 1163 when religious leaders issued the “Ecclesia Abhorret a Sanguine” (“the church abhors bloodshed”) edict, which removed surgery from the practice of physicians, in effect assigned an inferior status to surgical practice as compared with the practice of medicine, which further separated the two.

Henri de Mondeville of France became a strong proponent of healing without infection and pus during the 14th century. He proposed that foreign objects be removed immediately, that all bleeding be stopped, that the wound be closed and then dressed with compresses soaked in hot wine.

In 1497, Hieronymous Brunschwig authored the first book to describe treatment of firearm wounds. He promoted the idea that such wounds were poisoned by gunpowder, providing the rationale for cauterizing all war wounds and initiated a controversy that persisted for 300 years, before being debunked in the latter half of the 1700’s.

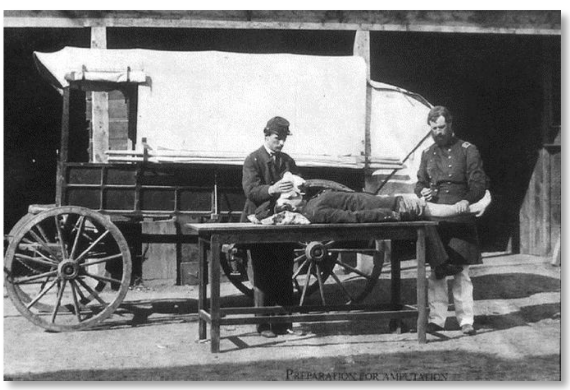
William Clowes was recognized as the greatest surgeon in Elizabethian England. In 1596, on the basis of his surgical training and experience in the British Navy, Clowes published a book for young surgeons in which he advocated debridement, extraction of foreign bodies, and avoidance of cauterization in treating wounds. Despite these advancements in medicine, treatment for battlefield injuries through the 1600’s consisted of variable combinations and doses of bloodletting, sweating, emetics, laxatives, and enema.

During the Revolutionary War in 1775, trepanning head injuries, amputation of limbs, setting fractures, and surgical removal of bullets were put into practice with good results. To avoid life-threatening infections, compound fractures were commonly amputated. Burns were treated by topical applications, which ranged from spirit of wine for superficial scalds to hog's lard for deep full-thickness burns. Bloodletting was a prominent feature in the treatment of serious burns involving muscle and was supplemented with enemas and purgatives.

The Baron Dominique Jean Larrey, Napoleon Bonaparte's surgeon, improved the care of combat casualties by use of a light horse-drawn “flying ambulance” to effect rapid evacuation, which permitted immediate amputation of severely injured limbs on the battlefield. Larrey's system of battlefield care was put to the test in 1793 at the Battle of Metz and was successful in creating a 75% survival rate.

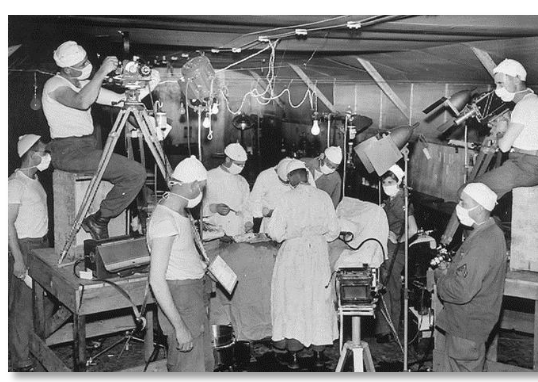
The first use of anesthesia in military casualties occurred during the Mexican-American War. Dr. Edward H. Barton used ether to amputate a leg on March 29, 1847 and at least a dozen more times in the next 3 weeks to operate on wounded soldiers.

During the Crimean War of 1854, Florence Nightingale and her cadre of 37 nurses coordinated medical relief activities, emphasizing sanitation and hygiene in the hospitals, resulting in a striking reduction of death from disease.
During the American Civil War, the battle of Bull Run epitomized the state of surgical care for the wounded. Many injured lay on the battlefield for days without food, fluid, or medical care. The wounded often lay in farmers fields where manure was used as a fertilizer. Infection was common and often killed soldiers faster than bullets. There were no field hospitals or ambulances, physicians were untrained, there was no anesthesia during procedures, and surgical equipment was often used over and over without being sanitized.
Penetrating abdominal wounds, typically not operated upon, had an overall mortality of 87%. Surgical intervention was also uncommon in the treatment of chest wounds, which, if caused by gunshot, were associated with a mortality of 62%. Pelvic fractures produced 80% mortality. By the end of the war, use of anesthetics, the horse-drawn ambulance, and creation of field hospitals had improved casualty care, but battlefield mortality had not significantly changed. Infection was at the root of almost all deaths.



A horse-drawn hospital wagon and a patient being readied for surgery. The surgeon is examining the leg to be amputated and his assistant is using a cloth cone to administer the anesthetic.

Beginning in 1861 with his identification of bacteria as a cause of putrefaction, Louis Pasteur developed vaccines for both human and animal infections. Building on Pasteur's findings, Joseph Lister developed a method of antisepsis using a carbolic acid spray during operative procedures.
The Spanish-American War, which lasted 5 months in 1898, was the first conflict in which the benefits of Lister's discovery were realized on the battlefield. Antiseptic treatment of wounds began at the time of wounding by application of the antiseptic dressing carried in the first-aid package fastened to each soldier's cartridge belt.
At the 1898 meeting of the Southern Surgical Association, the advisability of laparotomy for casualties with penetrating abdominal wounds was prominently discussed. It took another 16 years before it was accepted as a standard of practice as the best way to deal with infections from abdominal wounds. Combined with antiseptic treatment, mortality improved.
In 1901, Karl Landsteiner described the A, B, and O blood groups and in the following year, Sturli and De Castello described the fourth, or AB, blood group. The subsequent development of in vitro testing for compatibility reduced the risk of complications and expanded the use of blood transfusions.
The discovery of x-rays by Wilhelm C. Roentgen in 1895 was quickly followed by the development of x-ray equipment used by the military, allowing surgeons to pinpoint injuries and fragments during WWI. The use of anti-tetanus serum improved casualty care in WWI by essentially eliminating tetanus as a complication of war wounds.
Although transportation could be delayed for hours by the weather or the tactical situation, casualties generally benefitted from more rapid transportation by motorized ambulance to where warfare surgical care could be provided by surgical specialists. The discovery of penicillin In 1929 by Alexander Fleming as the first effective antibiotic aided the survival of surgical patients.
In the early years of the Korean Conflict (1950-1953), evidence of renal failure was present in slightly more than one third (36%) of autopsied casualties. After 1952, the prompt infusion of adequate volumes of resuscitation fluid to injured patients reduced the occurrence of renal failure to 0.5% of autopsied casualties.



MASH Unit, Korean War

Other advances that benefitted the injured soldier in the Korean Conflict were the development of the forward care surgical facility, Mobile Army Surgical Hospital (MASH), the first use of helicopters to transport casualties, and the use of prophylactic hemodialysis to minimize or avoid the complications of renal failure. The amputation of limbs with arterial injury ceased and limbs were salvaged by direct vascular repair and arterial replacement.

Additional improvement in the care of combat casualties was evident in the Vietnam conflict. Certified surgical specialists permitted full staffing of forward treatment facilities. The routine use of helicopters for patient transport resulted in the rapid transport, admission and treatment of patients who in previous conflicts would have never reached the hospital.

Bell casualty helicopter

The care provided those patients was state-of-the-art in terms of mechanical ventilation, physiologic monitoring, and fluid resuscitation and achieved further reduction in mortality of casualties with penetrating wounds and visceral injuries. Surgeons in Vietnam identified adult respiratory distress syndrome (ARDS) as a complication of severe injury and raised concern over its relationship to excessive fluid resuscitation.

With each successive generation of warfare, innovations and knowledge obtained from previous conflicts has evolved into the modern combat casualty care we recognize today, resulting in greater survivability of war wounds.

Factors Influencing Progress in Combat Casualty Care

I. Impediments
- A. Tyranny of surgical dogma
- B. Ecclesiastic dicta
- C. Lack of knowledge and qualifications
- D. Lack of sanitation and impact of comorbid conditions
- E. Absence of effective reliable trauma care system

II. Accelerators
- A. Expansion of knowledge base
- B. Prompt application of new technology
- C. Availability of residency trained board certified surgeons
- D. State of the art logistical capability
- E. Integrated clinical/laboratory research program

Weapons and Tactics Development

Beginning in 1860 the pace of weapons development increased enormously as the Industrial Revolution produced one technological advance upon another. The overall consequence of these circumstances was the rapid application of new weapons and other technologies of war to the battlefield at a pace never seen before in history, with the corresponding result that weapons became more lethal than ever.

Before a new weapon can reach its killing potential, military commanders have to discover new methods of fighting in order to bring the new weapon to bear in a manner that maximizes its killing potential. Once the killing power is exposed for all to see, however, one's opponent adopts passive and active means for limiting the most deadly effects of the weapon. This, in turn, requires new changes in tactics and combat formations in an attempt to preserve the killing power of the new technology.

In calculating the killing power of weaponry, any failure to adapt either weapons or tactics to new circumstances can be catastrophic. The failure of the World War I armies to alter their battle tactics in light of the machine gun's enormous rates of fire resulted in horrendous casualties in the early days of the war. The refusal of British commanders at the Somme to change their practice of massed infantry attacks against entrenched positions resulted in 54,000 men being killed or wounded in less than 10 hours.

When measured against the non-gunpowder weapons of antiquity and the Middle Ages, modern weapons (excluding nuclear weapons) have increased in lethality by a factor of 2,000. But while lethality has increased, the dispersion of forces on the battlefield made possible by mechanization and the ability of fewer soldiers to deliver more firepower has increased by a factor of 4,000! The result (with the exception of the Napoleonic wars which utilized the tactical field formation of the packed marching column) is that every war since 1600 has resulted in a decline in battle casualties even as the lethality of weapons increased.

Psychological Conditioning

There exists a powerful, innate human resistance toward killing one's own species, requiring psychological mechanisms to be developed by armies over the centuries to overcome that resistance. In both World Wars, 75 to 80 percent of riflemen did not fire their weapons at an exposed enemy, even to save their lives and the lives of their friends. In previous wars non-firing rates were similar.

During the Vietnam conflict, special training reduced the non-firing rate to as low as 5 percent. This was due to development of **operant conditioning,** which involved implementing specific conditioning methods, such as;

- reflexive shooting at human shaped popup targets;
- repeatedly double tapping automatically at center of mass;
- creating cultural distance, such as racial and ethnic differences, which permit the killer to dehumanize the victim;
- creating moral distance, which creates intense belief in moral superiority and justifies vigilante and revengeful actions;
- creating social distance, which results in thinking of a particular class as less than human in a socially stratified environment:
- creating mechanical distance, which includes the sterile video-game unreality of killing through a TV screen, a thermal sight, a sniper sight, or some other kind of mechanical buffer that permits the killer to deny the humanity of his victim.

Operant conditioning, therefore, creates an effective killing psychology that allows soldiers to overcome their normal reluctance to harm others.

Advantage Of Crew-Served Weapons

Throughout the history of warfare, it was patently obvious that when crews operated certain weapons, such as chariots, artillery, or machine guns, they did not have the normal resistance to killing that individual riflemen had. Though the rationale was not clear, military leaders recognized it and used them very effectively. The reasons crew-served weapons were responsible for most combat related deaths were that artillery, sniper, and machine gun crews had an authority figure to direct them, they worked in teams, and they killed at a large physical distance. All these factors acted to disperse responsibility and allow the soldier to distance himself psychologically from the kill. Anonymity and accountability in close proximity groups provided them a greater degree of freedom to fire on the enemy, resulting in higher casualties than individual riflemen could inflict.

Combat Casualties

On the battlefield, the pre-hospital period is the most important time to care for any combat casualty. Up to 90 percent of combat deaths occur before a casualty reaches a medical treatment facility. This highlights the primary importance of treating battlefield casualties at the point of injury, prior to casualty evacuation (CASEVAC) and arrival at a treatment facility.

Specifically, combat deaths result from the following:

- 31 percent: Penetrating head trauma
- 25 percent: Surgically uncorrectable torso trauma
- 10 percent: Potentially correctable surgical trauma
- 9 percent: Exsanguination
- 7 percent: Mutilating blast trauma
- 3–4 percent: Tension pneumothorax
- 2 percent: Airway obstruction/injury
- 5 percent: Infection and shock

Mechanisms of Injury: Blast and Ballistics

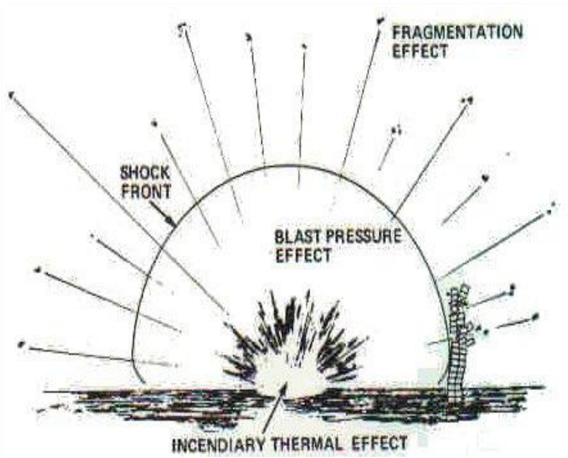
Blast Injuries

Explosions inflict injury to individuals, in four general categories. These are as follows:

Primary Blast Injury is due solely to the direct effect of the pressure wave on the body. It does so through three methods. The first is spalling. This occurs when a blast pressure wave encounters tissues of different densities causing cavitation and turbulence which results in the denser tissue being thrown (spalled) into the less dense tissue.

The second method is implosion, which occurs when a blast pressure wave passes through an organ containing gas, causing a rapid compression and decompression.

The instantaneous re-expansion of the gas, following the passage of the wave, creates small secondary explosions. The third method involves inertia. This is the shear stress created when the wave moves through tissues of different densities at different speeds, rupturing the interface between them.



Secondary Blast Injury results from penetrating or blunt damage caused by projectiles or secondary missiles, energized by the explosion, striking the victim. These may be in the form of shrapnel (fragments of the explosive devices casing), projectiles built into the device, or debris from the incident site.

Tertiary Blast Injury occurs when the victim's body becomes displaced and impacts against stationary objects. Tertiary effects generally result from the massive flow of gases (blast wind) away from the epicenter, and happen when the victim is in very close proximity to the explosion.

Quaternary Blast Injury include thermal injury due to exposure to the hot gases, and fire; traumatic injury due to the collapse of structures, and toxicity resulting from the exposure to, and/or inhalation of, the toxic gases produced by the explosion.

Blast Pressure Required To Cause Injury

Injury	Pressure (kilopascals)
Ear drum rupture	35
Lung damage	103
Lethal threshold	207-289
50% fatality	290-393
95-100% fatality	400-550

Category	Characteristics	Body Part Affected	Types Of Injuries
Primary	Results from impact of over-pressurization with body surfaces	Gas filled structures damaged – lungs, GI tract, ears	Blast lung, eardrum rupture, abdominal bleeds, eye rupture, traumatic brain injury
Secondary	Results from flying debris	Any contact surface	Ballistic or blunt injuries
Tertiary	Results from being thrown by blast wind	Any contact surface	Fractures, amputation, brain injury
Quaternary	Smoke, gas, fire, CBRN agent damage	Any contact surface	Burns, crush injuries, respiratory

System	Injury Or Condition
Auditory	Eardrum rupture
Eye, Face	Perforated eye, air embolism, facial fracture
Respiratory	Blast lung, hemothorax, pneumothorax, pulmonary contusion, sepsis
Digestive	Bowel perforation, hemorrhage, ruptured spleen/liver, sepsis
Circulatory	Cardiac contusion, MI from air embolism, vasovagal hypotension, air embolism
CNS injury	Traumatic brain injury- stroke, spinal cord injury, embolism
Renal injury	Renal contusion, laceration, acute failure
Extremity injury	Amputation, lacerations, crush, compartment syndrome, burns, embolism injury

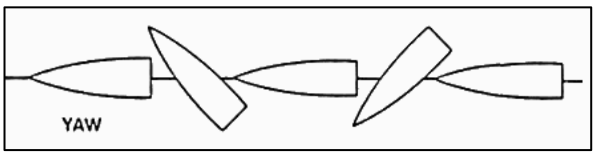
Ballistic Injuries

The degree of tissue disruption caused by a projectile is related to the size of the temporary versus permanent cavity it creates as it passes through tissue. The extent of cavitation, in turn, is related to the kinetic energy, yaw, deformation in flight, and fragmentation of the bullet.

KINETIC ENERGY

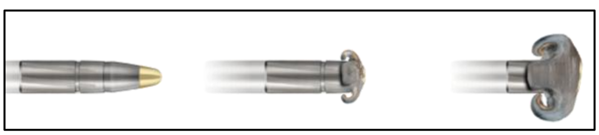
$KE = mv^2$ (where m is mass and v is velocity). The higher mass or velocity of the bullet will produce greater tissue disruption than missiles of lower mass and velocity, resulting in greater temporary cavitation.

YAW



Yaw occurs when the bullet rotates around its axis of flight, creating a wider path as it penetrates flesh, resulting in stretching the tissue more than normal, forming a wider permanent cavity.

DEFORMATION



Deformation can occur in flight, such that a hollow point bullet can mushroom and widen before it hits flesh, or it can occur as soon as it impacts the skin. This crushes the tissue surrounding the wound, which makes clotting difficult and causes profuse bleeding.

FRAGMENTATION

Fragmentation of a bullet creates multiple wound tracks, each of which increases the area of crushed tissue and overall contribution to hemorrhage.

CAVITATION

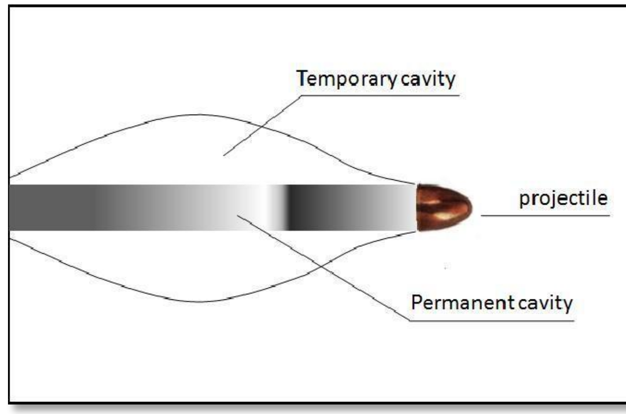
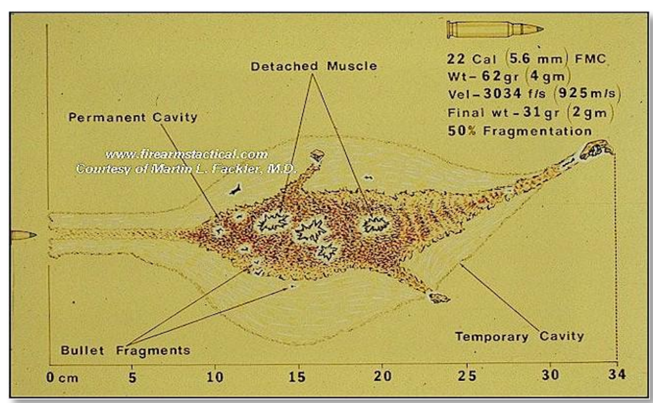


Diagram of Cavitation Effects

Example of Permanent Cavity in a Head Shot



Ballistic Damage from a Bullet

From this understanding of blast and ballistic injuries, combat casualty care specialists developed a methodology to triage and deal with battle injuries beyond the field dressing.

Combat Triage Principles

On the battlefield, casualties will fall into three general triage categories:

1. Casualties who will die, regardless of receiving any medical aid.
2. Casualties who will live, regardless of receiving any medical aid.
3. Casualties who will die if they do not receive timely and appropriate medical aid.

Combat Casualty Care Considerations

• Hostile fire may be present, preventing the treatment of the casualty.
• Medical equipment is limited to that carried by mission personnel.
• Tactical considerations may dictate that mission completion take precedence over casualty care.
• Time until evacuation is highly variable (from minutes to hours or days).
• Rapid evacuation may not be possible based on the tactical situation.

Stages of Care

In thinking about the management of combat casualties, care is divided into three distinct phases, each with its own characteristics and limitations:

• **Care under fire** is the care rendered at the point of injury while both the medic and the casualty are under effective hostile fire. The risk of additional injuries from hostile fire at any moment is extremely high for both the casualty and medic. Available medical equipment is limited to that carried by the medic and the casualty.

• **Tactical field care** is the care rendered by the medic once he and the casualty are no longer under effective hostile fire. It also applies to situations in which an injury has occurred on a mission but there has been no hostile fire. Available medical equipment is still limited to that carried into the field by mission personnel. Time to evacuation may vary from minutes to hours.

• **Tactical evacuation care** is the care rendered once the casualty has been picked up by an aircraft, vehicle, or boat. Additional medical personnel and equipment that has been pre-staged in these assets should be available during this phase of casualty management.

Tactical Emergency Medicine (TEM) Development in the Non - Military Theater

In non-military civilian populations, development of tactical medicine evolved from tactical combat casualty care (TCCC), with the priorities recognized as extremity hemorrhage (60%), tension pneumothorax (33%), and airway obstructions (6%) as the primary causes of death to civilian and law enforcement personnel. With regard to the law enforcement special operations response, threat environments are precipitated by critical incidents such as hostage situations, active shooter scenarios and terrorist incidents.

For TEM providers, the threat environment impacts acute care delivery in four significant ways:

1. First, TEM providers must maintain situational awareness of their surroundings while simultaneously providing effective patient care.
2. Second, several restrictions to care are imposed by this environment including the limited amount of medical equipment that can be carried by a TEM provider in the field, the need for prolonged extraction under hostile conditions and the need to operate behind cover with light and noise discipline.
3. Third, the casualty profile is shifted toward the potential for significant penetrating trauma, explosive blast injuries, multiple victims, delayed definitive care and contaminated patients.
4. Fourth, medical decision-making is impacted by the need for risk-benefit assessment. The benefits of proposed medical interventions (such performing cardiopulmonary resuscitation on a patient must be weighed against the potential for further harm to team members when the intervention is conducted under hostile conditions.

Zones in Tactical Medicine

The Hot Zone in tactical medicine refers to situations in which the provider and patient are under direct fire. Under these conditions, the best medicine is often fire superiority and patient extraction. If absolutely needed, medical care should be limited to rapid insertion of a nasal airway or application of a tourniquet. The Warm Zone refers to the "islands of cover" within a tactical environment where the provider may provide focused life-saving intervention for the patient. While not under direct fire, TEM providers in the Warm Zone must still be ready to react rapidly if shifting conditions suddenly put their patients in jeopardy. The Cold Zone designates the area outside the scope of the threat where traditional emergency care may be safely performed.

Tactical Primary Survey

A tactical primary survey (TPS) may be recalled by the memory aid "MABCDE" which stands for Massive Bleeding (M), Airway (A), Breathing (B), Circulation (C), Deficit and Decontamination (D) and Expose (E). As with the traditional primary survey, each step is performed in sequence and stabilized prior to proceeding to the next stage. For the TPS, however, there is a different emphasis necessitated by care in the threat environment.

Massive Bleeding (M) is addressed even before airway management. In tactical medicine, there is a critical focus on stopping life-threatening bleeding first.

OLAES combat dressing

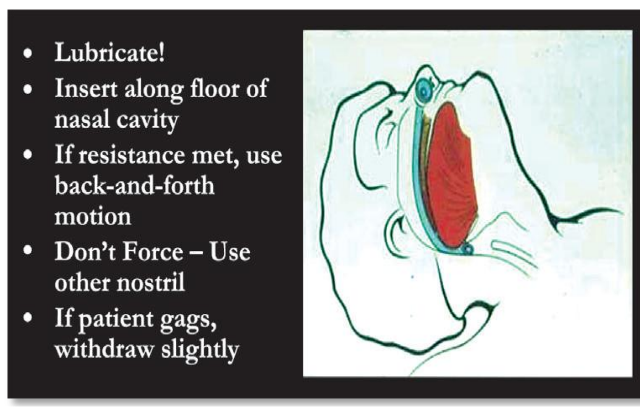
Since it is difficult to maintain direct pressure effectively under combat conditions, the technique of choice for rapid bleeding control is the tourniquet, which should be applied early.

Subsequent bleeding control involves efforts at de-escalating from the tourniquet to less aggressive approaches such as pressure bandages. The tourniquet may be left in place for up to four hours.

Once under cover, a hemostatic agent, like Quick Clot, is appropriate for uncontrolled bleeds in combination with pressure dressings, like the Israeli style dressing.

Combat application tourniquet

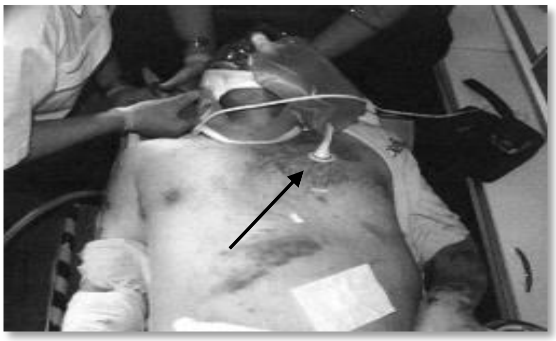
Airway (A) management is also affected by conditions of the tactical environment. Because they can be effectively and efficiently applied, basic airway skills are emphasized for immediate airway support. The nasal airway is particularly valued because of its versatile application in all patients regardless of a gag reflex. Rescue devices, such as the King Airway or Combi-Tube, play an increased role under tactical conditions because they can be inserted blindly and quickly. When a definitive airway is required under volatile conditions, digital intubation is preferred over oro-tracheal intubation because its placement does not involve a light signature or loss of situational awareness.



Nasal Airway

Conversely, cervical spine immobilization is not routinely recommended for victims of penetrating trauma under tactical conditions. Given the low incidence of occult unstable fractures in this situation, the practice of applying a cervical collar and backboard to these patients under hostile conditions likely places the patient and the extracting team unnecessarily under increased risk of harm. Types of trauma resulting in neck pain or unconsciousness can be treated with spinal immobilization, unless the danger of hostile fire constitutes a greater risk in the judgment of the medic.

Breathing (B) management in the tactical setting focuses on care for penetrating chest wounds. In general, application of occlusive bandages to such chest wounds should be reserved for instances of true "sucking chest wounds". Under conditions where continually monitoring a patient's condition may be difficult, routine application of an occlusive dressing raises the likelihood for the evolution of an undetected (and very lethal) tension pneumothorax. For similar reasons, current tactical medicine training emphasizes early needle thoracostomy in patients with penetrating chest trauma to avert this preventable progression to tension pneumothorax.



Asherman occlusive dressing in place

Circulation (C) - There is virtually no survival for victims who die in the field from penetrating trauma, so cardiopulmonary resuscitation (CPR) is generally not performed in the tactical setting, particularly if it places others at risk in a hostile situation.

Fluid administration for trauma victims follows a tiered approach: (1) placement of a saline lock but no fluid administration for patients with no signs of shock and controlled bleeding; (2) fluid resuscitation to normalization of vital signs for victims with signs of shock but controlled bleeding; (3) fluid resuscitation to restore mental status or radial pulse in victims of shock from uncontrolled internal bleeding.

Deficit/Decontamination (D) – This stage of the TPS is fairly straightforward. Mental status is assessed as in traditional care with the AVPU scale or the Glasgow Coma Scale (GCS). In the tactical field setting, emphasis on mental status gives you an idea of whether your patient is critical or not.

Decontamination is a capability that TEM field providers should be proficient in. Once the critical life threats are managed, decontamination in a CBRN environment may simply consist of removing all outer layers of clothing and a wipe down with an agent like reactive skin decontamination lotion (RSDL) to reduce up to 90% of contaminants.

Expose (E) – The decision to expose patients to assess the severity of injury must balance the need to uncover occult injury against the potential harm posed by both environmental factors and threat conditions. It is important to adequately search for the presence of previously unknown penetrating injury. However, in the tactical setting, it is also essential to protect the patient against hypothermia and the potential for further penetrating trauma from additional gunfire.

Tactical Medical Operator performing a primary survey with limited body exposure.

Transportation methods

Standard litters for patient evacuation may not be available for movement of casualties in the care under fire phase. Consider using alternate methods of evacuation, such as SKED or Talon II litters or dragging the casualty out of the field of fire by his web gear, poncho, or even a length of rope or webbing with a snap link. There are a number of drag straps and drag litters available to help expedite this move. Traditional one and two-man carries are not recommended, as the weight of the average combatant makes these types of casualty movement techniques extremely difficult.

SKED System in action

A "grab and drag" method is not the most effective, because the upper body strength required to drag a fully kitted injured operator is enormous, and exhausting. A drag harness made from webbing and wrapped around the casualty allows one or two rescuers to raise the casualty slightly, reducing friction, and then use the greater strength of the legs to rapidly exfiltrate the casualty to cover.

Drag harness made from 20 feet of 1" webbing

Hypothermia

Prevention of hypothermia is critical to patient survival. Warm IV solutions, getting the casualty off the ground, and actively preventing heat loss with a thermal blanket or other device is necessary, as even the mildly hypothermic casualty is prone to reduced blood coagulation and increased blood loss.

Tactical First Aid Kit

The tactical first aid kit increases the chances of survival for leading causes of death on the battlefield: severe hemorrhage, tension pneumothorax and inadequate airway. The following medical items are considered necessary:

- Nasopharyngeal airway
- Exam gloves (4)
- 2-inch tape
- Trauma dressing, OLAES or Israeli style
- Rolled sterile gauze for wound packing.
- Combat application tourniquet
- Occlusive dressing
- Hemostatic agent (optional)

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