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Introduction to Military Medicine: A Brief Overview

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Military medicine encompasses the entire spectrum of health care—from prenatal to end-of-life care. World-class, cutting-edge research, equipment, facilities, and education are all part of the military health care system of the United States of America. What makes United States military medicine unique, however, is the ability to project and sustain this care to soldiers, sailors, airmen, and marines in virtually any location on the planet and in the most chaotic, difficult, and hostile circumstances imaginable, specifically during combat operations. This ability has become possible because the structure of the military medical forces has evolved with every military operation since the Revolutionary War. This article provides an overview of the current organization and structure of the United States military medical forces. The levels of care (also known as ''echelons'' or ''roles'' of care, denoted 1–5 or I–V) are presented, with a specific focus on how this structure works to provide the military forces with the best combat medical care in the history of the world. The ''glue'' that binds the five levels of care together—medical evacuation, including the introduction of the Critical Care Air Transport Teams (CCATT)—is briefly discussed. The logistics system/structure that sustains military medical systems in remote locations is summarized. Finally, the overall command and control of in-theater combat medical assets, the initiative to establish a Joint Military Trauma System, and the ongoing efforts to collect real-time casualty data with the goal of enhancing combat care through improved training and early equipment fielding are described.

Brief historical perspective

Military medical care has evolved with the warfare it was designed to support. As the weapons of war became more destructive and lethal, medical

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care necessarily adapted and became more effective in treating the wounded. Likewise, as medicine advanced, wounded soldiers (who previously were beyond the capabilities of the care available) became salvageable. Near the beginning of the twentieth century, the concept of military triage was developed because, for the first time, improved evacuation systems resulted in more severely wounded soldiers reaching medical care than ever before and the rudimentary military medical systems of the time had never had to contend with the overwhelming volume of casualties being presented. Subsequently, military medical systems and structure had to adapt to the magnitude and volume of wounded produced by modern warfare. Before the introduction of general anesthesia, surgical salvage of severe intraperitoneal, intracranial, and intrathoracic wounds was a rarity, with most surgical care directed toward the extremities [1]. Because amputation was the major surgical intervention, rarely was there a need for significant sorting of casualties to make sure those who had a chance to survive would. With the introduction of general anesthesia into the mainstream of medicine, along with the improved initial treatment and evacuation of salvageable casualties from the battlefield to forward hospitals, the concept of triage of the wounded was an essential step in efficiently managing combat casualties. With more wounded surviving their initial injuries, military medical systems had to be developed to safely transport patients from the site of wounding back to a point of relative safety for stabilization and ultimate transport to a definitive-care facility. This system of combat casualty care has been refined to its current state over the greater than two-century history of the United States Armed Forces.

Basic military structure

Briefly, to understand the military combat medical structure, it is necessary to have a rudimentary understanding of conventional military combat organization. Although specific for an infantry combat unit, other US Army and Marine Corps maneuver combat units are similarly organized. Currently, although undergoing significant transformation, infantry soldiers are grouped in squads (led by a noncommissioned officer) of 10 men, with four squads in a platoon (led by a lieutenant). An infantry company, commanded by a captain, consists of four such platoons, with additional soldiers in leadership and staff positions. Five companies of similar composition constitute an infantry battalion (commanded by a lieutenant colonel), and three to five battalions make up a brigade. Other units of platoon, company, or battalion size are attached to this brigade to form a brigade combat team (commanded by a colonel), giving this team the necessary equipment, additional specialized weapons systems, logistics support, and soldiers to conduct independent combat operations. A typical brigade combat team has approximately 4000 to 5000 soldiers. Several brigade combat teams can be grouped under a division (commanded by a two-star general), and several divisions can be grouped

under a corps headquarters (commanded by a three-star general). The combat medical structure necessarily parallels this organization. Specifically, combat medics (level 1), found in an infantry company, are often assigned down to the squad and platoon level as necessary to support combat patrols and missions. The Battalion Aid Station (BAS, level 1), found at the battalion level, is the collection point for casualties from the different companies and the first level at which physicians or physician assistants are found. At the brigade level, the medical company (referred to as Charlie Med, level 2), with radiography, laboratory, and casualty holding capability, often augmented by a Forward Surgical Team (FST, level 2+) in the maneuver phase of the combat operation, is the first surgical capability found on the battlefield. Combat Support Hospitals (CSHs) are generally found in support of a division's several brigade combat teams (level 3). Specially augmented CSHs (level 4) are found at and above the corps and are generally far removed from actual combat operations. Finally, level 5 care is found in continental United States–based military medical centers.

Overview

In the ensuing paragraphs, a brief overview of battlefield medical care is presented. Although this overview is most typical of the capabilities found in the US Army Combat Health Care System, the setup is typical of the ground forces of all three services (Army, Navy [which includes the Marine Corps], and Air Force). Each level is elaborated on more fully in the remainder of this article, although the levels most closely associated with the combat zone (levels 1, 2, and 3) are presented in greater detail. Combat medical care occurs in a continuum, starting at the location of the combat wound and extending back to stateside medical centers. ''Levels of medical care describe the five levels of treatment within the military health care system. Each level has the same capabilities as the level before it, but adds a new treatment capability that distinguishes it from the previous level'' [2]. Care is usually initiated by the wounded soldier's compatriots, a combat lifesaver, or the combat medic (military occupational specialty designation 91W) assigned to that particular combat unit. This care is commonly referred to as level 1 care. Level 1 care continues at the BAS, a casualty collection point where physicians or physician assistants are first found and are capable of delivering Advanced Trauma Life Support care. Level 2 care begins at the brigade level where the Charlie Med, with basic radiography, laboratory, and holding capability, first appears. In recent decades, the FST has been inserted as level 2+ care, which introduces resuscitative surgical care to the battlefield and augments the Charlie Med. The CSH is the first surgical hospital capability and is designated as level 3 care. CSHs can add different modules to enhance surgical and other medical modality care and can constitute level 4 care. Level 4 capability can also be found outside of the

immediate vicinity of the combat theater. Landstuhl Army Regional Medical Center in Germany functions as a level 4 hospital in support of the current combat theater. Finally, level 5 care includes stateside Army Medical Centers (AMC) like Walter Reed AMC, Brooke AMC, Madigan AMC, William Beaumont AMC, and Dwight David Eisenhower AMC. Particularly at Walter Reed AMC and Brooke AMC, definitive care and rehabilitation of war wounded have become a significant focus of those respective facilities.

Levels of care

Level 1

The concept of fellow soldiers or assigned combat medics providing lifesaving care at the forward location of wounding is a concept that was not always doctrinally accepted by the US Army Medical Department. Following the Civil War, the combat medic became a more constant presence on the battlefields of the United States. The combat medic has historically been expected to render immediate first aid, including stopping bleeding, splinting fractures, dressing wounds, and administering pain medication. The use of intravenous fluids was introduced during World War II, with the use of plasma. During the Korean and Vietnam Wars, medics were also able to give crystalloid fluids. Antibiotic powder was introduced during World War II and has occasionally been part of the armamentarium of combat medics. Medical training for the common soldier has also been a staple of army training since the First World War, with significant emphasis in the past 2 decades. The emphasis of this training has been similar to that of combat medics: control of hemorrhage, wound dressing, and fracture splinting. Although there have been several attempts over the history of the Army Medical Department to collect information with respect to wounding and the common causes of death on the battlefield, the picture of precisely what kills soldiers on the modern battlefield did not emerge until COL (Retired) Ron Bellamy [3] published his landmark article in 1984. Although the database used by COL Bellamy was specifically designed to evaluate the effects of certain weapons on the human body, he used the data to give a clearer picture of why soldiers die. Although many of the reasons for death on the battlefield were not surprising, a startling discovery was the percentage of potentially preventable deaths from extremity hemorrhage, from apparently unsuspected tension pneumothorax, and from airway obstruction. These revelations, along with further observations of possibly preventable deaths that occurred during combat operations since the Vietnam War, began a transformation in the Army Medical Department educational system for combat medics. In addition, combat lifesavers, a group of nonmedical soldiers who receive additional training in initial combat wounding care, were trained in more advanced first aid techniques. A shift toward placing

a greater capability for dealing with hemorrhage, pneumothorax, and airway problems in the hands of combat medics began. With the advent of the current Global War on Terrorism, including Operation Enduring Freedom (OEF) in Afghanistan and Operation Iraqi Freedom (OIF) in Iraq, combat medics have been given more advanced tools, with a focus on hemorrhage control [4]. For example, in the past, the use of an extremity tourniquet was frequently taught to be the procedure of last resort after direct pressure and other methods to control bleeding were exhausted. This teaching has been modified significantly, with tourniquet control of bleeding extremity wounds often being used as the initial hemorrhage control method. Hemorrhage control of wounds not amenable to tourniquet application has also undergone intense research over the past decade [5]. Medics are now supplied with "active" dressings designed to control bleeding in these previously often-fatal wounds. Training for combat medics in the control of a compromised airway and treatment for tension pneumothorax, along with the necessary equipment for both, is ongoing. Given the historically high rate (~20%) of soldiers who are killed in action, this focus on the combat medic seems to have had an impact on the killed-in-action rates in the current war, with the current rate almost 25% lower (approximately 15% overall). Augmenting the level 1 care provided by combat medics is the closely located BAS, the first medical treatment facility found in the combat military health care system. The BAS acts as a casualty collection point and is staffed with primary care physicians, emergency medicine physicians, or physician assistants. This continuation of level 1 care brings Advanced Trauma Life Support capabilities close to the battle and provides further stabilization and resuscitation to allow further transport through the medical system.

Level 2

After a wounded soldier has been initially treated and stabilized by the combat medic and the BAS (level 1) to the extent possible, the wounded soldier's next stop depends on the tactical situation and the available assets for transport to the next level of care. Air and ground ambulances provide this transport capability. In general, when the patient is deemed stable enough to tolerate transport and it is likely that surgery is necessary, the patient is transported to the nearest level 3 facility (CSH), bypassing level 2. When the patient is too unstable to travel the distance to a CSH or does not require further resuscitation or surgery, the patient is transported to the nearest level 2 facility. This facility will typically be a brigade-level Charlie Med, with similar professional capabilities (primary care or emergency medicine physicians) as the BAS but with additional equipment including basic radiography, laboratory, and holding capability. In a highly mobile battlefield, the distances involved and the potential delay in obtaining lifesaving surgical care at the CSH spawned the development of FSTs. FSTs are attached to

the Charlie Med at the brigade level and are typically attached to the combat maneuver brigades involved in the rapidly moving battle. This highly mobile level 2 capability is a 20-man team consisting of 4 surgeons and the necessary support soldiers and equipment to perform lifesaving surgery on wounded who would not survive transport to the next level of care (level 3, CSH). Up to 50 units of packed red blood cells are carried with the unit. Various "soft" shelters including special rapidly erectable tents are used for the triage/resuscitation, operating, and recovery areas (Fig. 1). The FST is 100% mobile and capable of setting up quickly (Fig. 2). In addition, they are also capable of breaking down quickly and following closely behind the battle. Not all casualties presented to the FST who require surgery undergo surgery at that location. Only those wounded soldiers deemed too unstable to survive transport to level 3 facility undergo intervention at the FST. Even those patients who are operated on at the FST rarely undergo extensive operations. Damage-control procedures for the control of bleeding, minimizing contamination, and restoring blood flow to compromised extremities are rapidly performed. FSTs fielded at the onset of Operation Iraqi Freedom were provided with specially equipped vehicles capable of providing chemically sealed self-inflating shelters, allowing operations in a contaminated (chemical, biological, or nuclear warfare) environment. After the patient is resuscitated and stable enough to survive transport, she is then rapidly evacuated to the next level of care.

Level 3

The first level of full surgical and hospital capability occurs at level 3, the CSH. In the past, various levels of theater hospitals were available. As recently as Desert Storm (1991), the Mobile Surgical Hospital, the CSH, the Evacuation Hospital, the Field Hospital, and the General Hospital—each different in configuration and capability—were found at different levels

Fig. 1. FST setup in three rapidly deployable tents.

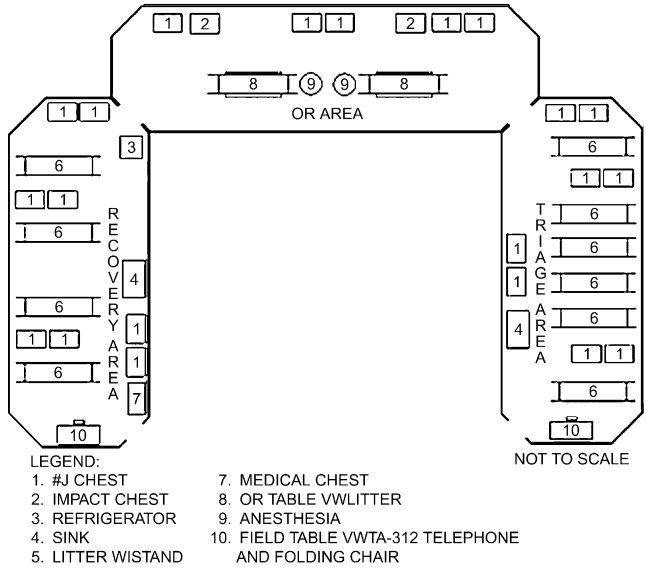

Fig. 2. Sample layout of an FST. (*From* Employment of forward surgical teams: tactics, techniques and procedures. FM 4–02.25. Washington, DC: Headquarters, Department of the Army; 2003.)

within the combat theater. Although the last active Mobile Surgical Hospital (the 212th Mobile Surgical Hospital) was effectively deployed during the initial maneuver phase of OIF, the US Army has moved to a single, modular hospital—the current Medical Re-engineering Initiative (MRI) CSH. The basic configuration is a 248-bed facility consisting of composite endoskeleton modular tentage (temper tents) with climate control, lighting, and water and power systems. Initial triage, resuscitation, and patient holding capacity including ICUs, intermediate care wards (ICWs), and minimal care wards are contained in various-sized "sections" of these temper tents. Eight-section temper tents provide a standard-sized 12-patient ICU or a 20-patient ICW. These tents interconnect with uniquely designed International Organization for Standards shelters, which are expandable metal "boxes" in which completely contained operating theaters, radiography (including CT), laboratory (including blood banking), and pharmacy operations are performed. This entire system is known as DEPMEDS (**dep**loyable **med**ical **s**ystems). This transportable and entirely self-contained and self-sufficient hospital has a modular design that allows the appropriate number of beds to support the medical mission assigned. Modules of the MRI CSH allow a 44-bed, an 84-bed, a 164-bed, and a full 248-bed configuration as needed. Fig. 3 is a photograph of an 84-bed CSH currently being used in Iraq. The full 248-bed hospital has six operating room tables capable of providing 96 hours of operating capability daily. The professional capability of the basic

Fig. 3. Photograph of an 84-bed CSH in Iraq.

CSH includes general, thoracic, orthopedic, and oral and maxillofacial surgeons; anesthesia providers (anesthesiologists and nurse anesthetists); internists; emergency medicine physicians; other primary care physicians; a radiologist; and a psychiatrist. This professional capability can be augmented as necessary (see the level 4 section that follows). Approximately 500 soldiers are assigned to an MRI CSH and provide the necessary medical and support activities required to carry out the broad spectrum of level 3 medical care.

Level 4

This same MRI CSH, in the 248-bed configuration, also provides the next level of care in the military health care system. Typically located in the communications zone, far from the area of active combat operations, the 248-bed hospital is augmented by various modules that easily integrate into the existing structure. Most commonly, a head and neck augmentation team is added, which provides neurosurgical, eye, ear, nose, and throat surgery capabilities. Renal dialysis and infectious disease modules are also available, as is the special-care module that includes pediatric, family practice, preventive medicine, obstetrics/gynecology, and community nursing services. A pathology module is also available to provide anatomic pathology services and enhanced laboratory and microbiology capabilities as needed. Finally, a minimal-care module provides additional holding capacity, rehabilitation services, nutritional care support, and emergency nursing augmentation along with administrative support that might be needed by this larger CSH. When the tactical situation does not permit establishing a level 4 facility in the region of combat operations, level 4 care may require fixed-wing transport to a location and fixed facility far removed from the combat zone. Currently, Landstuhl Army Regional Medical Center in Germany functions as a level 4 facility for both OIF and OEF.

Level 5

The highest level of care available for combat wounded is in the United States, which is the final destination for soldiers who cannot be returned to duty. Typically, these casualties include those who undergo major abdominal, thoracic, vascular, brain, head and neck (including eye), and extremity operations and treatment for major burns. They may require prolonged intensive care or rehabilitation at the military's Centers of Excellence for Extremity wound care. This care may extend to the Veterans Administration Health Care System for soldiers unable to continue on active duty. The ultimate goal is to reintegrate these individuals into society with the highest level of function possible.

Medical evacuation

The five levels of care function as a continuum due to the capability of the medical evacuation system to deliver casualties from a lower level to a higher level of care without a decrement in the casualty's condition. Ground evacuation is available on the battlefield, and these vehicles assist in evacuating casualties from the site of wounding back to the first medical treatment facility available. Casualties are stabilized and evacuated to the next level of care as soon as possible. Often, helicopter evacuation is available to take seriously wounded soldiers from the site of wounding directly to level 2 care (Charlie Med or FST if the patients would not survive transport to the CSH) or level 3 care (CSH). Patients evacuated in this manner by ground and by air are kept stable by the accompanying combat medics; however, treatment (other than emergent airway, breathing, or hemorrhage control) en route is extremely difficult on the aforementioned evacuation platforms. This form of evacuation is labeled casualty evacuation (CASEVAC). After patients arrive at level 3, they undergo the appropriate surgery to resuscitate and stabilize them for transport to level 4, which in the current theater is Landstuhl Army Regional Medical Center in Germany. The evacuation times by fixed-wing transport aircraft (US Air Force) can be up to 10 to 12 hours. This form of evacuation is labeled medical evacuation (MEDEVAC). Before the Global War on Terrorism, limited en route care during MEDEVAC was available. Severely wounded patients who could be stabilized [6] but not rendered absolutely stable could not be transported unless accompanied by a physician capable of providing surgical critical care (typically a general surgeon from the sending hospital). Lessons learned from the previous conflicts (particularly from Somolia) contributed to the transformation of the MEDEVAC system, with the development and introduction of the CCATT (phonetically referred to as "see cat team") [7]. The CCATT is a three-person team that includes a physician (usually one with critical care skills—typically a general surgeon, an anesthesiologist, or a pulmonary-critical care physician), a respiratory therapist, and a critical care

nurse. Critically ill, stabilized patients are routinely transported from Iraq to Germany with excellent results and safety. It is not unusual for a critically ill patient who has a temporary abdominal closure and who is on a ventilator to undergo transport in the hands of a CCATT. At the level 4 fixed facility, patients are further cared for until well enough to undergo MEDEVAC back to the United States for ultimate recovery and rehabilitation.

Medical logistics

Although medical assets (from combat medics to CSHs) are required to carry enough medical supplies to perform their missions during the initial phase of combat operations, this effort cannot be sustained without almost immediate resupply. During the maneuver phase of combat, resupply can prove extremely challenging because of the rapid movement and vast distances covered on the modern-day battlefield. Medical equipment, supplies, and blood are handled entirely separately from the rest of the logistic needs of the US Army (ammunition, fuel, food, water, repair parts, and so forth), with entire units devoted to medical logistics resupply. Medical supply specialists are found at each level of care (1–5) to ensure that each level's unique requirements are filled in a timely manner. Points of delivery and distribution are established, and entire information systems including satellite uplinks are dedicated to this mission. Ultimately, success of the medical mission depends on timely and appropriate medical resupply.

Command and control

Although having appropriate medical assets (with the ability to deliver the five levels of medical care), a logistics stream, and evacuation capabilities is essential to deliver world-class combat casualty care, it is not sufficient. Coordinating this effort in the most chaotic environment imaginable is essential to mission success. The Medical Brigade (MB) is the unit responsible for orchestrating this effort. The MB is the headquarters with the staff and communications assets necessary to coordinate the main-theater medical plan, including the deployable hospitals, evacuation assets, and medical logistics resupply system. The MB commander generally works directly for the theater commander as his senior medical officer and typically advises the theater commander on theater hospitalization and medical care. In conjunction with the combat maneuver brigades (who own all of the level 1 and much of the level 2 assets), it falls to the MB to ensure that level 3 assets are properly deployed to support the war fight and help coordinate FST placement in the theater. In addition, the MB is responsible for medical regulation throughout the theater of operations. Medical regulation involves identifying patients requiring evacuation, coordinating this evacuation using appropriate assets (ground transportation, helicopter, or fixed-wing aircraft), and ensuring

that patients are appropriately distributed to facilities with the appropriate capacity and type of medical care required by those patients. Before the Global War on Terrorism, most coordination by the MB was done without direct input from physicians trained in trauma systems. Recently, an initiative has been instituted to place a senior clinician (specifically a general/trauma surgeon) on the MB commander's staff to specifically develop and organize a theater trauma system. The first phase of this initiative focused on data acquisition. It has always been extremely difficult to obtain prospective data on combat casualties, so to accomplish this, a data sheet was developed that would capture the essential data points of combat wounded (Fig. 4). Using

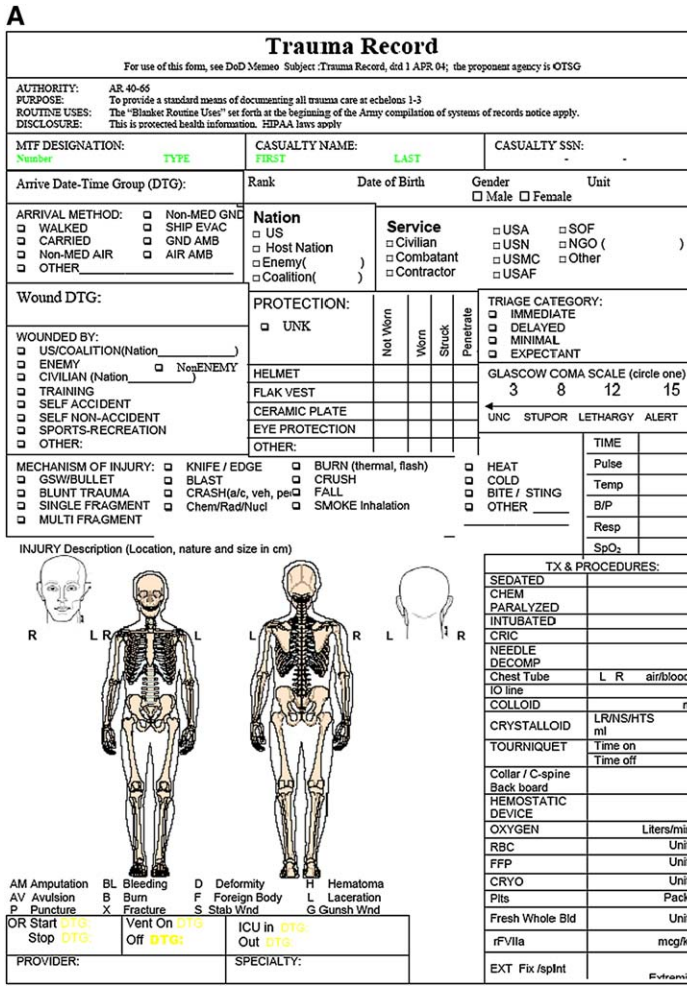

Fig. 4. (*A*) Front page of an early iteration of the Joint Theater Trauma Record. (*B*) Back page of an early iteration of the Joint Theater Trauma Record.

B

Trauma Record

DISCHARGE SUMMARY

MEDICATIONS:	LABS:	XRAYS:	PMH: Allergies:

REGION	DIAGNOSIS, PROCEDURES and COMPLICATONS
Face	
Head & Neck (incl C-spine)	
Chest (incl T-spine)	
Abdomen (incl L-spine)	
Pelvis	
UPPER /LOWER Extremities	
Skin	

DISPOSTION	☐ EVAC to _____	Evacuation Priority
DTG:	☐ RTD ☐ DECEASED (see below)	☐ ROUTINE ☐ PRIORITY ☐ URGENT

Damage Control Procedures? Y / N Hypothermic (< 34°C)? Y / N Coagulopathy? Y / N

Cause of Death at DTG .

ANATOMIC:
☐Airway ☐Head ☐ Neck ☐ Chest ☐Abdomen ☐Pelvis ☐ Extremity (Upper/Lower)
☐Other

PHYSIOLOGIC:
☐ Breathing ☐CNS ☐Hemorrhage ☐Total Body Disruption ☐Sepsis ☐Multi-organ failure

COMMENTS: SURGEON: (printedName)

MEDCOM Test Form 1381, JAN 2004

Fig. 4 (*continued*)

what is known as the Joint Theater Trauma Record (JTTR), initial data was retrospectively abstracted from the busiest CSHs in the theater by reviewing patient records. Then, similar to stateside trauma centers, each CSH was staffed with a trauma nurse coordinator whose principle job was to insure that the JTTR was being properly filled out, in addition to collecting the information from the JTTR and forwarding it to the trauma surgeon at the MB for collation and analysis. Virtually all casualties in the current conflict have been abstracted from records or prospectively recorded, giving a real-time picture of wounding types and rates and some insight into causes of mortality. Ongoing evaluation of autopsy data of war dead has given additional insight into the principle causes of death in this conflict, with the main focus on analyzing

potentially preventable deaths. Using the JTTR and the autopsy information, medical training for deploying medical soldiers can and has been tailored to reflect current conditions.

Disaster relief

The actual practice of medicine on the battlefield, especially as it pertains to trauma care, is similar to the care available in trauma systems around the United States. What is unique, however, is the fact that this care can be projected and sustained in the most austere and remote locations on the earth and can be conducted under extremely chaotic and hazardous conditions. The combat military health care system has been developed over its 2 centuries of responding to the nation's wars in foreign and domestic settings. As previously described, this care is tiered so that casualties receive care almost immediately after wounding and are rapidly returned to duty or continued along the continuum of care until they reach the level appropriate to their medical need. By necessity, the military health care system has developed the appropriate structure and command/control to be rapidly deployable, mobile, modular, flexible, and sustainable in almost any environment. These qualities also allow the military medical system to respond to noncombat disasters. Many national and international disasters in the past, natural and manmade, have required a rapid medical response. There is no organization comparable to and as capable as the United States military in responding to and providing the medical care necessary in such scenarios. As has been extensively described in the previous text, the military medical structure can be configured, mobilized, and deployed forward with the appropriate medical, evacuation, and logistics assets along with the necessary command and control elements to rapidly respond to virtually any medical need. As recently as the disaster resulting from hurricane Katrina, the military, when alerted, had medical assets on the ground and functioning within 48 hours. No other local, state, or federal agency had the capability of responding in a similar manner. Over the past decade, military medical systems have had the opportunity to train such deployments and have been deployed on many occasions for combat and noncombat medical operations. Most medical soldiers used in the Katrina response had recently returned from Operation Enduring Freedom/Operation Iraqi Freedom or were awaiting departure for the current combat theater.

Summary

Combat medical care has evolved since the Revolutionary war to its current state in the midst of the Global War on Terrorism. The five levels of care have been designed to ensure that our combat wounded receive immediate and lifesaving treatment virtually at the moment of wounding and that this care continues with safe and timely evacuation until final recovery and

rehabilitation is completed. The ability to place and sustain this system of care in any location and environment and to coordinate the many elements necessary for effective health care delivery is the precise mission that military medicine is uniquely designed to accomplish. Given this capability and the current tempo of disasters (manmade and natural), it is likely that our military medical forces will have many opportunities in the future to project this care at home and around the globe.

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