Chapter 39

CASUALTY TRANSPORT AND EVACUATION

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INTRODUCTION

Casualty evacuation, a key phase of combat casualty care, has evolved along three intersecting vectors of technology: (1) military weapons and tactics, (2) medical care, and (3) transportation. This chapter discusses the historical evolution of casualty evacuation, including lessons most recently learned in Iraq and Afghanistan. This historical perspective is critical to understanding how current US systems developed and provides insight into how casualty care during evacuation can be improved. It discusses the potential challenges future conflicts may bring and provides a set of principles that can be used by military physicians on future battlefields. This is not an in-depth technical manual discussing the nuances of each individual evacuation platform that can be found on the modern battlefield, nor does it substitute for current medical evacuation field and technical manuals. Rather, the chapter's goal is to provide a conceptual understanding and a set of principles that will enable military medical providers to deliver the best possible care to their patients during evacuation, from point of injury (POI) to definitive care.

MILITARY CASUALTY EVACUATION TERMINOLOGY

To understand the history, evolution, and current state of the science of casualty evacuation and en route care, it is essential to understand the language of this key domain of battlefield medicine.

Casualty evacuation (CASEVAC), in a traditional sense, is rapid, *unregulated* movement of any casualty at any point along the continuum of casualty care from the POI onward. CASEVAC can take place via personnel carries, vehicles, or aircraft available for transport. Regulated movement of these casualties, with the addition of medical personnel on a medically equipped platform, from both POI to dedicated medical care or a medical treatment facility (MTF), or from one MTF to another, is termed **medical evacuation (MEDEVAC)**. **Tactical evacuation (TACEVAC)** is the overarching term for both CASEVAC and MEDEVAC, and encompasses the full spectrum of transport from a hostile or austere POI to advanced medical care in a secure environment.

The term **en route care** is defined by the twin goals of *providing* medical treatment and *sustaining or improving* the patient's medical condition during the evacuation process. It is not based on the movement platform itself. En route care is a dynamic process with the goal of providing the best care possible for patients, by adjusting for patient condition, threat, and mission constraints by selection of appropriate platforms and personnel to accomplish the medical evacuation mission.

Much like modern medicine, these terms are continually evolving, now referring more simply to the *platform* and *regulatory status* in which a casualty is moved and less to the nature of personnel on board. A variety of patient movement platforms are utilized for evacuation and en route care. Ground transport can be by standard ambulance, tactical vehicle, bus, or any other available medium. Air assets consist of both rotary and fixed-wing aircraft, including assets of the US Army, Air Force, Navy, and more recently, the Marine Corps.

Unregulated patients are the injured, typically located at or close to the POI, before they have been assigned a **patient movement request (PMR)**. Regardless of platform, the unregulated status of these patients defines their transport as CASEVAC, and their movement is influenced by tactical factors and by triage status. These patients may or may not receive en route care; if they do, it can vary greatly, from flight medics placing a tourniquet and performing needle decompression to critical care teams performing damage control resuscitation en route. An example of an unregulated patient is a casualty thrown from a vehicle in an improvised explosive device blast, dragged to a casualty collection point, and subsequently transported via another military vehicle immediately to the nearest forward medical care.

Once patients receive a PMR, they are termed r**egulated.** PMRs are created by the attending physician at the patient's location in conjunction with an Air Force aeromedical evacuation liaison team. The PMR is further evaluated and subsequently validated by an aeromedical evacuation control center flight nurse and flight surgeon team, with subsequent preparation for the patient's airlift and movement requirements. This process requires both time and personnel, which typically means the patient has been stabilized at an MTF prior to movement. Regulated medical evacuation takes into account the availability of air assets, the patient's clinical status, the nature of the en route care expertise available, and the accepting facility's space and specific medical capability for the casualty. A casualty with a traumatic amputation of the leg, who has had damage control surgery at a Role 2 MTF and is being transported by Air Force aeromedical evacuation, is an example of a regulated patient. Army MEDEVAC often transports patients in both categories, carrying patients from POI as well as between MTFs when intra-theater transport is necessary.

Dynamic en route care capability is now being positioned on what were traditionally considered CASEVAC air platforms. These medical teams are comprised of highly trained critical care physicians, critical care nurses, and advanced medics, bringing a higher level of medical care closer to the POI and adding flexibility in the rapid deployment of aircraft to move patients via unregulated flight.

EVOLUTION OF MILITARY CASUALTY EVACUATION DOCTRINE

Organized evacuation of battle casualties is a relatively new advancement in the history of warfare. From the times of Greek hoplites and Roman legions until the 1800s, no systematic method of evacuating battlefield casualties existed. Wounded fighters had to evacuate themselves from the line and dress their own wounds, or depend on other soldiers to provide care. If the battle were won, those who were too wounded to march with the army were often quartered locally or in field hospitals constructed to care for these patients. Over time, the wounded would "triage" themselves by recovering and returning to duty, recovering but remaining unable to serve further, or dying. Wounded on the losing side did not fare as well. The lightly injured were captured and ransomed or sold as slaves; the more seriously injured were killed or left to die.[1]

Larrey and Letterman

The Napoleonic Wars of the 19th century produced the "father" of modern military medicine and perhaps the greatest military surgeon who ever lived, Dominique Jean Larrey. Larrey was surgeon-in-chief of the Napoleonic armies from the French campaigns in Italy in 1797 to Waterloo in 1815. Larrey's chief contribution to military medicine was the systematized evacuation of battlefield casualties using a field ambulance. The term "ambulance" comes from the Latin *ambulare*, meaning "to walk." As it was used at the time, the term "ambulance" typically meant the field hospital (or the "walking hospital") that followed the army. Prior to Larrey's effort, field hospitals were located 3 miles behind the front. The wounded were typically left on the field until after the battle, sometimes receiving no care for 24 hours or more after injury.[2] Larrey, inspired by the speed and mobility of French artillery wagons, developed a system of medical wagons that were both mobile aid stations and evacuation platforms. These *ambulance volantes* or "flying ambulances" were staffed for, organized to support, and dedicated to the evacuation of the wounded.

Larrey's ambulance corps was divided into three divisions of 113 personnel each. Each division was commanded by a chief surgeon and equipped with twelve light carriages and four heavy carriages, with each carriage manned by about seven men. Larrey's ambulance configuration was both mobile and flexible—different equipment could be carried, and different draft animals (eg, camels in the Egypt campaign) could be used, depending on to the mission and environment.[3] Larrey organized the care and evacuation of wounded like any other military operation: with a staff, chain of command, noncommissioned officers, and enlisted men under the leadership of a medical officer.

Part of Larrey's philosophy of rapid evacuation was based on his 24-hour principle of wound management. Previous surgical opinions recommended that amputation be performed in a delayed fashion, and only through gangrenous tissue. Larrey felt that in cases where an extremity could not be salvaged, rapid amputation while the soldier was still in shock, and before infection had set in, not only improved survival but also was more humane, especially during transport. He felt that patient movement on horseback or by wagon with a clean, well-dressed amputation was much more comfortable for the patient, causing less pain and fewer complications, than being transported with a shattered limb. Thus, Larrey was the first to recognize that time to treatment after injury was a key factor in casualty outcomes. His system of forward care on the field followed by rapid evacuation to surgical care in the field hospital formed the basis for modern medical evacuation systems.[2]

The defeat of Napoleon at Waterloo brought an end to prolonged war in Europe. A worldwide era of unprecedented industrial innovation and economic growth followed, setting the stage for even larger armies to be deployed during the American Civil War. Advances in transportation such as steamboats, locomotives, and railway lines made it possible for large numbers of troops to be moved rapidly in an orderly manner. Food preservation techniques such as canning and dehydration were improved. Weapons technology was enhanced. The smooth-bore musket of Napoleon's era was notoriously inaccurate; thus, tactics dictated tight formations exchanging volley fire at close range. During the American Civil War, however, the rifled musket firing the 0.58-caliber minié ball was the principal weapon used by both sides. In contrast to the smooth-bore musket, the rifled musket was accurate up to 500 yards. Unfortunately, military tactics did not take into account the capabilities of these new weapons;

American generals on both sides of the Civil War still studied and employed Napoleonic tactics. Maneuvering large, tightly packed, linear formations against fortified positions produced devastating results and caused unprecedented numbers of casualties during Civil War battles.

Likewise, military medical leaders in the US Army did not recognize that the nature of warfare had changed from small frontier engagements to warfare on a massive scale. At the outbreak of the war, the Union Army's medical department was completely unprepared. Physicians were often graduates of unregulated, 2-year medical schools, and few had any training in surgical care or battlefield injuries. Most military leaders did not anticipate a prolonged, large-scale conflict. Additionally, previous campaigns against Indians and the recent Mexican-American War (1846–1848) had resulted in only a few battle casualties. Most campaigns up until that time were short lived, and most deaths were from disease. All US military conflicts from the Revolutionary War to 1860 had resulted in slightly more than 23,000 killed in action or wounded, whereas in the Civil War, the Union side alone would ultimately suffer 600,000 killed or wounded.[4]

The First Battle of Manassas, or Bull Run, in July 1861, was the first significant ground battle of the war. The medical evacuation plan was essentially improvised at the regimental level.[5] Wagons to carry the wounded were driven by civilian teamsters, many of whom fled from the field at the first sound of gunfire. As a result, many Union wounded were left on the field and along the roadside for several days until they could be recovered. The ensuing scandal led to the eventual appointment of Major Jonathan Letterman, MD, as the medical director of the Army of the Potomac, and Letterman's establishment of the Ambulance Corps in August 1862.[6] In 1864, Congress approved Letterman's casualty care plan, with few changes, for adoption by the entire Union Army.

Letterman's plan, like Larrey's, authorized an ambulance corps controlled by a physician medical director for each army corps. Wagons were dedicated specifically to the mission of evacuating casualties and were under the control of medical officers, not the quartermaster. Medical directors established standards for personnel, equipment, and training. Casualties were treated close to the field, moved to division- or corps-level field hospitals, and then eventually transported to larger fixed facilities in Philadelphia, Baltimore, and Washington, DC. Although still significantly understaffed and strained throughout the war, Letterman's system of evacuation through echelons of care from the POI, through division and corps field hospitals, to a fixed brick-and-mortar hospital for definitive care and convalescence, would serve as the model for most industrialized nations into the next century.

Total War

The advancement of military weapons and technology, combined with nearly 40 years of peace among the major powers, set the stage for the horrific numbers of battlefield casualties during World War I. The absence of a major conflict in the preceding decades meant that tactical and operational concepts that accounted for long-range, rapid-fire precision artillery; machine guns; or improved, breech-loading, bolt-action rifles using modern cartridges and smokeless gunpowder had yet to be understood or developed. These military advances, as well as improvements in communication, organization, and transportation, enabled massive numbers of soldiers, inspired by nationalist fervor, to meet in battle armed with new weapons and unprecedented destructive power.

Several medical developments had occurred during the relatively peaceful period between the US Civil War and World War I. Lister's principles of asepsis were introduced. The individual battle dressing, or field dressing, was developed for issue to individual soldiers. Henry Dunant's humanitarian-focused Red Cross movement expanded in the United States and Europe. In Britain, the Red Cross partnered with the St John Ambulance Association, a first-aid-focused organization that operated in the major cities teaching first aid concepts to workers in industrial centers and other civilians. World War I was the first major conflict with specially trained "medics" assigned to combat formations who moved about the battlefield rendering aid and evacuating the injured. It was also the first war in which combat deaths outnumbered those from disease.

The destructive firepower of the first modern industrial war quickly resulted in a stalemate at the front. Trench warfare characterized combat on the Western front as combatants sought protection from the powerful artillery barrages and machine gun fire in trenches and bunkers. These emplacements remained relatively static during the war, and both sides suffered incredible numbers of casualties trying to win the new type of warfare.

Casualty care during World War I began at the POI. The wounded soldier performed whatever self-aid he could, or perhaps his comrades would provide initial care. At the company aid post, medics focused on sorting patients ("triage"), bandaging wounds, and splinting any fractures to minimize pain and additional injury during litter transport to the battalion or regimental aid post, located 250 to 500 yards behind the line. Once there, splints and dressings were examined and adjusted if necessary, and morphine and anti-tetanus serum were administered. The patients were wrapped in blankets and given hot drinks to keep them warm. Treatment was noted on a casualty tag attached to the patient.

The wounded were then carried by litter to the ambulance dressing station. These stations were located as far forward as safely possible. During the day this was 3,000 to 6,000 yards from the front, located along a road at a relatively protected point such as a building or cellar if possible. If a litter transport more than 800 to 1,000 yards from the battalion aid post was required, relay stations might be set up where litter teams handed off patients for the next stage. It was often safer to move ambulance dressing stations farther forward at night and evacuate patients under the cover of darkness, saving a long and often dangerous litter transport during daylight.

At the ambulance dressing stations, casualties were re-triaged by medical officers. Casualties in severe shock or those deemed non-transportable were held until they improved or died. From the ambulance dressing stations, casualties requiring further care were evacuated to a field hospital. For the first time in history, large numbers of casualties were transported by motorized ambulance. Ambulances made by Ford, Fiat, Peugeot, and General Motors proved their value in terms of speed and patient comfort under brutal combat conditions.[7,8] Overall, in the American Expeditionary Forces, the time from wounding until the arrival at the first triage point was 5 to 6 hours.[8]

Field hospitals, where surgical care was first available, were located 6 to 8 miles from the front, out of artillery range. Time from injury at the front lines until arrival at the first surgical care varied depending on road conditions, intensity of combat operations, visibility, and similar factors. Personnel at field hospitals would evaluate and triage patients once again. Casualties stayed a few hours to a few days at the field hospital, depending on the nature of their wounds and the level of combat and casualty flow. Cases that could not be returned to duty but who were stable for further transport were moved to evacuation hospitals. Those casualties deemed nontransportable (ie, those who were likely to die during further transport without immediate surgical care) were retained at the field hospital. These cases typically included three classes: open (or "sucking") chest wounds; perforating abdominal wounds; and severe hemorrhage cases. Casualties requiring neurosurgical care tended to stand transportation better before an operation than after and were typically sent forward.[8]

Field hospitals were essentially emergency hospitals or more robust dressing/triage stations, and more intensive medical and surgical care was provided at the evacuation hospital. Army Expeditionary Forces evacuation hospitals were typically 1,000-bed facilities located alongside a railway line between 9 and 15 miles from the front. Casualties reached the evacuation hospital on average 10 to 16 hours following triage at the field hospital. In addition to serving the wounded who required immediate surgical care before they could be transported further, evacuation hospitals served as relay or clearing stations in the hospitalization and evacuation chain. Patients were transported from evacuation hospitals by train to a system of base hospitals and then on to fixed facilities throughout France and England for definitive care and convalescence. At each stage of the evacuation chain, those who would not survive transport would be held until they improved or died. Those with minor injuries were returned to duty, and those who required further care were sent on through the chain.[9]

World War II

The world wars of the 20th century saw the development of the internal combustion engine and motorized ambulances that could carry casualties through "echelons of care." While the Western front was relatively static in the First World War, World War II was a war of speed and mobility. Armored vehicles, which had emerged in rudimentary forms during World War I, were perfected and integrated into a combined arms strategy using air power, artillery, and infantry. Entire armored and mechanized divisions were fielded. The airplane had advanced significantly during the interwar period and would play a key role in moving men, materiel, and casualties across large distances in both the European and Pacific theaters of war. As surgical care advanced and military aviation developed, large numbers of casualties in World War II were able to receive forward stabilizing surgical care and subsequently be transported to a second hospital by airplane. Blood transfusions, advances in resuscitation science, antibiotics, and improvements in surgical technique revolutionized combat surgery and resulted in a reduction of the hospital case fatality rate in patients with abdominal or visceral wounds from 45% during World War I to 15% in World War II.[10]

Evacuation in World War II operated on similar principles as during World War I. The goals at each stage or echelon of care were to provide only those treatments necessary to save lives and ensure patients were stable for transport to the next level. At each stage, those who could be safely returned to duty were sent back to their units, and those who required further treatment continued through the evacuation chain. Those who could not recuperate within 4 to 6 months in theater were evacuated back to the United States. During the war, fixed-wing aeromedical evacuation became the principal method of transporting patients from forward hospitals to rear area facilities.

EVOLUTION OF AEROMEDICAL EVACUATION

After the invention of the airplane in 1903, militaries around the world began to realize the implications aircraft and aviation would have on warfare. Airplanes would offer unprecedented new opportunities on the battlefield. Likewise, aviation's implications for combat medicine were not lost on military medical planners. During World War I, several countries experimented with medical evacuation by aircraft, but safety, expense, and limited load capacities did not make casualty transport by aircraft feasible on a large scale until World War II. Large, fixed-wing aircraft functioned in the same role as the casualty trains of World War I. Intra-theater patient movement was accomplished on planes such as the Curtiss C-46 Commando or the Douglas C-47 Skytrain, while inter-theater transport required larger planes with greater range, such as the Douglas C-54 Skymaster. These planes would move more than one million casualties from forward evacuation hospitals to base hospitals in the rear.[11] In total, more than 1.34 million patients were aeromedically transported during the war.[12]

The helicopter was introduced toward the end of World War II. Initially used to rescue the crew of a downed aircraft in the jungles of Burma, the first evacuation of combat casualties under fire by helicopter was done in Manila in 1945, when 75 to 80 soldiers were evacuated one or two at a time.[13]

Korea

Helicopter evacuation came to the fore during the Korean War. The Bell H-13 Sioux helicopter, an adaptation of the Bell commercial Model 47 was used to evacuate more than 20,000 casualties.[14] These helicopters were crude as evacuation platforms and lacked advanced navigation or communication capabilities. Because patients were in pods located outside the crew compartment, no medical care could be given during flight. Pilots sometimes received ad hoc medical training from surgeons at the receiving hospitals, but the pilot had to land the helicopter to render any aid.

Helicopter evacuation in the US Army evolved with a focus on speed of casualty transport to surgical care. For the first time, casualties could be taken from a remote, rugged location near the POI, and transported rapidly to surgical care, bypassing the intermediate stops through echelons of ground-based evacuation. Helicopter evacuation spared patients prolonged litter or ground ambulance transports over rough terrain through hostile territory, preventing much death and suffering.

Vietnam

Military trauma systems built during the Korean and Vietnam eras steadily increased the survival rates of wounded soldiers. Helicopter evacuation underwent significant expansion and growth during the Vietnam era, when dedicated MEDEVAC helicopters were deployed en masse. The Bell UH-1, or "Huey," was large enough to carry several patients as well as a combat medic who could provide care en route to the hospital. Rapid evacuation to surgical care is often cited as one of the principal reasons for the significant reduction in battlefield mortality during the Vietnam conflict compared to other wars of the 20th century. Helicopter MEDEVAC (referred to as "DUST-OFF" after its motto: "Dedicated, Unhesitating Service to Our Fighting Forces") epitomizes modern battlefield care whereby an injured soldier can be whisked from the battlefield to surgical care within minutes of wounding. Indeed, the icon of modern battlefield medicine is the MEDEVAC helicopter.

Late 20th Century

During the postwar period following Vietnam, US and NATO military planning remained focused on fighting Soviet and Warsaw Pact forces on the plains of Europe. Large-scale, intensive combat with massive numbers of conventional battlefield wounded, as well as casualties from nuclear and chemical warfare, were expected. Combat was expected to be fast paced, highly mobile, and conducted day and night in all weather conditions.

MEDEVAC doctrine continued to focus on rapidly clearing the battlefield. Speed, aircraft performance, and communications were key priorities for MEDEVAC commanders. Little, if any, attention was given to the medical care provided by the flight medic. No substantive medical treatment was expected in a fully loaded aircraft carrying multiple casualties staffed with only a single flight medic. From the Vietnam era until 2012, the flight medic was trained only at the basic combat medic level and had no requirement for any hands-on patient care experience during their training.

During this period, civilian air ambulance services proliferated. The first one was established in 1970. By 1992, more than 220 helicopter ambulance services were established in the United States.[15] Although initially modeled on the military's rapid transport model, the emerging civilian model evolved with a "care is critical" philosophy whereby highly trained and skilled providers were matched with specific patients' medical needs, bringing tertiary level care to the patient during transport.[16] As civilian helicopter emergency medical service (HEMS) evolved to bring resuscitation to the patient, the military model continued to focus on bringing the patient as rapidly as possible to resuscitation.

US forces were involved in several small conflicts in the 1980s and 1990s, including operations in Grenada, Iraq, Kuwait, Panama, Somalia, and Kosovo. In all instances, combat operations were short-lived, with relatively few casualties. No trends emerged during these limited conflicts to challenge the Cold War model of evacuation. During the same period, civilian HEMS models became increasingly sophisticated.

On October 3, 1993, the most intense conflict involving US forces since the Vietnam War took place in Mogadishu, Somalia. This conflict revealed some hints about the future of what would be called "asymmetric warfare." The challenges of fighting in an urban environment, such as the vulnerability of helicopters, difficulty of finding landing zones and resulting prolonged care in the field, and delayed evacuation heralded conditions to come during Operation Iraqi Freedom almost a decade later in Fallujah, Sadr City, and other heavily populated urban areas.[17]

Evacuation Lessons From Iraq and Afghanistan

Iraq

When US and coalition forces invaded Iraq and Afghanistan following the World Trade Center bombing of September 11, 2001, the military medical evacuation model remained focused on time, or rapidly clearing the battlefield of casualties. Further, US evacuation doctrine was directed toward military combat casualties from the POI to surgical care. It did not anticipate the large numbers of pediatric, medical, and critical care transports that would be encountered in the battlescapes of Iraq and Afghanistan.

During the initial maneuver phase of the war, nonstandard CASEVAC vehicles or MEDEVAC ground or air ambulances were often the modes of evacuation to the rear. Casualties entered the evacuation chain at different levels. Sometimes they were transported to an aid station (Role 1) or a brigade support medical company (Role 2), where they were stabilized by non-surgeon medical staff and then transported by MEDEVAC to a forward surgical team (FST). In some instances, casualties were transported directly from the POI to small, mobile FSTs. After surgical stabilization, casualties would be transferred from the FSTs to forward hospitals (Role 3), usually by MEDEVAC helicopters.

In the later phase of the war, a large and robust system of Role 3 facilities was established near most populated areas in Iraq. Compared to Afghanistan, Iraq's road and highway infrastructure was well developed, with significant urban and suburban populations centered along the Tigris and Euphrates river valleys. Medical assets were robust and located near the areas of most military operations. FSTs were consolidated with Role 3 facilities to provide a more robust surgical and critical care capability. Battalion aid stations (Role 1) or brigade support medical companies (Role 2) were often bypassed by MEDEVAC because surgical care was often close by. Military medical planners had adopted the "golden hour" concept in Iraq and were able to attain an average evacuation time of 55 minutes for seriously injured casualties. Evacuation times from one battalion aid station in Baghdad ranged from 20 minutes to 2 hours during major combat operations, with an average of about 25 minutes.[18]

Challenges during the transfer of postoperative patients aboard MEDEVAC helicopters were noted early in Iraq. A number of cases were described in which patients were stabilized at an FST, transferred to Role 3 by MEDEVAC, and arrived either dead or in extremis.[19] At that time, MEDEVAC helicopters were staffed by a single combat medic credentialed at the Emergency Medical Technician-Basic (EMT-B) level. These medics were not typically qualified to manage patients requiring critical care or advanced resuscitative procedures, such as airway and ventilator management, advanced pharmacology, or blood product administration. It was common for new flight medics to encounter their first seriously injured or ill patient on their first mission in combat.

Treatment protocols, documentation, medical direction, and quality improvement processes were not standardized and varied significantly across US Army helicopter evacuation units, nor were these processes integrated with the overall trauma system. This is in contrast to civilian HEMS systems that operate within the United States, the United Kingdom (UK), and most European countries. Current civilian helicopter evacuation platforms are routinely staffed by critical care trained flight paramedics or comparably trained flight nurses, operating under the medical direction of physicians with emergency medical service (EMS) training, and using formalized protocols, standardized patient care documentation, and rigorous quality improvement processes.[20]

In 2004, the theater trauma director published clinical practice guidelines (CPGs) that directed physicians or nurses trained in critical care to augment postoperative transfers from Role 2 to Role 3.[21] While the CPG provided detailed instructions for critical care transport, no additional personnel were dedicated to this mission by the US military, so the critical care providers would have to come from the transferring Role 2 or the receiving Role 3 facility. At the tactical level, this resulted in the difficult decision of either sending a key provider from a small forward team during combat operations, thus degrading the effectiveness of the team; sending a provider from the receiving Role 3 to the pick-up point; or transporting the patient with a minimally trained flight medic. When providers were sent from an FST or combat support hospital, they often lacked any formal in-flight critical care training or experience. A mix of all three techniques were used, and all presented particular logistical and patient care challenges.[22]

The incidence of poor outcomes during MEDEVAC in Iraq is unknown. No standardized patient care record, chart review, or performance improvement process was in place. Documentation of care during a MEDEVAC flight was not required as part of the medical record, and thus was not subject to review or analysis performed by the Joint Theater Trauma System.

Afghanistan

After major combat operations ended in Iraq in 2009, combat and stability operations in Afghanistan became a primary focus of the US and its coalition partners. Afghanistan presented many different challenges than fighting in Iraq. Afghanistan, in contrast to Iraq, is a vast and sparsely populated country with numerous mountain ranges, poor road networks, and primitive infrastructure. Combat forces were widely dispersed. Unlike in Iraq, most medical evacuations to surgical care in Afghanistan could only be conducted by MEDEVAC helicopter (ground transport was not practical nor safe based on lack of infrastructure, distance to receiving facilities, and semipermissive environments).

Conditions in Iraq had begun challenging the Cold-War-era legacy MEDEVAC model; in Afghanistan, distance and time magnified the challenges of the asymmetric, nonlinear battlefield. The operational environment caused stress to the legacy MEDEVAC model with (*a*) increased numbers of postoperative critical care patients being transported from Role 2 to Role 3; (*b*) unprecedented numbers of civilian transports including pediatric, geriatric, and medical cases similar to those seen in civilian EMS; and (*c*) massively injured polytrauma patients, who would have died in previous conflicts, being kept alive by tactical combat casualty care, improved protective equipment, and access to early surgery.

Gaps in en route critical care capability in Afghanistan were noted as early as 2002.[23] Since then, efforts were made to overcome these institutional gaps by tactical-level providers and commanders on the ground doing the actual day-to-day mission. These ad hoc fixes included mandating licensed medical providers (physicians, physician assistants, nurses) to fly on MEDEVAC platforms; sending flight medics to civilian paramedic training programs between deployments; deploying critical care nurses to augment MEDEVAC crews; using paramedic-trained US Air Force pararescue personnel to perform MEDEVAC; and employing the tiered dispatch of higher capability units such as the British Medical Emergency Response Team (MERT) for the most severely injured patients, particularly in the south and southwest of Afghanistan.

Similar to the Army field surgeons' experience in Iraq,[19] the deployed theater trauma director in Afghanistan in 2009 noted a number of anecdotal cases where patients had left a Role 2 facility following surgery and had deteriorated significantly or died en route to the Role 3. While Role 2 to Role 3 flights in Iraq were usually much shorter,[22] postoperative transfers in Afghanistan before 2009 often took over an hour to several hours, averaging 1.5 hours.[24] In January 2009, Secretary of Defense Robert Gates prioritized the need to decrease evacuation times to under 1 hour. More FSTs and medical evacuation assets were deployed, and by December that year, the average evacuation time in Afghanistan had been reduced from 100 to 42 minutes.[25]

The 2004 CPG published in Iraq still recommended that a nurse or physician accompany postoperative patients. However, many FSTs, already small in size, were now being split into two 10-person teams in Afghanistan to achieve the 1-hour standard mandated by Secretary Gates. The smaller FSTs were then even less able to give up a provider to accompany a patient during evacuation. In response to the reports of poor patient outcomes following postoperative transfer by MEDEVAC, the theater trauma director initiated a request for forces for the deployment of critical care nurses to augment the MEDEVAC crews during these flights. These en route critical care nurses arrived in Afghanistan in 2010 without predeployment training or recent flight experience, yet they and subsequent groups were able to perform at high standards. Patient documentation and quality assurance measures were put in place, and the outcomes of postoperative patients improved.[26]

Between December 2008 and October 2009, a US Army National Guard MEDEVAC unit was deployed in southern and eastern Afghanistan with a unique crew: nearly 75% of its flight medics were credentialed and experienced EMT-Paramedics who actively practiced in the United States before deployment. These medics had an average of 9 years' field experience and extensive training in critical care transport prior to deploying. They brought civilian HEMS protocols, documentation, medical direction, staffing, and process improvement standards to their MEDEVAC unit, effectively adapting their civilian expertise to the military environment in Afghanistan. An analysis of this group's performance demonstrated a 66% reduction in casualties' risk of death at 48 hours compared to the standard MEDEVAC units deployed before and after them.[20]

The MERT, consisting of a large CH-47 Chinook helicopter staffed with a physician, a nurse, two paramedics, and a ground security force, also appeared to improve the survival of the most seriously injured casualties. The MERT was created for use in Iraq for rapid incident response and deployed in southern Afghanistan in 2006. In Afghanistan, the extensive battle area in the UK's area of responsibility led to the far-forward employment of critical care assets. UK forces leveraged the experience of many of their deployed clinicians in HEMS. Initially, the MERT's medical component consisted of a general medical officer delivering advanced trauma care. As the fielding of this team evolved, UK forces scaled their MERT response to add physicians as needed, extending the forward care and life-saving interventions they can provide. It is important to note, though, that MERTs were employed only in areas in which air superiority or air supremacy had been established. It would be premature to extrapolate the MERT's current success to other phases of battle in which air superiority has not been achieved.[27]

At coalition regional patient evacuation coordination centers, staffed in southwestern Afghanistan around the clock by experienced trauma nurses, the appropriate evacuation platform based on the patients care needs was dispatched. This clinically based dispatch model was aimed at optimizing the patient's care during transport. The MERT was dispatched for the most severely wounded; US Air Force Pararescue (with two paramedics, call sign PEDRO) were dispatched for advanced life support cases or in nonpermissive environments; and DUSTOFF (with a single EMT-B medic) for all others. Even when the PEDRO or DUSTOFF units have a more rapid response, a MERT was dispatched preferentially for the most severe cases so that advanced resuscitation could be started as soon as possible. If a MERT had a 15-minute response time to the POI, for example, and a DUSTOFF unit had a 10-minute response with a 10-minute subsequent flight to Role 2 or 3, the MERT would be dispatched so that resuscitation began in 15 versus 20 minutes. This tiered response system was unique to one region of Afghanistan.[28]

Specialized Teams

For longer-range transport, beyond the rapid response of a DUSTOFF or MERT unit from the POI, the US Air Force Aeromedical Evacuation system provides fixed-wing movement of regulated casualties with extensively trained aircrew, which can be tasked across the full spectrum of military operations.[29] Traditional aeromedical evacuation teams consist of two flight nurses and three aeromedical evacuation technicians, with specialty training to care for patients on a variety of opportune aircraft, primarily the C-130 Hercules, the C-17 Globemaster, and the KC-135 Stratotanker. In the early 1990s, the US Air Force surgeon general, Lieutenant General P.K. Carlton, had envisioned a critical care air transport team (CCATT) to serve as a mobile intensive care unit, augmenting a traditional aeromedical evacuation mission to provide expert care for critically ill casualties.

CCATTs now consist of a critical care physician, a critical care nurse, and a respiratory therapist, capable of caring for a number of ventilated casualties while simultaneously providing ongoing resuscitative interventions in-flight.[30] Combat casualties surviving extensive, multi-system trauma and stabilized in theater via damage control surgery can now be evacuated safely and rapidly to the United States, often within 48 to 72 hours of the initial injury. Specialized critical care personnel can also augment CCATTs to support patients with additional requirements, including the use of more advanced ventilation protocols and extracorporeal membrane oxygenation.

Special Operations Teams

The Air Force Special Operations Command (AFSOC) developed its own en route care capabilities to meet special operations forces (SOF) mission sets.

The earliest AFSOC en route care specialists were the Special Operations Forces Medical Element (SOFME) teams, comprised of a flight surgeon (typically an internship-trained flight surgeon) and two independent duty medical technicians.[31] These teams had in-garrison base-operating support duties and were on alert at all times for forward taskings. As AFSOC physician assistants (PAs) proved their worth in the SOF medical arena, it became increasingly common for PAs to serve in the SOFME teams in place of the flight surgeon.[32] The SOFME role evolved in the post-9/11 world of increasing operations tempo and expanding SOF application in global engagement. The SOFME operational medical pipeline is robust and has come to involve clinical skills (eg, Advanced Trauma Life Support, Prehospital Trauma Life Support, Tactical Combat Casualty Care, aeromedical disposition) and tactical skills (the AFSOC CASEVAC course, field skills training, and small unit tactics).[33] SOFME teams are located on multiple continents and engage in everything from combat CASEVAC to multilateral training with partner nations and humanitarian assistance/disaster response.

The success of the Air Force CCATT and Mobile Forward Surgical Team (MFST; a five-person surgical team able to carry its own gear and walk into a location) led to the next generation of SOF medical support. The advent of the Special Operations Surgical Team (SOST) and Special Operations Critical Care Evacuation Team (SOCCET) changed the landscape of SOF medical support capability. Now, theater SOF teams had far-forward damage control surgical support with embedded intensive care capability. SOST/SOCCET personnel are highly trained medical and surgical professionals who must keep their medical skills up to date.[34] In addition, their pipeline training requires awareness of small unit tactics, field skills, and essential SOF field support capability.

These teams were initially designed to operate independently as needed, but their field application more often required joint basing in support of ground force SOF operations. SOST/SOCCET teams have worked successfully in many forward settings, ranging from combat support to humanitarian assistance/disaster response.[35] As it became increasingly clear that their predominant use was in support of ground operations, in 2012 the command surgeon of the 24th Special Operations Wing coordinated AFSOC's plan to place the SOST/SOCCET units under the command of the 720th Special Tactics Group. This strategic move paved the way for major advances in the organization, training, equipping, and application of these mission-critical medical support assets. SOST/SOCCET units based in the continental United States are embedded at civilian trauma centers, a unique feature.[36] As self-contained, geographically separated units, teams live and work at busy civilian trauma centers, honing their critical care and surgical skills. Always on-call, they are able to respond rapidly to the next SOF support mission anywhere in the world.

EVACUATION IN FUTURE CONFLICTS

The Operational Environment

Cold War-era MEDEVAC doctrine emphasized clearing the battlefield and relieving the fighting troops of the burden of casualty care. In today's conflicts, the challenge for medical evacuation is to provide state-of-the-art care to patients; this will likely be true in future asymmetric conflicts as well. Indeed, the aim of current NATO evacuation doctrine is "to provide a standard of medical care which is as close as possible to prevailing peacetime standards, and follows the principles of best medical practice, while acknowledging the operational posture and environment."[37]

In the foreseeable future, US military operational environments are likely to be much more complex and challenging than the relatively stable settings of the Cold War, where one large, constant, and discernible threat was the focus. Today, threats are numerous, poorly understood, difficult to identify, and unpredictable. Radical Islam, rogue states possessing weapons of mass destruction, regional instability in the Middle East and northern Africa, international criminal activity, a rising China with a culture and history unknown to most in the West, the threat of pandemic disease, environmental and natural disasters, and global economic instability all create a complex environment for military and military medical planners. No longer is rapid evacuation through echelons of care within a defined battle area or front line axiomatic.

Armed conflict will likely remain asymmetric because most nations and non-state actors cannot match US and NATO forces in conventional air-land battle. Asymmetric war will be fought in urban areas where enemy forces will attempt to negate the superior technology, mobility, and firepower of the United States and its allies. Civilians will be encountered and will be purposefully put into harm's way as opposing forces seek not only to burden the medical system, but also to create the appearance of atrocities and civilian deaths as a result of US and allied actions. Intensive military operations in urban environments will create difficulties in evacuation similar to those seen in Mogadishu and Fallujah.[38]

Evacuation will often be delayed, necessitating prolonged care in the field. Unarmed MEDEVAC helicopters will be vulnerable to small arms fire and rocket-propelled grenades, and landing zones will be limited. Casualties will be carried by hand on litters and moved by nonstandard CASEVAC vehicles to forward aid stations and forward surgical care, or transported outside the city where landing zones can be secured. A newly evolving capability, the US Air Force tactical critical care evacuation team (with an emergency/critical care physician, certified nurse anesthetist, and emergency/critical care nurse) will provide substantial clinical capability, available on a variety of platforms, with minimal staffing and equipment. Future conflicts will certainly require use of this light, life-saving capability.

Following the withdrawal of combat forces in Afghanistan, political and economic pressures will make another prolonged conflict politically unpopular unless vital interests are directly threatened. Expeditionary operations will likely be the norm. Large, robust, fixed forward medical facilities will not be in place, especially during initial entry operations. Yet state-of-the-art care for US forces will be expected, especially given the low case fatality rates during operations in Iraq and Afghanistan. Combat casualty survival in such an environment will require expert prehospital care and an evacuation chain that emphasizes advanced far-forward damage control resuscitation focused on airway management, resuscitation with blood products, and hemorrhage control.[39]

Military planners have described "an arc of instability," extending from the Mediterranean Sea to the Sea of Japan, where future conflicts are most likely to arise. This region encompasses vast geographic areas such as Africa, the Indonesian archipelago, the Indian subcontinent, and the South Pacific. Conducting medical evacuation in these areas poses significant problems, and the golden hour requirement will be difficult to attain. US MEDEVAC doctrine will require a fundamental cultural change that focuses on extending the golden hour by bringing skillful advanced resuscitation to the patient in the manner of civilian HEMS systems or the British MERT. Expeditionary medical support will not have a robust holding capability. Patients will be moved mostly by air, and resuscitation will be ongoing throughout transport.

In the event of a large-scale conventional war or a period of intensive conflict in a smaller war, military medical planners may have the option of implementing a "mass casualty" protocol that would return to the Cold War goal of rapidly clearing the battlefield. Evacuation platform staffing, treatment protocols, and patient loads could then be modified according to the tactical situation based on predetermined criteria.

Finally, the military medical evacuation systems must take into account domestic and international disaster support. Military forces offer a tremendous resource to governments following disasters. The military's logistics and communications capabilities, in conjunction with efficient command and control mechanisms and expeditionary medicine expertise, will continue to be called upon during large-scale humanitarian crises. An evacuation system that operates under the local standard of care will be more adept and more easily integrated into the disaster response.

Principles of Evacuation for Future Conflicts

Overall System Design

The key element in providing quality patient care given the available resources is the design of the prehospital care and evacuation system. Evacuation concepts have carried over from war to war, often based in historical precedent, convenience, and military tradition rather than on a deliberate analysis of patient care needs by experts. Evacuation systems in future conflicts will benefit from a systems analysis approach with patient outcomes as the primary driver. Although resources and military exigencies must be accounted for, keeping the wounded casualty at the center of the system design process allows deliberate policy decisions to be made with the focus on optimizing patient care.

Medical Direction and Oversight

Active supervision of the evacuation system by physicians who practice and have expertise in emergency, critical care, and critical care transport medicine is required to optimize patient outcomes.[40] The medical director should have oversight and accountability of all aspects of the system related to patient care. This includes training and clinical supervision of prehospital providers, development and fielding of patient care protocols, selection of medical equipment, and quality assurance processes including chart/case review, research, and process improvement efforts. The medical director must be competent in providing and supervising patient care in the field and should participate in direct patient care in the field on a regular basis. Regular exposures to conditions in the field are the only way to fully understand how the system functions and where improvements need to be made.[40]

Patients cared for in the evacuation system are the responsibility of the system's medical director. The non-physician providers in the system are practicing under the license of the medical director; therefore, the medical director should not be subordinate to the commander of the evacuation system but should be free to make decisions and give orders related to the provision of clinical care. He or she must be the final authority over all clinical aspects of the evacuation system. This prehospital specialist, or "prehospitalist," will change the battlespace not only by applying advanced skills in the administration and oversight of prehospital care systems, but also by bringing to bear specific clinical skills designed for prehospital, austere, and en route care settings. The Department of Defense (DoD) currently trains such "prehospitalists" in a 2-year accredited fellowship based at a Level 1 military trauma center.

Dispatch and Response

Requests for medical evacuation by US forces require transmission of a "9-line" report (Table 39-1).

TABLE 39-1

STANDARD 9-LINE MEDEVAC REQUEST FORMAT

Line 1	Location of pick-up site
Line 2	Radio frequency, call sign, and suffix
Line 3	Number of patients of precedence (A-Urgent, B-Urgent surgical, C-Priority, D-Routine, E-Convenience)
Line 4	Special equipment required (A-None, B-Hoist, C-Extraction equipment, D-Ventilator)
Line 5	Number of patients (A-Litter, B-Ambulatory)
Line 6	Security at pick-up site (in peacetime, number and types of wounds, injuries, illness) (A- No Enemy in area, B-Possible enemy in area, C-Enemy in area, D-Enemy in area & armed escort required)
Line 7	Method of marking site (A-Panels, B-Pyrotechnic, C-Smoke, D-None, E-Other)
Line 8	Patient nationality and status (A-US Military, B-US Civilian, C-Non-US Military, D-Non-US citizen, E-EPW)
Line 9	NBC (in peacetime: terrain description at pick-up site) (N-Nuclear, B-Biological, C-Chemical)

EPW: enemy prisoner of war

The "9-line" focuses mostly on tactical considerations; only two parts deal with patients. Line 3 lists numbers of patients by precedence (urgent, urgent surgical, priority, routine, and convenience) and line 5 lists the number of patients who are on litters and those who are ambulatory. Because the order of clinical precedence of the patients is subjective, "over-triage" is common using this process; providers on the ground often assign a higher priority than is needed. The recent addition of the MIST (mechanism, injury type, signs, and treatment given) report to the 9-line provides injury mechanism data with physiologic data similar to civilian trauma center transport guidelines.[41] While the current American College of Surgeons (ACS) guidelines, which focus on civilian trauma systems, are too extensive for field use by military medics, the methodology proposed by the ACS guidelines should be applied to military trauma, with the development of military-specific criteria. Expanding on the prehospital MIST report concept, future evacuation systems should take into account physiologic, anatomic, and injury mechanism data to more accurately identify patients requiring aggressive forward resuscitation and rapid transport to forward surgical care.

Medical director involvement is required to ensure not only a well-structured dispatch process, but also dispatch of the appropriate evacuation capability based on patient needs. The patient evacuation coordination center or evacuation dispatch element must be staffed with trained and experienced medical personnel and should be collocated in key command and control communications centers to synchronize military operational, security, and medical evacuation operations.

Evacuation Platforms

Many vehicles can be used to move casualties. These may be dedicated ground and air ambulances marked with red crosses, staffed with medically trained personnel, and equipped for patient care, or they may be a nonmedical vehicle or aircraft without medical equipment or personnel. The type of vehicle used will depend on availability, weather, terrain, and the type and intensity of combat operations. A thorough mission analysis by military medical planners using the "PACE" methodology should identify a primary, alternate, contingency, and emergency method for evacuation.

Ground ambulances are the principal method of moving patients from the forward edge of battle during conventional combat operations. A number of variations, each with different capabilities and patient load capacities, exist. Although a detailed discussion of each type is beyond the scope of this chapter, medical directors and planners should be intimately familiar with each ambulance configuration used in their area of operations. Ground ambulances are most appropriate for short transits on established road networks and across relatively flat, open terrain. Some ground ambulances are capable of limited transit across rugged terrain; however, their use in mountainous, jungle, and heavily forested regions will be limited to established road networks. Weather and illumination conditions may degrade the speed of ground ambulance transport, but generally will not inhibit ground evacuation.

In Afghanistan, evacuation by helicopter has emerged as the principal method of transporting patients from the POI to forward surgery and from forward surgery to the combat support hospital. The MEDEVAC helicopter will continue to be the key method of casualty transport during low-intensity and asymmetric conflicts because these types of operations require a wide distribution of forces but a relative centralization of medical assets. In this environment, helicopters will be required to meet current time to surgical care guidelines. MEDEVAC helicopters can be dispatched directly to the POI and are able to retrieve patients from small landing zones or hoist them from the ground while hovering; thus, they are very effective in rugged or heavily forested terrain that may be inaccessible to ground ambulances. Unfortunately, patient care space is limited on helicopters. Noise, cabin lighting, and vibration make patient assessment and treatment difficult. Weather and illumination conditions may inhibit helicopter evacuation. Additionally, operations in urban environments will limit the use of MEDEVAC helicopters because landing zones are difficult to establish and unarmed helicopters are vulnerable to ground fire in dense urban areas.

Fixed-wing aircraft, such as the C-130 Hercules, are excellent forward evacuation platforms under certain circumstances. They have a large cargo area that provides significantly more workspace, and they travel at nearly twice the speed of helicopters, making them ideal for long-distance evacuation. Medical attendants are able to stand erect and move about. Along with substantially less noise and vibration than in a helicopter, this makes patient care and assessment easier to perform. Most fixed-wing cargo aircraft can readily be converted to carry a large number of litters.

However, evacuation by fixed-wing aircraft requires access to a suitable runway. Ground or helicopter evacuation is required to transport the patient from a forward treatment facility to the airfield. Requests for fixed-wing evacuation platforms will become more complex and time-consuming because these aircraft will often not be dedicated to forward medical evacuation. Medical crews and equipment, not typically assigned to the aircraft, will need to be assembled. Weather and illumination conditions may limit fixed-wing evacuation, but to a lesser degree than helicopter transport. Fixed-wing evacuation, when available, is ideal for moving large numbers of casualties or those requiring intensive critical care over longer distances. When MEDEVAC helicopters are limited in urban warfare, moving casualties by ground to an airstrip outside of the urban area for fixed-wing evacuation may be a viable alternative.

Navy en route care has taken a quantum leap forward with the advent of EMS board-certified medical directors; the development of standardized protocols, education, and training; and the evolution of joint en route care CPGs. Sea-basing of casualty collection and treatment, as well as specific en route care training for corpsmen, may revolutionize naval evacuation over vast distances in theaters such as the Pacific Command.

Provider Staffing and Capability

A number of staffing models for both civilian air and ground ambulances exist. For ground ambulance services these include basic life support (BLS), EMT-B level; advanced life support (ALS) providers (paramedics); and in some instances, intermediate-level providers capable of more advanced airway and vascular access techniques than EMT-Bs, yet lacking the advanced capabilities of paramedics. Most civilian air ambulance systems in the United States (93%) are staffed with two providers, most commonly a flight paramedic and flight nurse (67%). Other configurations include two flight nurses (8%), two flight paramedics (5%), and a single nurse or paramedic (3%).[42] There have been no large prospective studies demonstrating an advantage of one staffing model over another. Physicians in North America rarely perform prehospital or field care, although in Europe many ground and air evacuation platforms are routinely staffed by physicians trained to provide prehospital care.

Most military ambulances are staffed with at least two military medics, although Army MEDEVAC helicopters have traditionally been staffed with a single combat medic. Combat medics in the US Army are credentialed at the EMT-B level, but they are trained in more advanced techniques such as surgical airways, needle chest decompression, and intravenous as well as intraosseous access. While studies of military ground ambulance staffing models are lacking, several recent retrospective military studies have shown improved patient outcomes related to helicopter evacuation platform staffed with critical care paramedics[20] and physicians.[43]

In addition to unprecedented numbers of civilian transports, operations in Afghanistan have challenged the conventional evacuation platform staffing model for US forces with (*a*) severely injured casualties with multiple traumatic injuries kept alive by advanced body armor and tactical combat casualty care, many whom would have died in past conflicts, and (*b*) increased numbers of postoperative cases. This pattern will likely continue in future scenarios. During a conventional conflict, military-age males with traumatic injuries will be the majority of patients transported, whereas in low-intensity and asymmetric conflicts, civilians of all ages as well as medical cases will frequently be transported.[44] Optimizing casualty outcomes in future conflicts requires MEDEVAC crews capable of meeting the needs of the patients transported across the full spectrum of conflict, from counterinsurgency operations to conventional combined arms battles.

Evacuation times in combat can be incredibly variable, especially during the initial entry phase of operations. Expeditionary, initial entry, and special operations will therefore require forward medical personnel to accompany the wounded during what may be a prolonged evacuation. These medical assets must be trained, experienced, and competent in forward resuscitative care. Staffing models should be flexible and able to care for all types of patients that may be encountered. Using a tiered system (with separate critical care, ALS, and BLS responses) is feasible in a small geographic area such as described above in southeastern Afghanistan. However, such a tiered system would be difficult to implement across a large geographic area or during initial operations in an immature theater of war. Here, a single efficient and flexible staffing model capable of responding across the full spectrum of patient care needs is key.

Although one provider may be adequate for most stable and routine transfers, two providers should be available for any seriously ill or injured patients. Evacuation platform providers should be capable of retrieving a severely injured casualty from the POI and performing stabilizing care (including advanced airway management, hemorrhage control, resuscitation with blood products, chest decompression, and pharmacologic therapy for sedation, pain, blood pressure support, and coagulopathy). Rather than simply transporting the casualty, the goal should be to begin resuscitation on retrieval and continue it until the patient reaches forward surgical care. This same team should be capable of transporting the same patient in the postoperative period to a definitive care hospital, continuing to provide critical care in transit.

Data and Quality Improvement

Military medical providers are dedicated professionals committed to performing quality patient care during medical evacuation in extremely hazardous environments. Such high-quality patient care is expected not only by those in uniform who place themselves in harm's way, but also by the political leaders, military commanders, and citizens of their respective nations who ask the military to risk life and limb for national defense. Though service members deserve the highest quality of care that can realistically be delivered in a combat setting, functional military systems of data collection, patient care documentation, and quality improvement processes were generally lagging until well into the mid-2010s.

Incomplete patient care data from the prehospital phase of care is the single greatest challenge to improving military medical care. A growing body of evidence suggests the prehospital phase (including evacuation) is the where the largest number of potentially salvageable deaths occur.[45] Yet fewer than 14% of casualties had any documentation of prehospital care on arrival to a surgical facility in Iraq and Afghanistan, according to a 2011 report.[46] Any effort to improve the quality of care during medical evacuation requires data; competency and quality of care cannot be demonstrated nor improved without data collection and documentation.[47] One cannot improve what one cannot measure, and one cannot measure without data.[48]

A detailed discussion of data collection systems, patient documentation, and quality improvement methods is beyond this scope of this chapter. However, the following general principles from "Data A–Z" by Mears[49] should be mentioned:

- For any quality initiative, it is essential that data collection systems be created to measure the fundamental tenets of the EMS system—patient care and service delivery.
- Data elements must be standardized and uniform, with consistent definitions.
- Generating a medical record holds EMS personnel accountable for their critical decision-making and patient care. Medical records also allow identification of educational needs and areas of improvement.
- Information systems should obtain a large portion of data passively from automated systems such as medical devices (monitors) and computers.

- EMS information systems should be strategic and clearly defined. The application of data should enhance patient care, not detract from it. Information systems should drive the EMS system, its service delivery, and its patient care.
- Data entry requirements must be balanced with patient care requirements. Extensive demographic data and other elements not immediately related to patient care should be deferred until the patient reaches a fixed facility.
- If a data system is put into place without adequate training and support, the user experience will be negative. A negative user experience at this critical point can be devastating.
- Technology is critical to the success of an information system, but can be damaging if it is applied inappropriately or before it is mature.[49]

The main argument against prehospital data collection by field providers is that it is precluded by the chaotic nature of combat. While this may be true in some major combat operations at certain periods, the US Army's 75th Ranger Regiment, one of the most heavily engaged combat units of the US forces, has successfully collected patient data on every casualty sustained during operations in Iraq and Afghanistan. This data has been used to continuously improve the quality of the organization's casualty response system. The 75th Ranger Regiment is also the only unit in the US military that has demonstrated zero potentially preventable deaths in the prehospital setting after more than a decade of combat.[50]

Prehospital and evacuation patient care data must be captured, integrated, and synchronized with the patient's medical record and the theater trauma system. With accurate evacuation care data, clinical benchmarks can be established, outcomes can be evaluated, and quality improvement initiatives implemented in a continuous cyclical process.

MODEL FOR FUTURE CASUALTY CARE CONTINUUM SUCCESS

To replicate the successful trauma registries and trauma systems used by US civilian trauma centers, forward deployed trauma surgeons developed the Joint Theater Trauma System, which evolved into the Joint Trauma System (JTS), serving the DoD's global operations. Housed at the US Army Institute of Surgical Research, the JTS is helping to enable a more structured approach to trauma care from POI to definitive care and rehabilitation. Recognizing that trauma care is a continuous and enduring DoD mission, the system was established to improve standards in trauma care across the continuum of care, built on standardized documentation, registry development, outcome analysis, performance improvement, and evidence-based medical practice across the entire continuum. The JTS continues to evolve, and its trauma registry has served as the model for similar registries in partner nation military medical systems. CPGs are published and routinely updated in an effort to optimize care for combat trauma both on the ground and in the air. This system is built to adapt to the current and future political, strategic, and operational needs of the DoD.

SUMMARY

Evacuation is a core military medical function. Enhanced en route care is the latest innovation in the history of medical evacuation. The interrelationship between military and civilian medicine in this field is clear: each community has made advances in medical evacuation, and each has adopted advances made by the other. While war has driven many of the current advances in prehospital combat casualty care (junctional tourniquets, hemostatic agents and dressings, telemedicine, and TCCC), civilian emphasis on critical care evacuation, quality assurance, protocols, and proactive medical direction is equally improving the landscape of prehospital military medicine.

For combat arms commanders, who place a premium on accomplishing the mission, the best possible care of the combat wounded is an absolute priority. In addition to the first-order effect of reducing mortality and morbidity, exceptional medical care and evacuation provide second- and third-order effects as well: combat troops undertake the mission with peace of mind, knowing the medical team is behind them, ready to take care of them and evacuate them to life-saving care each time they protect national interests by going into harm's way.

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