Changes in Combat Casualty Care

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My first United States Army obligation was in 1964 to 1966. During my internship at The University of Oregon Hospitals from 1993 to 1994, I applied for the Berry Plan. This was a lottery and I was not allowed to finish my postdoctoral training. I was given a choice to volunteer to join the Army as a captain or be conscripted as a private. I was assigned to the European Command Theater and was posted as a general medical officer to a dispensary in Bamberg, Germany. After returning to the United States, I finished my surgical training at The University of California, San Francisco under J Englebert Dunphy. At the same time, I remained in the obligatory 6 years of inactive reserve. At the end of the 6 years, I resigned from the Reserves.

In 1986, representative GV “Sonny” Montgomery (D Miss.) was the chairman of the House Committee on Veterans’ Affairs, and a ranking member of the House Armed Services Committee. He estimated that only 3 in 10 casualties could be treated promptly under the current level of medical readiness. As a consequence, I approached the military in San Francisco and stated that I would be happy to rejoin the Reserves. I had been teaching at Letterman General Hospital and very much enjoyed the opportunity to teach surgical residents within military institutions. This continued when I moved to Oregon and I enjoyed my teaching obligations at Madigan Army General Hospital.

In mid-1990, Saddam Hussein invaded Kuwait. Over the next few months, the military mobilized to respond to this military threat. Two days before Thanksgiving in 1990, I returned home from a trip where I was giving grand rounds at a hospital in Florida. There was a message on my phone that informed me that I was to report to Fort Lewis for activation back into the military on active duty, and that I would be going to Saudi Arabia. The next morning I went into the dean’s office and informed him that I had been called to active duty. He responded by saying that he would be able to get me out of this obligation by calling then Senator Hatfield. I looked at him and said, “You don’t understand, I want to go.” He became very pensive, thought for a moment, then said, “Well, give me your parking permit back.” So much for priorities.

I went to Fort Lewis and over the next 6 weeks, readied the 50th General Hospital for deployment to Saudi Arabia. I was made Chief of Surgery and the Chief of Professional Services. During the time we were at Fort Lewis, I was able to teach Advance Trauma Life Support (ATLS) to all of the surgeons and I had permission from the American College of Surgeons to also include some of the critical care nurses during the course. I was also able to set up 17 resuscitation teams from the staff and we held 2 separate goat surgical laboratories to bring everybody up to skill in regard to tube thoracostomy, cricothyrotomy, diagnostic peritoneal lavage, endotracheal intubation, and Advanced Life Support (ALS).

We arrived in Saudi Arabia in early January and I immediately was faced with a number of problems relating to our Saudi hosts and bringing the hospital we were assigned to up to speed. On January 17, the air war started, and 4 days later the first Scuds came into Riyadh and we were immediately taking care of civilian casualties. Unfortunately, over the next 2 months, we received approximately 300 American casualties and approximately 125 civilian casualties. In addition, at the end of the conflict, we received a number of Iraqi prisoners of war. We returned to Fort Lewis on March 17, 1991.

In September 1991, I was asked to go to Phoenix, AZ by the United States Army to assess our experience and to write up our “Lessons Learned.” My report on lessons learned was not well received by several individuals, who cited it as negative and somewhat belligerent. However, one Two Star General and one Bird Colonel wrote very positive letters back to me thanking me for my candor and in particular, outlining measures that would have improved combat casualty care. I took the liberty to submit my “Lessons Learned,” somewhat modified, to The Archives of Surgery, which then published it.1

SUMMARY OF MY “LESSONS LEARNED” TO THE MILITARY

1. The training command structure was incompatible with establishing command and control, spirit de
11. The relationship with Air Force evacuation personnel and equipment was suboptimal. Recommendation: Each general hospital must have an Air Force Medevac officer who answers directly to the hospital commander.

12. The relationship between medical corps, hospital units, and the medical command structure at the brigade and group levels was abysmal. Recommendation: All Medical Department Activities (MEDDAC) must be commanded by medical corps officers.

13. The command medical structure within theater lacked experience, seniority, and clinical-medical input. Recommendation: The medical command surgeons should be individually selected on the basis of demonstrated leadership and experience. This implies a certain degree of seniority and a track record of successful command assignments.

14. The opportunity for research in theater was wasted by a combination of poor planning and an extremely low priority by the Army Component of the US Central Command (ARCENT) surgeon. Recommendation: Provisions for combat casualty research must be planned at the earliest possible moment. A special panel should be automatically assigned with the mission to review or design research projects to be carried out during the combat phase of operations. Only this type of activity can assure accurate record keeping and any hope of improving combat casualty care.

I must emphasize directly from my original “Lessons Learned,” the following issue: “At no time during any of the briefings with the Air Force did the Air Force Officer state they were there to help in the evacuation process. It was made clear to us that certain patients could not undergo evacuation using Air Force personnel or equipment. If patients were on ventilators, this would require personnel and equipment from the transferring hospital. This would include a physician and possibly a nurse or respiratory therapist to manage the ventilator. Special teams were not designated by either the Air Force or the Army to aid in this evacuation process and release some of the bottlenecks that could have occurred at the forward areas. Most surprising of all was the unavailability of Nightingale (C9) aircraft to evacuate critically ill and injured patients from theater to the communication zone. It was an 8-hour flight to Germany and we had at least 3 patients who would have benefitted from such evacuation. Why these aircraft were not made available to us in theater was never explained.”

It is noteworthy that my observations were shared by the General Accounting Office, and several reports from that organization were published in 1992, 1993, 1994, and 2 subsequent General Accounting Office reports in 1996.
Lecture in 2004. A brief history of previous conflicts is noteworthy. During World War I and World War II, it was necessary to have general hospitals or evacuation hospitals in theater to provide definitive care, including the initial operations, subsequent critical care, and ward care. Ventilators were very primitive and seldom used during these two conflicts. Return to the continental United States was usually by large hospital ships. Air transport was not practical because of the distances and the need for intermediate stops. This changed in the Korean War in that helicopters were used for the first time to retrieve the injured close to the front lines. Many of these critically ill patients were either operated on in Korea or transported to hospitals in Japan. Some went on to Clark Air Force Base in the Philippines. The first “critical care air transport” was used in Vietnam in the spring of 1966 and focused on burn care. Initially, these burn patients were taken to Clark Air Force Base, but later, to Kashini Barracks in Japan. The United States Institute of Surgical Research was put in charge of transporting these patients in as timely a fashion as they could. Patients usually went from Kashini to Elmendorf Air Force Base in Alaska or to Tripler Army Hospital in Hawaii. Once a week, a C-141 accomplished this critical care transport. A major positive difference in outcomes was obvious.

As noted above, studies by the General Accounting Office showed progress was slow in changing the ability to evacuate casualties from foreign soil back to the continental United States (CONUS). Fortunately, in the late 1990s, and into the early part of the 21st century, the Air Force, under the leadership of 2 individuals, James Peake and CK Carlton, who both became Surgeons General of the Air Force, made major changes in the way patients are cared for and evacuated. One of the first major changes was establishment of a Joint Theater Trauma Registry modeled after the American College of Surgeons’ National Trauma Database. At the same time, the Center for the Sustainment of Trauma and Readiness Skills (CSTARS) was created. It focused on another critical component of optimal trauma care: The Critical Care Air Transport Team (CCATT). CSTARS is based in Cincinnati and maintains skills for the Critical Care Air Transport Team, which operates within the war theater and transports patients out of the war zone to Landstuhl, Germany (Table 1). After a brief stay in Landstuhl, the casualty is transferred to appropriate military hospitals in CONUS. The average time from wounding to initial surgical care is now down to 26 minutes. (Personal communication. Site Visit for Centcom, November 2011, Afghanistan). Typically, time to Level I facilities in the United States ranges from 48 to 96 hours.

<table>
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<th>Table 1. Levels of Care</th>
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<tr>
<td>Level 1—scene or battalion aid station</td>
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<tr>
<td>Level 2—forward surgical hospital</td>
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<td>Level 3—standing hospital</td>
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<tr>
<td>Level 4—out-of-theater general hospital (Landstuhl Regional Medical Center [LRMC])</td>
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<td>Level 5—continental United States (CONUS) general hospital</td>
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**WOUNDED AGENTS IN DESERT STORM**

The wounding agents primarily used in Desert Storm were gunshots, artillery, mortars, tank fire, vehicular accidents, and Scuds. After the air war started, bombs became very frequent and were used primarily against the Iraqis dug in along the Iraqi Saudi border.

Gunshot wounds were most often due to high velocity firearms. There were many missions in which jet airplanes and helicopters strafed the enemy with 20-mm and .50-caliber missiles. In addition to the air war, Dunnigan and Bay stated, “The 100 hour war accomplished a lopsided coalition victory and made the lopsided casualty rates possible.” The air war started on January 17, 1991 and continued until March 2, 1991. Our forces flew more than 112,000 sorties, dropped more than 88,000 tons of bomb, and it is estimated that they either killed or injured 150,000 Iraqi ground troops.

Four days after the air war started, in January, the first Scuds were fired by Saddam Hussein into Riyadh. The Scud originated in 1951 in Russia and was very similar to the German V-2 rocket. It was a short-range rocket and had a maximum range of approximately 180 miles. The Iraqis modified these rockets, which included the AL-HUSSEIN. They also developed the AL-HIJARAA, which was a shortened HUSSEIN and the AL-ABBAS, which was an extended range Scud fired from fixed launching sites that was never used. Scuds were responsible for many of the coalition deaths outside of Iraq and Kuwait. Forty-two Scud missiles were fired into Israel. They killed one Israeli directly and one Saudi security guard. Tragically, 28 members of the Pennsylvania National Guard were killed when one struck the United States Army barracks in Dhahran, Saudi Arabia. In total, there were 46 Scuds fired into Saudi Arabia during the conflict. In addition to the deaths, there were several instances of injuries caused by a Scuds when they struck apartment buildings and other buildings within Riyadh. Most of the injuries were not directly from the bomb, but from collapse of buildings and debris.

Figure 1 shows a wounded US soldier who was wounded when his “buddy” dropped a hand grenade that had already had the pin removed. It rolled under the driver seat of the Humvee where this patient was sitting, and it exploded. This caused extensive damage to his buttocks, an open fracture of his left hip, and injury to the rectum. A colos-
tomy was done, multiple debridements were carried out, and open reduction internal fixation of his left hip was necessary. Figure 2 shows a Saudi soldier (sergeant) who ran out on the battlefield to pick up his lieutenant, who had been struck by a bullet. As he was returning, a .50-caliber machine gun missile struck his left hip, destroying the entire acetabulum and proximal femur. This was debrided multiple times and disarticulation was performed; however, he ultimately had to have a hemipelvectomy on his left side. Near the end of the war, many Iraqi prisoners of war were brought in from the desert for treatment of high velocity injuries. None of these involved the torso because those patients succumbed in the desert. Many of them were already infected and the only recourse was amputation in many cases. It is noteworthy that at the hospital where I was assigned, there were only 2 patients with burns. Both of these soldiers had 30% body surface area partial thickness injuries. Neither soldier required grafting.

Unfortunately, vehicular accidents occur frequently during combat. One soldier had his arm out the window of a truck when it rolled over, causing an injury to his left brachial artery. This required a saphenous vein graft. Another casualty was an obstetrician gynecologist who was serving as a battalion surgeon. He was severely injured when a deuce and a half rolled over, causing severe brain injury. He was ventilated and had extensive subarachnoid hemorrhage and diffuse axonal injury. He was transferred to Landstuhl on postinjury day 11, but he later died in a CONUS hospital. There were at least 2 instances in which soldiers were injured because they had been sleeping underneath military vehicles at night. It is cold in the desert and they sought some relief from the cold underneath these vehicles. Unfortunately, when started up the next morning, people did not check, and at least 2 injuries occurred that I am aware of.

BODY ARMOR

Armor has been used in warfare and conflicts since 1400 BC. Early armor consisted of leather, metal, chainmail, and steel plates. More recently, plastics have been used (Kevlar [Du Pont]) and ceramic fibers. The United States military used armor in the Revolutionary War, The Civil War, World War I, and World War II. Military and law enforcement agencies have a need to find out the performance standards these various materials exhibit. Due to the various different types of projectiles, it is often inaccurate to refer to a particular product as “bullet proof.” Instead, the term “bullet resistant” is generally preferred. The United States National Institute of Justice Ballistic Instruments is an example of broadly accepted standards. Although Kevlar was used in the first Gulf War, there was insufficient data to tell whether Kevlar was effective. It was subsequently found that Kevlar did not stop and completely protect the soldier from high velocity rifle injuries, armor piercing bullets, high energy fragments from mortars and artillery, or rifle propelled grenades, to name a few. Ceramic plates were added to the Kevlar vest, but even this addition of protection is not foolproof. It is also noteworthy that these vests do not protect certain areas of the body such as the lower part of the forehead, face, upper neck, groin area, lower abdomen, and of course both arms and both legs. However, there is no question that personal armor has prevented mortality in our soldiers.

Body armor is fairly effective, and this is depicted in Figure 3. In Figure 3, the soldier has multiple fragment wounds to his left upper extremity, but there is a well de-
fined cut-off as one moves on to the chest wall, which is the area protected by the body armor. Figure 4 depicts a soldier who was hit by a rocket-propelled grenade to his right pectoral area and triceps on the right arm. This soldier was not completely protected and sustained significant wounds. Other areas of the body that are still vulnerable are shown in Figure 5. Figure 5A shows bilateral lower leg amputations with tourniquets placed. The legs and arms are especially vulnerable. Figure 5B shows a sniper rifle injury through both hemispheres of the fore brain. This bullet exited below the Kevlar helmet. Facial wounds are common for sniper fire (Fig. 6). Snipers are also able to hit the high neck area, which is shown in Figure 7A. This patient had C5/6 quadriplegia. The missile entered the right side of the base of the neck and is visible in the left axilla (Fig. 7B). The AK-47 missile is show in Figure 7C. This was removed because of contamination by clothing.

OPERATION ENDURING FREEDOM/OPERATION IRAQI FREEDOM

After the bombing of the Twin Towers in New York City on September 11, 2001, almost a month later, on October 7, 2001, President George Bush addressed the Joint Session of Congress and in essence declared war on the insurgents in Afghanistan. His intent was to destroy the terrorist training camps and the infrastructure within Afghanistan that condoned the Al Qaida leaders and to stop terrorist activities in Afghanistan. Subsequent associated Operation Enduring Freedoms included the Philippines, Operation Enduring Freedom in the Horn of Africa, Operation Enduring Freedom Pankisi Gorge, Operation Enduring Freedom Trans-Sahara, Operation Enduring Freedom Caribbean and Central America, and Operation Enduring Freedom Kyrgyzstan.12,13 In addition to these conflicts was the conflict that occurred in Iraq from March 20, 2003 to December 18, 2011, entitled Operation Iraqi Freedom. The number of soldiers killed in action and wounded between Operation Enduring Freedom and Operation Iraqi Freedom is shown in Table 2. In the next few pages of this article, I will point out the changes made in combat casualty care that have led to a standard of care that is second to none.

CHANGES IN WOUNDING AGENTS

In addition to the weapons used in the first Gulf War, there was remarkable evolution to more destructive weapons epitomized by the introduction of the improvised explosive device (IED). Although land mines, booby traps, and other devices have been used to kill, maim, or cause psychological issues, IEDs are particularly noteworthy. Initially, the IEDs were made up of Russian land mines left over from the 1980 Russo-Afghan War. During the March to Baghdad, multiple ammunition depots were discovered but not emptied and were left unguarded. The consequence was that insurgents captured these ammunitions and quickly made
them into IEDs. The typical IED would be 1 to 3 155-mm Howitzer shells, which were altered to have a detonator that was either hooked to a telephone that could be used to explode it remotely or it was armed with a pressure switch so that when a soldier or vehicle went over the pressure switch, it exploded. It is possible with a 3-Howitzer shell device to tip over an Abrams tank. A single shell can destroy a Humvee and obviously seriously maim or kill infantry soldiers. A photograph of a number of IEDs that have been liberated by US soldiers is shown in Figure 8A, and a 155-mm Howitzer shell with a detonator that will be triggered by the phone is shown in Figure 8B. In Figure 8C, a typical IED is lying alongside the road in a plastic garbage bag, and the wires can be seen exiting in the upper left part of the picture. More recently, IEDs have been made with ammonium nitrate, which comes from Pakistan, and typically they contain 1,000 pounds of this substance. In addition, shaped charges are obtained by the insurgents from Iran. It is noteworthy that soldiers can go on patrol in the MRAP (Mine Resistant Ambush Protected) vehicle, which is superior to the Humvee in protecting the occupants.

**BLAST INJURIES**

Blast injury is caused by a direct blast peak overpressure measured by the magnitude of sudden pressure rise over ambient pressure. In addition, there are indirect blast...
wind drag forces, which are measured by wind velocities. There are 3 types of blast injuries. Primary blast injury is due to the blast wave, which primarily damages air-containing organs. There may well be injury to tissue either by injury to the microcirculation or small vessels due to shear forces. Secondary blast injury is a penetration of the body from fragments, usually as a consequence of the dynamic overpressures. Tertiary blast injury is displacement of the body as a whole and includes traumatic amputation, concussions, and contusions to tissue. Figure 9A shows a blast in a forest. One can see the primary blast wave as a halo around the incendiary cloud. Figure 9B shows injuries to the intestines of an animal. Figure 9C shows extensive hemorrhage to the lung. Figure 9D shows contusion to the right ventricle, and the right atrium has shear injury and streaks of blood within the fat surrounding the myocardium.

These definitions of blast injury are somewhat imprecise, particularly with current armor that protects the soldier to some extent. We also do not have complete understanding of the pathophysiology of the primary blast effect. The brain is particularly susceptible to overpressure waves, which may cause shear injury to the neurons and microvascular bed. Similarly, these shear forces may cause damage to muscles, particularly in closed compartments. In my experience, it is remarkable that at the first debridement, some muscle appears pink and twitches when electrocautery is applied. At the next debridement, the muscle is pale, edematous, and no longer responds to stimulation by the electrocautery unit. In many ways, this justifies the repeated washout and debridements at every step of their evacuation from war zone to CONUS.

**Table 2. Killed and Wounded in Operation Iraqi Freedom and Operation Enduring Freedom**

<table>
<thead>
<tr>
<th>Conflict</th>
<th>Date</th>
<th>Killed, n</th>
<th>Wounded, n</th>
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<tr>
<td>Operation Iraqi</td>
<td>March 20 to December 18,</td>
<td>4,085</td>
<td>32,226</td>
</tr>
<tr>
<td>Freedom</td>
<td>2011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation Enduring</td>
<td>October 7, 2001 to the</td>
<td>1,657</td>
<td>10,313</td>
</tr>
<tr>
<td>Freedom</td>
<td>present</td>
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**BURN WOUNDS**

Burn wounds can be particularly devastating and are still quite common. Tragically, some soldiers are trapped in a burning Humvee and sustain 90% to 100% full-thickness injury and associated ventilation injury. It may even be associated with traumatic amputations, which will only compound mortality and morbidity issues (Fig. 10A). Burn patients have benefitted from so-called hypotensive resuscitation. The primary resuscitation guideline is urine output, and is kept at 0.5 mL/kg/hour. Bronchoscopy is routinely performed if there are char marks around the face and escharotomy will be necessary for all limbs and torso to relieve increased subcutaneous pressures between the eschar and the muscle fascia. Figure 10 (B, C, D) shows
typical burn wounds and escharotomy incisions. It should be emphasized that in some cases, not only escharotomy is performed, but fasciotomy may be necessary. Soaked dressings of 5% sulfamylon solution are placed on the wounds.

Almost all severely burned soldiers are returned to the Institute of Surgical Research (ISR) at Brooke Army Medical Center. Burn injuries still occur in 5% to 20% of all soldiers.

Figure 8. (A) A photograph of a number of improvised explosive devices (IEDs) that have been liberated by US soldiers. (B) A 155-mm Howitzer shell with a detonator that will be triggered by the phone. (C) A typical IED is lying alongside the road in a plastic garbage bag, and the wires can be seen exiting in the upper left part of the picture.

Figure 9. (A) A blast in a forest. One can see the primary blast wave as a halo around the incendiary cloud. (B) Injuries to the intestines of an animal. (C) Extensive hemorrhage to the lung. (D) Contusion to the right ventricle and the right atrium has shear injury and streaks of blood within the fat surrounding the myocardium.


TORSO WOUNDS

Torso wounds are not as common compared with their incidence in other conflicts. This is due to the protective armor that each soldier wears. When torso wounds are seen, they can be caused by blast injury, where the soldier becomes part of the tertiary blast. They can also be caused by high energy or velocity shrapnel or debris that penetrates the armor. Blunt force injuries can also cause internal organ injuries, particularly to the lungs, liver, kidneys, and spleen. They are often associated with multiple fractures, including the spine and pelvis. Figure 11 (A, B) depicts a terrible injury to the groin and pelvis from an IED. This is a relatively unprotected area of the body. This soldier had injuries to the genitalia, rectum, and bladder. Figure 11B shows the symphysis pubis diastasis with the surgeon’s finger pointing at a bladder injury. Figure 11C shows his open pelvic fracture on x-ray.

In many instances, damage control to the abdomen may be necessary (Fig. 12). If abdominal closure is not performed, wound vacuum-assisted closures (VACs) may be placed temporarily. In some instances, thoracotomy or sternotomy may be required to control hemorrhage within the lungs, and in rare circumstances, to treat penetrating wounds to the heart. Pneumonectomy used to have a very high mortality. Recently a portable extracorporeal circulation membrane oxygenation (ECMO) or the Novalung have been used to rescue soldiers from remote areas and take them to Landstuhl or Regensburg, where they are weaned from these devices.

EXTREMITY INJURIES

Extremity injuries are the most common injuries treated in modern warfare. If possible, the primary priority is to try to salvage limbs or to minimize the amount of tissue that has to be debrided. However, the axiom “life over limb” is still in place. All open fractures are treated with external fixators, as shown in Figure 13 (A, B, C). Figure 13C shows an incomplete fasciotomy as compared with Figure 13A. If there is an injury to an artery, temporary shunting can be accomplished (Fig. 13D). In many instances, the vein is repaired or shunted as well until the patient can be transferred to a higher echelon of care. Wound VACs are used
extensively after multiple debridements. Wound VACs (Fig. 14) do well with transportation and are particularly useful in reducing the need to do repeat amputations because they tend to minimize the amount of recession of the skin up the extremity.

**EVACUATION**

Figure 15A shows the evacuation route currently used by the military. Figure 15B shows the helicopter rescue units in Afghanistan. This undoubtedly accounts to a great degree for the short time from wounding to surgery.

**RESEARCH**

Fortunately, combat care teams have been doing research in-theater. This is a very positive change since Desert Storm. There have been a number of studies on new tourniquets and development of guidelines for their use. Each soldier carries 2 tourniquets and they must all be able to be put on with 1 hand.

There have been some very interesting studies on resuscitation and the appropriate ratios of component management and the use of fresh whole blood. Component treatment is most effective with a 1-to-1-to-1 ratio (packed red blood cells/fresh frozen plasma/platelets). Not surprising to many surgeons is the advantage of having fresh whole blood to resuscitate patients who require massive transfusions. This obviously requires attaining the blood from walking donors in-theater.

Figure 11. (A) A terrible injury to the groin and pelvis from an improvised explosive device (IED). This soldier had injuries to the genitalia, rectum, and bladder. (B) The symphysis pubis diastasis with the surgeon’s finger pointing at a bladder injury. (C) The patient’s open pelvic fracture on x-ray.

Figure 12. Damage control to the abdomen may be necessary.
Hemostatic adjuncts have been studied in depth. The fibrin sealants still have a role in controlling parenchymal bleeding from solid organs. They may even have a role in muscle bleeding and in some instances, will control the ooze from bone. Based on research, some dressings have been removed from the pharmaceutical armamentarium. One of the most interesting studies was carried out by Joe DuBose and colleagues,16 and was presented at the American Association for the Surgery of Trauma in 2010. They looked at patients with isolated severe traumatic brain injuries. This was a retrospective study comparing patients treated in-theater with those treated in trauma centers in the United States. The Abbreviated Injury Score was 3 or greater, and they obtained 604 matched patients from the Joint Theater Trauma Registry and compared these with patients from the National Trauma Data Bank. Patients were 18 to 55 years old and had penetrating and blunt injuries. There were remarkable differences between the 2 groups. Operative interventions were 3 times more in-theater compared with in civilian practice. Intracranial pressure monitoring was used 10 times more in-theater than it was in civilian practice. Craniotomy was double the rate of that in civilian practice, and craniectomy had almost a 20-fold difference between the military and the National Trauma Data Bank patients. Overall mortality was 3 times greater in the National Trauma Data Bank patients vs the Joint Theater Trauma Registry patients. There are many possibilities on how these differences could occur. The bottom line is that our soldiers are getting excellent care and there is a need to improve care for civilian injuries in a prompt manner and use practice guidelines.

**REHABILITATION**

I would be remiss not to mention postinjury care that is now being provided to our soldiers. There have been multiple changes to improve outcomes and the ability to ambulate. We have guidelines that state that one should try to conserve as much soft tissue and length of the extremity as possible. Modern prosthetics restore athletic ability and day-to-day walking. Hand and arm prosthetics are also being improved, allowing patients to work and do sports.
Some soldiers return to active duty after an amputation. Rehabilitation for traumatic brain injury is somewhat problematic secondary to the high volume of patients and limited resources in the Veterans Administration.

**SUMMARY**

There have been many positive changes in combat casualty care since Desert Storm. The Air Force has made a major change and significant improvement in combat casualty care, which is aided by the United States Army and Navy. The current care is second to none, including rehabilitation. This improvement in care and outcomes is due to the dedication of the doctors, nurses, corpsmen, pilots, and the incredible support services that make it happen.

**REFERENCES**