

PERSPECTIVE

NOTES OF A SURGEON

Casualties of War — Military Care for the Wounded from Iraq and Afghanistan

Atul Gawande, M.D., M.P.H.

Each Tuesday, the U.S. Department of Defense provides an online update of American military casualties (the number of wounded or dead) from Operation Iraqi Freedom and Operation Enduring Freedom.¹ According to this update, as of November 16, 2004, a total of 10,726 service members had suffered war injuries. Of these, 1361 died, 1004 of them killed in action; 5174 were wounded in action and could not return to duty; and 4191 were less severely wounded and returned to duty within 72 hours. No reliable estimates of the number of Iraqis, Afghans, or American civilians injured are available. Nonetheless, these figures represent, by a considerable margin, the largest burden of casualties our military medical personnel have had to cope with since the Vietnam War.

When U.S. combat deaths in Iraq reached the 1000 mark in September, the event captured worldwide attention. Combat deaths are seen as a measure of the magnitude and dangerousness of war, just as murder rates are seen as a measure of the magnitude and dangerousness of violence in our communities. Both, however, are weak proxies. Little recognized is how fundamentally important the medical system is — and not just the enemy's weaponry — in determining whether or not someone dies. U.S. homicide rates, for example, have dropped in recent years to levels unseen since the mid-1960s. Yet aggravated assaults, particularly with firearms, have more than tripled during that period.² The difference appears to be our trauma care system: mortality from gun assaults has fallen from 16 percent in 1964 to 5 percent today.

We have seen a similar evolution in war. Though firepower has increased, lethality has decreased.

In World War II, 30 percent of the Americans injured in combat died.³ In Vietnam, the proportion dropped to 24 percent. In the war in Iraq and Afghanistan, about 10 percent of those injured have died. At least as many U.S. soldiers have been injured in combat in this war as in the Revolutionary War, the War of 1812, or the first five years of the Vietnam conflict, from 1961 through 1965 (see table). This can no longer be described as a small or contained conflict. But a far larger proportion of soldiers are surviving their injuries.



It is too early to make a definitive pronouncement that medical care is responsible for this difference. With the war ongoing and still intense, data on the severity of injuries, the care provided, and the outcomes are necessarily fragmentary. But from the data made available for this report and discussions with surgical teams that have returned home, a suggestive picture has emerged. It depicts a military medical system that has made fundamental — and apparently effective — changes in the strategies and systems of battle care, even since the Persian Gulf War.

One key constraint for planners has been the limited number of medical personnel available in a voluntary force to support the 130,000 to 150,000 troops fighting in Iraq. The Army is estimated to have only 120 general surgeons on active duty and a similar number in the reserves. It has therefore sought to keep no more than 30 to 50 general surgeons and 10 to 15 orthopedic surgeons in Iraq. Most have served in Forward Surgical Teams (FSTs) — small teams, consisting of just 20 people: 3 general surgeons, 1 orthopedic surgeon, 2 nurse anesthetists, 3 nurses, plus medics and other support

Lethality of War Wounds among U.S. Soldiers.*			
War	No. Wounded or Killed in Action	No. Killed in Action	Lethality of War Wounds %
Revolutionary War, 1775–1783	10,623	4,435	42
War of 1812, 1812–1815	6,765	2,260	33
Mexican War, 1846–1848	5,885	1,733	29
Civil War (Union Force), 1861–1865	422,295	140,414	33
Spanish-American War, 1898	2,047	385	19
World War I, 1917–1918	257,404	53,402	21
World War II, 1941–1945	963,403	291,557	30
Korean War, 1950–1953	137,025	33,741	25
Vietnam War, 1961–1973	200,727	47,424	24
Persian Gulf War, 1990–1991	614	147	24
War in Iraq and Afghanistan, 2001–present	10,369	1,004	10

* Data are from the Department of Defense.^{1,3}

personnel. In Vietnam, only 2.6 percent of the wounded soldiers who arrived at a surgical field hospital died, which meant that, despite helicopter evacuation, most deaths occurred before the injured made it to surgical care.⁴ The recent emphasis on leaner, faster-moving military units added to the imperative to push surgical teams farther forward, closer to battle. So they, too, were made leaner and more mobile — and that is their fundamental departure from previous wars.

Each FST is equipped to move directly behind troops and establish a functioning hospital with four ventilator-equipped beds and two operating tables within a difficult-to-fathom 60 minutes. The team travels in six Humvees. They carry three lightweight, Deployable Rapid Assembly Shelter (“drash”) tents that can be attached to one another to form a 900-ft² facility. Supplies to immediately resuscitate and operate on the wounded arrive in five backpacks: an ICU pack, a surgical-technician pack, an anesthesia pack, a general-surgery pack, and an orthopedic pack. They hold sterile instruments, anesthesia equipment, medicines, drapes, gowns, catheters, and a handheld unit allowing clinicians to obtain a hemogram and measure electrolytes or blood gases with a drop of blood. FSTs also carry a small ultrasound machine, portable monitors, transport ventilators, an oxygen concentrator providing up to 50 percent oxygen, 20 units of packed red cells, and six roll-up stretchers with

their litter stands. Teams have forgone angiography and radiography equipment. (Orthopedic surgeons detect fractures by feel and apply external fixators.) But they have sufficient supplies to evaluate, and perform surgery on, as many as 30 wounded soldiers. They are not equipped, however, for more than six hours of postoperative intensive care.

The 274th FST is led by a 42-year-old surgical oncologist who was my chief resident when I was a surgical intern. He went to West Point, Johns Hopkins Medical School in Baltimore, Brigham and Women’s Hospital in Boston for surgical residency, and then M.D. Anderson Cancer Center in Houston for a fellowship. He was known in training for three things: his unflappability, his intellect (he’d already published 17 papers on work toward a breast-cancer vaccine), and the five children he and his wife had during residency. He owed the Army 18 years of service when he finally finished his training, and neither I nor anyone I know ever heard him bemoan that commitment. In 1998, he was assigned to Walter Reed Army Medical Center in Washington, D.C., where he practiced surgical oncology. Then, in October 2001, after the September 11 attacks on the World Trade Center and the Pentagon, he and his team were sent with the first troops into Afghanistan. He returned after service there only to be sent to Iraq, in March 2003, with ground forces invading from Kuwait through the desert to Baghdad.

The 274th FST traveled 1100 miles with troops over the next four months, setting up in Nasiriyah, Najaf, Karbala, and points along the way in the southern desert, then in Mosul in the north, and finally in Baghdad. According to its logs, the unit cared for 132 U.S. and 74 Iraqi casualties during that time (22 of the Iraqis were combatants, 52 civilians). Some days were quiet. Others, overwhelming. On one day in Nasiriyah, the team received 10 critically wounded patients, among them 1 with right-lower-extremity shrapnel injuries; 1 with gunshot wounds to the stomach, jejunum, and liver; another with gunshot wounds to the liver, gallbladder, and transverse colon; 1 with shrapnel in the neck, chest, and back; 1 with a gunshot wound through the rectum; and 2 with extremity gunshot wounds. The next day, 14 more casualties arrived.

On the arrival of the wounded, teams carry out the standard Advanced Trauma Life Support protocols that civilian trauma teams follow. However, because of the high incidence of penetrating wounds — 80 percent of casualties seen by the 274th FST had gunshot wounds, shrapnel injuries, or blast

injuries — lifesaving operative management is required far more frequently than in civilian trauma centers. Today, military surgical strategy aims for damage control, not definitive repair, unless it can be done quickly. Teams pack off liver injuries, staple off perforated bowel, wash out dirty wounds — whatever is necessary to stop bleeding and control contamination without allowing the patient to lose body temperature or become coagulopathic. Surgeons seek to limit surgery to two hours or less, and then ship the patient off to a Combat Support Hospital (CSH), the next level of care. Abdomens can be left open, laparotomy pads left in, bowel unanastomosed, the patient paralyzed, sedated, and ventilated. For this approach to be successful, however, control of air space and major roadways and establishment of the next-level hospital (achieved early in Iraq but delayed in Afghanistan) are essential.

Two CSHs with four sites now exist in Iraq. These are 248-bed hospitals with six operating tables, some specialty surgery services, and radiology and laboratory facilities. Mobile hospitals, too, they arrive in modular units by air, tractor-trailer, or ship and can be fully functional in 24 to 48 hours. Even at the CSH level, the goal is not necessarily definitive repair. The maximal length of stay is intended to be three days. The policy is to transfer any American soldier who requires more to a level IV hospital — one was established in Kuwait, one in Rota, Spain, and one in Landstuhl, Germany. If expected to require more than 30 days of treatment, wounded soldiers are to be transferred home, mainly to Walter Reed or to Brooke Army Medical Center in San Antonio, Texas. (Iraqi prisoners and civilians, on the other hand, receive all their care in Iraq.)

It is a system that took some getting used to. Surgeons at every level initially tended to hold on to their patients, either believing that they could provide definitive care themselves or not trusting that the next level could do so. According to statistics from Walter Reed, during the first few months of the war, it took an injured soldier an average of eight days to go from the battlefield to a U.S. facility. Gradually, however, surgeons have embraced the wisdom of the system. The average time from battlefield to arrival in the United States is now less than four days. (In Vietnam, it was 45 days.)

One airman with devastating injuries from a

mortar attack outside Balad on September 11, 2004, was on an operating table at Walter Reed just 36 hours later. In extremis from bilateral thigh injuries, abdominal wounds, shrapnel in the right hand, and facial injuries, he was taken from the field to the nearby 31st CSH in Balad. Bleeding was controlled, volume resuscitation begun, a guillotine amputation at the thigh performed. He underwent a laparotomy with diverting colostomy. His abdomen was left open, with a clear plastic bag as covering. He was then taken to Landstuhl by an Air Force Critical Care Transport team. When he arrived in Germany, Army surgeons determined that he would require more than 30 days' recovery, if he made it at all. Therefore, although resuscitation was continued and a further washout performed, he was sent on to Walter Reed. There, after weeks in intensive care and multiple operations, he did survive. This is itself remarkable. Injuries like his were unsurvivable in previous wars. The cost, however, can be high. The airman lost one leg above the knee, the other in a hip disarticulation, his right hand, and part of his face. How he and others like him will be able to live and function remains an open question.



As lifesaving as the new strategies have been, teams have been forced to confront numerous unanticipated circumstances. The war has gone on far longer than planned, the volume of wounded soldiers has increased, and the nature of the injuries has changed. Blast injuries from suicide bombs and land mines — improvised explosive devices (IEDs), in military lingo — have increased substantially and have proved particularly difficult to manage. They often combine penetrating, blunt, and burn injuries. The shrapnel include not only nails, bolts, and the like, but also dirt, clothing, even bone from assailants. Victims of IED attacks can exsanguinate from multiple seemingly small wounds, even those in the back. Teams have therefore learned to pack the bleeding sites before laparotomy or other interventions are performed. And they are now performing serial operative washouts to ensure adequate removal of infectious debris.

Surgeons also discovered a dismayingly high incidence of blinding injuries. Soldiers had been directed to wear eye protection, but they evidently found the issued goggles too ugly. As some soldiers put it, “They look like something a Florida senior

citizen would wear.” So the military bowed to fashion and switched to cooler-looking Wiley-brand ballistic eyewear. The rate of eye injuries has since decreased markedly.

Still, for many new problems, the answers remain unclear. Early in the war, for example, Kevlar vests proved dramatically effective in preventing torso injuries. Surgeons, however, now find that IEDs are causing blast injuries that extend upward under the armor and inward through axillary vents. Blast injuries are also producing an unprecedented burden of what orthopedists term “mangled extremities” — limbs with severe soft-tissue, bone, and often vascular injuries. These can be devastating, potentially mortal injuries, and whether to amputate is one of the most difficult decisions in orthopedic surgery. Military surgeons have relied on civilian trauma criteria to guide their choices, but those criteria have not proved reliable in this war. Possibly because the limb injuries are more extreme or more often combined with injuries to other organs, attempts to salvage limbs following the criteria have frequently failed, with life-threatening blood loss, ischemia, and sepsis.

Every other Thursday, surgeons at Walter Reed hold War Rounds by telephone conference with surgeons in Baghdad to review the American casualties received in Washington during the previous two weeks. The case list from October 21 provides a picture of the extent of the injuries. There was one gunshot wound, one antitank-mine injury, one grenade injury, three rocket-propelled-grenade injuries, four mortar injuries, eight IED injuries, and seven patients with no cause of injury noted. The least seriously wounded of these patients was a 19-year-old who had sustained soft-tissue injuries to the face and neck from a mine and required an exploration of the left side of the neck. Other cases involved a partial hand amputation; a hip disarticulation on the right, through-knee amputation on the left, and open pelvic débridement; a left nephrectomy and colostomy; an axillary artery and vein reconstruction; and a splenectomy, with repair of a degloving scalp laceration and through-and-through tongue laceration. None of the soldiers were more than 25 years of age.

Late complications have emerged as a substantial difficulty as well. Surgeons are seeing startling rates of pulmonary embolism and deep venous

thrombosis, for example, perhaps because of the severity of the extremity injuries and reliance on long-distance transport in management. Initial data show that 5 percent of the wounded at Walter Reed have had a pulmonary embolism, resulting in two deaths. The solution is not obvious. Using anticoagulants in patients with fresh wounds and in need of multiple procedures would seem unwise. On the other hand, there is no facility or expertise in Iraq for the routine placement of inferior vena cava filters.

Injured soldiers from Iraq have also brought an epidemic of multidrug-resistant *Acinetobacter baumannii* infection to military hospitals. It is not known how this has occurred. No such epidemic ap-

peared among soldiers from Afghanistan, and whether the drug resistance is being produced by antibiotic use or is already carried by the strains colonizing troops is still being debated. Regardless, data from 442 medical evacuees seen at Walter Reed showed that 37 (8.4 percent) were culture-positive for acinetobacter — a rate far higher than any previously experienced. The organism has infected wounds and prostheses and caused catheter-related sepsis in soldiers and, through nosocomial spread, in at least three other hospital patients. Medical evacuees from Iraq are now routinely isolated on arrival and screened for the bacteria.

These are just the medical challenges. Perhaps the most pressing difficulties arise from the changing conditions of the war. Medical teams were designed and outfitted for lightning-quick, highly mobile military operations. The war, however, has proved to be slow-moving and protracted. To adapt, CSHs have had to be converted into fixed facilities. In Baghdad, for example, the 28th CSH took over and moved into an Iraqi hospital in the Green Zone. This shift has brought increasing numbers of Iraqi civilians seeking care, and there is no overall policy about providing it. Some hospitals refuse to treat civilians for fear that some may be concealing bombs. Others are treating Iraqis but find themselves overwhelmed, particularly by pediatric patients, for whom they have limited personnel and few supplies.

Requests have been made for additional staff members and resources at all levels. As the medical needs facing the military have increased, however, the supply of medical personnel has gotten tighter.



Many surgeons have been on a second deployment or an extended deployment, and even this has not been sufficient. As a result, military urologists, plastic surgeons, and cardiothoracic surgeons have been tasked to fill some general surgeon positions. Planners are having to contemplate pressing surgeons into yet a third deployment.

Compounding the difficulties, none of these realities have made it appealing to sign up as a military surgeon. Interest in joining the reserves has dropped precipitously. President George W. Bush has flatly declared that there will be no draft. However, the Selective Service, the U.S. agency that maintains draft preparations in case of a national emergency, has recently updated a plan to allow the rapid registration of 3.4 million health care workers 18 to 44 years of age.⁵ The Department of Defense has indicated that it will rely on improved financial incentives to attract more medical professionals. Whether this strategy can succeed remains unknown. The pay has never been competitive. One now faces a near-certain likelihood of leaving one's family for duty overseas. And without question, the work is dangerous.

The nation's military surgical teams are under tremendous pressure, but they have performed remarkably in this war. They have transformed the strategy for the treatment of war casualties. They have saved the lives of an unprecedented 90 percent of the soldiers wounded in battle. And they have

done so under extraordinarily difficult conditions and with heroic personal sacrifices.

One surgeon deserves particular recognition. Dr. Mark Taylor began his Army service in 2001, to fulfill the terms of his military scholarship to attend medical school several years before. He, like many, was deployed twice to Iraq — first from February through May 2003 and then from August 2003 through the following winter. On March 20, 2004, outside Fallujah, four days from returning home to Stockton, California, the 41-year-old surgeon was hit in a rocket-propelled-grenade attack while making a telephone call outside his barracks. Despite his team's efforts, he could not be revived.

None among us have paid a greater price.

From the Department of Surgery, Brigham and Women's Hospital, and the Department of Health Policy and Management, Harvard School of Public Health — both in Boston.

1. U.S. casualty status. Washington, D.C.: Department of Defense, 2004. (Accessed November 17, 2004, at <http://www.defenselink.mil/news/casualty.pdf>.)
2. Harris AR, Thomas SH, Fisher GA, Hirsch DJ. Murder and medicine: the lethality of criminal assault 1960-1999. *Homicide Stud* 2002;6:128-66.
3. Principal wars in which the United States participated: U.S. military personnel serving and casualties. Washington, D.C.: Department of Defense, 2004. (Accessed November 17, 2004, at <http://web1.whs.osd.mil/mmid/casualty/WCPRINCIPAL.pdf>.)
4. Whelan TJ Jr. Surgical lessons learned and relearned in Vietnam. *Surg Annu* 1975;7:1-23.
5. Pear R. U.S. has contingency plans for a draft of medical workers. *New York Times*. October 19, 2004:A22.