Innovations From a Decade of War

Soldiers' Final Sacrifice Has Improved Emergency Care

By ERIC BERGER

Special Contributor to Annals News & Perspective

Since the beginning of the war in Afghanistan in October 2001 and the Iraq War in March 2003, the US Department of Defense says there have been more than 2,000 US military deaths in Afghanistan and more than 4,400 in Iraq. In the 2 wars combined, there have been an additional 40,000 US soldiers injured. These are by far the largest military casualty numbers since the 1975 end of the Vietnam War, when an estimated 47,000 US soldiers died.

The war on terrorism during the last decade has thus produced terrible hardship and suffering in young men and women who were at the prime of their lives and health. For emergency medicine, however, the wars have also provided a trove of information about best practices in medical care for patients with the most urgent needs.

"These wonderful young men and women have made a great sacrifice," said Vikhyat S. Bebarta, MD, an emergency physician, medical toxicologist, and lieutenant colonel in the US Air Force. "Their great sacrifice has produced great achievements for medical care. The war isn't about the medical care we give, of course; it's about the soldiers whose stories we'll never read and the sailors who arrive home draped in a flag. Their sacrifices have tremendously advanced our knowledge of trauma and emergency medicine."

Ten years of war have advanced knowledge of battlefield medicine and how to care for patients with traumatic wounds and have also led to the translation of that information back to emergency departments (EDs) in the United States, in the form of tourniquets, blood transfusions, burn treatments, and a host of other types of care.

It has ever been so in war.

During the War of 1812, for example, while there were still no specially designated vehicles for the transport of wounded or sick soldiers, medics were moved closer to the battlefield, where they could treat patients. By the Civil War, the Union Medical Department began implementing the use of customized horse-drawn wagons as ambulances and created a corps of stretcher bearers and ambulance wagon attendants. A system of triage was implemented to deliver care based on the intensity of need. By 1864, President Lincoln had signed a law mandating the use of an ambulance service throughout the military.

"Following the Civil War, several hospitals throughout the country maintained the ambulance services they had created to transport soldiers of the conflict," concluded Vincent D. Robbins, president and chief executive officer of the Monmouth Ocean Hospital Service Corporation in New Jersey, in his *A History of Emergency Medical Services & Medical Transportation Systems in America*.

In 1865, the Commercial Hospital and Lunatic Asylum, currently known as Cincinnati General Hospital, created what medical historians generally agree was the first regular ambulance service for the general public in the United States. Similar services soon were established in other cities, such as Atlanta and New Orleans.

So it was in more recent wars as well, with World War I accelerating the use of blood transfusions, World War II having a similar effect on antibiotics, the Korean War debuting helicopter evacuation, and the Vietnam War helping to bring about such innovations as advanced trauma life support.

It was the latter war that really spurred development of the concept of EDs in hospitals, said Sudip Bose, MD, an emergency physician and former major in the US Army who served in the Iraq War.

"Advanced trauma life support was developed after we discovered that there was a better chance of survival if someone suffered an injury in Vietnam than if they were in a car accident in the streets of Los Angeles," Dr. Bose said, agreeing with Dr. Bebarta that improved medical care is one of war's few silver linings. "Despite the horrors of war, there is a glimmer of hope in the form of medical innovation. Because of the sacrifice of the wounded in combat, we learn from those injured heroes, and as a result more people in the future generations survive. For example, in the Korean War, if a soldier suffered an amputation he was guaranteed to die. Today we have essentially erased extremity trauma as a source of death if the patient receives medical care in an adequate timeframe."

LESSONS LEARNED

Physicians who served in Iraq, including Dr. Bose and Dr. Bebarta, cite a host of medical lessons learned from combat there since 2003.

Foremost among those, they say, was an increased realization of the value of tourniquets because most combat deaths physicians were seeing were due to exsanguination. During World War II, Dr. Bebarta said, tourniquets were viewed as a good thing, but they fell out of favor during the Vietnam War because they were believed to be killing people. But their value was recognized again during the Iraq War, and

eventually all soldiers deployed carried tourniquets with them. Dr. Bebarta said tourniquets played a major part in reducing mortality during the war.

The war experience has led to improvements in tourniquets, as well as development of entirely new kinds for use in areas other than body limbs.

American troops enter combat in Iraq and Afghanistan well armored in vests that use lighter, stronger ceramic plates that absorb the force of a bullet's impact by shattering. Adapting to this, insurgents began to aim below a soldier's armor, where the trunk of a body meets the legs, causing soldiers to bleed to death by injury to the body's largest blood vessels. Tourniquets don't fit around the proximal femoral artery, noted Richard Schwartz, MD, chairman of the Department of Emergency Medicine in the Medical College of Georgia at Georgia Health Sciences University.

Dr. Schwartz was thinking about this problem while attending an American College of Emergency Physicians meeting in the middle of the 2000s and listened to a presentation on the use of a knee pressed into the midabdomen to slow bleeding and block blood flow to the legs. "We saw some data presented by researchers who had placed weight on volunteers' abdomens; they essentially had externally cross-clamped the aorta, which allowed them to protect the brain, blood, and kidneys," said Dr. Schwartz, who served as command surgeon, Task Force 185 Aviation in the US Army in Iraq in 2004. "We thought about how we could do this without kneeling on the casualty, which perhaps was not a tactically feasible approach."

What Dr. Schwartz's group came up with was a tourniquet that could go around the abdomen where the aorta splits into the iliac artery, a bladder that inflates and creates pressure over the aorta, cross-clamps, and isolates the blood supply of the upper body from the lower body. With their initial prototype, in a study that used a pig model, the researchers wanted to address the questions of whether inflation of the device would cause ischemia to the bowels, raise potassium to dangerously high levels, or cause other problems. It did not, and the physicians moved forward with tests in humans, in whom the device worked.

With those results in hand, Dr. Schwartz said he was able to obtain premarket approval from the Food and Drug Administration, and he hopes to have their abdominal aortic tourniquet for sale in the summer of 2012. He said he already has orders from the Department of Defense. He also plans to explore the possibility of using the device in civilian medicine, perhaps to treat cardiac arrest.

Without the war, he said, he never would have developed the device. "If there wasn't a conflict, I don't think so," he said. "These injuries are relatively infrequent. One innovation leads to another. This particular device has some potential resuscitation applications that we're going to be looking at that will be much more applicable to emergency care down the road. That's really rewarding, and it's something that probably would have not come about without the original question being asked about the combat environment."

THE MANY INNOVATIONS FROM WAR

The changing nature of tourniquet usage is just one of many innovations made on the battlefields of Iraq and Afghanistan during the last decade.

Another significant change is the concept of one-to-one blood transfusions because military experience in both the Iraq and Afghanistan Wars suggested that a high fresh frozen plasma:packed RBC transfusion ratio improved outcomes. Dr. Bebarta, who served as chief of emergency medicine at the American military hospital in Balad, Iraq, and later held a similar title at the American hospital in Bagram, Afghanistan, said the military experiences with whole blood transfusions have led to a tremendous amount of interest and funding for civilian transfusion studies.

Much of the groundwork for these studies was laid in initial, large studies at the American military hospital in Baghdad, where Todd Baker, MD, served as chief of emergency medicine from late 2007 to early 2009. "A big thing I brought back with me to the United States is the concept of blood first," said Dr. Baker, who is co–medical director of Skaggs Regional Medical Center in Branson, MO. "We don't give fluid any more in trauma, we replace blood with blood. For some people, this has been a huge hurdle to get over, but we found that whenever you lose blood you need to replace it with blood instead of giving fluids to raise their blood pressure. This dilutes their blood. In theory and in the past, we've thought that helps the patient, but it doesn't really help the patient."

Transportation of patients is another area of care that has been radically changed since the Vietnam War. During that conflict, at times it took patients 12 weeks to get home for advanced care. Now an Air Force team with an emergency or critical care physician can transport patients to a hospital in Germany in 12 hours, Dr. Bebarta said. He believes this model of critical care air transport could be applied to US medical care during hurricanes, earthquakes, and other natural disasters.

The list goes on: advances in diagnosing traumatic head injuries, use of hemostatic dressings such as QuickClot, the use of thoracic ultrasonography to detect a small pneumothorax when computed tomography scans are not available, intraosseous resuscitation, a changing paradigm for treating burn patients after seeing a tremendous number of large body-surface area burns, and so on. Many of the above technologies are being implemented in EDs and emergency medical services systems around the country, physicians say.

EMERGENCY MEDICINE IN THE BATTLEFIELD

The wars represented a major step forward for the field of emergency medicine in another way, Dr. Bebarta said. The Vietnam War led stateside hospitals and medical leaders to recognize the value of lifesaving care shortly after injuries were incurred and helped facilitate the development of emergency medicine as a recognized specialty. The Iraq and Afghanistan Wars, then, marked the first time residency-trained emergency physicians were widely involved in combat care. "Emergency physicians really have played a large role in delivering care in these wars, and they have done a lot of good," Dr. Bebarta said.

That work, in turn, gave some emergency physicians a greater appreciation for the sacrifices made by soldiers serving their country. "To be honest, and believe me I know this sounds like a cliché, but I've got 2 sets of heroes in my life now," Dr. Baker said. The first set was the medics who

worked with us in Baghdad. They're 18- to 20-year-old guys and girls, and they don't have that much medical training, and they saved lives out there every day. They were doing advanced trauma life support by themselves. It just blew me away how good they were. I couldn't imagine doing that out of high school.

"My second group of heroes are the combat guys out in the field. You watch a movie and you see soldiers running around and making selfless sacrifices for their buddies, and you think that's just Hollywood. But it blew me away how many times I saw guys turn around and run into a burning building or refuse to be evacuated until all the other guys were out. The behavior was absolutely amazing. It was a privilege to take care of them."

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Automated External Defibrillator Regulations Threaten Wider Use

States Grapple With Disparate Regulatory Approaches

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Automated external defibrillators (AEDs) seem to be everywhere, from ballparks to airports, but the patchwork of regulations meant to encourage their lifesaving use may actually be hampering them.

Most states have regulatory schemes describing how owners of AEDs in public places must maintain them, register them with local emergency responders, and ensure that potential users are trained. Business owners worried that they can't meet the regulatory requirements—or concerned about the potential for legal liability—are keeping their AEDs locked away, advocates complain.

Elizabeth Hunt, MD, a physician in the Johns Hopkins Pediatric Intensive Care Unit, told a Maryland legislative committee in February that her unit treats children who could have benefited from an AED in the field, but the unit was locked away. "I know of several groups that today do not have the AEDs . . . ready to use because they haven't yet gotten their staff trained on how to use it," Dr. Hunt testified. "They are afraid they will be sued by someone if they use it wrong since they are not in compliance with the laws."

"When there is an AED nearby but it is locked up so no one can get to it, or no one remembers it is there and the child dies . . . . [T]his is an absolute travesty," she said.

The Maryland legislature considered a bill that would ease the training requirement in state law for owners of AEDs in public places. The Maryland Institute for Emergency Medical Services Systems maintains an AED registration program, which includes training requirement for all "expected responders."

That requirement is one of the reasons AEDs are locked away, argued Dr. Hunt and Myron Weisfeldt, MD, chair of the Department of Medicine at Johns Hopkins University School of Medicine. "We should be encouraging training in every way we possibly can, short of making the person buying the AED legally responsible for seeing that the training is done," he argued.

EASY TO USE

Because the devices are so simple to use—and there are many people with medical training who already know how to use them—Dr. Weisfeldt said there should be minimal training requirements to encourage as many people as possible to step up and use an AED in the crucial few minutes after a cardiac arrest. Dr. Weisfeldt is lead author of an article evaluating the Resuscitation Outcomes Consortium, which involved a population base of 21 million people, of whom 13,769 experienced out-of-hospital cardiac arrests. Survival was 9% with bystander cardiopulmonary resuscitation but no AED compared with 38% with AED shock delivered.[1]

Maryland SB461, the subject of the hearing, did not move forward, in part because of opposition from Maryland regulators, who maintain that it's better for AEDs to have a plan in place so that the devices are well maintained and usable when needed.

"We look at the literature, which says that AEDs can be very effective, but that is dependent on somebody picking up the device and using it, the device working, and also an appropriate and timely interface with the local EMS [emergency medical services] system," said Bob Bass, MD, an emergency physician and executive director of the Maryland agency. "Our public program is set up to address those issues."

AED purchasers register with Maryland Institute for Emergency Medical Services Systems (MIEMSS) at no charge and receive reminders every 3 years to check batteries and pads and ensure that they train individuals to use the devices.