At the MSTC facility in Fort Lewis, Washington, there's a downed helicopter.
Image credit: Computer Sciences Corporation.

Care Under Fire

Medical simulation has gone mainstream in recent years. Here are some examples of how virtual worlds, intelligent dummies, and other technologies are being applied to military-specific healthcare challenges. **Rick Adams** explains.

Care under fire. It's an odd phrase for a unique situation. When we think of medical care, the frantic call to 911, the typical injury patient has about 60 minutes, "the golden hour," to get to the hospital and be treated before serious complications might set in.

On the battlefield, there's far less time and far more complications. The first 10 minutes, sometimes fewer, are critical after a gunshot or shrapnel wound. And there's no well-equipped ambulance to serve as a mobile stabilizing room enroute to the ER. The combat medic has only what he's able to carry on his back during a mission. And while he's trying to focus on preventing his buddy from dying, the medic may also be dealing with hostile fire, oppressive heat or numbing cold, fierce winds, and blinding sand.

Injuries from roadside IEDs (improvised explosive devices) and car bombs, rocket-propelled grenades, and mortars account for more than half the combat deaths in Afghanistan and Iraq. Lessons learned from the early months of those conflicts indicated corpsmen were not prepared to treat such injuries and were therefore less effective in applying their full medical skills.

In contrast to civilian medical treatment, the warfighter's procedures are different in two significant ways. "Fire suppression is a responsibility of the medic before, during, and after treatment," explains Nick Guerra. The other fundamental difference is the order of priorities. "In civilian situations, the focus is ABC – airway, breathing, circulation. In combat, circulation comes first. You have to have coagulation so the soldier doesn't bleed to death." Guerra is the CSC training director for the US Army's Medical Simulation Training Centers (MSTC).

The Army now has 20 MSTCs around the globe, 14 in the US and 6 overseas, with plans for 4-6 more in 2008. Since the first one opened only two years ago, more than 40,000 medical and non-medical personnel have been trained in first responder skills. Why non-medical? When you're the first one on the scene of an injury, you become the default medic, at least until someone more qualified arrives. Guerra says

It All Started With SAM

SAM was a bit on the clammy side, and his expression was always the same. But he had a good heart – at least when he was hooked up to a power source. And he always played his role like a veteran.

Which he was, in a sense, since SAM was born at the Veterans Administration teaching hospital in Palo Alto, California.

I had the privilege of working with SAM, short for Simulated Anesthesiology Mannikin, and his creator Dr. David Gaba in the early 90s. SAM was the first commercial manifestation of computerized simulation in medicine, a tool to train crisis management scenarios in the operating room. He was a modest marketing success, and several SAM clones are still used around the world today. But his significance was in establishing the initial acceptance of simulation technology as viable for healthcare training.

"Today, simulation is being more and more incorporated into the fabric of healthcare organizations. Simulation is now in just about every school of medicine and school of nursing," notes Dr. Gaba, who still looms large as editor in chief of the field's first peer-reviewed journal – Simulation in Healthcare – and as

other services and agencies have trained at the MSTCs as well – Air Force, Navy, Marine Corps, Coast Guard, US Marshals Service, National Park Service, civilian firefighters, and law enforcement. "Saving lives is pretty important to them all."

The operative term for the MSTC training is "under fire." The centers use manikins to represent wounded soldiers. But the setting is not a sterile operating room where trainees can leisurely practice sewing sutures on the dummy on the gurney. "We try to create as realistic an environment as they will have on the battlefield," says PJ Penny, CSC account training manager. Lighting is low, punctuated by strobe flashes. Smoke is pumped in. They hear the sounds of small arms and artillery all around. (After some of the initial training, "we had to back off on the sounds; they were a little too realistic!") At Fort Lewis, Washington, in the MSTC facility's backyard, there's a downed helicopter, burning vehicles, and trenches, so trainees must navigate their way around and over obstacles while carrying the 200-pound "patient" on a stretcher.

The METI and Laerdal manikins not only simulate breathing, dilating pupils, pulse, heart sounds, and collapsed lungs, they bleed. And if an arm or leg has been blown off, it will gush dark red "gooey" dye until the trainee properly applies a tourniquet to stop the bleeding. "This is some of the most exciting training I've seen in 40 years," exclaims Guerra. "The scenarios are rigorous, exhaustive, and eerily similar to what soldiers might encounter on an actual battlefield."

In addition to the heightened realism, the purpose behind the MSTCs is to standardize the Army's CMAST (Combat Medical Advanced Skills Training) and CLS (Combat Life-Saver) curricula … and in a non-sterile setting. Dr. Jim Blake, program executive officer for the Army's PEO STRI, says the ultimate goal is "to emulate the operating environment in training while stressing the warfighter."

According to a US Army War College research project by Col. Richard Thomas, "Ensuring Good Medicine in Bad Places," one in every eight injured troops (9 percent) has died of wounds during Operation Iraqi Freedom, compared with one in four (24 percent) during Korea, Vietnam, and the first Gulf War, and one in three during World War II. "An important contributor to improved survivability is the enhanced training for Army combat medics in caring for trauma victims," Thomas states. "It is the skills of a combat medic (or other 'first responder') that determines the outcome for most of the wounded." Through the

MSTC program, the Army hopes to reduce the "died of wounds" rate on the order of 70 to 90 percent.

The training program has even contributed to a new item for the first aid field kit, according to CSC's Penny. Medics struggled during the course with a dressing packet that stops internal bleeding – it took both hands to apply and tie. A new bandage was developed that can be applied with one hand - in fact, a soldier can even place it over his own wound.

VR in the ER

When Dr. Claudia Johnston, associate vice president for special projects at Texas A&M University – Corpus Christi, set out on a quest for funding to develop a multi-user healthcare training tool based on video game technology, "the standard grant sources looked at me and laughed. If you use the word 'game,' they don't take you seriously." Fortunately, the congressman for the 27th District, Solomon Ortiz, "instantly understood the concept." Ortiz asked if Johnston's "learning platform," as it is now termed, could be used for military applications, and her answer was, "Of course!"

Enter the Office of Naval Research and funding now approaching US $10 million for what is expected to be the most realistic virtual representation yet of a real-world

Pulse!! users can listen to their virtual patient's thoracic sounds in stethoscope mode.
Image credit: Texas A&M University - Corpus Christi

healthcare environment. The Pulse!! Virtual Clinical Learning Lab project (yes, two exclamations) is currently running test protocols at Yale University, Johns Hopkins School of Medicine, and the National Naval Medical Center in Bethesda, Maryland. The target is to make Pulse!! available for student training in early 2009. "I'm unwilling to release it for use until we've thoroughly

Director of the Center for Immersive and Simulation-based Learning at Stanford University School of Medicine. He is a founding member of the Society for Simulation in Healthcare (SSH), which has about 2000 members.

One significant trend over the past decade, Gaba says, is development of training devices in the $30-35,000 range. "These do on the order of 70 percent of the more expensive [$200,000-plus] simulators, so the features-to-price ratio has gone up." They're also easier to program and easier to use.

Gaba is disappointed, however, that the capabilities of the higher-end manikin-based simulators "haven't improved enormously" in the dozen or more years since SAM came to life. "Airways are still not as realistic as they need to be, and some body systems are not modeled at all." The medical simulation pioneer would also like to see an obese manikin for physician training that reflects "our more and more morbidly obese population."

In the military arena, Gaba sees growing interest in simulators that can represent traumatic brain injury, as well as applications for chemical/radiological/nuclear exposure.