

Bioengineering on Front Lines In Assessing, Treating War-Related Brain Trauma

Special Panels at the Annual Event Examine Challenges, Opportunities

The medical challenges presented by modern warfare struck home at AIMBE'S Annual Event in Washington, DC, during February – and were answered with views of the promise medical and biological engineering hold for addressing the war's physical impact on soldiers.

During *AIMBE-Military Collaboration: Bioengineering Challenges of Brain Trauma*, a day-long seminar at the National Academy of Sciences in which a team of military and civilian experts, including several AIMBE Fellows, looked at important new technologies addressing what has been called the “signature wound” of the war on terrorism.

The session was the brainchild of AIMBE Fellow Warren Grundfest, M.D., F.A.C.S., a professor at the University of California, Los Angeles. He wanted to provide a forum for AIMBE members and other leaders in the field of medical and biological engineering to discuss this important topic and identify the most important areas for future work. Grundfest spearheaded AIMBE's co-sponsorship of the event with the U.S. Army Medical Research and Materiel Command's Telemedicine and Advanced Technology Research Center (TATRC).

TATRC's Chief Scientist, Kenneth C. Curley, M.D, was Grundfest's partner in planning the event and assembling its panel of more than 20 distinguished speakers. TATRC is responsible for a broad array of advanced and developing technologies to meet military medicine requirements.

In Afghanistan and Iraq, body armor saves many soldiers from fatal injuries they might have suffered in earlier conflicts, but the head remains vulnerable. Aside from ongoing work to improve protective equipment, military healthcare providers face a two-fold challenge – identifying and assessing the extent of brain trauma from attacks on the battlefield, then treating the injury effectively once a soldier reaches a hospital.

Army COL Geoffrey Ling, M.D., Ph.D., noted that traumatic brain injury (TBI) “has always been there” – historically accounting for 15-20 percent of battle-related casualties. In the past, Ling said, it was often assumed that a soldier would die from a severe head injury, but new technologies and procedures allow military doctors to focus on brain trauma treatments and save many of their patients.

“Mild TBI” – often resulting from a blast shockwave, with no visible head injury – also is a concern, according to Ling, who is Program Manager in the Defense Sciences Office of the Defense Advanced Research Projects Agency. “We don't know what that number is,”

he said, but estimated that 25-40 percent of soldiers in Iraq and Afghanistan may have suffered a closed head injury.

Navy Commander Jack Tsao, M.D., D.Phil., Associate Professor of Neurology at the Uniformed Services University of the Health Sciences, noted that one of the greatest head injury threats in the current war comes from improvised explosive devices (IEDs), the “roadside bombs” often cited in news accounts. He cited statistics from Walter Reed Army Medical Center showing that, as of summer 2007, 30 percent of patients requiring medical evacuation for battle-related injuries from the war zone to Walter Reed had TBI.

Tsao noted that, while penetrating head injuries are typically identified and cared for immediately, “non-penetrating, or closed, TBI’ (where there is no piercing of the skull) may be missed when more visible injuries to other body parts require immediate attention.

Touching on another theme, Tsao noted that, “There is an overlap between PTSD (post-traumatic stress syndrome) symptoms and mild traumatic brain injury symptoms.” During the program, several other speakers also touched on the on-going discussion of how best to identify that line so that patients can receive appropriate treatment.

Much of the discussion was devoted to the appropriateness – and portability – of various imaging technologies in assessing the different types of brain injuries suffered by soldiers.

Ling noted that field-capable diagnostics are needed to help assess the true extent of injuries and manage prompt treatment in the field. “You can’t wait for a radiologist,” he said. “You need simple, deployable diagnostics devices at the point of care.”

Tsao pointed out that imaging at major field hospitals in the war zone is limited to X-Ray and CT scanning, and examined efforts to improve TBI detection through use of portable CT, MRI, TCD, NIRS, or other methods.

Mark S. Cohen, Ph.D., of the University of California, Los Angeles, discussed the development of a new approach to magnetic resonance imaging (MRI) that will greatly reduce the size, weight, cost and complexity, improving access both in combat support and in health management of injured soldiers, many of who require followup imaging.

Rather than detect the magnetic resonance signals by electromagnet induction, the device Cohen described uses Superconducting Quantum Interference Detectors (SQUIDs) as pickups. These allow the MRI unit to operate effectively at very low magnetic field strengths. MRI is particularly important in the followup of concussive incidents that may lead to TBI.

Cohen said MRI is generally acknowledged to be both more sensitive and more specific in assessing such injuries, but that practical problems such as cost, scheduling and

transport limit its use. He believes that the Ultra Low Field MRI will mitigate these problems.

Alisa D. Gean, M.D., Professor of Radiology, Neurology and Neurological Surgery at the University of California, San Francisco, and Chief of Neuroradiology at San Francisco General Hospital, stressed the importance of portable imaging equipment in reducing the stress patients endure in being moved from their beds to a separate room with fixed imaging devices.

She also said CT equipment is superior to MRI technology in assessing many of the war's most prevalent injuries – particularly when a patient has been peppered with shrapnel from an IED.

Gean said mobile equipment is easy to operate, can be run from a conventional 120-volt wall outlet or even a battery, is compact and does not require shielding of the room, performs axial and coronal images quickly, and can provide CTA and 3D images.

Several speakers said they support proposals to collect MRIs of the brains of all soldiers when they enter the military, to serve as benchmarks against scans taken later when brain trauma is thought to have been suffered on the battlefield.

Curley praised the session as “an opportunity for national leaders in the fields of neurotrauma diagnostics and therapeutics to meet, exchange ideas and obtain feedback from their biomedical engineering colleagues.”

“Development of medical technologies is increasingly multidisciplinary,” Curley noted. “The AIMBE session resulted in valuable feedback from experts across many disciplines regarding what technologies are most promising and how they might best be further developed.”