

An Insidious Enemy: Mild Traumatic Brain Injury

By Barbara Stahura

The number of traumatic brain injuries (TBIs) continues to mount and take its toll on warfighters in Iraq and Afghanistan. While severe TBIs took the spotlight in the beginning, mild TBIs (mTBIs), which affect far greater numbers, are finally beginning to receive the attention they deserve.



Photo by Air Force Staff Sgt. Brian Ferguson

The human brain could well be one of the most complex objects in the universe. This 3-pound chunk of gelatinous tissue crackles with miniscule jolts of electricity and roils with internal chemicals to produce our every thought and action, magnificent and mundane alike. Yet despite its workhorse, life-long stamina, the brain is as delicate as an egg yolk. Floating within the skull, it can be damaged by a blow that sends it bouncing against the rough bones. Even a whack to the head that leaves not the slightest

mark can injure brain tissue. Obviously, a penetrating head wound can cause great harm. But what happens to a brain in proximity to a blast fierce enough to toss around a 25-ton armored personnel carrier? What damage does it sustain when a roadside explosion creates gigantic waves of pressurized air, followed by a blast wind of amazing force that rips past the body encasing it? And what occurs within its fragile structures in response to repeated blasts, as is happening to troops deployed over and over in Iraq and Afghanistan?

We don't exactly know. Not yet. But we do know that damage is being done. The evidence is internalized within the brains of an estimated 20 percent – 300,000 – of the 1.5 million U.S. service members who have so far served in this war. Many victims of traumatic brain injury show no outward sign, such as a head wound, and may not have been diagnosed, since military personnel tend to shake off “little” problems like being knocked unconscious for a short time. TBI, now the signature wound of this war, is a most insidious enemy.

TBI in civilians often results from vehicle accidents, sports, falls, domestic or street violence, gunshots, and even shaken baby syndrome. In addition to many of these causes, warfighters also face the added factors of grenades, high-velocity missiles, mortar and artillery shells, land mines, and antitank weapons. Furthermore, in the urban war zones of this war, another deadly cause quickly appeared after the U.S. invasion: the improvised explosive device, or IED – insurgent-crafted bombs of terrifying power that troops can encounter almost anywhere at any time.

No one – not the Bush administration, the Department of Defense (DoD), or the Department of Veterans Affairs (DVA), and certainly not the troops – was prepared for this kind of weapon on this scale. Only slowly did awareness dawn that brains exposed to these blasts were quite literally rattled in harmful ways. On the plus side, the preponderance of these blast-induced neurotraumas has led to ramped-up research on brain injuries and could eventually lead to improved prevention as well as care after the fact, for military and civilian victims alike. On the negative side – well, there are many negatives.

These TBIs are different

TBI is so far known to come in three types: subdural hemorrhage, in which veins around the brain tear; contusion, which is a bruise on the brain; and diffuse axonal injury, where brain cells are stretched by changing pressure. In addition, TBIs are categorized as mild, moderate, or severe. While a severe TBI can leave a person totally incapacitated for life, even a mild one can cause irreparable harm, though it is less obvious and much harder to diagnose and treat. Sometimes, an mTBI is called a concussion, which can be serious, despite belief to the contrary. A concussion is really “an energy crisis in the brain,” explained Beth Pearson, senior research associate at the Hood Center for Children and Families of Dartmouth Medical School, who has studied TBI in battered women and is part of Dartmouth's Mild Traumatic Brain Injury Program for Maine National Guard members returning from Iraq and Afghanistan. “The brain needs more glucose and can't access it or use it effectively. A concussion starts a cascade, affecting metabolism in the brain.”

In the war's early years, severe TBI got everyone's attention. That made sense: These devastating, often very visible injuries could not be ignored. But as time went on, and IEDs continued their deadly work, more troops were exposed to blast waves, often repeatedly. Only more recently have mTBIs in warfighters begun to attract notice (typically, mTBIs account for 80 to 90 percent of all TBIs).

The human damage from IEDs often has more to do with the physics of air pressure on a human body than with hurtling projectiles. A blast's resulting pressure waves – more than 1,000 times atmospheric pressure – travel 1,600 feet per second for hundreds of yards and are followed by a huge volume of air rushing back after being displaced by the explosion. This massive double wave can defeat even the best helmet or body armor now available, simply passing through them to the fragile body beneath, damaging or killing organs and structures. When they affect the brain, cognitive and motor system deficits result. The usual imaging scans do not reveal this kind of brain injury, which can be permanent.

“The wave that hits them and its major impact is much different from a sports concussion, which is a one-time insult to the brain,” said Sandy Schneider, Ph.D., director of Vanderbilt University's Bill Wilkerson Center Pi Beta Phi Rehabilitation Institute, which is partnering with Fort Campbell, Ky., to treat returning troops with TBI. “With blast injuries, we just don't know yet, but intuitively it makes sense that the neurochemistry of the brain is affected. Our brains are very sensitive to any changes, especially neurochemically. We know that hormones affect brain behavior, as does adrenaline, drugs of any kind. We know that atmospheric pressure changes in ADHD [attention deficit hyperactivity disorder] or learning-disabled children cause behavioral changes. It then makes sense that a pressure wave to the degree that IEDs create would cause some neurochemistry changes, and it is usually more than one incident with the soldier. So while it is speculation – meaning we don't have the research to prove this – it is a good possibility.”

Even if left without a scratch, people nearby a blast can suffer massive concussions, resulting in unconsciousness plus permanent problems such as blindness, deafness, amnesia, and a decrease in intelligence. Lesser neurological deficits include short-term memory loss, stuttering, behavioral changes, the inability to handle basic reading and math, fuzzy reasoning, shortened attention spans, confusion, anxiety, headaches, irritability, and depression. They may also face a boosted risk for Alzheimer's disease in later years.

Unlike a more severe brain injury, in mTBI, “effects at the time of trauma might not manifest right away,” said Dr. Ibolja Cernak, who began studying blast-induced neurotrauma during the Balkan Wars of the 1990s and is now a neurologist at the Johns Hopkins Applied Physics Lab. “It might take months or years, in a cascading effect, where injuries amplify each other.”

She suspects that blast damage follows a vascular pathway, with the kinetic energy of the blast traveling through blood vessels to the brain. “This could explain why so much of the damage is manifested from the cerebellum,” she said, “with balance and gait problems, respiratory problems, very unstable blood pressure.”

Furthermore, the cumulative effect of repeated exposure “acts on an already desensitized brain so that a much smaller power [of

Opposite: Staff Sgt. John Womack plays the game “Blokus” on June 27, 2008, with Rebekah McLean, speech language pathologist. The game is used by medical personnel at the Traumatic Brain Injury and Neuro Rehab-Center at the post's Womack Army Medical Center, Fort Bragg, N.C., to help patients with memory and speech problems by strengthening problem-solving and reasoning skills.

a blast] can cause greater damage,” Cernak explained. Even worse, statistics show that someone who suffers a TBI is more likely to incur another one.

Are new mTBI screenings working?

Five years into the war, military doctors have learned that even troops far away from a blast should be suspected of having significant neurological injuries. However, at this point, given the limited knowledge and care available, some warfighters with blast-induced neurotrauma may not fully recover, according to Ronald Glasser, M.D., a former Army physician in Vietnam who continues to follow military medicine and is the author of *Wounded: Vietnam to Iraq*.

“[Doctors] know what to do when you hit your head in an accident on the highway,” he said, “but I’ve had a neurosurgeon tell me it’s better to take a bullet through the head than to be struck by a blast wave.”

DoD has recently instituted mandatory pre- and post-deployment screenings designed to provide a snapshot of brains before and after blast exposures. The first test includes “looking at performance on reaction time, memory, how they learn. It gives a baseline of how people function before injury,” said Lt. Col. Michael Jaffee, national director of the Defense and Veterans Brain Injury Center (DVBIC), created in 1992 in a collaborative effort of DoD and the DVA. DVBIC, and the Defense Centers of Excellence for Psychological Health & Traumatic Brain Injury, has been developing clinical practice guidelines for TBI with all three military services and civilian experts.

Service members also receive field-testing for TBI and are “tested for lingering symptoms when they come out of theater,” said Kathy Helmick, deputy director, division of clinical and educational affairs at DVBIC. “Landstuhl [Germany, DoD’s Regional Medical Center] began screening for TBI in May 2006, with DVIBC consulting on how to do that.”

Another important screening test is MACE, or Military Acute Concussion Evaluation, a five-minute test that has been deployed in theater since 2006. It provides for triage and treatment for presumed concussion – particularly important when there may be no outward sign. DVBIC is also using or researching imaging technologies that look for physical diagnostic markers of TBI, such as functional MRI, diffuse tensor imaging, and other emerging techniques, according to Jaffee.

In a holistic approach, DVBIC is also developing TBI education for military families and caregivers, and researching protection, mitigation for prevention, and rehab techniques for maximum recovery.

Jaffee added that it is most important for military personnel themselves to be aware of symptoms of mTBI and concussion, and to know they should seek medical attention. “The spirit and will of service members in theater is to suck it up and carry on,” he said. “So we target commanders [with educational information] so service members will get the care they need.”

In 2007, the Army launched its “chain-teaching” program to teach soldiers and their families about the signs and symptoms of TBI and PTSD (post-traumatic stress disorder). More recently, it issued a new requirement that all soldiers who experience dizziness or loss of consciousness from a blast, fall, or collision receive immediate medical attention.

However, despite the heroic efforts of DVBIC, others are doubtful about the efficacy of some pre- and post-deployment screenings. In one instance, the Government Accountability Office found that the DVA was struggling to best determine the validity and clinical

PDAs and TBI

When a traumatic brain injury (TBI) means you can’t remember to take your meds, how to get to work, or even how to brush your teeth, what do you do? You can stress your spouse. Overmedicate or fail to take necessary drugs. Or you might just give up altogether. On the other hand, you could use a personal digital assistant (PDA) to help the parts of your memory that no longer function well.

Some innovative rehabilitation programs are training military TBI survivors to use PDA as memory aids. One such program is run by Tony Gentry, Ph.D., assistant professor and director of the Assistive Technology for Cognition Laboratory at Virginia Commonwealth University (VCU). The program, run by VCU’s occupational therapy program, is part of the DVA polytrauma network.

Having used PDA with civilian TBI patients for a decade, Gentry was ready to begin with military personnel when they began appearing at VCU. Today, he said, PDAs “are standard in the kit bag for occupational therapists who work with brain injury.”

Using a PDA as a memory and task-sequencing aid has allowed people with TBI to be more independent and live more normal lives. For many, it has also improved their marriages since a person “doesn’t have to rely on a spouse to play parent anymore,” he said.

Tired of waiting for fancy gizmos from brain injury research labs, Gentry uses off-the-shelf Palm Pilots, Timex® Data Link watches, and sometimes cell phones; many are equipped with WiFi and GPS. They can be set to beep when meds are due or an appointment is scheduled. They can guide someone around town. With additional software, a therapist can program the device to display the steps of any routine, sequenced behavior, like tooth brushing or assembly line work, using photos, video, and voice commands.

In one instance, said Gentry, a young Iraq war veteran with TBI had to take a bus to work during his job trial. Due to PTSD, he believed the driver was dodging a bomb every time the bus pulled to the curb, so he would begin screaming and have to get off. On his own initiative, he programmed his PDA with a repeating, soothing message that reminded him he was safe and to keep taking calming breaths. He now plays it continuously during his rides and can make it to his destination.

“Sometimes, people grow out of their need to use a PDA,” said Gentry. But for whatever time they have to depend on them, these inexpensive and easy-to-use electronic tools are providing dignity and independence to many people living with brain injury.

For more information, see Consortium for Handheld Technology at www.vcu.edu/partnership/pda or call 804-828-3397.



The 4th Infantry Division will receive an internally mounted TBI helmet sensor before its deployment to Iraq this fall.

accuracy of its own screening tool for mTBI, months after the tool was implemented.

“How do you decide if someone is just mean or angry, or just had a tough time, or is brain damaged?” asked Glasser. “What about those pre-deployment tests? You put Xs in the wrong box, and they won’t let you patrol” – meaning that the test-takers might lie or deny their condition in order to not let down their buddies or harm their careers.

Pearson agreed that the current screening for TBI, for which warfighters answer questions about themselves and their injury history, is “almost useless. It’s not predictive of how they really are. It’s not as simple as asking if you were exposed to a blast and how you felt.”

Other elements not considered in these screenings, but which should be, according to Schneider, are “who goes into the service?

The infantry? Who has the military mindset to be told what to do and not do? Some of them have learning disabilities, some are troubled kids. They’re a different person to begin with. Some of these behaviors play a role, too.”

Under Secretary for Health for the Veterans Health Administration Dr. Michael Kussman said, in a separate interview for this publication, that while all new veterans coming into DVA are screened for TBI and PTSD, screening tools are still being perfected.

“What we’re finding so far is that, when you screen everybody, there’s a percentage [that] will be false positive on the screens, but the screens are deliberately loose, if you will. This is because we’d rather have false positives than false negatives. You then go to a secondary screening and ultimately, if need be, neuro-cognitive testing. The important thing about identifying these conditions early is not that there’s any magic about it, or a pill or medication to give, but rather that we can now put these people into a registry and follow them, and see what happens over years to see if they do indeed get back to normal.”

Efforts for better care continue

Efforts are still under way to get more and better medical care for all veterans of Iraq and Afghanistan, with special emphasis on those with TBI and PTSD. Rep. Bill Pascrell (D-N.J.), co-chairman of the Congressional Brain Injury Task Force, was recently instrumental in obtaining reauthorization of the Traumatic Brain Injury Act through 2011, with \$1 billion from DoD. This is the only federal law that specifically authorizes programs to support individuals with TBI, both civilian and military. The act extends services and establishes new studies to register brain-injured veterans of this war.

As pleased as he was about the reauthorization, Pascrell said, “If they had listened to me three years ago, we would have screened our guys and gals before they went over there then. We were not at all prepared for the signature wound of this war. We did not properly equip vehicles or helmets. How could we have known?”

In August, presidential nominee Sen. Barack Obama and Sen. Evan Bayh, D-Ind., along with eight other senators, signed a letter to Defense Secretary Robert Gates asking for expanded medical coverage and care

About BrainTrain, Inc. and Veterans

BrainTrain, Inc., has devoted itself to helping people with head injuries since 1989. This family-owned company was founded by Dr. Joseph Sandford, a professional computer programmer turned neuropsychologist, who began his clinical career working with head-injured patients in a VA hospital. Now, after nearly 20 years, the Captain's Log Cognitive Training System, which he began developing at that time, is used world-wide and has been validated in hundreds of research studies.

BrainTrain was among the very first companies to pioneer software for improving people's cognitive abilities. Through a series of highly systematized, challenging exercises, the mind is stimulated to build new connections, restoring mental fitness and often transforming people's lives. The Captain's Log "games" range from simple tasks that can be used shortly post-coma, to exercises that challenge high functioning adults. The system provides over 2,000 hours of training in attention, working memory, conceptual reasoning, processing speed, and more.

Recently, BrainTrain has released SmartMind™, a system that integrates brain wave biofeedback with Captain's Log. Based on published clinical research, this combination approach intensifies the training effect significantly.

BrainTrain's "Captain's Log at Home" system can be used independently on its own, or, for better results, can be integrated with the professional system. The clinician can use his professional version of the software to build a training protocol, then export the protocol for the client to use on a daily basis at home.

In 2007, BrainTrain received a pivotal phone call. A VA psychologist asked if one of his clients, a veteran of the Iraq war, could get the software but defer paying for it until his benefits became available. Hearing of this, Dr. Sandford launched a campaign, still ongoing, to give away the software free to veterans of Iraq and Afghanistan. BrainTrain is proud to have given away over a half million dollars in software to these veterans.

for veterans with brain injuries. Specifically, they asked that TRICARE, the military insurance plan, cover cognitive rehabilitation therapy – a critical element of TBI rehab – at outside care facilities.

Glasser and Pearson, along with many others, also insist that veterans with TBI must be able to receive quality care close to home. Traveling many miles to a VA center is often not possible for many TBI survivors. Additionally, the care providers must be experienced in TBI rehab. According to Schneider, "Just hiring bodies can do more harm than good."

In addition, Schneider said an interdisciplinary approach is required, including social workers, physicians, neurophysical therapists, and other specialists.

A great deal still needs to be done to provide the best care possible for military personnel returning from Iraq and Afghanistan with TBI. Even though it will take years to uncover the mysteries of brain injury, especially blast-induced neurotrauma, research is expanding, often in military-civilian partnerships and consortiums.

There has been exciting progress, for example, in medical trials of a blood test to detect and diagnose mild to severe brain injury, according to Col. Dallas C. Hack, director of the Combat Casualty Care Research Program at the Army Medical Research and Materiel Command (MRMC). The test would detect damage to five different types of brain cells, because the different types of cells show damage at different rates, and could be fielded in two to three years. Hack also said that clinical trials of a drug that appears to dramatically reduce some of the effects of brain injury also look promising.

The administration clearly did not anticipate the desperate ferocity with which IEDs would be employed. As one of the signature battlefield injuries of the fighting in Iraq and to a lesser extent, in Afghanistan, TBI is likely to become an increasingly common diagnosis among service members and veterans. While the Department of Defense and the DVA are working to create better diagnostic tools and treatments for TBI and mTBI, much remains to be done in order to provide the very best care for America's warfighters.

For more information:

- Defense and Veterans Brain Injury Institute (DVBIC) – www.dvbic.org or 1-800-870-9244

Mission: to serve active-duty military, National Guard, and reservists, their dependents, and veterans with TBI through state-of-the-art medical care, innovative clinical research initiatives, and educational programs regarding TBI.

- National Veterans Foundation (NVF) – www.nvf.org or 1-877-777-4443

The NVF is committed to continually seeking and developing the most effective means to help those who have served our country and their families. The NVF is open to all who seek emotional support and other assistance.

- The Congressional Brain Injury Task Force – www.pascrell.house.gov/work/braininjury.shtml

The task force is a clearinghouse for information for Congress and the public on traumatic brain injury.

- Dartmouth Medical School Mild Traumatic Brain Injury Program – http://dms.dartmouth.edu/news/2008/05/09_pearson.shtml or 603-650-1492

A joint program among Dartmouth Medical School, the Maine Army National Guard, and others to provide a system of care for Maine service members integrated among community-based health and mental health providers, as well as community and military resources.

- Vanderbilt Bill Wilkerson Center Pi Beta Phi Rehabilitation Institute – www.mc.vanderbilt.edu/root/vumc.php?site=PiBetaPhi or 615-936-5040

Mission: to assist those with traumatic brain injury and other forms of acquired neurological impairments improve their quality of life by improving their communication and cognitive skills, psychosocial skills, and physical independence.