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Traumatic Brain Injury: An Exploding Problem

by Janice Arenofsky

Since the October 2006 attack on her Army unit in Baghdad, Staff Sgt. Linda Brashears cannot fall asleep at night without the comfort of a light, radio and TV. “It was a night of blasts,” the 53-year-old mother from Louisville, Ky., says of the long evening she and other frightened soldiers spent in the unit’s post office.

In the morning, when Brashears poked her head out, the horror still had not stopped. Tear gas and other toxic fumes overwhelmed her.

“It was life-changing,” she says. “Nothing has been the same since.”

The Invisible Wound: ‘Closed’ TBI

Soldiers stationed in Afghanistan and Iraq constantly face the perils of improvised explosive devices (IEDs), rocket-propelled grenades and land mines. The path of destruction often leads to blindness, deafness and catastrophic injuries forcing multiple amputations. In the past six years, officially about 15% of all wounded vets have struggled with a traumatic brain injury (TBI).

Although the U.S. military diagnosed 4,471 TBI cases between October 2001 and September 2007, neurologists have now increased that number substantially. Physicians originally based their statistics on “open” cases of TBI—incidents in which shrapnel entered the skull, spewing blood, brain tissue and other fluids. They failed to factor in “closed” TBIs, which are invisible to the naked eye and number 20,000 cases, reported USA Today.

Counting these, the TBI tally skyrockets, as the Vienna, Va.-based Brain Injury Association of America (BIA, www.biausa.org) found. The BIA estimates that as of March 2007, the TBI count edges closer to the 12,200 mark, but could easily reach 150,000.

All TBIs—whether from IEDs, accompanying debris, burns, falls and/or inhalation of gases and vapors—result from the shake-up and bleeding of the brain.

The reason why closed TBI injuries have become the “signature” malady of recent wars stems from “over pressurization waves” produced upon detonation of IEDs, says Dr. Elaine Date, director of the Palo Alto Polytrauma Rehabilitation Center at Stanford University in California.

The waves travel hundreds of yards at the rate of 1,600 feet per second, writes Ronald Glasser, physician-author of *Wounded: Vietnam-Iraq* (2006), who treated Vietnam troops.

According to the Defense and Veterans Brain Injury Center (DVBIC) in Washington, D.C., the primary blast jostles the brain against the skull; a “secondary wind,” which pushes a tremendous amount of displaced air back into the skull, delivers another shock. The possibility for brain and other traumas multiplies if the explosive force should overturn a vehicle or trigger a fire.

Depending on the extent of neurological damage (mild, moderate or severe), symptoms at the time of impact and later on can include everything from headaches, nausea and memory difficulties to mood changes, cognitive problems and loss of consciousness, according to the Centers for Disease Control and Prevention’s National Center for Injury Prevention and Control.

Brashears says she knew immediately that “something was wrong with me.” Doctors observed her for several weeks for signs of a concussion. But “if you are not bleeding or losing a limb or eyesight,” she says, “you were not medically evacuated.” Later, she developed headaches, short-term memory loss, insomnia, balance problems and dizziness.

Mild TBI: Mistakes and Misdiagnoses

Many times, however, soldiers exhibiting anxiety, depression or irritability fall between the cracks. The symptoms of mild TBI often are taken for signs of post-traumatic stress disorder (PTSD) or a personality disorder. One study recently reported that 40 soldiers at Fort Carson, near Colorado Springs, Colo., were misdiagnosed with personality disorders. Doctors tend to attribute similar symptoms to psychological rather than physical causes, say brain experts.

That is what happened to Brashears. Initially diagnosed with PTSD only, she was not re-evaluated until she returned stateside to Ft. McCoy in Wisconsin. After a routine medical exam, physicians transferred her to Walter Reed Army Medical Center in Washington, D.C., where an MRI showed damage to the left superior cerebellum of her brain.

Brashears was actually relieved to hear the diagnosis of moderate TBI. “I felt vindicated,” she said. “It justified my pain and feelings that something more was there.”

Another factor complicating diagnosis is the common failure of MRIs or CT scans to pick up on brain injuries, especially mild TBIs, says Date. Which is why physicians at Evans Army Community Hospital at Fort Carson are testing single photon emission computerized tomography (SPECT) to determine if this imaging technique might spot more brain injuries.

Date says imaging limitations heighten the importance of screening. “The DVBIC has developed a screening tool to use in the field to detect mild brain injury,” she says. “Questions cover such areas as memory, attention and processing and are very helpful in determining if the soldier should be monitored and tested in greater detail.”

As of April 2007, VA facilities began administering the Military Acute Concussion

Evaluation (MACE). The first section, according to the American Psychology Association, deals with symptoms; the second draws from the Standardized Assessment of Concussion. Depending on the results, patients can be referred to Walter Reed or other DVBIC centers for follow-up.

Screening should help reduce the problem of soldiers and veterans who are unaware of their brain injuries. Take Brett Miller, 31, a U.S. Army sergeant. Miller received medical care for knee, hearing and vision damage, but his TBI went unrecognized for nearly a year.

However, recent results published in the *New England Journal of Medicine* (Aug. 23, 2007) may significantly decrease diagnostic errors such as Miller's. It turns out that hearing loss (tympanic-membrane perforation) is often associated with brain injury, and thus is a good marker for it. The quicker a diagnosis, the better the medical options.

Timing is important. Neurologists now know that the brain possesses a certain flexibility or "neuroplasticity" and can repair and/or retrain itself within a certain window of time, usually up to 24 months following the injury.

"At one time, it was thought there was limited potential for damaged brain cells to recover," Date says. "We now see that with proper early medical management, there is a possibility of regaining a significant amount of function."

Research and Rehab

Moderate and severe head traumas are easier to spot and diagnose. The patient experiences convulsions, seizures or an inability to awaken from sleep, slurred speech, weakness or numbness, loss of coordination and increased confusion, restlessness and agitation.

Fine-tuning a TBI diagnosis as mild, moderate or severe using symptoms at the time of the injury is easier than predicting outcomes, says Barbara Sigford, VHA national program director for Physical Medicine and Rehabilitation Services. "Often, people don't seek help until a crisis comes along, such as the loss of a job or the departure of a family member."

Medical care stabilizes the patient and prevents further injury. Physicians work to control blood pressure, maintain good circulation and ensure enough oxygen flows to the brain. After CT scans and skull and neck x-rays, patients start the arduous process of rehabilitation—physical, occupational, speech and recreational. They also receive psychological counseling and social support.

"We combine high-tech equipment with community-based athletic activities," Sigford says. "Patients are evaluated, and individualized strategies, exercises, devices and medications are used to improve the person's functioning in daily life."

For those who qualify for Vision Restoration Therapy (VRT), an FDA-approved, cutting-

edge treatment devised by the Boca Raton, Fla.-based medical company NovaVision, improvement may be significant.

VRT is being tested at the Tampa (Fla.) Polytrauma Veterans Rehabilitation Center. It draws from the concept of neuroplasticity or self-repair of the brain. Studies show VRT can be 70% effective in restoring vision to TBI patients.

Over a six-month period, eligible patients receive a customized program of brain stimulation based on a computer map of their visual field. Representatives at NovaVision say per-patient cost is approximately \$6,000. They are optimistic that VA will cover the procedure should other VA centers across the country offer the procedure.

Speaking of costs, thanks to a \$3 million grant, the Memorial Hermann/ TIRR Foundation and the Michael DeBakey VAMC in Houston have joined together to offer Project Victory—a no-cost, special rehabilitation program for vets with moderate to severe TBI. The program aims to return 65 vets each year to their maximum level of functioning. One condition is a family member or caregiver must also participate. (Contact Dr. Helene K. Henson, for more information: Henson.Helenek@med.va.gov; (713) 794-7117.)

Beyond rehabilitative exercises, TBI patients also can take positive steps by participating in related research trials. Some trials evaluate different medications, such as sertraline, citalopram, rivastigmine and valproate, for their potential effectiveness.

Others, for example, investigate the efficacy of computerized assessments or the practicality of new helmet designs. Currently, the governmental Web site <http://clinicaltrials.gov> shows more than 60 studies that recruit TBI patients. The trials include everything from gait training and cognitive therapy to telerehabilitation and depression.

Fortunately, research on TBI is alive and well and increasing, due mainly to the Iraq War. Patrick Kochanek, director of the Safar Center for Research at the University of Pittsburgh, is testing the use of nitroxide resuscitation on TBI. Dalton Dietrich at Miami University is researching hypo-thermia, or the cooling of the brain. Various scientists are experimenting with cellular transplant procedures.

“The use of low brain temperature (hypothermia) can reduce inflammation and damage,” says L. Gomez-Pinilla, a neurosurgery professor at UCLA, as well as a researcher with the VAMC in Sepulveda, Calif. “But when you’re hit in the head, brain damage is diffuse [as opposed to localized] and makes transplant [of cells] difficult.”

Other projects focus on pharmaceutical, technological and physical therapies. Investigator Dr. Mark A. Dichter, professor of neurology and pharmacology at the University of Pennsylvania in Philadelphia, is testing the drug topiramate as a method of preventing or reducing epileptic seizures in the up to 30% of TBI patients who develop this disorder. Henry Lew, clinical associate professor at Stanford University Medical

Center, is researching driving simulation therapy. Because 40% to 80% of TBI patients take up driving again—despite doctors’ warnings—Lew hopes a driving simulator can improve patients’ cognitive abilities and predict long-term outcome.

Also, Emory University researchers are using Constraint Induced Movement Therapy (CIMT), initially used with stroke patients, to test whether the forced use of a “weaker” limb (instead of the stronger one) will strengthen functioning.

Therapy Off the Grid

Despite the excellent care Brashears says she received from VA, she still has PTSD, headaches and back pain. Since VA officially sanctions only evidence-based therapies, Brashears pays out-of-pocket for biweekly massage treatments to ease her pain.

DVBIC, however, recently began exploring non-traditional avenues, including the treatment methods of research psychologist Catherine Harrison, employed at the Air Force Research Laboratory, Human Effectiveness Directorate (AFRL/HE) at Wright Patterson Air Force Base in Ohio.

While traditional therapies can retrain patients to perform specific behaviors, Harrison believes that “enriched” environments (such as three-dimensional exploration and virtual acrobatics like flying and climbing into buildings) stimulate the brain to regain more general capacities that patients can apply to the learning of a variety of tasks.

Harrison says the stimulation affects the hippocampus—that area of the brain that controls learning—and may allow patients to reform memories more easily. Besides using multi-sensory virtual reality experiences, Harrison uses Tai Chi.

“We are deliberately trying to form alternative pathways in the brain...,” Harrison said in a recent article in the online magazine *Military Medical Technology* (April 11, 2007). “We want to recover the fundamental ability to learn.”

Another controversial technique is hyperbaric oxygen therapy (HBO). Patients lie in submarine-style compression chambers, breathing higher-than normal amounts of oxygen. In a recent study in *Neurology Research* (March 2007), University of Minnesota experimenters proved that a one-hour dose of oxygen therapy is not toxic, is relatively safe and improves the aerobic metabolism of brain cells.

“Growing evidenceshows that HBO may be a potential treatment for patients with severe brain injury,” researchers concluded.

Other alternative/complementary treatments are food-based. UCLA neuroscientists and Sepulveda VAMC researchers Fernando Gomez-Pinilla and Greg M. Cole found that TBI patients, who as a group run a higher risk of developing dementia, should avoid high-sugar and high-saturated-fat foods.

They also need to include the food spice curry (curcumin) in their diet. When Gomez-

Pinilla fed curcumin to rats with concussion-like injuries, the curcumin reduced the negative effects of brain-derived neurotrophic factor (BDNF) levels, which determine cell synaptic strength, memory and learning.

“The effects are doubled when exercise [30 minutes daily] is combined with a healthy diet,” says Gomez-Pinilla. He also stresses the need for Omega-3 fish oil since it reduces beta amyloid—the plaque associated with Alzheimer’s.

Better known as equine therapy, hippotherapy is gaining credibility with veterans. The program Horses for Heroes, sponsored by the North American Riding for the Handicapped Association (NARHA), offers services to vets at the organization’s 700 centers.

Similarly, Back in the Saddle Bit by Bit (BITS), based in Broomfield, Colo., uses a nationwide network of ranches and therapists to provide services. Army Reserve Spc. Claudia Carreon says her memory improved after equine therapy from Therapeutic Riding of Tucson (TROT).

In an odd twist, botox, widely touted as a cosmetic aid for wrinkles, also seems to help TBI patients. It can reduce spasticity, enhances cortical reorganization and jump-starts motor function in the upper extremities. (Skeptics can read the October 2006 issue of Archives of Physical Medicine & Rehabilitation.)

TBI patients eager to avoid drugs can try Holistic Approach to NeuroDevelopment and Learning Efficiency (HANDLE). Initiated by Dr. David Lewis, associate professor in nuclear medicine at the University of Washington’s Harborview Medical Center in Seattle, HANDLE provides physical and mental activities patients can perform at home to strengthen weak areas of sensory-motor processing.

(A small study in the Journal of Imaging’s July 2006 issue showed improvement in brain activity in five adults with chronic TBI.)

Other alternative therapies include massage, dance, hypnosis, prayer, aromatherapy, aquatics, herbal supplementation, vitamins, meditation, magnetic fields, transcutaneous electrical stimulation, chiropractic treatment, craniosacral therapy, acupuncture, neuromuscular re-education, acupressure, physical therapy and spiritual techniques.

TBI Technology

Future technological innovations may prevent or reduce the incidence of TBI in war vets. Along those lines, retired Navy captain Dr. Robert H. Meaders, whose grandson served in Iraq, founded Operation Helmet in 2004. Meaders hired a manufacturer to upgrade the military’s helmets with a shock-absorbing pad suspension system. (See www.operation-helmet.org). So far, Operation Helmet has donated 36,597 upgrades to servicemen and women.

Another technology player is Head Impact Technology (HIT), a computerized system

developed by Lebanon, N.H.-based Simbex. HIT is currently researching the biomechanical factors that lead to concussion. When and if HIT yields sufficient information, Simbex intends to market better head-protection gear to sports players and soldiers alike.

So far, more than 250,000 head impacts in college and high school football games have been collected using data-registering helmets connected to a computer.

Also, researchers in Canada and the United States are developing real-time portable devices to test soldiers' cognitive abilities immediately after explosions. "The statistics from the United States suggested that [brain injuries] are undiagnosed and underdiagnosed," scientist-inventor Bob Cheung, with Ontario-based Defence Research and Development, told the Canadian press.

Financial Fix

According to a January 2007 report—"The Long-Term Costs of Providing Veterans Medical Care and Disability Benefits" co-authored by Linda Bilmes of Harvard's Kennedy School of Government and Joseph Stiglitz of Columbia—combined treatment and health care for TBI veterans over the next 20 years could cost as much as \$14 billion. One reason is that Iraq and Afghanistan War veterans typically claim five to eight different disabling conditions, says Bilmes.

And cost is not the only worry. There is a shortage of TBI-trained health-care professionals to serve the large percentage of injured troops who survive blasts and thus have the potential for brain injuries.

The good news, though, is Americans are finally responding to this health crisis. A federal Task Force on the Future of Military Healthcare addressed VA's financial and administrative problems in a December 2007 report. And the House Committee on Veterans Affairs, chaired by Rep. Bob Filner (D-Calif.), proposed H.R. 2199, which, if passed, will provide for mandatory screening, long-term rehabilitation of veterans and an outreach program for rural vets. This bill is presently in the Senate Committee on Veterans Affairs.

Moreover, in April, the Brain Injury Association of America published a position paper calling for public and private cooperation to deliver the "right treatment right now."

"The government doesn't have to reinvent the wheel," says Pat Radice, with the BIA. "A continuum of care already exists with the DoD and VA. We need to augment it with private contractors."

Silent No More

Brashears hopes mandatory MRI/CT scans before and after deployments will become part of that continuum of health care. She also hopes to return to active duty as an assistant chaplain and retire in seven years. Meanwhile, Brashears receives behavioral therapy (in the form of electronic memory devices), takes anti-seizure medication for

headaches and uses an inhaler for asthma-like symptoms.

“I still deal with symptoms [of PTSD], but they are less intrusive on my daily life,” she says. “Some days I can cope with almost anything, but other days I seem to not be able to deal with the smallest item.”

Still, she calls herself “lucky” to have received good health care. “I think there are a lot of soldiers that suffer and go untreated, sometimes due to their own desire to be silent about their pain,” she says. “No one that returns home after being involved in an explosion or blasts should be discharged or returned to duty without having at least an MRI or CT scan to determine if they have a TBI. And a six-month follow-up exam should be mandatory.”

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