The Centers for Disease Control (2004) report that at least 1.4 million traumatic brain injuries (TBI) occur each year with an estimated 80–90,000 individuals experiencing permanent disability. Among those with severe injuries requiring medical attention and hospitalization, the most common causes of injury are motor vehicle crashes (64%), violence related injuries (21%) and falls (11%). Age is closely linked to cause of TBI. Older adults are more likely to be injured by falls while younger adults are more often involved in motor vehicle crashes and violence related injuries.

Despite the decrease in TBI related to violence over last couple of decades, it remains the second leading cause of death in the US. Within the past two decades, violence related deaths have surpassed motor vehicles crashes as the leading cause of TBI related death. Firearm related incidents account for 40% of TBI related deaths while motor vehicle crashes accounted for 34% of fatalities and falls about 10%. This may be due in part to improved safety measures decreasing the incidence of motor vehicle crashes and falls as violence related deaths have been more stable.

Violent injury can occur in a number of ways. Someone intentionally striking another person in the head with a fist or an object is one common example. Another example is a fall intentionally caused by another person in which the injury is sustained in the fall, such as the head hitting the ground. Violent injuries can be caused by an assault, in which one person injures another, or can be caused by the person injured, such as in an attempt at suicide. The most devastating type of violent injury is from a gunshot wound, which can cause brain injury that is very different from the injury experienced in a car crash or fall. The focus of this newsletter is on brain injuries due to gunshot wound.

**Risk Factors for Violent Brain Injury**

Males between the ages of 20–24 have the highest firearm related TBI death rates. Injury from a gunshot is more prevalent among minority populations, but such injury can occur to anyone. Firearm related death among minority populations is more often caused by another person (up to 70%), such as in an assault, whereas the non-minority population has a higher percentage of self inflicted (suicidal) death (up to 78%).

Based on data collected by the TBI Model System program, those sustaining brain injury from a gunshot are likely to be male, unmarried, unemployed at the time of injury, and living alone. This is consistent with prior research with other samples which have also indicated that living in an urban setting, alcohol/drug use at the time of injury, and access to firearms are linked to violence related injuries.

**What Happens to the Brain?**

Passage of a bullet can cause laceration (tearing) injuries to the brain, as well as shock waves with cavitation (temporary stretching). A bullet passing through the brain creates a brief wave effect in the tissue leading to rapidly alternating expansion and contraction of the tissue. This creates an area of disrupted tissue surrounding the path of the bullet. The area of disrupted tissue can be as much as 30 times larger than the missile diameter and can cause...
injury to parts of the brain a considerable distance from the actual bullet path. Sometimes there are multiple paths of injury in the brain caused by a bullet fragmenting after entering the brain.

**Treatment of Brain Injury Caused by Gunshot Wound**

A gunshot wound (GSW) to the head is often fatal. For those who survive the injury, the presentation at the emergency room can vary a great deal. Sometimes people are fully conscious and able to talk after being shot in the head and other times the person is unconscious (comatose). For those who are unconscious, the Glasgow Coma Scale (GCS), which is based on a person’s verbal responses, ability to follow commands, and eye opening, can be used to measure the severity of the injury. Scores on the GCS range from 3 to 15 with higher scores indicating better functioning. A GCS score of 3-5 indicates that in most cases (90% or more) the person will not survive the injury. A GCS score of 13-15 is certainly much better, but does not mean an absence of brain injury. Any time a person experiences a gunshot wound to the brain there will be brain injury.

Medical treatment is necessary following a gunshot wound to the brain if there is to be a chance of survival. Typically, a neurosurgeon performs a procedure called debridement that involves removing the bone and bullet fragments that can be reached. Sometimes fragments are so deeply imbedded in the brain or near very sensitive areas that the surgeon decides that the risk of removal is too great. People can survive with bullet and bone fragments in the brain, but it is preferable to remove the fragments if possible. Often the greatest concern is about secondary effects that cause further brain injury and even death. Bleeding from ruptured blood vessels and swelling (edema) can be severe and difficult to control. The entry of a bullet and scalp tissue along with the bullet into the brain provides a path for infection and it is common for people with gunshot wound to receive strong antibiotics. Even with that treatment an infection can be difficult to overcome. Finally, the type of injury experienced with a gunshot wound increases the chances of having seizures. A seizure is an uncontrolled abnormal release of nerve impulses in the brain. Seizures, particularly a seizure that lasts for several minutes, can cause further brain injury. For this reason, people who experience gunshot wound to the brain are often given medications (called anti-convulsants) to decrease the risk of seizures.

**Outcome After Brain Injury Due to Gunshot Wound**

It is difficult to predict what type of physical and mental problems a person might experience following a gunshot wound to the brain. It depends on what areas of the brain have been injured, which varies from case to case. Some areas of the brain may have been spared injury, meaning that the functions controlled by those parts of the brain are unaffected. Because the frontal area of the brain is often injured, many people with gunshot wounds have difficulty with attention, learning, memory, and problem solving. These mental difficulties, along with physical problems (for example, paralysis of one side of the body) can impact the independence of the injured person. It is common following a gunshot wound for the injured person to need some assistance and supervision from family members. Sometimes people are able to return to work and to live independently, but that cannot be guaranteed. Return to driving may be impacted by the presence of seizures.

A person can experience emotional problems following a gunshot wound to the brain. In part this may be caused by the area of the brain injury. In many cases, problems with depression are caused by the change in lifestyle for the injured person. The sudden lack of independence and the presence of significant mental and physical problems weighs heavily on some people, leading to depression. In some cases depression was a problem before the injury, particularly among those whose brain injury was caused by a suicide attempt. It is important that people experiencing emotional problems after brain injury receive treatment. In most cases, there is a good response to anti-depressant medication and counseling.
About the Authors

- **David Salisbury, Psy.D.,** is presently a clinical neuropsychology postdoctoral fellow in the Department of Physical Medicine & Rehabilitation. He provides a variety of clinical services to patients and families at the Spain Rehabilitation Center and the greater UAB medical community. He is a psychologist with an emphasis in neuropsychology and research interests including traumatic brain injury, epilepsy and executive functioning.

- **Thomas A. Novack, PhD**, is the Director of UAB Traumatic Brain Injury Model System and is a Professor in the UAB Department of Physical Medicine & Rehabilitation, Psychology, UAB School of Medicine. Dr. Novack is a Neuropsychologist and works with people experiencing brain injury, particularly traumatic brain injury. He is recognized nationally for his research exploring recovery from traumatic brain injury.

- **Robert Brunner, M.D.,** is the Medical Director of the UAB Traumatic Brain Injury Model System. Dr. Brunner is a Physiatrist and Assistant Professor in the UAB Department of Physical Medicine and Rehabilitation. His clinical care activities focus on traumatic brain injury, spasticity (Intrathecal Baclofen, Botox), musculoskeletal disorders and electromyography.

References


Visit the UAB TBI Model System website at: [www.uab.edu/tbi](http://www.uab.edu/tbi)
National TBI Resources

Brain Injury Association of America
The Brain Injury Association of America (BIAA) encompasses a national network of more than 40 chartered state affiliates across the country, as well as hundreds of local chapters and support groups. The organization acts as a clearinghouse of community service information and resources, participates in legislative advocacy, facilitates prevention awareness, hosts educational programs and encourages research. BIAA’s Family Helpline provides resources to individuals involved in brain injury, family members and providers seeking assistance, education and support. Family Helpline: 1-800-444-6443 Website: http://www.biausa.org

Address: 8201 Greensboro Dr., Suite 611, McLean, VA 22102

Traumatic Brain Injury National Data Center (TBINDC)
The website for the TBINDC includes a listing of all TBI Model System Centers located in the United States. Each Center collects important data about individuals with traumatic brain injury and submits this data to the TBINDC. Facts & Figures newsletter is available on the website to provide information on the status of the database. The TBINDC also provides a registry of publications and research projects related to traumatic brain injury. Website: http://www.tbindc.org/ Address: TBINDC c/o Kessler Medical Rehabilitation Research and Education Corp., 1199 Pleasant Valley Way, West Orange, NJ 07052

TBI Community Online
This Rehabilitation Research and Training Center (RRTC) on Community Integration of Persons with Traumatic Brain Injury (TBI) provides information for persons affected by TBI and for treating professionals. Information is provided in English and Spanish. Materials include the TBI Community News, links to TBI related websites and The National Database of Educational Resources on Traumatic Brain Injury. This database contains information on over 350 educational videotapes, audiotapes and written materials. Toll free phone: 1-800-732-8124 Website: http://www.tbicommunity.org/
Address: 2455 S. Braeswood, Houston, TX 77030

Alabama TBI Resources

Alabama Head Injury Foundation
Phone: (205) 823-3818 or (800) 433-8002 Website: http://www.ahif.org
Address: 3100 Lorna Road, Suite 226, Hoover, AL 35216

Alabama Head & Spinal Cord Injury Helpline
Alabama Department of Rehabilitation Services
Phone: 1-888-879-4706 (in Alabama) or 1-800-671-6837 Website: http://www.rehab.state.al.us/tbi