

The Missouri Greenbook Living with Brain Injury



A guide for survivors, families and caregivers



1-800-451-0669

Understanding traumatic brain injury

The brain and how it works

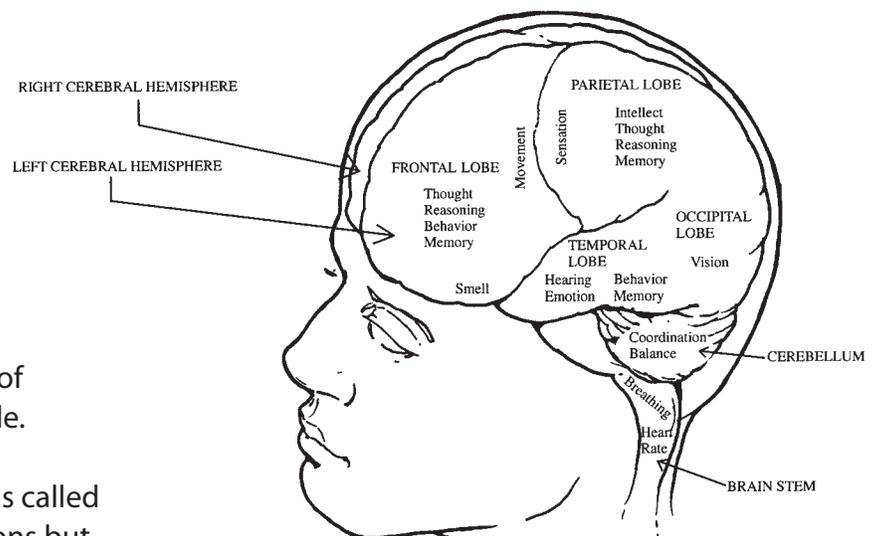
The brain is responsible for everything we do. It controls all movements, sensations, speech, thoughts and emotions. Surprisingly, for such an important structure, the brain is very soft, almost the consistency of firm gelatin.

The brain (Figure 1) would easily be injured if it were not contained by the skull, the bony covering of the brain. The largest part of the brain is made of two halves, the right and left cerebral hemispheres, which fill the top and front of the skull. The right cerebral hemisphere controls the left side of the body, and the left cerebral hemisphere controls the right side of the body and speech in most people.

Within the hemispheres are sections called lobes. Each lobe has special functions but

also works together with the other lobes. The cerebellum, the lower part of the brain located in the back of the skull, controls coordination. The brain stem connects the cerebral hemispheres with the spinal cord and controls basic life-sustaining functions such as heart rate and breathing.

Figure 1



“Learn everything possible about traumatic brain injury. Explore all available sources of information and use what you learn.”

- Arpie Vermillion, Seneca, Mo.
Mother of a TBI survivor

The brain (Figure 2) is surrounded by cerebrospinal fluid (CSF), a clear liquid that is produced by the brain. There are spaces inside the brain, called ventricles, that are filled with CSF. The CSF flows around the brain and down the spine, surrounding the spinal cord and nerve roots all the way to the lower back. The dura is a thin layer of tissue under the skull and bones of the spine that surrounds the brain and spinal cord and contains the CSF.

Traumatic brain injury

A traumatic brain injury is any injury to the brain caused by a blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain. Not all blows or jolts to the head result in a TBI.

Common causes of TBI are motor vehicle crashes, falls, assaults or blast injuries. The injuries are categorized according to severity as mild, moderate or severe. In most injuries, damage occurs immediately when forces are exerted on the brain. Forces are exerted either directly, as in the case of penetrating or blunt impact, or indirectly as when the brain is subjected to strong forces of movement.

There is a rich network of neural connections linking the brain for rapid transmission and coordinated functions. Injury to the connections can interfere with the brain's ability to function as efficiently as it did prior to the injury.

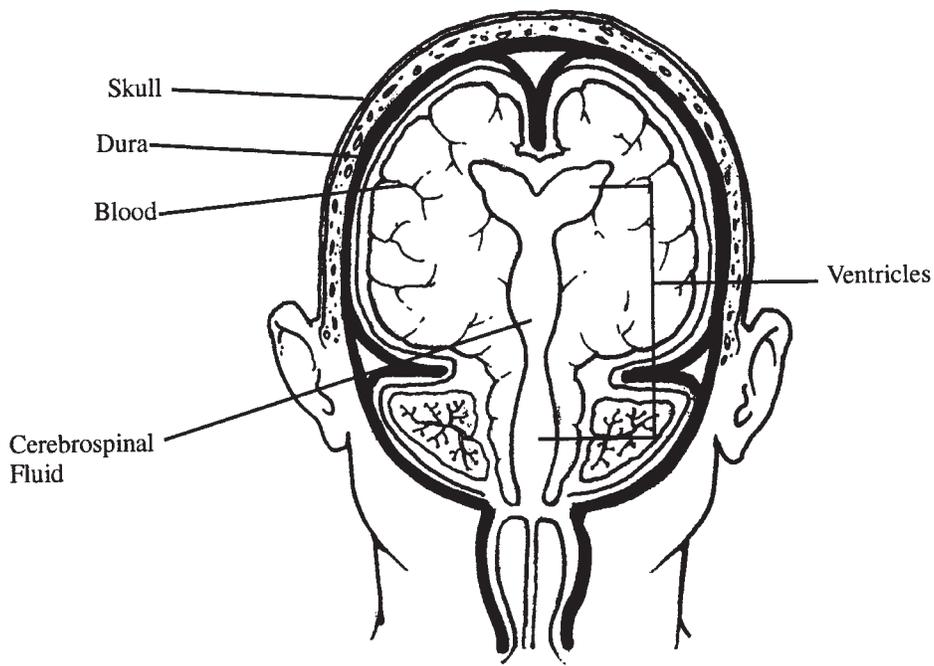


Figure 2

Sometimes bleeding occurs, which results in additional damage to the surrounding brain tissue. In most injuries, the brain responds by swelling. Since the brain is enclosed by the rigid skull, swelling in one area can result in pressure and additional damage to the surrounding areas.

Skull fractures, or breaks in the bone surrounding the brain, may occur with or without damage to the underlying brain. The bone itself will heal over time. Additional treatment may be required if there is damage to the brain beneath the fracture.

Concussion is the mildest form of brain injury. When a person has a concussion he or she may pass out or lose consciousness for a short time, or experience memory loss or loss of other brain functions briefly. Treatment is usually not necessary, however, it is important to observe the patient closely for signs that a more severe injury has occurred.

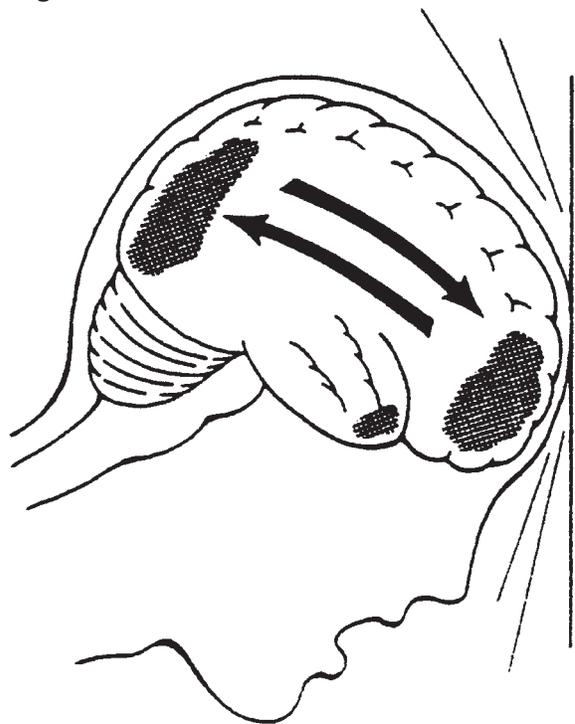
In a **contusion**, a part of the brain is bruised and develops small areas of bleeding and swelling that can be seen on tests. Patients with contusions often complain of headaches, nausea and slow

thinking. Patients with contusions must be watched closely for signs of additional swelling, bleeding or further injury of the brain.

Sometimes opposite sides of the brain are injured when the brain first strikes one side of the skull during the impact and then bounces back against the opposite side of the skull. This is called a **coup contrecoup** injury (Figure 3).

A generalized injury to the brain can occur when stretching or shearing forces are applied to the entire brain. This can result

Figure 3



in damage to the connections, or axons, deep in the brain and is called a **diffuse axonal injury**. In response, swelling can occur throughout the brain. Since the axons cannot be repaired through medical intervention, treatment is directed at preventing further damage. Bleeding in or around the brain is very damaging and is often treated with surgery.

Bleeding that occurs between the skull and the dura, the thin covering over the brain, is called an **epidural hematoma** (Figure 4). If the blood clot is large or increasing in size it is treated with surgery to remove the clot and take the pressure off the brain.

Bleeding also can occur between the dura and the brain. The blood clot forms what is called a **subdural hematoma** (Figure 5). Acute subdural hematomas occur at the time of the injury and are often associated with damage to the underlying brain and severe swelling.

Chronic subdural hematomas occur most commonly in the elderly after a relatively mild head injury. In some cases, a small amount of blood in the subdural space will cause the space to enlarge slowly over time, producing increasing pressure on the brain. In both cases, surgery is often required.

Figure 4

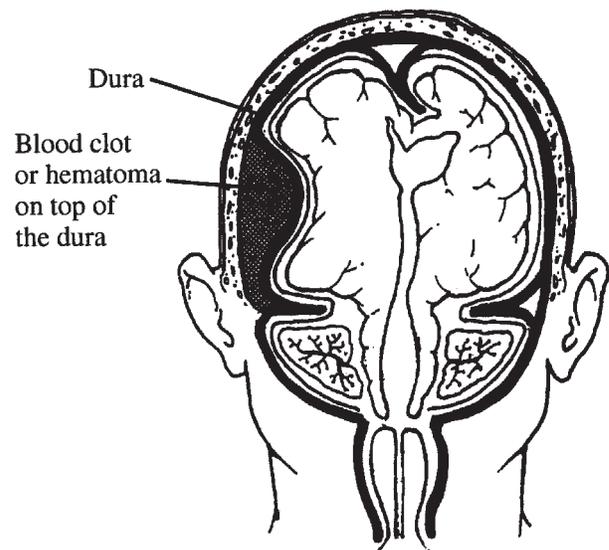
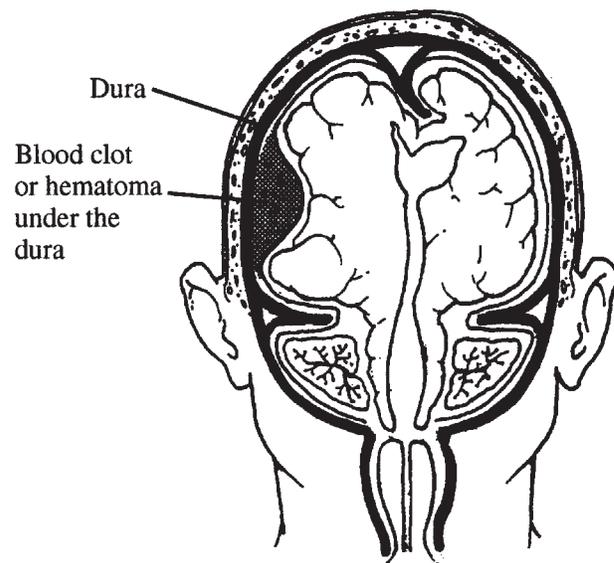


Figure 5



An **intracerebral hemorrhage** is a blood clot within the brain (Figure 6). Surgery may be required to remove the clot, but surgery has significant risks because it may be necessary to go through areas of normal brain to get to the clot and remove it.

Occasionally, bleeding occurs into the spaces filled with CSF. The blood can block the flow of CSF so that pressure builds up in the ventricles, and the ventricles enlarge. This condition is called **hydrocephalus** (Figure 7). Hydrocephalus is often treated with a drainage tube, or ventriculostomy, that drains the fluid to a collection bag outside the body or under the skin into the abdomen.

Any injury to the brain can affect the **intracranial pressure** (ICP), the pressure inside the skull. Since the skull is rigid and cannot stretch, swelling, blood clots or blocked CSF can cause everything inside the skull to become tight and the pressure inside the brain to increase. Much of the treatment of traumatic brain injuries is directed at keeping the intracranial pressure as close to normal as possible.

Figure 6

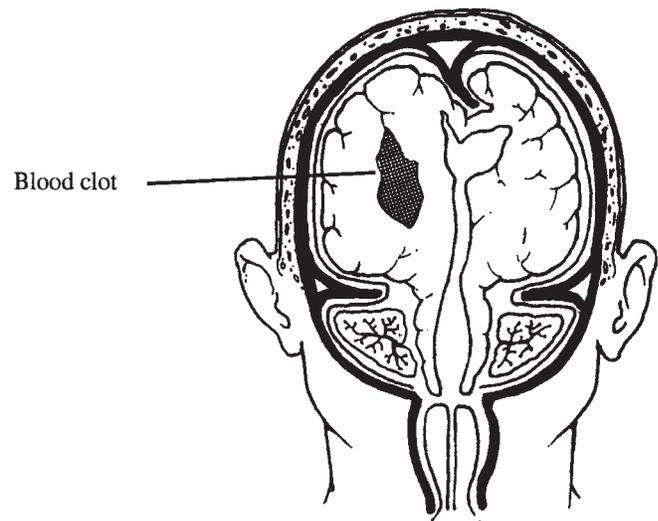
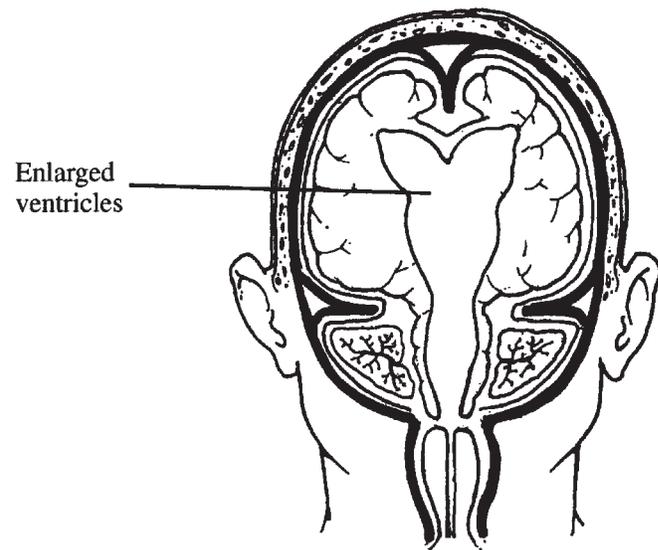
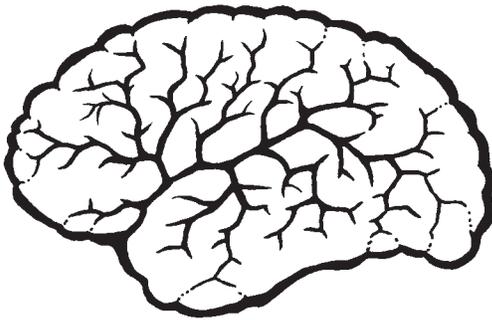


Figure 7

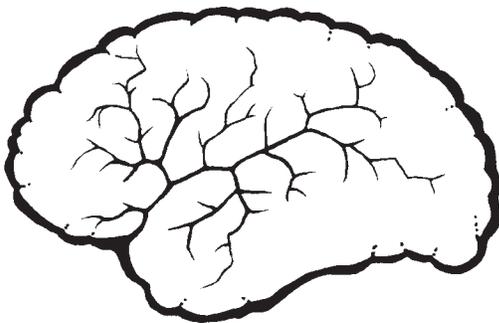


Cerebral perfusion pressure is the pressure that pushes blood into the brain and supplies the brain with oxygen. If the blood pressure is low or the intracranial pressure is high, or both, then the cerebral perfusion pressure will be low, and the blood flow to the brain will decrease. This can cause a low oxygen level and possible damage to the brain (Figure 8).

Figure 8



Normal blood flow



Limited blood flow

Types of TBI

Blows to the head can cause injury to the brain. Sometimes the brain bounces back and forth inside the skull. Other times, objects penetrate the skull and the brain. Both types of injuries are called traumatic brain injuries. A brain tumor or a stroke can result in the same consequences as a TBI but is not a traumatic brain injury.

There are two main types of traumatic brain injury: closed head injury and open head injury. **Closed head injury** (CHI) is caused when the brain is bounced against the skull, often in a back and forth motion, but the skull does not fracture or open.

Some common causes of CHI are:

- Motor vehicle injuries
- Falls
- Bicycle injuries
- Sport injuries
- Blast injuries

CHI may cause problems in a number of areas including:

- Physical
- Cognitive
- Emotional
- Social relationships

The difficulties can even change an individual's personality. Because the injury can affect many places in the brain, CHI is referred to as a diffuse injury.

Open head Injury (OHI) is a visible injury that involves a displaced fracture or penetration of the skull and is less common than CHI. A common cause of OHI is a gun shot wound. An OHI can cause focal (specific) injury at the place of fracture or penetration. In some cases the injury may be more extensive.

Symptoms of TBI

Two signs that indicate the severity of a TBI are:

- Time in coma (not medication induced)
- **Posttraumatic amnesia (PTA)**, the length of time from the injury to the time a person begins to remember things

Impaired consciousness, often called coma, is one symptom of TBI. There are two main ways to measure a person's level of

consciousness: the Glasgow Coma Scale and the Rancho Los Amigos Scale.

The Glasgow Coma Scale, sometimes known as the Glasgow Coma Score, is a neurological scale that aims to give a reliable, objective way of recording the conscious state of a person. The Glasgow Coma Scale assesses a patient's level of consciousness on a scale of 3 to 15.

The Rancho Los Amigos Scale is used to describe cognitive behavior functioning after a TBI on a scale of 1 to 10. The scale provides a way of describing a patient's level of cognitive functioning at a given point in time and is mostly used during rehabilitation.

For more in-depth information about the levels of either scale, ask your health care provider.

Glasgow Coma Scale (GCS)
(E) Eye Opening Response (1-4) (M) Best Motor Responses (1-6) (V) Best Verbal Response (1-5)
$E + M + V = 3 \text{ to } 15$

Rancho Los Amigos Scale	
Level I	No Response: Total Assistance
Level II	Generalized Response: Total Assistance
Level III	Localized Response: Total Assistance
Level IV	Confused/Agitated: Maximal Assistance
Level V	Confused, Inappropriate, Non-agitated: Maximal Assistance
Level VI	Confused, Appropriate: Moderate Assistance
Level VII	Automatic, Appropriate: Minimal Assistance for Daily Living Skills
Level VIII	Purposeful, Appropriate: Stand-by Assistance
Level IX	Purposeful, Appropriate: Stand-by Assistance on Request
Level X	Purposeful, Appropriate: Modified Independent

Effects of TBI

It is hard to predict what changes are likely to occur as a result of a TBI. Each individual is unique. The effects of TBI are not always apparent. TBI is often called “the silent epidemic” because thousands of people

“ It is hard to predict what changes are likely to occur as a result of a TBI. Each person is unique. ”

with TBI have symptoms that are not generally evident to others.

The changes experienced after a TBI depend on a number of factors including:

- Pre-injury: educational and vocational history, health history, history of alcohol and substance abuse, intellectual ability
- Injury characteristics: severity of the injury, secondary complications
- Available medical and rehabilitation resources
- Emotional reaction to the injury
- Family and social support

Common problems associated with injury to the brain may include:

- **Motor:** weakness or paralysis of one side of the body (hemiplegia), poor balance and coordination (ataxia), less endurance, abnormal muscle tone and stiffness
- **Perceptual:** hearing, vision, taste, smell, touch, knowing the relationship of the body to fixed objects

- **Speech and language:** difficulty in expressing thought (aphasia), speaking clearly (dysarthria)
- **Executive functioning:** thinking, reasoning, paying attention, judgment, problem-solving
- **Memory and learning:** problems with short-term memory (storing and retrieving recent information), slower learning, limitations in learning, difficulty with retrieval of long-term memory
- **Emotional changes:** moody, easily frustrated, anxious, impatient, angry, depressed and low self-confidence

In addition, a person with a TBI might find changes in basic bodily functions. These include:

- Body temperature control
- Level of alertness
- Swallowing
- Bowel and bladder function
- Sleep patterns
- Endurance for physical and mental activities
- Sexual function

Seizures may occur after a brain injury. They may happen immediately or much later. It is difficult to predict if a survivor will develop seizures.

A diffuse head injury may be mild to severe. It may cause various difficulties with memory, processing speed, attention and reasoning.

A focal injury, on the other hand, affects a specific area of the brain. The difficulties from a focal injury are often more specific and may affect one area such as language or perception.

Following a brain injury, damage to the optic nerve and other parts of the brain can result in a visual blind spot, partial vision loss, or one or more types of visual field deficits.

Visual field deficits after brain injury can be overlooked early on as more severe and life-threatening injuries sustained from the brain injury are treated. People with brain injury should undergo a vision evaluation as soon as possible after injury. Even if problems with vision are not perceived, deficits may be present and can have an extensive impact on life and rehabilitation efforts.

TBI severity

Concussion/mild TBI (MTBI) is defined by an impact to the head that results in minimal to no loss of consciousness, limited posttraumatic amnesia (PTA) and no findings of injury on brain scans.

People with concussion/MTBI might have **postconcussion syndrome** (PCS).

Symptoms include:

- Headache
- Dizziness
- Fatigue

- Diminished concentration
- Memory impairment
- Irritability
- Depression
- Anxiety
- Sleep problems
- Complaints of being physically sick with no apparent reason
- Hypersensitivity to noise and sensitivity to light (photophobia)

Often PCS symptoms cannot be seen by others. This can lead to loss of self-confidence, frustration, depression and anxiety.

Moderate brain injury may be defined as an injury to the brain resulting in extensive loss of consciousness and PTA as well as some finding of injury on brain scans. Individuals with moderate TBI are likely to experience a higher incidence of cognitive, physical and emotional changes.

Severe TBI may be defined as an injury to the brain resulting in significant loss of consciousness of weeks or longer, PTA extending for days or weeks past emerging from unconsciousness and substantial findings on brain scans evidencing injury across areas of the brain. A person with severe TBI is likely to experience impairments in cognitive, physical, perceptual, social and emotional functioning.

“Be proactive about diagnosis and prognosis. Don’t accept any evaluation as the final word. There is no final word about TBI.”

- Arpie Vermillion, Seneca, Mo.
Mother of a TBI survivor