



X-Plain *Traumatic Brain Injury* **Reference Summary**

Introduction

A sudden violent movement or blow to the head can cause damage to the brain. This is known as a traumatic brain injury, or TBI. About 1.5 million people suffer a TBI in the United States every year.

TBI can be mild, moderate, or severe. A mild traumatic brain injury may cause confusion and headache, and most people recover from it. A severe traumatic brain injury can cause disability or death.

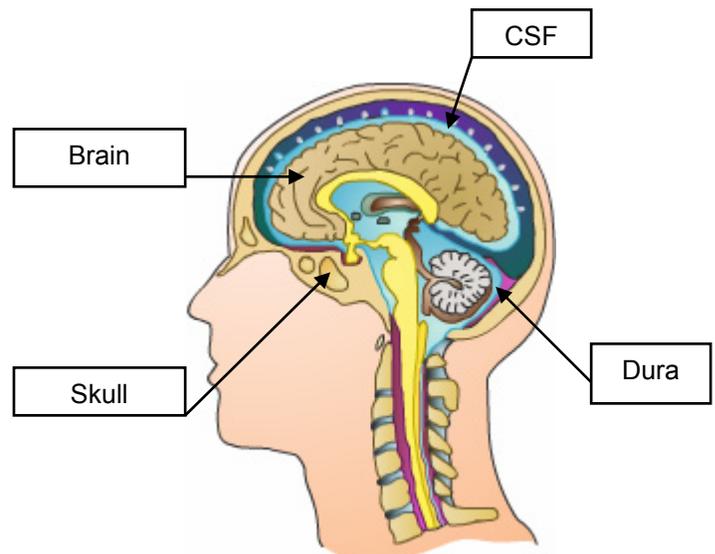
A severe traumatic brain injury may happen even if the head does not come in contact with a hard object. This may happen to people in car accidents and to service members exposed to the shock of an explosion. The term service member refers to people serving in the military: Army, Marine Corps, Air Force, National Guard, etc.

If you or your loved one has a traumatic brain injury, this reference summary will explain the different terms that your doctor may use. It also discusses the types of traumatic brain injuries, their causes, and their symptoms. Finally, it explains potential complications and treatment options.

Anatomy of the Brain

The brain is the most important organ in the body. It controls the 5 senses, as well as the ability to speak and move.

The brain is inside your skull. The skull is made of bone. It protects the brain from mild blows to the head.



This document is a summary of what appears on screen in *X-Plain*[™]. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

The brain has the consistency of gelatin. It floats inside the skull in a special fluid called cerebrospinal fluid, also known as spinal fluid or CSF. This fluid acts as a shock absorber, protecting the brain from blows to the skull.

The brain is protected by the skull and is covered by three layers of tissue. The thickest and outermost layer is known as the "dura." These membranes protect the brain and keep the cerebrospinal fluid from leaking to the outside.

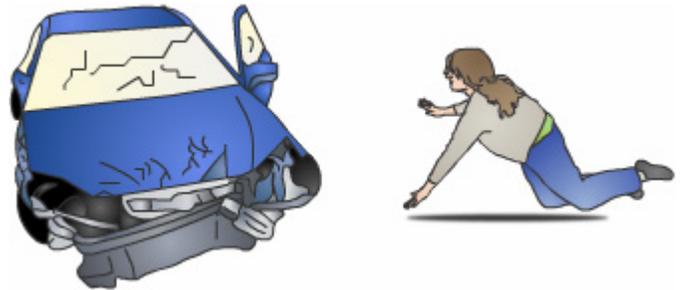
The brain has two main parts, called the left and the right hemispheres. Each hemisphere has specialized areas for movement, thinking, sensations, and feelings. If you injure your brain, different functions can be affected.

The brain is a very complex organ and scientists do not fully understand how the brain thinks, feels emotions, and coordinates body functions. It is not always easy for doctors to tell what will happen with a brain injury. TBI can affect a person's thinking, feelings, relationships, and physical abilities.

Causes of TBI

A traumatic brain injury is caused by a strong force, blow, or penetrating injury to the head. The leading causes of TBI in the United States are falls and motor vehicle accidents.

Other causes of TBI include being accidentally struck by a hard object, assault, and sport injuries.



TBI is most common among male teens and young adults ages 15 to 24, and among elderly people of both sexes 75 years and older. In young people, the major cause is motor vehicle accidents. For those 75 and older, falls cause the majority of TBIs.

Babies can get severe brain injury if they are violently shaken either because of child abuse or playing rough. Shaken baby syndrome is a traumatic brain injury.

Explosive blasts are a common cause of traumatic brain injury in the military during wartime. Many service members have suffered from TBIs following a blast injury. In most of these cases, there was no direct injury to the skull or brain from shrapnel or bullets. The injury was caused by two factors: the sudden violent movement of the

This document is a summary of what appears on screen in *X-Plain™*. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

brain inside the skull, and the pressure wave of the explosion passing through the brain.

Effects of TBI

In accidents where the head is suddenly and violently shaken, the brain may move and may even hit the skull. Even if the brain does not hit the skull, the sudden movement of the brain can cause injury. This is known as shearing injury. It is as if the brain tissue tears from the inside. This may cause bruising and swelling known as contusions.



When injured brain tissue swells, it creates pressure against the rest of the brain because the skull does not expand. This makes brain swelling dangerous. It causes more pressure on the brain itself, which results in more damage to the brain cells.

Usually, brain swelling starts at the time of the injury. The swelling worsens over three days before the brain starts shrinking back to its normal size. If the swelling and pressure is severe and is not treated, it can lead to death.

The brain is surrounded by a membrane called the dura. If an object goes through the skull and enters the dura, this may lead to a bacterial infection known as meningitis. If not controlled, the infection can spread throughout the body and can be fatal.

The blood vessels of the brain can get hurt easily during a head injury. They can even burst. This causes bleeding in or around the brain. Hemorrhage is another word for bleeding. In some cases the blood forms clots, also known as hematomas.

Bleeding, swelling, and pressure inside the brain can also cause less blood to flow to the brain. This can cause problems in how well oxygen, blood sugar, and certain minerals are delivered to the brain cells. Minerals are substances such as calcium and sodium. If a balance is not kept, too little or too much of certain substances can become toxic to the brain cells, causing them to die.

This document is a summary of what appears on screen in *X-Plain™*. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

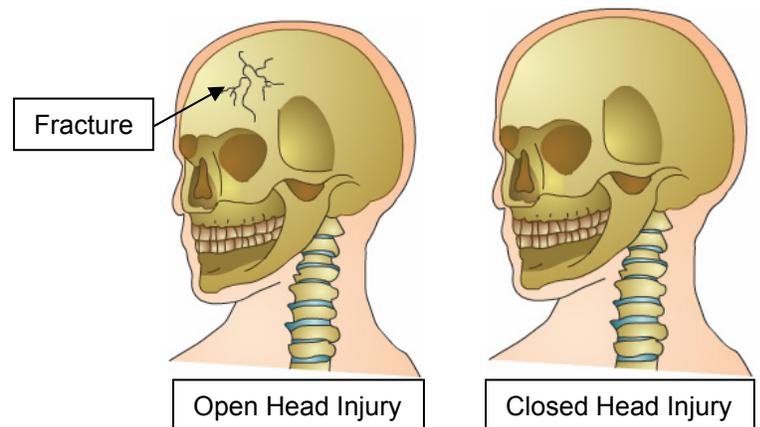
Brain tissue is made up of cells called neurons. Neurons have long connections called axons. Axons can be seen only with microscopes. Axons act as cables that transfer information between brain cells.

A sudden and violent trauma to the head can cause injury and shearing to the axons. This type of injury is known as diffuse axonal injury or DAI. This microscopic injury of axons can lead to long lasting mental problems, coma, and possibly death.

Types of TBI

Doctors use different factors to tell traumatic brain injuries apart. One factor is if it is an open head injury or a closed head injury. Open head injury involves a fracture of the skull. Closed head injury does not.

The injuries that happen immediately after the incident and those that happen later are also different. The first injuries are called primary injuries. Later injuries are called secondary injuries.



A more important classification is that of the severity of the traumatic brain injury. Treatment and rehabilitation options depend on the severity. Doctors use three categories to describe how severe a TBI is. These include mild, moderate, and severe TBIs. For this they use scales, such as the Glasgow Coma Scale.

The Glasgow Coma Scale is a test that helps your doctor figure out how severe a traumatic brain injury is. The doctor checks your ability to follow directions, blink your eyes, move your limbs, withdraw from pain, and obey other commands.

Based on this, she or he then gives you a score. The maximum score is 15 points. The higher the score the milder the injury is. The categories and score ranges are:

- Mild TBI has a score of 13 to 15.
- Moderate TBI has a score of 9 to 12.
- Severe TBI has a score of 8 or less.

This document is a summary of what appears on screen in *X-Plain™*. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

Patients sometimes lose consciousness after a brain injury. Consciousness or being conscious means being awake and aware of what is going on around you. They may also have problems remembering the events right before, during, and right after the accident. Other scales use how long the patient lost consciousness and how long it took him or her to start remembering as more ways of telling how bad a TBI is.

Symptoms

A TBI can be mild or very severe depending on the extent of the brain injury. Severe traumatic brain injuries can happen if a person is in a prolonged state of unconsciousness that lasts days, weeks, or months. Coma is a category of severe TBI where the patient is in a state of unconsciousness from which he or she cannot be awakened.

In a person with a moderate TBI, the person loses consciousness from a few minutes to a few hours. The person may be confused from days to weeks. Changes in the person's ability to move or to think lasts months and can be permanent.

In a person with a mild TBI, the person may or may not lose consciousness. A mild TBI is sometimes referred to as a concussion. If consciousness is lost, it lasts from a few seconds to minutes. The person is dazed and confused. A concussion may happen after a fall at home or during a tackle at a football game. It is normal for someone who had a concussion not to remember the events right before, during, and right after the accident.

Other symptoms of mild TBI include:

- headache,
- confusion,
- lightheadedness,
- dizziness,
- blurred vision or tired eyes,
- ringing in the ears,
- bad taste in the mouth,
- fatigue or lethargy,
- sleep disturbances, and
- behavioral or mood changes.



This document is a summary of what appears on screen in *X-Plain™*. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

Symptoms may also include trouble with:

- memory,
- concentration,
- attention, or
- thinking.

These symptoms may take weeks to months to go away in a patient with mild TBI. For instance, the person may have a headache that gets worse or does not go away, repeated vomiting or nausea, convulsions or seizures, an inability to awaken from sleep, dilation of one or both pupils of the eyes, slurred speech, weakness or numbness in the extremities, loss of coordination, increased confusion, restlessness, and agitation.

When to See a Doctor

If you or a loved one suffers a blow to the head, always get the victim checked by a doctor to be on the safe side. Seek emergency medical care if symptoms include:

- Convulsions
- Weakness or numbness in the hands or legs
- Slurred speech
- Repeated vomiting



Some people may not feel bad right after a blow to the head. But bleeding around the brain may still happen. It should be treated immediately or it may cause complications and possibly death. Signs of brain hematoma include headache, fatigue, sleep disturbances, weakness, nausea, vomiting, and irritability.

The doctor may order a CT scan or MRI to see pictures of the inside of the brain. These pictures can help the doctor see signs of hematomas or other injuries. Even if none are found, he or she may still decide to keep the patient at the hospital to be watched closely. CAT or CT scan is an advanced X-ray machine that allows doctors to see images of organs inside the body. The machine takes many x-ray images as it rotates around the body and a powerful computer creates the final images.

This document is a summary of what appears on screen in *X-Plain™*. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

In some cases, the doctor may send the patient home with a responsible adult. The doctor may ask the adult to wake the patient up frequently and ask “Where are you?”, “What is your name?”, and “How are you feeling?” to make sure everything is okay.

Complications

Complications of traumatic brain injuries depend on the severity of the injury. Severe traumas to the brain, such as a gunshot bullet going into the brain, can lead to death. Most people who have a mild TBI, on the other hand, recover fully.

TBIs that cause a lot of pressure in the brain can lead to serious complications such as bleeding, blood clots, and cell death resulting from decreased blood flow to the brain. If not treated, these complications could lead to further damage to the brain and can even be life-threatening.

Some complications respond well to treatment. However, the brain may take a long time to fix the damage or may never be able to fully recover. Some of these long-term effects include:

- **Cognitive disabilities:** Most people who have had a significant TBI will experience some problems in their cognitive skills. This may include problems with reasoning, problem solving, memory, speed of thinking, focusing, multitasking, and communicating.
- **Personality changes:** People who had a significant TBI may become more impulsive, more irritable, agitated, and depressed. They may also develop post-traumatic stress disorder. Their damaged social skills and unstable emotions may become one of the greatest challenges for families and friends of the recovering person.
- **Sensory problems:** A person recovering from a TBI may sense ringing in the ears which may last months or years. This is known as tinnitus. Possible vision changes include blind spots, double vision, or difficulty recognizing objects. The person may have less muscle coordination, which may make him or her look clumsy. In some cases, the person may lose their sense of smell.
- **Headaches:** Some people who have had a traumatic brain injury develop chronic headaches. Tension-type headache is the most common form but migraine-like headaches are also common.



This document is a summary of what appears on screen in *X-Plain™*. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

- Seizures: Some people who have had a traumatic brain injury may have seizures during the first weeks or months after the injury. A seizure is caused by abnormal electrical activity in the brain, and usually comes with convulsions or sudden movement of the body.
- Post-traumatic stress disorder: After a brain injury resulting from an emotionally traumatic event, the injured person may develop post-traumatic stress disorder. The person may have flashbacks or feel as if the event is happening again. People with post-traumatic stress disorder may also have nightmares, sleep disturbances, and feelings of anger, guilt, loneliness, or fear.

Diagnosis

Whether the brain injury looks severe or mild, doctors usually need to assess the situation quickly to treat any complications before they get worse. They rely on images of inside the brain called CT scans.

CT scans of the brain may be done to make sure that there are no fractures in the skull and no blood clots or bruising in or around the brain. Depending on the patient's condition and the first CT scan, the patient may need to stay at the hospital and be watched closely. If the injury is severe and needs surgical treatment, the patient may go immediately to surgery.



CT Scan

CT scans may be repeated frequently in the first few days to check if blood clots are getting bigger or if the brain is swelling. MRI scans may be done later to check for more subtle damage that cannot be seen on CT scans. MRIs use strong magnets and radio waves to create detailed images of the inside of the brain. CT scans are more specific for bleeding in and around the brain and can be done faster. This is why CT scans are usually done first.

Treatment

Treatment of a traumatic brain injury depends on its severity. Mild traumatic brain injuries with no signs of internal brain bleeding require no treatment other than rest. The doctor may also tell the patient or the legal guardian how to watch for signs of any complications such as severe headaches, blurred speech, nausea, vomiting, and sleepiness. These could be signs of bleeding inside the brain.

This document is a summary of what appears on screen in *X-Plain™*. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

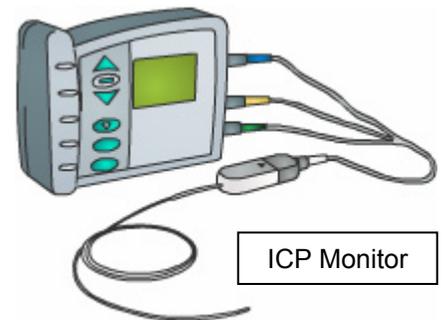
More severe traumatic brain injuries require hospitalization, close monitoring, and treatment. If there is an open head injury, surgery may be needed. For instance, if there is a skull fracture, surgery may be needed to take out a blood clot, and fix the skull.



If there is a gunshot wound, surgery may be needed to clean the wounds. If a bullet is still in the brain and the surgeon can get to it, he or she may also take it out. Doctors will also work to stop bleeding, prevent infections, prevent blood clots, and treat the pressure resulting from the swelling.

In cases of mild to moderate TBIs with pressure build-up inside the brain, treatments focus on controlling the pressure, making sure there is enough oxygen supply to the brain and the rest of the body, and keeping enough blood flow to the brain. Severe TBI is sometimes treated with placement on a respirator in order to protect the airway and hyperventilate the patient. Hyperventilation decreases the pressure inside the skull.

Doctors may use special monitors to take a constant measurement of brain pressure. This pressure is called intracranial pressure. These monitors are known as ICP monitors. A very high ICP can be very dangerous to the brain and can lead to permanent brain damage or even death. The monitors may be put in or on top of the brain through the skull.



Doctors may use medications to decrease the intracranial pressure. Most of these medications are given through an IV. IV stands for intravenous, which means through a catheter in the vein.

If there is severe swelling inside the brain, a catheter is placed inside the ventricles of the brain. The ventricles are fluid-filled cavities in the brain. Such catheters decrease intracranial pressure by draining some of the cerebrospinal fluid. The build-up of cerebrospinal fluid inside the brain is known as hydrocephalus.

At times, surgery may be needed to take part of the skull out. This helps make space for brain swelling and reduces the pressure inside the brain. To do this, doctors

This document is a summary of what appears on screen in *X-Plain™*. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

remove a piece of skull and then close the skin. The removed piece of skull usually is replaced a few months later, depending on the patient's condition.

Because patients with TBI are at an increased risk of developing seizures, doctors may give patients anti-seizure medications during the first week after the injury.

The most critical time for patients with moderate to severe TBI is the first three to five days after the injury. Once the patient makes it through this critical period, the danger of death is often over and rehabilitation can start.

People who have TBI may have traumas to other parts of their body. This includes service members hit by bullets or explosions, car crash victims, and people who fall from upper levels or floors of buildings.

The potential complications resulting from damaged blood flow and imbalances in the chemicals of the body can cause problems throughout the body. Doctors will recommend additional treatments based on the injured body parts.

Conclusion

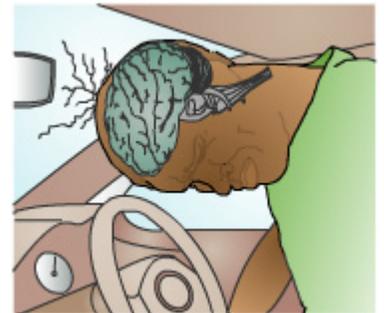
A sudden violent movement or blow to the head can cause the brain to get hurt. This is known as a traumatic brain injury or TBI. TBIs can be mild, moderate, or severe.

A mild traumatic brain injury may cause confusion and headache and most people recover from it. A severe traumatic head injury can cause disability or death.

A severe traumatic brain injury may happen even if the head is violently shaken without coming in contact with a hard object.

This can happen as the brain moves inside its protective fluid and hits the skull. It can also happen if the blow causes microscopic damages to the cells of the brain.

If you or your loved ones suffer a blow to the head, always get checked by a doctor to be on the safe side.



This document is a summary of what appears on screen in *X-Plain™*. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.

Seek emergency medical care if symptoms include:

- Seizures
- Weakness or numbness in the hands or legs
- Slurred speech
- Repeated vomiting
- Severe Headache

When patients recover from moderate to severe TBI they may be left with long-term effects such as:

- Cognitive disabilities
- Personality changes
- Sensory problems
- Headaches
- Seizures



Thanks to advances in medicine, it is now possible to successfully treat most traumatic brain injuries and limit their complications. Rehabilitation programs are also available to help people cope with the long-term effects of their injuries.

This document is a summary of what appears on screen in *X-Plain*™. It is for informational purposes and is not intended to be a substitute for the advice of a doctor or healthcare professional or a recommendation for any particular treatment plan. Like any printed material, it may become out of date over time. It is important that you rely on the advice of a doctor or a healthcare professional for your specific condition.