UNDERSTANDING TRAUMATIC BRAIN INJURY

A GUIDE FOR FAMILIES AND FRIENDS

BOOKLET # 1

Leading with Innovation
Serving with Compassion

ST. MICHAEL'S HOSPITAL
A teaching hospital affiliated with the University of Toronto

TABLE OF CONTENTS

INTRODUCTION

A sudden traumatic brain injury of a family member or close friend can be overwhelming and frightening. Adding to this stress are the unknowns associated with brain injury. It is difficult for anyone to predict the future during the first days, weeks, and even months. Along with family members, they must 'wait and see' how the person improves. Struggling to understand this complex condition, most people feel alone and confused as they strive to learn more about brain injuries.

The staff of the Trauma and Neurosurgery Program at St. Michael's Hospital understand how difficult this time may be for you and have developed two booklets to explain some of the things that may be happening around you and to your loved one following a brain injury.

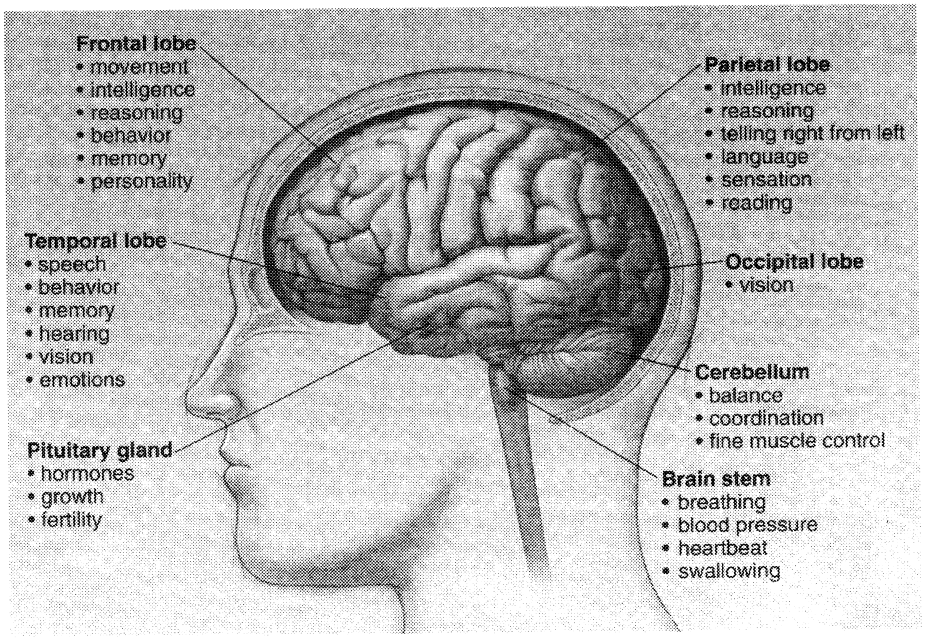
Booklet #1 focuses on the first few days following a head injury. During this time, the patient will likely be in the Trauma and Neurosurgery Intensive Care Unit (TNICU). Booklet #2 additional information related to long-term recovery following a brain injury.

Read these booklets at your own pace. Use them as guides to help you collect information about your family member's brain injury and to discuss your concerns with family, friends, and hospital staff. We hope this booklet provides you with some useful information for the days ahead.

HOW THE BRAIN WORKS

A basic knowledge of how the brain works will help you to understand traumatic brain injury and some of the effects it can have on the brain. Before we can understand what happens when a brain is injured, it will be helpful to know how a healthy brain works and what it does.

- The brain is the control center for the whole body.
- It controls our consciousness, how we think, learn and remember. It controls how we move. It also controls our personality and how we act.
- The brain is responsible for controlling our heart rate, breathing and blood pressure.
- Each part of the brain serves a specific function and links with other parts of the brain to carry out more complicated functions.
- The brain is made up of three parts: the cerebral hemispheres, the cerebellum and the brainstem.
- Most brain injuries affect the cerebral hemispheres. Each cerebral hemisphere (left and right) is divided into 4 sections (called lobes). Each lobe is responsible for different things but they are all connected and work very closely together.
- The left side of the brain controls movement and sensation on the right side of the body. The right side of the brain controls movement and sensation on the left side of the body.



HOW THE BRAIN WORKS

- The skull is made up of bones that protect the brain. The brain sits inside the skull. The skull acts as a protective covering for the soft brain.

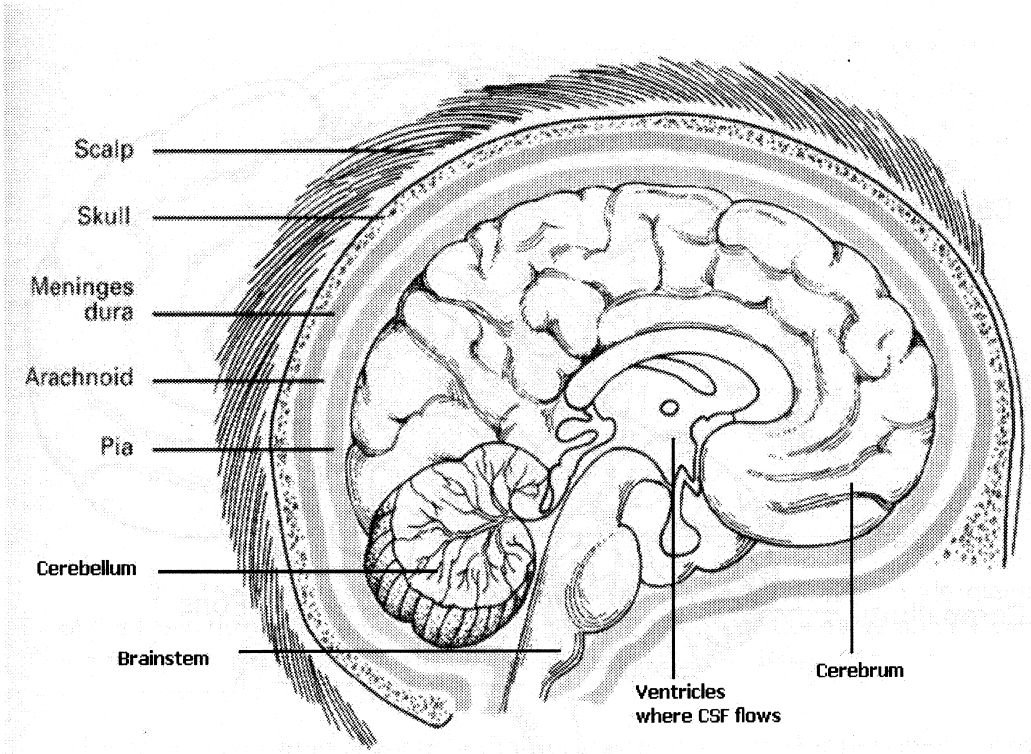
- The brain is also protected by three layers of special tissues called meninges. The three layers are called the dura, arachnoid and pia mater.

- The brain is also protected by a fluid called cerebrospinal fluid (CSF). CSF surrounds and cushions the brain. CSF passes through spaces inside the brain called ventricles. CSF acts like a 'shock absorber' for the brain.

- Blood vessels in the brain carry blood, oxygen and nutrients to all the areas of the brain.

- The cerebellum is a much smaller section of the brain. It is located at the back of the brain below the cerebral hemispheres. It controls balance, coordination and fine muscle movement.

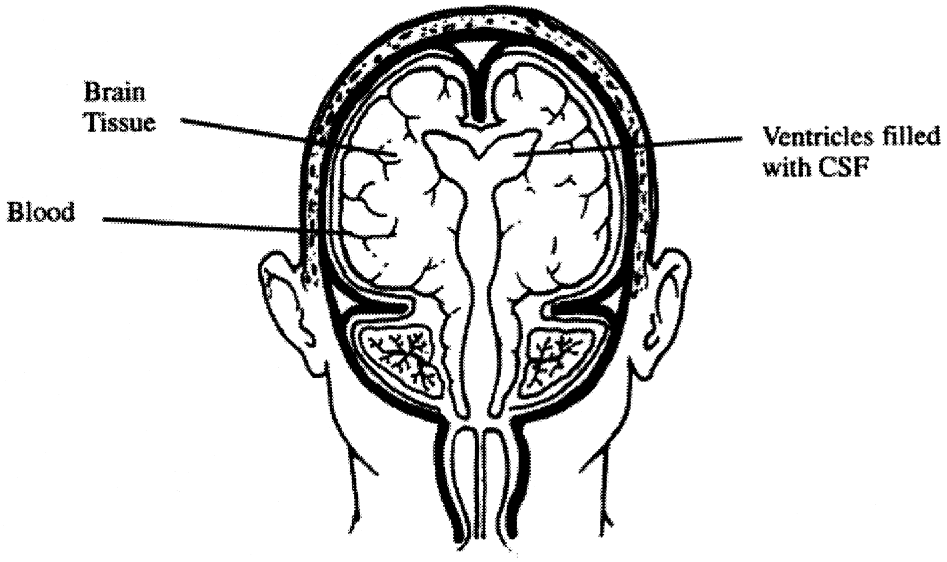
- The brainstem connects the brain to the spinal cord. It controls breathing, blood pressure, heartbeat and swallowing.



WHAT HAPPENS WHEN THE BRAIN IS INJURED?

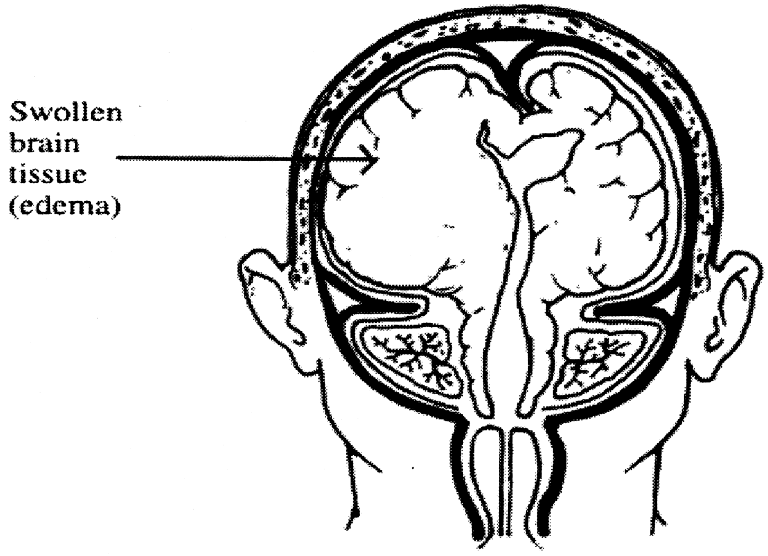
- Damage to the brain can occur immediately, as a result of the injury, or it may develop from swelling or bleeding that can happen after the injury.

Normal Brain



- The skull is like a box that holds the brain, blood and CSF tightly together so that the brain doesn't move around and get damaged during everyday activities.

- After an injury, brain tissue may swell causing it to take up more room in the skull. This is called edema. When this occurs, the swollen brain tissue will push the other parts of the brain to the opposite side.



- As the brain tissue swells or blood takes up space in the skull, the increase in pressure in the head (intracranial pressure) rises and this can cause or be a sign of problems for the brain.

- Increased pressure in the head interferes with the brains' ability to carry out all of its important functions.

- To understand intracranial pressure, think of the skull as a hard box. After a brain injury, the skull may become overfilled with swollen brain tissue, blood or CSF. The skull will not stretch like skin to make room for the swelling brain. The skull may become too full and increase the pressure on the brain tissue. This is called increased intracranial pressure.

- The doctors and nurses in the Intensive Care Unit (ICU) will be doing everything they can to try to keep the brain swelling down and prevent further damage from happening. Sometimes, even with all of the healthcare team's efforts, the pressure will remain too high or the damage will be too bad that there may be little the team can do.

- Intracranial pressure that is very high and does not come down even with treatment may be a sign of permanent brain damage and sometimes death.

WHAT CAUSES THE BRAIN TO SWELL?

After a head injury the brain reacts to the damage by starting a healing response. This healing response causes materials like proteins, vitamins and chemicals to come to the brain to try to help it get better. These materials are specially designed to help repair the damage, fight off infection and stop bleeding.

Even though these materials are trying to help the brain, they can also increase the pressure in the brain because they take up room in the skull. This can cause more pressure on the brain and sometimes more damage.

HOW IS A BRAIN INJURY DIAGNOSED?

It is important to know that only some of the injury to the brain happens at the same time as the injury happens. A lot of the time in the hours and days following the injury, the brain may continue to swell and this can lead to more damage to the brain.

The first minutes, hours and possibly days after the injury can be very difficult for families and close friends. During this time, doctors and nurses will try to determine how much damage has happened and prevent any further damage from occurring. There are different tests that can be done to try to know how bad a brain injury is. The following are some of the tests that may be done:

Skull and Neck X-Rays

Skull x-rays may be done to look for cracks or dents in the skull. Sometimes people who have struck their heads also hurt their necks, so neck x-rays are often done to make sure there was no damage to the bones of the neck.

CAT Scans / CT Scans

Computerized Axial Tomography (CAT or CT scan) is a special type of x-ray that sees through the skull bone and takes pictures of the brain tissue. It is a very useful test because it can show bleeding in the head, blood clots or swelling of the brain. It is a painless procedure.

MRI's

Magnetic Resonance Imaging (MRI) is a painless test similar to a CAT scan but uses magnetic fields instead of x-rays to produce a picture of the brain tissue. MRIs can sometimes pick up changes not seen on a regular x-ray or CAT scan.

EEGs

An Electroencephalogram (EEG) is a recording of the electrical activity of the brain. Specially trained technicians paste electrodes, which are like small flat sponges with wires attached, onto the scalp and connect the wires to a machine. Persons with seizures often require EEGs to locate the area of abnormal electrical activity in the brain.

Intracranial Pressure Monitoring (ICP)

When the brain is injured, it can swell inside the skull. The swelling can cause the pressure inside the skull to go up and cause pressure on the brain. This means that the brain may become squished, causing further injury or death. The pressure in someone's head is called intracranial pressure or ICP. In the ICU, intracranial pressure can be measured through a special tube called a ventriculostomy. To do this, the patient must go to the operating room to have a small tube placed into the brain through a hole in the skull. Once the patient is back in the ICU, the nurses will connect this tube to a monitor to see what the pressure inside the head is.

Vital Signs and Reflexes Monitoring

In the hospital the nurses are looking for signs that may be a warning of increasing pressure inside the head or other problems that may occur following a brain injury. Nurses carefully check the patient's temperature, heart rate, breathing rate and blood pressure. They will also check the patient's level of consciousness and will shine a flashlight into their eyes. Doctors may check some of the main nerves that are in the brain to see how well they are working.

Glasgow Coma Scale (GCS)

The Glasgow Coma Scale is used to help find out how badly the brain is hurt. It looks at three different things:

- Eye opening: how easily and quickly a person opens their eyes tells us how awake the person is.
- Speaking: lets us know if they are confused, or, whether they make sense when speaking, or, whether they make any sounds at all.
- Movements: this part of the test looks at how well patient's understand what we are asking them and helps see any abnormal movements that may be happening because of the brain injury.

Depending on how a patient does with each part of these tests, they are given a score. The score helps us see how bad the brain injury is. This test is done several times a day.

Even though there are lots of different tests to help us see how badly a brain is injured, it is sometimes hard to say how a patient will recover. Sometimes brains are so badly injured that doctor's know there is no hope of recovery. Other times, it is impossible to tell what will happen over the hours and days after a severe head injury. Each of the tests described helps the health care team know what the best thing is to do for each patient. Each person is different and every brain injury is also different.

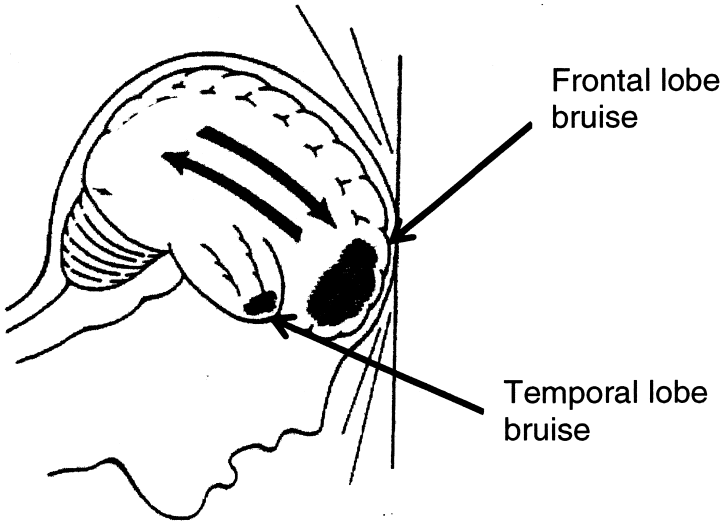
WHAT ARE THE DIFFERENT TYPES OF BRAIN INJURIES?

CONTUSION

- A contusion is the bruising of brain tissue.

- The area that is bruised and the seriousness of the brain injury depend on where the head was hit and how hard it was hit. Common places for contusions are the frontal and temporal lobes. The underside of the frontal lobes and the tips of the temporal lobes have the biggest risk of contusions because they can be dragged across the very bumpy and sharp inner surface of the skull.

- Bruising to the brain can cause bleeding and swelling of the brain. This can be very serious.



HEMATOMAS

- A strong hit to the head may damage or break blood vessels inside the brain.

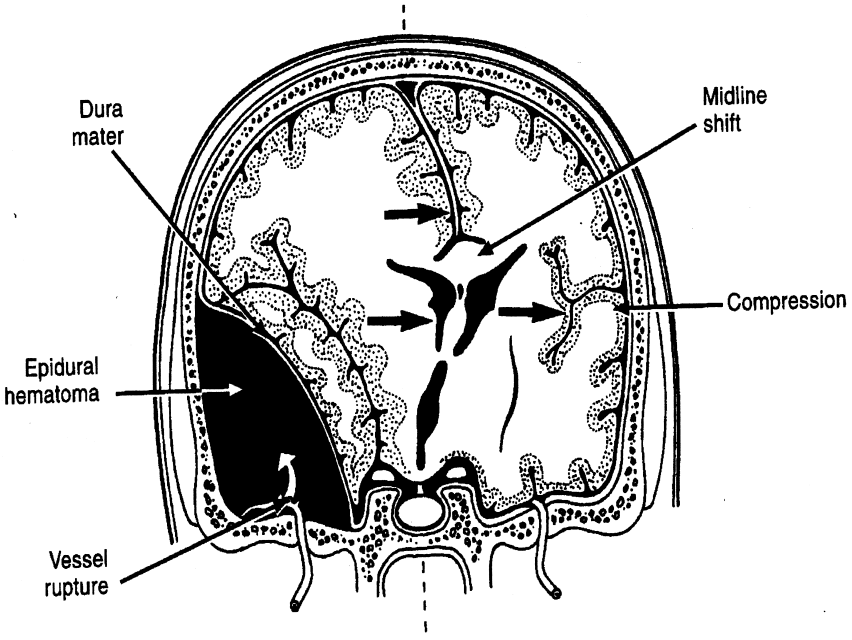
- The collection of blood from these injuries is called a hematoma. There are three different types of hematomas depending on where the bleeding collects: epidural, subdural and intracerebral.

- Often a neurosurgeon can remove subdural and epidural hematomas and stop the bleeding because they are near the surface of the brain. Bleeding deep within the brain tissue may not be treatable with surgery, like the intracerebral hematomas.

EPIDURAL HEMATOMA

- Bleeding that occurs between the skull and the top lining of the brain (dura) is called an epidural hematoma.

- Initially the person may only have a brief loss of consciousness and then appear fine. However, as the amount of bleeding gets bigger, it begins to press on the brain. The patient then becomes very sleepy, and may become unconscious.



- Although the brain may not have been damaged, the pressure the bleeding exerts on the brain can lead to brain injury.

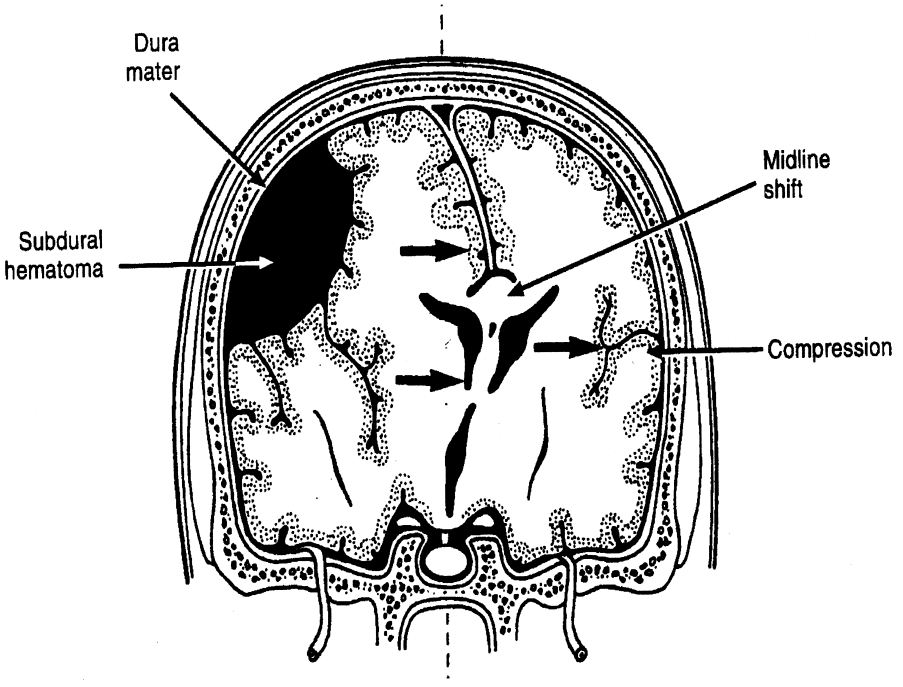
- An epidural hematoma can be life threatening and may require emergency surgery to remove the blood.

SUBDURAL HEMATOMA

- A subdural hematoma results from tears in the veins that are between the dura and the brain tissue.

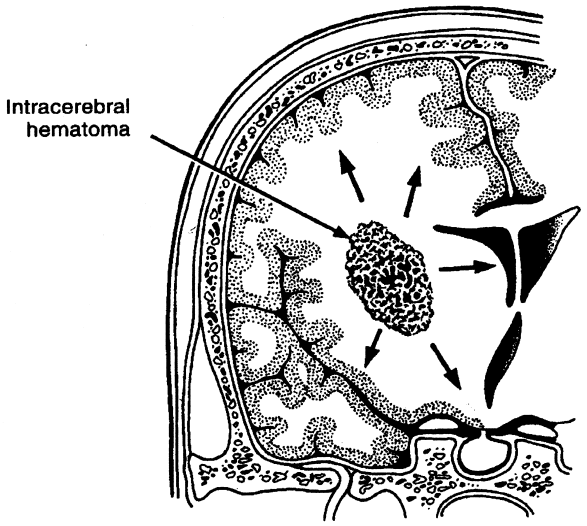
- A subdural hematoma can occur quickly or can bleed slowly for days before any symptoms of pressure on the brain appear.

- The bleeding may cause increased pressure and may need to be removed by an operation.



INTRACEREBRAL HEMATOMA

- An intracerebral hematoma is bleeding directly in the brain tissue. It may be deep in the brain and hard to remove.
- Pressure from this blood may cause damage to the brain.



BLEEDING/HEMORRHAGE

- Blood vessels in the brain can break and can cause blood to leak into and around the brain.
- Bleeding can occur in either tiny vessels of the brain (called a **punctuate hemorrhage**), or, may affect larger vessels of the brain causing a lot of bleeding throughout the brain.
- Blood can accumulate in different spaces in the brain. If a blood vessel breaks and blood collects in the subarachnoid space (which is between two skin-like layers on the surface of the brain) then this is called a **subarachnoid hemorrhage**. Blood can flow from the site of injury and enter the ventricles of the brain where cerebral spinal fluid is present. This is known as an **intraventricular hemorrhage**.
- If a person is on blood thinners like aspirin or Coumadin prior to an injury more bleeding may occur. Prior alcohol use can also aggravate this problem.

CONCUSSION

- A concussion is caused by either a hit to the head, or by sudden changes in speed (for example a fast car hitting a pole and stopping very suddenly). A concussion happens when the blood vessels and/or nerves in the brain are stretched and damaged.
- A person with a concussion may or may not experience a loss of consciousness or they may remain conscious, but feel dazed.

- Concussions may cause headaches, nausea, vomiting, dizziness and problems with memory and concentration.

- Even though concussions rarely show up on CT scans, they can result in temporary or permanent damage. It may take weeks, months or very rarely, a few years for a concussion to heal. The effect of repeated concussions are more likely to last longer.

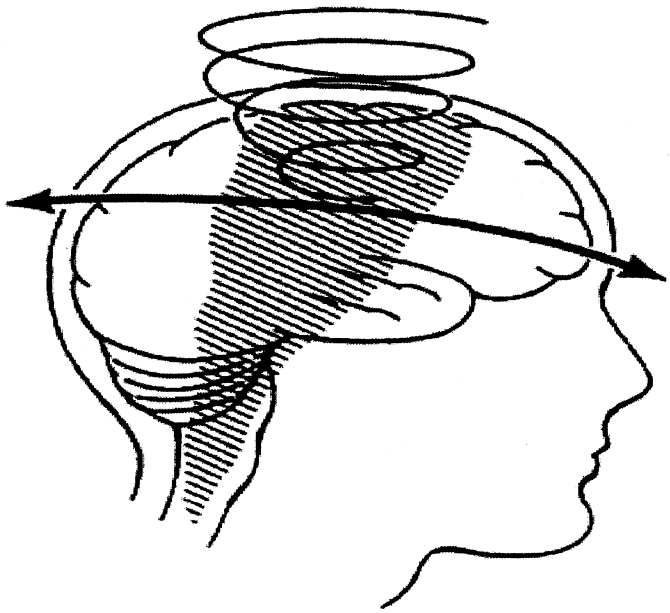
DIFFUSE AXONAL BRAIN INJURY

- Diffuse axonal brain injury can be caused by going at a certain speed, and then suddenly slowing down, causing the brain to move at different speeds inside of the skull. The brain tissue can twist and turn at the time of injury. This can cause extensive tearing of nerve tissue throughout the brain. The brain messages are slowed or lost.

- The disturbance in the brain can produce temporary or permanent widespread brain damage.

- A person with a diffuse axonal injury can have a variety of impairments depending on where the shearing, or, tearing occurs within the brain.

- Treatment is aimed at managing swelling in the brain because torn axons (nerves within the brain) cannot be repaired.



HYPOXIC BRAIN INJURY

- A hypoxic brain injury results when the brain receives some, but not enough oxygen. The cells in the brain need oxygen to survive and function. Decreased oxygen can cause brain cells to die.

- This is common in patients who have a lost a lot of blood from an injury (such as a broken leg or a broken pelvis), or in patients who have problems breathing and therefore can not breathe in the right amount of oxygen the body needs to feed the brain. This can happen if someone has a chest injury where the lung is collapsed, or, if the person is unconscious and is not able to take in deep breaths.

SKULL FRACTURES

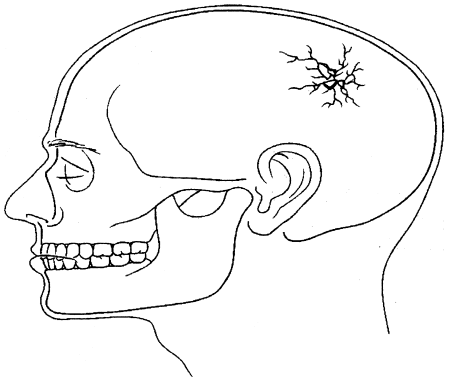
- A strong knock to the head can cause the skull bone to break. Sometimes the injury results in a simple cracking without movement of the bone. These fractures usually heal on their own.

- When pieces of bone are displaced and press in against brain tissue, a more serious injury results called a **depressed skull fracture**. To prevent further brain injury or bleeding, these fractures usually require surgery to remove the bone fragments from the brain.

- Because the skull is damaged, or open, it cannot protect the brain as it did before. The once protected brain is now exposed, which leaves it vulnerable to infections and further injury.

- A skull fracture can cause damage to the nerves and blood vessels that are present near the fracture.

- A basal skull fracture is a fracture that is located at the bottom of the skull. When there is a skull fracture located near the ear there may be bruising present below the ear, on the jaw and/or neck. Blood or cerebral spinal fluid may leak out of the ear. When there is a skull fracture located in the front part of the skull the patient may have 'raccoon eyes', or, bruising around the eyes. Blood or cerebral spinal fluid may leak out of the nose.



HOW WILL THE PATIENT RESPOND TO A BRAIN INJURY?

COMA

- When someone is in a coma they are unconscious. They do not speak and their eyes are closed. They may appear to be asleep, but they cannot be awakened. Sometimes patients in coma do not move at all, or they may have abnormal, very stiff body movements.

- The length of coma varies from person to person. It can last from a few days to several months, or longer. Family members may expect a patient to suddenly wake up from a coma, but coming out of a coma is usually a very slow process. Usually, patients will become more aware of the people and things around them as they wake up from a coma. Predicting how quickly or how well a patient will come out of a coma depends on a number of factors such as the location, severity, and extent of damage. People may emerge from a coma with a combination of physical, intellectual, and psychological difficulties that need special attention. Some patients never progress beyond very basic responses, and some recover full awareness.

- Family members and friends often wonder if comatose patients can hear. Sometimes patients seem to be calmed by a familiar voice or music. Since patients rarely remember these events later, it is impossible to know what they actually hear. Nevertheless, health care professionals recommend that people should speak to comatose patients as if they could hear and understand.

- Patients in a coma can develop some medical problems because they are not moving on their own. Some of these problems include stiff joints, skin sores, infections and blood clots. The health care team will be working to try to prevent these problems from happening.

MINIMALLY RESPONSIVE STATE

- This is a term used for patient's who are no longer in a coma. They may inconsistently follow simple commands and may have an awareness of their surroundings.

- Persons who sustain a severe brain injury can make significant improvements, but are often left with permanent physical (movement), cognitive (thinking and reasoning), or behavioural (emotions and judgement) problems.

HOW ARE BRAIN INJURIES TREATED?

Brain injury that happens at the time of the trauma is called primary brain injury. Once this damage happens, it cannot be changed or reversed. The damage that happens in the hours or days after the trauma is called secondary brain injury. The health care team will be working together to try to prevent any secondary brain injury from happening. Secondary brain injury is due to the brain swelling that often happens after a brain injury.

There are different things that can be done to try to prevent secondary brain damage.

SURGERY

- Surgery for brain injury cannot reverse the damage that has already happened. Surgery may be performed to try to stop the brain from becoming more injured.

- Some of the things a doctor can do in the operating room are:

    - Remove a blood clot

    - Remove a very badly damaged or dead area of brain so that the rest of the brain has more room to swell. If there is more room for the brain to swell then there will be less pressure on the brain.

    - Put a special tube (ventriculostomy) into the brain to measure the pressure in the head. The tube goes directly into the ventricle. It measures and controls pressure inside the skull. It can be used to drain some fluid from the brain.

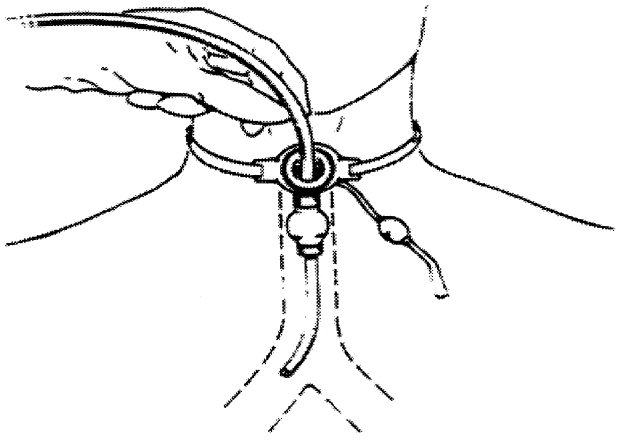
MEDICATIONS

- There is no medicine to heal brain injury but there are medicines that are used to try to stop secondary brain injury.
- These medicines may be used to try to decrease brain swelling, prevent or stop seizures, keep patients calm or sleepy and to treat pain.

AIRWAY MANAGEMENT

- Patients who have serious head injuries may not be able to breathe well on their own. These patients need the help of a breathing machine (ventilator) to make sure their brain and body are getting enough oxygen. Ventilators are attached to a tube that goes into the patient's mouth (or nose) and into their lungs.

- If the patient has a lot of lung secretions or is expected to be on a ventilator for a long time they may need a tracheostomy. A tracheostomy is a tube that is placed in the trachea (windpipe). It will make it easier for the patient to cough up secretions. It also allows the nurse to suction the patient's lungs to get out secretions (mucous or phlegm) deep in the lungs.



- Initially the patient will not be able to talk when the trach is in place. As the patient improves, a talking trach is sometimes used. A trach is usually not permanent.

NUTRITION

- Many patients with a head injury are not able to swallow/eat on their own. Nutrition is important for healing. A tube is inserted through the nose that goes down the back of the throat until it reaches the stomach. This tube is used to deliver food supplements and medications to the patient. For patients expected to need this tube for a long time, another tube called a PEG tube is inserted directly into the abdomen.

SKIN CARE

- Bedsores can happen to patients who are in bed for a long time. To prevent this, the nurses will change a patient's position frequently and check the patients skin regularly. They may also be placed on a special bed/mattress that decreases the pressure on the patient's skin.

POSITIONING AND EXERCISE

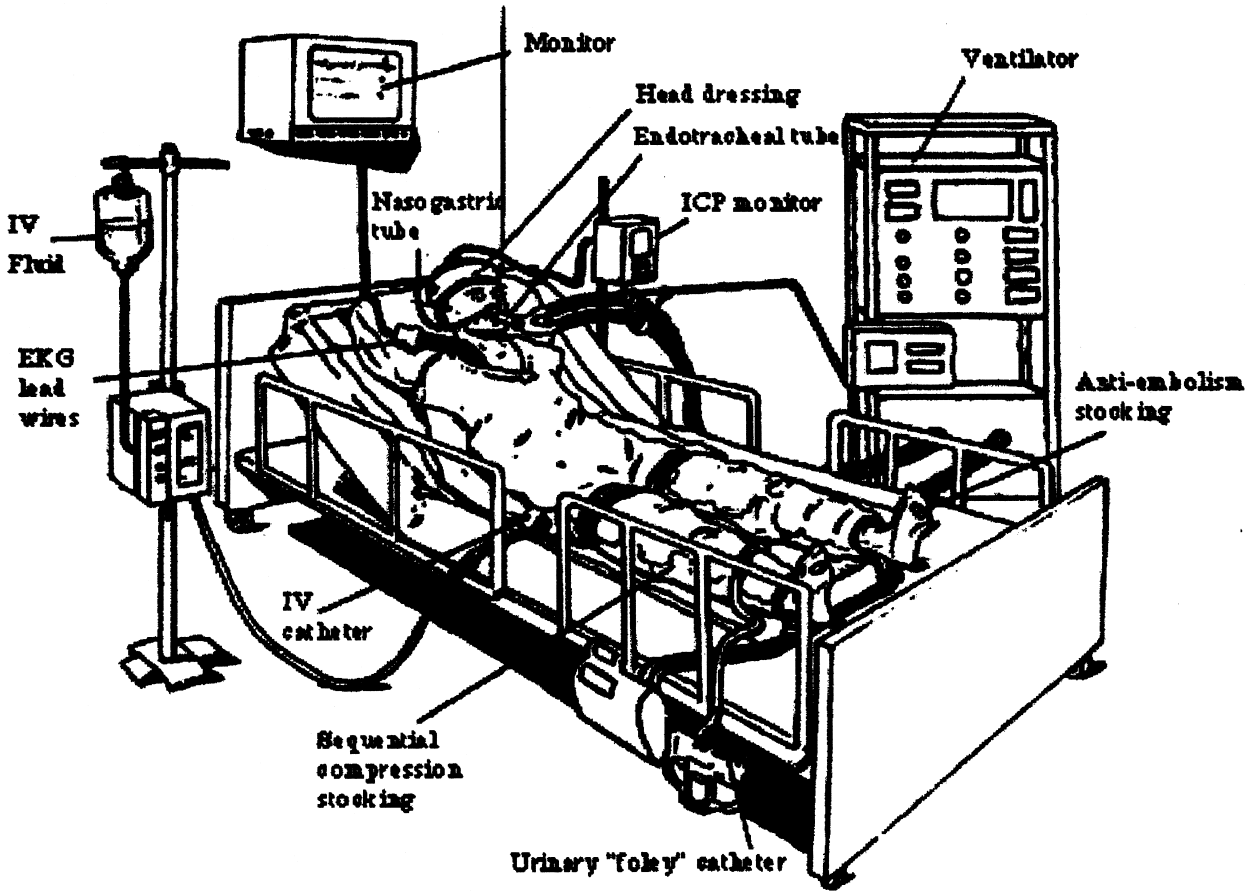
- Joints that are not moving very much can get stiff. Muscles can lose their tone. In order to prevent this, physical therapists and nurses will move patient's arms and legs for them. Family members can sometimes help with these exercises. Ask the healthcare team how you can help.

PAIN CONTROL

- Comfort measures and medication will be used for pain control.

WHAT EQUIPMENT WILL YOU SEE WHEN YOU VISIT?

Depending on the type of brain injury, different kinds of equipment will be used at the bedside. Some common equipment is shown in the picture below. Ask a member of the health care team if you have any questions about the equipment.



TERMS THAT YOU MAY HEAR WHILE IN THE INTENSIVE CARE UNIT:

Agitation: A state of anxiety displayed in restlessness

Amnesia: A lack of memory about events occurring during a particular period of time.

Anoxia: A lack of oxygen. Cells of the brain need oxygen to stay alive. When blood flow to the brain is reduced or when oxygen in the blood is too low, brain cells are damaged.

Anticonvulsants: Medication given to stop and control seizures; a common anticonvulsant is Dilantin.

CAT / CT Scan: Computerized axial tomography. A technique using x-rays and computer technology to distinguish between various tissue densities in the brain. Detailed pictures of the brain, bone and fluid are provided.

Cerebral Contusion: Bruising of the brain.

Cerebral Hemorrhage: Bleeding into the brain that damages the tissues.

Cerebral Spinal Fluid: The fluid that is made by the brain inside the ventricles. It protects the brain and spinal cord. It also carries nutrients to the brain.

Cerebrum: The main portion of the brain. Consists of two halves connected together by a thick bundle of nerve fibers (the corpus callosum). Contains the frontal lobes in the forehead, the temporal lobes on the side, the parietal lobes at the crown, and the occipital lobes in the back.

Closed Head Injury: An injury to the brain in which the skull remains intact.

Coma: A coma is said to exist when the person's level of consciousness is such that he or she is unable to purposefully interact with their environment.

Craniotomy: Opening of the skull by an incision to allow the surgeon to work on the brain.

Decerebrate Posturing: An abnormal motor response caused by compression of the brainstem. The patient reflexively straightens the legs and the arms and hands are straight and turn inwardly. This is an involuntary response, in that the patient is not willfully performing the action. This position is not a good sign.

Decorticate Posturing: An abnormal posture occurring in the unconscious patient in which the arms are bent and tucked close into the body and the legs are extended. This position is not a good sign.

Dura: A tough connective tissue membrane that surrounds the brain. Contained within the dura are the brain and cerebrospinal fluid.

Edema: Generalized term for swelling.

EEG (Electroencephalogram): A test that reveals brain wave patterns. Can be used to detect seizure activity. Can help to determine the cause of a coma. It helps to locate surface brain lesions.

Epidural Hematoma: A collection of blood formed by a broken artery between the skull and dura (ie. 'outside' the brain).

Frontal Lobes: The paired lobes located in the front of the brain. Functions located in these lobes include movement, speech, emotion, motivation, and personality.

Flaccid: Loss of muscle tone resulting in limbs which feel floppy or heavy.

Glasgow Coma Scale (GCS): A system used to grade the severity of a patient's head injury. The scale is based solely on the finding of the physician's neurologic examination of the patient. The scale ranges from 3 to 15 with 3 being the worst.

Hematoma: A localized collection of blood usually clotted, due to a break in the wall of a blood vessel.

Hemiparesis: Muscular weakness on one side of the body only.

Hemiplegia: Muscular paralysis on one side of the body only.

Infarct: An area of tissue that is dead due to insufficient blood flow or oxygen. Often results form a blockage of an artery by a clot.

Intracerebral Contusion: A bruising of a specific region of the brain from trauma to the head.

Intracranial Pressure: Pressure within the skull due to a hemorrhage or swelling of the brain.

Magnetic Resonance Imaging (MRI): A machine that produces extremely detailed pictures of all the different parts of the brain; it uses magnets instead of x-rays to create the pictures.

Nasogastric Tube: A tube placed in the nose and passed down the esophagus and into the stomach; can be used to suck material such as blood and air out of the stomach. These tubes can also be used to give medicines and feedings.

Occipital Lobes: Paired lobes, located in the back of the brain, that deal predominately with vision.

Parietal Lobes: Located behind the frontal lobes and above the temporal lobes. The left parietal lobe typically deals with multiple language functions, including understanding speech, reading, and writing.

Seizure: A convulsion of sudden unpredictable onset usually with loss of consciousness.

Subarachnoid Hemorrhage: A pocket of blood formed below the arachnoid mater. Refers to blood within the spaces that the brain's blood vessels travel. This is usually scattered in the brain.

Subdural Hematoma: A collection of blood formed by a broken vein which forms between the dura and the brain.

Temporal Lobes: The temporal lobes are located on each side of the brain. Functions of these lobes include speech, memory, behaviour, hearing, vision and emotions.

Ventriculostomy: A special catheter that measures brain pressure.

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This booklet was prepared by the members of the Family Resource Education Group of the Trauma and Neurosurgery Program at St. Michael's Hospital.