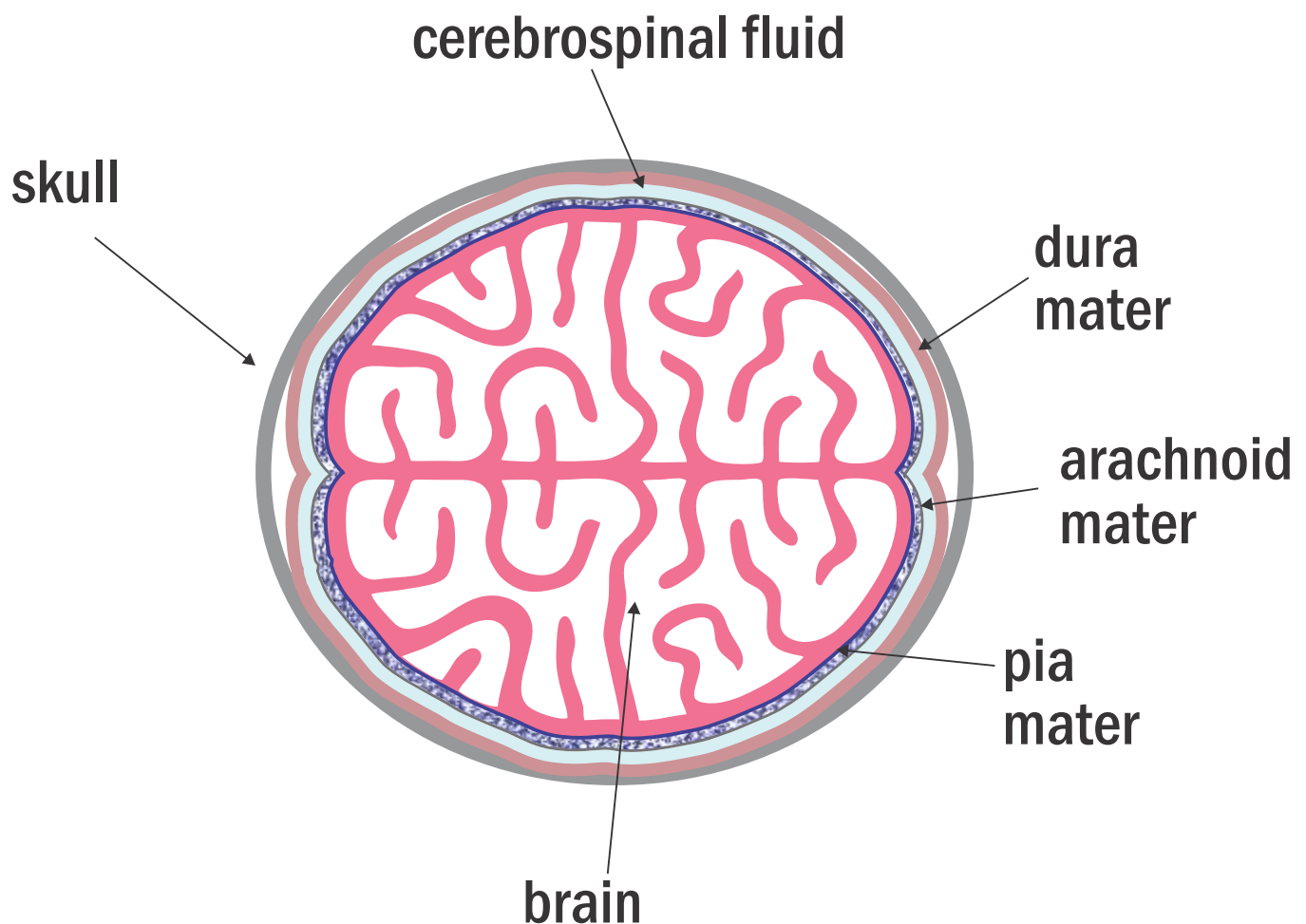
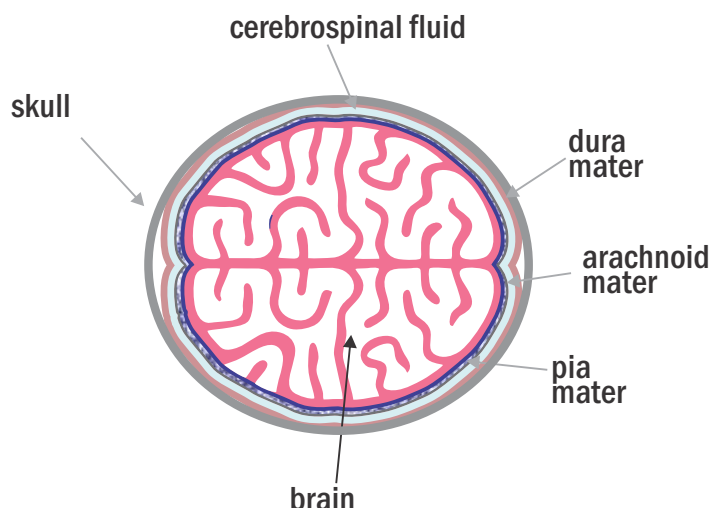


# The Brain

The brain is located inside the skull, surrounded by liquid (cerebrospinal fluid) and covered by three membranes: the pia mater, the arachnoid and the dura mater. These membranes, together with the cerebrospinal fluid protect the brain from shakes and blows. A brain injury is produced when the brain has a blow that is too strong or has a very abrupt movement.



# Concussion



▲ Normal brain

Concussions are the most common and less serious type of brain injuries. When a child has a concussion his brain undergoes chemical changes and sometimes some brain cells are stretched and damaged.

Children who have concussions may lose consciousness, but this does not always happen. They may also feel disoriented, move awkwardly, respond slowly, and complain of blurred vision, headache, or vomiting.



▲ Moving head suddenly stops

▲ The brain is compressed into the skull

▲ It can also be compressed by bouncing back.

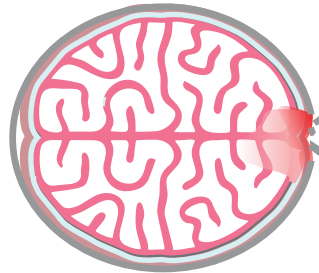
# Skull Fracture

A skull fracture is a damage in the continuity of the skull bone. A skull fracture can be displaced or not and may occur in any place of the skull.



## Non-displaced skull fracture

Skull fractures can cause injuries to the brain tissue, such as contusions.



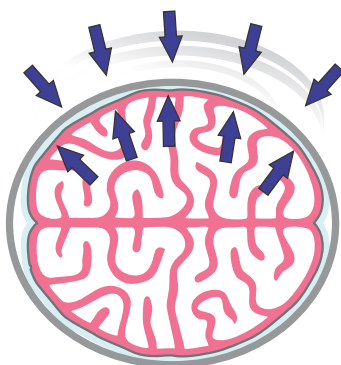
## Displaced skull fracture, contusion and bleeding

Broken bones can break into the dura and arachnoid membranes as well as the brain tissue, causing contusions and bleeding.

## Basilar skull fracture (picture not shown)

A basilar skull fracture is a fracture at the base of the skull. This type of fracture may need to be managed differently from other types of skull fractures if the lesion causes a tear in the brain membranes resulting in leaks of cerebral spinal fluid (CSF).

# Cerebral Edema



Cerebral edema is a generalized swelling of the brain that causes an elevation of the intracranial pressure (pressure within the brain).

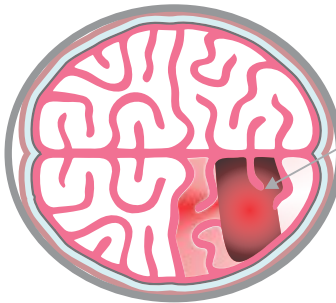
# Contusions and Intracranial Hematomas

An intracranial hematoma is a bleeding within the skull. It's caused by damage to the blood vessels (veins and arteries) of the head. There are three types of hematomas.



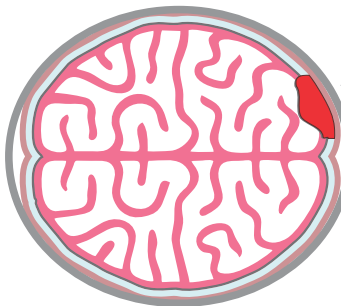
## Contusion

A contusion is an area of brain tissue that is swollen, like a "bruise" on the brain.



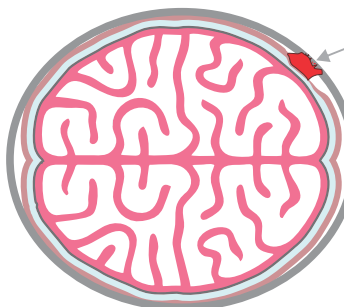
## Intracerebral Hematoma

Bleeding into the brain itself is called an intracerebral hematoma.



## Subdural Hematoma

It is the accumulation of blood between the dura and the subarachnoid membranes.



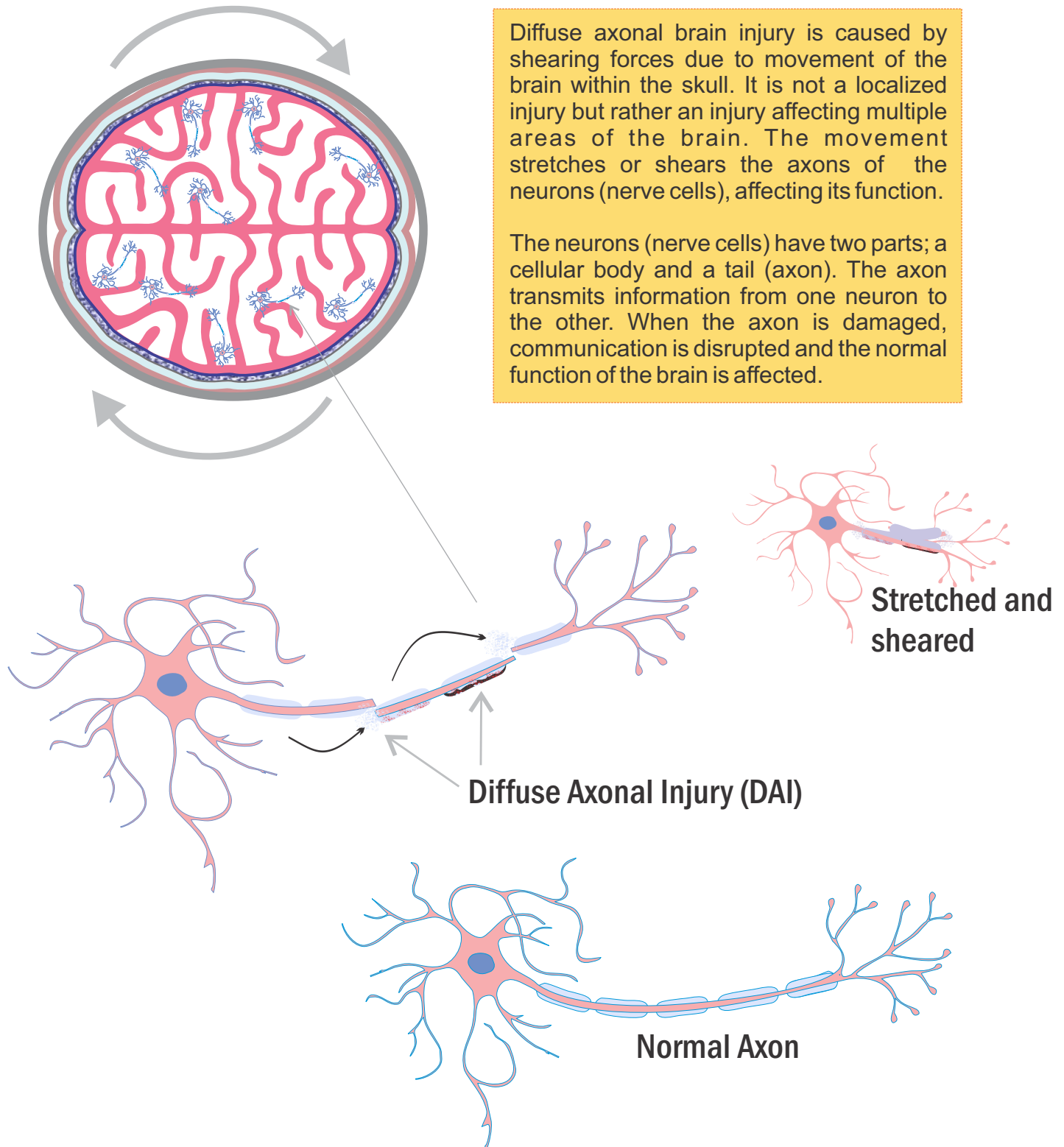
## Epidural Hematoma

It is the bleeding between the skull and the dura.

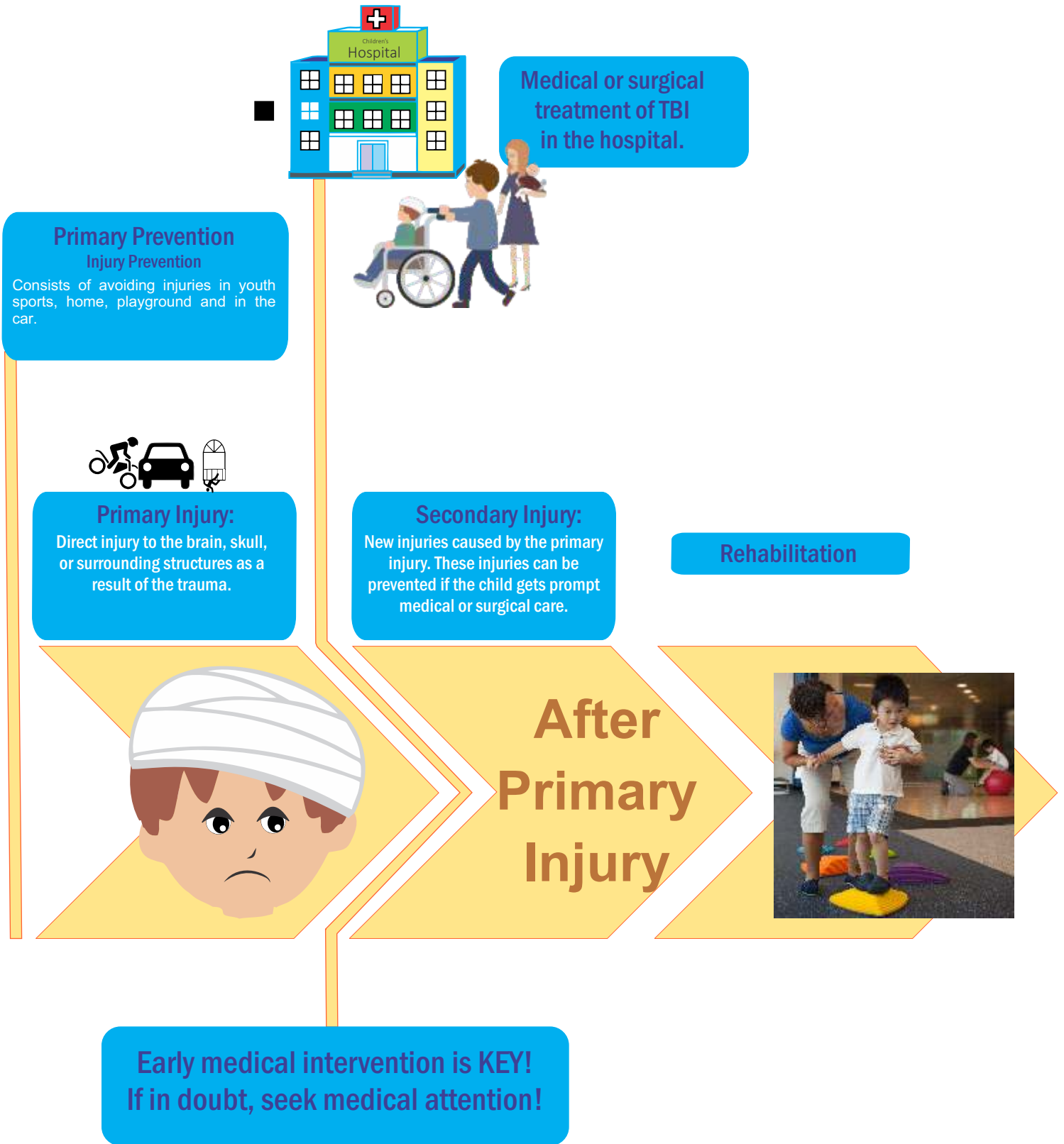
# Diffuse Axonal Injury (DAI)

Diffuse axonal brain injury is caused by shearing forces due to movement of the brain within the skull. It is not a localized injury but rather an injury affecting multiple areas of the brain. The movement stretches or shears the axons of the neurons (nerve cells), affecting its function.

The neurons (nerve cells) have two parts; a cellular body and a tail (axon). The axon transmits information from one neuron to the other. When the axon is damaged, communication is disrupted and the normal function of the brain is affected.



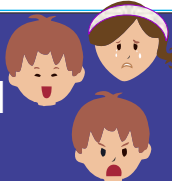
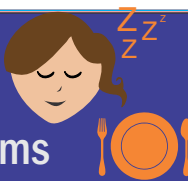
















# Primary and Secondary Brain Injury



# TBI Symptoms

TBI symptoms fall into four categories: cognitive, physical, emotional and other problems. These symptoms

<b>Cognitive (Thinking)</b> 	<b>Physical</b> 	<b>Emotional</b> 	<b>Other symptoms</b> 
<b>Attention difficulties (difficulty concentrating)</b> 	<b>Paralysis (inability to move one or more extremities)</b>	<b>Little or no expression of emotions</b> 	<b>Fatigue (tiredness, lack of energy)</b> 
<b>Speech and language problems</b> 	<b>Numbness or weakness of the limbs</b>	<b>Depression</b> 	<b>Sleep problems (sleeping more or less than usual)</b> 
<b>Learning difficulties</b> 	<b>Balance problems (disequilibrium, or dizziness)</b> 	<b>Unable to deal with emotions (more emotional)</b>	<b>Visual changes</b> 
<b>Memory problems (Difficulty remembering information)</b>	<b>Loss of coordination</b> 	<b>Anxiety</b> 	<b>Trouble swallowing</b> 
<b>Reasoning difficulties (Difficulties with planning, problem solving and decision making)</b>	<b>Seizures</b>		<b>Hearing changes (difficulty to hear)</b> 
<b>Lack of self-control (inappropriate, embarrassing or impulsive behavior)</b>	<b>Headaches</b> 		<b>Changes in the sense of smell</b>
	<b>Muscle spasticity (stiffness)</b>		

# Detecting a Traumatic Brain Injury

While your child is in the hospital, one or more of the following tests may be done to better understand the location and severity of their injury.

While tests are useful, the most important part of detecting and following up a TBI is the physical and neurological exam of your child.



## Physical exam:

Repeated physical exams is key to assess progress in your child's treatment.



## Imaging:

Imaging is useful for detecting possible lesions that can be treated with surgery. It also helps to assess initial prognosis.

After initial diagnosis, there is no need for extra images, unless there are changes in the physical exam or condition of your child.

### CT Scan or CaT scan:

A Computer Tomography machine takes a series of detailed X-Ray images and show multiple images of different parts of the brain. CT scans take less time than MRI.

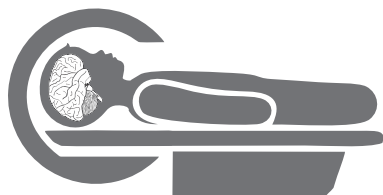
### MRI:

Magnetic Resonance Imaging. MRI uses a magnetic field, radio waves and a computer to see the brain. MRI does not use radiation, and takes more time to complete than a CT scan.

Note: Some children require anesthesia or sedation for the MRI.

### Ultrasound:

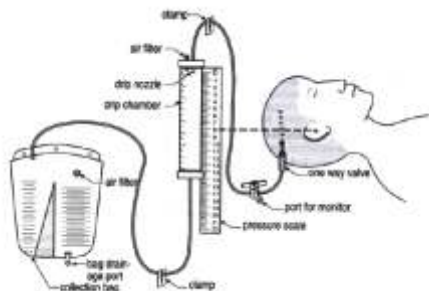
Ultrasound imaging may be used to detect increased intracranial pressure (pressure inside the brain). This test also tells doctors if the brain is receiving enough blood flow.



## Other ways to monitor the brain:

### Intracranial Pressure (ICP) Monitoring and External Ventricular Drain (EVD)

Doctors may also use catheters and sensors that are placed by drilling a hole in the skull to measure the pressure inside the brain.





## 1 Initial treatment

- When a patient with a TBI arrives to the hospital, the first steps are to monitor vital signs and address any life-threatening challenges.

## 2 Acute treatment

- The goal of acute treatment is to minimize secondary injury. Sometimes a patient may be put on a machine to help them breathe in order to keep down the pressure inside the skull (intracranial pressure).
- Doctors can also drill a hole in the skull to monitor the intracranial pressure.
- Medications are used to sedate a patient to minimize the risk of further agitation and secondary injury.

## 3 Surgical treatment

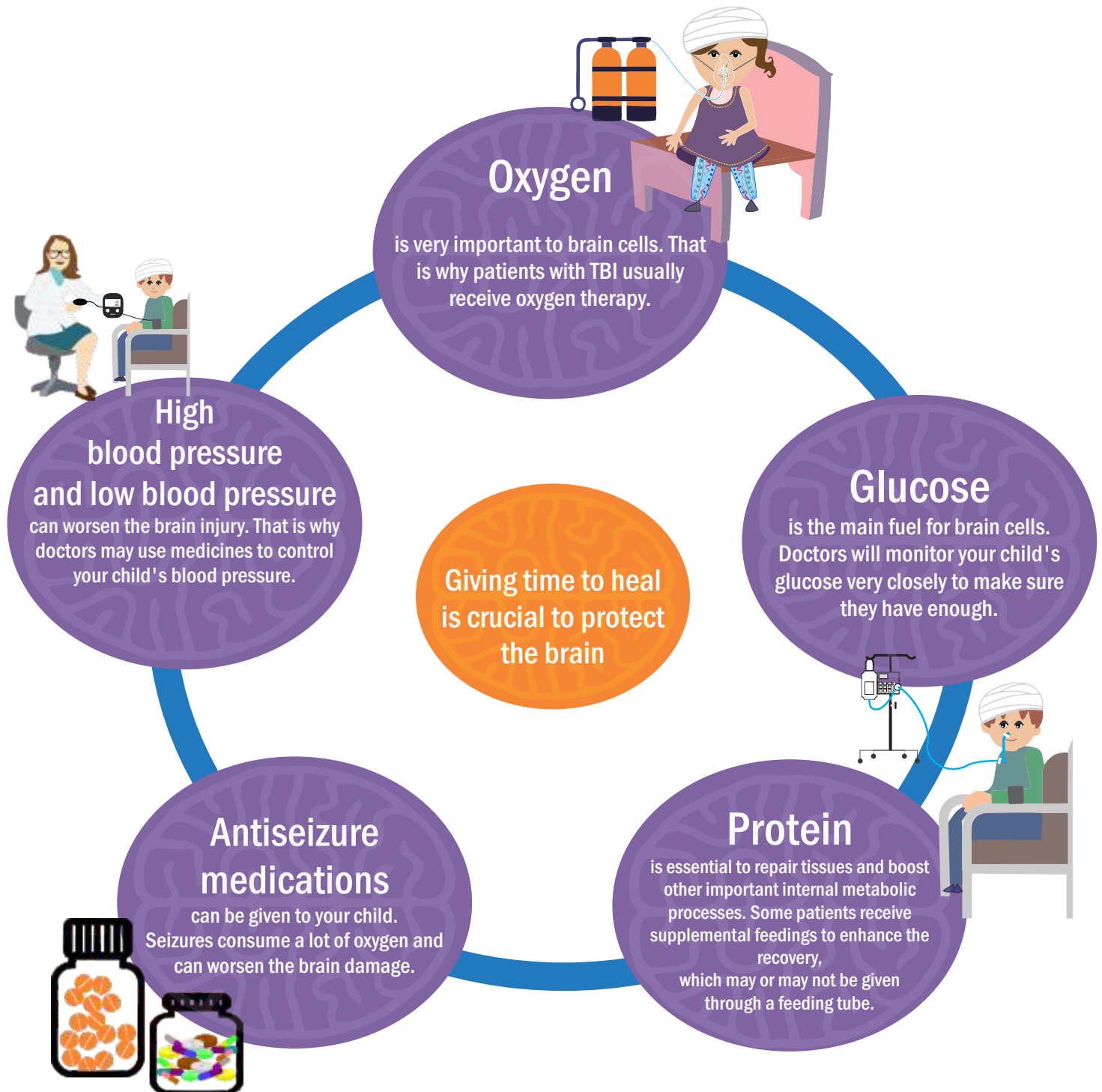
- Not all patients need surgery.
- Bleeding in the skull cavity can be surgically removed or drained and broken vessels (arteries and veins) can be repaired.
- Extensive swelling of the brain might require surgical treatment to decrease the pressure of the brain.
- Some patients may require drains, like an External Ventricular Drain (EVD), for a short period of time.
- Ventriculoperitoneal Shunt (VP shunt) may also be placed to manage the pressure of the brain for longer periods of time.

## 4 Support treatment

- After initial, acute and surgical treatment, patients must be monitored for changes in breathing, heart rhythm, blood pressure, pulse, and temperature.
- Patients may also be monitored for changes in intracranial pressure.
- Other symptoms to monitor and treat are seizures and dystonia (muscle stiffness).



# Protecting the Brain after a TBI



## 5 Questions to ask to your child's doctors, nurses and therapists:

- 1) What type of injury did my child have?
- 2) What type of treatment is my child receiving and why?
- 3) What are the next steps in her/his treatment?
- 4) Will my child have deficits after the injury?
- 5) How can I help my child to recover from these deficits?

