

## Traumatic Brain Injury

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### Abstract

*Traumatic brain injury (TBI) is an injury to the brain that is non-degenerative and non-congenital but is caused by external mechanical forces that can cause a decrease in consciousness and temporary or permanent disturbances in cognitive, physical and psychosocial functions. The latest data from the CDC in 2014 there were as many as 2.87 million people in the world suffered head injuries. Certain segments of society that are at high risk for TBI include young people, low-income individuals, unmarried individuals, members of ethnic minority groups, male gender, urban dwellers, substance abusers and people with previous TBI.*

**Keywords:** Head Trauma; Traumatic Brain Injury; Radiology;

## **Introduction**

Head injury or commonly called Traumatic Brain Injury (TBI) is a trauma that affects the scalp, skull, or brain that occurs as a result of injury either directly or indirectly with or without bleeding that results in impaired brain function (BIAA, 2011). Head injury is a brain disorder caused by a collision, blow, or stab to the head that causes impaired brain function (CDC, 2015). According to the Brain Injury Association of America, a head injury is defined as damage to the head that is not congenital or degenerative but is caused by an attack or physical impact from the outside, which can reduce or alter consciousness which will cause damage to cognitive abilities and physical function (BIAA, 2011).

Head injury is a major health problem that causes death and long-term disability, especially in young adults. The global prevalence of head injury or head trauma was recorded at 69 million with an incidence rate of 939 per 100,000 people. The latest data from the Centre for Disease Control and Prevention (CDC) in 2014 showed that 2.87 million people worldwide had head injuries (CDC, 2019; Faul dan Coronado, 2015). Nationally, the prevalence of head injuries in Indonesia in 2018 was 11.9% of all residents who suffered injuries in the past year (Kementerian Kesehatan Republik Indonesia, 2018).

This high mortality and morbidity rate can still be reduced by making an early diagnosis using radiological examination, because the sooner the diagnosis is made, the faster the patient will be treated. The purpose of the radiological examination is to detect lesions so that they can be treated immediately to prevent secondary neurological damage (Lolli *et al.*, 2015). Computed Tomography (CT) is the examination of choice for the diagnosis of acute head injury with the aim of determining whether there are life-threatening lesions. CT examination is non-invasive, rapid, and has few contraindications (Lolli *et al.*, 2015; Sylvani, 2017).

## **Method**

The method used in writing this literature review using literature searching. Library search using website-based search tools, namely Google Scholar, National Centre for Biotechnology Information (NCBI) and PubMed using keywords Brain Trauma and Traumatic Brain Injury. The selected articles were 18 journal articles published between 2011 and 2021.

## **Definition**

Brain trauma or traumatic brain injury (Traumatic Brain Injury) is an injury to the brain that is non-degenerative and non-congenital but is caused by external mechanical forces that can cause a decrease in consciousness and disturbances in cognitive, physical, and psychosocial functions that are temporary or permanent (Dawodu, 2019). Traumatic brain injuries are divided into 2 sub-categories: (1) primary injuries, which occur at the time of the trauma, and (2) secondary injuries, which occur immediately after the trauma and have long-lasting effects. One form of primary injury is intracranial haemorrhage which is divided into several types, namely Epidural Hematoma (EDH), Subdural Hematoma (SDH), Intracerebral Haemorrhages (ICH), intraventricular haemorrhage (IVH), and Subarachnoid haemorrhage (SAH) (Dawodu, 2019).

Subdural Hematoma is an accumulation of blood between the dura mater and arachnoid whereas Epidural Hematoma is an accumulation of blood in the potential space between the

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dura mater and the skull bone (Meagher, 2018; David, 2018). Intracerebral Haemorrhages (ICH) are the formation of a hematoma in the brain parenchyma with or without the expansion of blood into the ventricles (Rajashekar and Liang, 2021). Intraventricular haemorrhage (IVH) occurs when blood from a cerebral haemorrhage has expanded into the ventricular system of the brain (Garton *et al.*, 2017). Subarachnoid Haemorrhage (SAH) is an accumulation of blood between the arachnoid and pia mater (Ziu and Mesfin, 2021).

**Epidemiology**

Traumatic brain injury is a major health problem that causes considerable mortality and long-term morbidity worldwide, especially under 44 years of age. The incidence is about 1.6 million per year in the United States resulting in 50,000 deaths and 70,000 patients with permanent disabilities (Lolli *et al.*, 2015). About 52,000 deaths in the US per year are due to TBI. The out-of-hospital mortality rate is about 17 per 100,000 people, about 6 per 100,000 people for hospitalized patients. The National Institutes of Health Consensus Development Panel on Rehabilitation of Persons with TBI shows that 2.5-6.5 million Americans live with a TBI-related disability. Certain segments of society that are at high risk for TBI are young age groups, low-income individuals, unmarried individuals, members of ethnic minority groups, male gender, urban dwellers, substance abusers, and people with previous TBI (Dawodu, 2003). 2019).

Epidural hematoma (EDH) occurs in 0.2-12% of acute head injury patients with an overall mortality rate of 5%. Meanwhile, the incidence of Subdural Hematoma (SDH) is 12-29% of patients with severe TBI, the main causes are motor vehicle accidents and assault. The incidence of subarachnoid haemorrhage (SAH) is approximately 40% in patients with moderate to severe TBI, whereas IVH varies between 1.5% and 3% (Lolli *et al.*, 2015). ICH is diagnosed more frequently in the elderly (>55 years) and male population. In the Japanese population, the incidence increased to 55 cases of ICH per 100,000 people, this was due to the increasing prevalence of alcohol use and hypertension (David, 2018).

**Etiology****Subdural Hematoma (SDH)**

Causes subdural hematoma acute to include: head trauma, coagulopathy or anticoagulation medical (e.g., warfarin, heparin, haemophilia, liver disease, thrombocytopenia), intracranial haemorrhage nontraumatic due to brain aneurysms, arteriovenous malformations, or tumor (meningioma or metastatic Dural), postoperative (craniotomy, CSF shunting), intracranial hypotension (e.g., after lumbar puncture, lumbar CSF leak, lumboperitoneal shunt, spinal epidural anaesthesia). Causes of chronic subdural hematoma include head trauma, acute subdural hematoma with or without surgical intervention as well as idiopathic (Meagher, 2018).

**Epidural Hematoma (EDH)**

Epidural Hematoma is caused by both traumatic and non-traumatic mechanisms. The majority of cases associated with traumatic mechanisms are head injuries from motor vehicle collisions, physical assaults, or accidental falls. Non-traumatic mechanisms include

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infection/abscess, coagulopathy, haemorrhagic tumors, and vascular malformations (Khairat dan Waseem, 2021).

### **Intracerebral Haemorrhage (ICH)**

Cranial trauma is a common cause of intracerebral haemorrhage. Patients who experienced blunt head trauma and subsequently received warfarin or clopidogrel were considered to be at high risk for traumatic intracranial haemorrhage. While non-traumatic intracerebral bleeding most often occurs due to hypertension, eclampsia, drug abuse, brain aneurysms, arteriovenous malformations (AVM), and cerebral venous thrombosis (David, 2018).

### **Intraventricular Haemorrhage (IVH)**

Intraventricular Haemorrhage (IVH) occurs when blood from a cerebral haemorrhage extends into the ventricular system of the brain. In adults, IVH occurs as an extension of intracerebral haemorrhage (ICH). In preterm neonates, IVH usually results from germinal matrix haemorrhage (GMH), this is referred to as GMH-IVH and affects more than one-third of infants born prematurely with a mortality rate of more than 50% in this population. Those who survive often experience significant neurological symptoms such as cerebral palsy, developmental delay, deafness, and blindness (Thomas et al., 2018).

### **Subarachnoid Haemorrhage (SAH)**

Trauma is the highest cause of subarachnoid haemorrhage (SAH). Non-traumatic subarachnoid haemorrhage is mostly due to vascular malformations. In some conditions, patients experience subarachnoid haemorrhage after using certain drugs such as cocaine. Determining the exact etiology of bleeding is very important in order to adapt treatment to the cause of bleeding (Ziu and Mesfin, 2021).

## **Pathogenesis**

The most common cause of death and clinical deterioration of the condition of head injury patients is intracranial haemorrhage. The pathophysiology of an intracranial haemorrhage depends on the cause of the occurrence, can be traumatic or non-traumatic. Traumatic intracranial haemorrhage occurs as a result of a traumatic process that causes the rupture of a blood vessel in the brain. In non-traumatic intracranial bleeding, bleeding is caused by a disease that causes damage to the blood vessels (Pangilinan, 2020).

Several classifications of intracranial hematomas based on their anatomical location include (Pangilinan, 2020; Silver dan Yudofsky, 2011; Zollman, 2016):

### **Extradural hematoma or epidural hematoma or Epidural Hematoma (EDH)**

Epidural Hematoma (EDH) usually occurs due to a skull fracture (about 50%) with an incidence of between 0.2% and 4% of all head injury cases. Hematoma is located between the dura mater and the skull with the source of bleeding being an artery.

Subdural hematoma or *subdural hematoma* (SDH)

Subdural hematoma (SDH) bleeding occurs in the subdural space which is usually caused by rupture of a cortical vein. Bleeding may extend throughout the hemisphere.

### **Hematoma or Subarachnoid Haemorrhage (SAH)**

Subarachnoid Haemorrhage (SAH) usually results from a rupture of the vertebral or basilar artery. The incidence of subarachnoid hematoma is associated with worse 6 months after injury in moderate to severe head injury patients. Subarachnoid haemorrhage is caused by rupture of blood vessels around the surface of the brain, resulting in extravasation of blood into the subarachnoid space. Subarachnoid haemorrhage is usually caused by rupture of a saccular aneurysm or bleeding from an arteriovenous malformation (AVM). Blood in the subarachnoid space, particularly in the basal cisterns, can induce vasospasm. Continued vasospasm can lead to secondary cerebral infarction, which results in widespread damage to brain tissue. Aneurysm is one of the causes of haemorrhagic subarachnoid. Where an aneurysm is an injury caused by hemodynamic pressure on the artery wall branching and indentation.

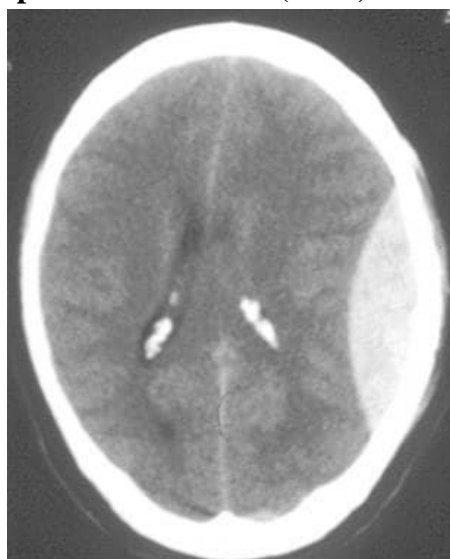
### **Intraventricular Haemorrhage (IVH)**

The pathogenesis of IVH is multifactorial, complex, and heterogeneous. The pathogenesis of the germinal matrix blood vessels is as follows (Praveen Ballabh, 2014): (1) The fragility of the blood vessels in the germinal matrix causes bleeding, (2) Fluctuations in cerebral blood flow causing blood vessel rupture, (3) Platelet and coagulation disorders.

Primary IVH is confined to the ventricles whose source arises from intraventricular or adjacent ventricular lesions. Examples are intraventricular trauma, aneurysms, vascular malformations, and tumors. Approximately 70% of IVH is secondary IVH. Secondary IVH can occur due to the spread of intraparenchymal haemorrhage or SAH into the ventricular system (Hinson *et al.*, 2011).

### **Radiological Features**

#### **CT scan of left-sided acute epidural hematoma (EDH)**



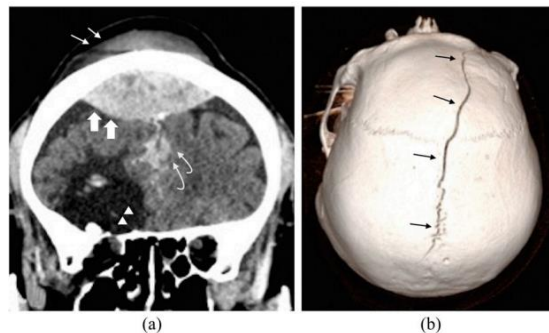
A characteristic convex or lens image is seen. The hematoma occupies this section as part of the dura layer originating below the surface of the cranium, which is bounded by the suture line. There is a midline shift of the ventricular system. This bleeding requires immediate surgical evacuation (Ullman, 2016).

#### **CT scan of a vertex epidural hematoma (EDH)**



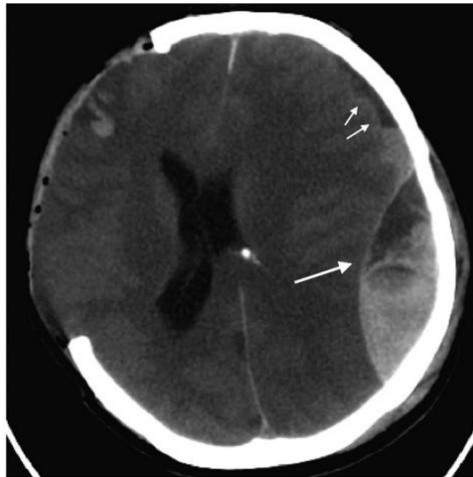
Coronal CT scan reconstruction clarifies the thickness and mass effect associated with this vertex epidural haemorrhage (EDH) (Ullman, 2016).

#### **Venous epidural hematoma as a result of superior longitudinal sinus disruption**



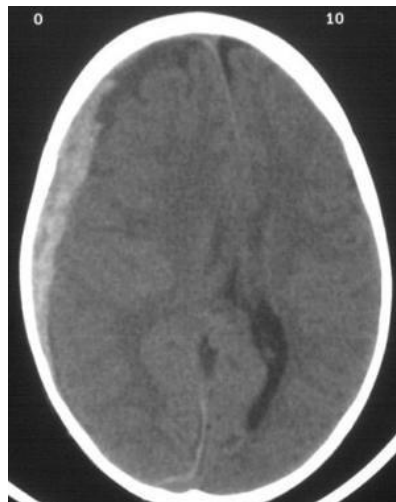
(a) Coronal reconstruction on CT scan shows subgalea haemorrhage and a collection of images with increased hyperattenuating in the form of a biconvex spread along the midline. Epidural hematoma on the vertex will cause an excessive mass effect in the frontal lobe. At the vertex, the periosteal layer of the dura, which forms the external wall of the superior longitudinal sinus, is less attached to the sagittal suture. Therefore, the EDH on the vertex could cross the midline. There was also right frontal encephalomalacia after the injury. (b) 3-dimensional CT reconstruction viewed from above shows a sagittal fracture line involving the left frontal and parietal bones bilaterally, crossing the coronal and sagittal sutures (Lolli *et al.*, 2015).

### **Late-onset epidural hematoma following decompressive craniectomy**



NECT showed a large temporoparietal epidural hematoma with a low-density area indicating active bleeding (Swirl sign). There was a severe mass effect, with a left-to-right midline shift, and external cerebral herniation via a craniectomy defect. A small subdural hematoma on the left with a fluid-fluid level is also seen. The development of a late-onset epidural hematoma as a result of decompressive craniectomy is a life-threatening complication and indicates the need for urgent neurosurgical intervention (Lolli *et al.*, 2015).

### **Acute subdural hematoma**



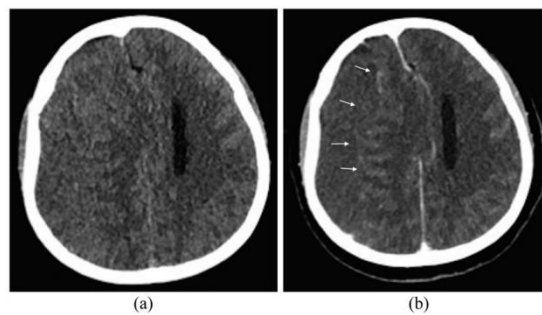
A bright or white image is seen, it is an accumulation of blood on the results of a non-contrast cranial CT scan, and there is also a shift in the midline (Meagher, 2018).

### **Left-sided acute subdural hematoma (SDH)**



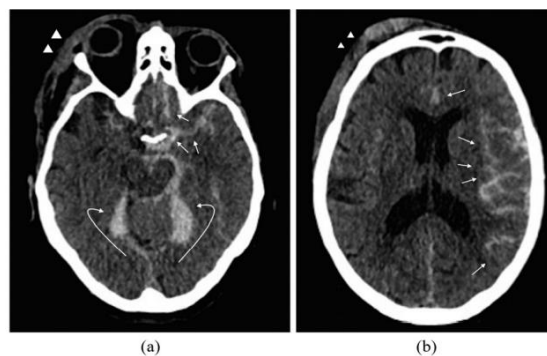
The lesion on the left shows SDH which represents high blood density and a midline shift in the ventricles (Meagher, 2018).

### **Isodense acute subdural hematoma**



(a) NECT shows a right ventricular lateral loss, mild dilatation of the contralateral ventricle, and moderate midline shift. Hematomas are difficult to see. (b) A contrast-enhanced CT scan shows an increased appearance of cortical veins along the surface of the brain which facilitates easier detection of an isodense subdural hematoma in the left frontoparietal area that shifts the Gray-white matter border medially (Lolli *et al.*, 2015).

### **Traumatic subarachnoid haemorrhage**





(a,b) NECT showed an increase in material density in the basal cistern, front orbital sulcus, and left Sylvian fissure. The subdural hematoma appears to overlap the tentorium. There is soft tissue swelling in the right front orbital region (Lolli *et al.*, 2015).

## **Management**

### **Medical Therapy**

The main purpose of intensive care is to prevent secondary damage to the injured brain. The basic principle of TBI treatment is that if the injured nerve tissue is given optimal care, the injured organ can recover and function normally again. Medical therapy for brain injury includes intravenous fluids, correction of anticoagulants, transient hyperventilation, mannitol (Osmitrol), hypertonic saline, barbiturates, and anticonvulsants (American College of Surgeons, 2018).

### **Surgical Treatment Surgical**

The management may be required for scalp injuries, skull fractures, intracranial lesions, and penetrating brain injuries (American College of Surgeons, 2018).

## **Conclusion**

Brain trauma or traumatic brain injury is an injury to the brain that is non-degenerative and non-congenital but is caused by an external mechanical force that can cause a decrease in consciousness and disturbances in cognitive, physical and psychosocial functions that are temporary or permanent.

### References

- BIAA (Brain Injury Association of America). (2011). *BIAA adopts new TBI definition*. Retrieved from <https://www.biausa.org/public-affairs/public-awareness/news/biaa-adopts-new-tbi-definition>
- CDC. (2015). Report to Congress on Traumatic Brain Injury in the United States: Epidemiology and Rehabilitation. *Journal of Neurosurgery*. <https://doi.org/10.3171/2011.3.jns102010>
- CDC. (2019). Surveillance Report of Traumatic Brain Injury-related Emergency Department Visits, Hospitalizations, and Deaths. *Centers for Disease Control and Prevention, U.S. Department of Health and Human Services*, 24.
- David, S. L. (2018). Epidural Hematoma. Retrieved from <https://emedicine.medscape.com/article/1137065-overview>
- Dawodu, S. T. (2019). Traumatic Brain Injury (TBI). Retrieved from <https://emedicine.medscape.com/article/326510-overview#a1>
- Faul, M., & Coronado, V. (2015). Epidemiology of traumatic brain injury. In *Handbook of Clinical Neurology* (3rd ed., Vol. 127). <https://doi.org/10.1016/B978-0-444-52892-6.00001-5>
- Garton, T., Hua, Y., Xiang, J., Xi, G., & Keep, R. F. (2017). Challenges for intraventricular hemorrhage research and emerging therapeutic targets. *Expert Opinion on Therapeutic Targets*, 21(12), 1111–1122. <https://doi.org/10.1080/14728222.2017.1397628>
- Hinson, H. E., Street, N. W., & Ziai, W. C. (2011). Management of Intravascular Hemorrhage. *Curr Neurol Neurosci Repp*, 10(2), 73–82. <https://doi.org/10.1007/s11910-010-0086-6.Management>
- Kementerian Kesehatan Republik Indonesia. (2018). *RISKESDAS*. <https://doi.org/10.1088/1751-8113/44/8/085201>
- Khairat A, Waseem M. (2021). Epidural Hematoma. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK518982/>
- Lolli, V., Pezzullo, M., Delpierre, I., & Sadeghi, N. (2015). EMERGENCY RADIOLOGY SPECIAL FEATURE : REVIEW ARTICLE MDCT imaging of traumatic brain injury. *British Institute of Radiology*, 89 (November 2015).
- Pangilinan, P. H. (2020). Classification and Complications of Traumatic Brain Injury.

- Praveen Ballabh, M. (2014). Pathogenesis and Prevention of Intraventricular hemorrhage. *National Institute of Health*, 41(1), 47–67.
- Rajashekar D & Liang J. W. (2021). Intracerebral Hemorrhage. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK553103/>
- Richard J Meagher, M. (2018). *Subdural Hematoma*. Retrieved from <https://emedicine.medscape.com/article/1137207-overview>
- Silver, J. M., McAllister, T. W., & Yudofsky, S. C. (2011). *Textbook of traumatic brain injury* (Second Edi). American Psychiatric Publishing.
- Sylvani. (2017). Peran Neuroimaging dalam Diagnosis Cedera Kepala. *Kalbemed*, 44(2), 97–102.
- Ullman, J. S. (2016, Apr 13). *Epidural Hematomas Workup*. Retrieved from Medscape: <https://emedicine.medscape.com/article/248840-workup#c7>
- Ziu E & Mesfin F. B. (2021). Subarachnoid Hemorrhage. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK441958/>
- Zollman, F. S. (2016). *MANUAL OF TRAUMATIC BRAIN INJURY ASSESSMENT AND MANAGEMENT* (second edi). Springer Publishing Company.
- American College of Surgeon. (2018). *Advanced Trauma Life Support*. 10<sup>th</sup> edn. Chicago: American College of Surgeons.

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