Introduction

**Definition**

- Primary vs. Secondary
  - Primary - injury at the time of impact
  - Secondary - Cellular and biomechanical mechanisms that cause prolonged effects of brain injury

**Epidemiology**

- CDC
  - An estimated 1.7 million people sustain TBI yearly
  - TBI contributes to 1/3 of injury related deaths
  - About 75% of TBI are concussions or in the form of minor TBI
  - ~500,000 ED visits by children between 0-14 are for TBI
  - In every age group the incidence is always higher in males

**Classification of TBI**

- Mild TBI
  - GCS 13-15
  - aka “concussion”
- Signs/Symptoms
  - HA, confusion, amnesia
  - POC (Post Concussive episode)
    - Can last from weeks up to a year
    - HA, dizziness, difficulty concentrating, anxiety, depression and insomnia

Learning Objectives

- Definition of traumatic brain injury (TBI)
- Define classifications of TBI
- Management of TBI

Disclosures

- I have no relationships with commercial companies to disclose.

**Traumatic Brain Injury**

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Classifications of TBI
- Moderate TBI
  - GCS 9-12
  - Concussion with neurologic symptoms
  - May be associated with prolonged consciousness
  - +/- abnormal imaging
  - Post concussive syndrome
- Severe TBI
  - GCS ≤ 8
  - Diffuse brain injury
  - Significant neurologic deficits
  - Abnormal imaging
  - Recovery can be prolonged and incomplete

History and Physical
- Non accidental trauma
- Subdural hemorrhage
- Retinal Hemorrhages
- Battle Sign
- Raccoon Eyes

Types of Cranial Hemorrhages

Pathophysiology
- Primary Brain Injury
  - The trauma that occurs directly from the impact.
  - Substantiates the importance for preventive campaigns
  - helmets, seatbelts, and airbags, and car seats
  - Increase head- body ratio
  - Diffuse brain injury
- Secondary insults
  - Events that increase the severity of the brain injury after the primary brain injury
  - hypotension, hypoxia, seizures, and ICH

Pathophysiology
- Secondary Brain Injury
  - Both physiological and biochemical events that began after the primary TBI
  - The loss of cerebral auto regulation
  - Increase the diffuse swelling or cerebral edema
  - These events can be complicated by the secondary insults
**Imaging**

- CT without contrast
  - Imaging of choice
- Fast
- Demonstrates
  - Intracranial hemorrhages
  - Cerebral edema
  - Fractures

**Subdural Hemorrhage**

**Epidural Hemorrhage**

**Imaging**

- CT or No CT
  - Need CT if children > 2y/o with following symptoms
    - Focal neurologic findings
    - Skull fracture, especially findings of basilar skull fracture
    - Seizure
    - Altered mental status
    - Prolonged loss of consciousness
  - May need neuroimaging or observation if child is > 2y/o with following symptoms
    - Vomiting
    - Headache
    - Questionable or brief loss of consciousness
    - Injury caused by high risk mechanism of injury

**Management - Mild to Moderate TBI**

- Discharge home
  - Normal mental status and at a baseline
  - Low-risk mechanism of injury
  - No LOC or seizures
  - No other apparent injuries
  - No vomiting or only one episode of vomiting occurring shortly after injury
  - No significant headache
  - For the infants <1 year of age, trivial injury without significant no frontal hematoma
  - No underlying conditions predisposing to intracranial injury
  - Reliable caretakers who are able to seek care, if indicated

**Management - Mild to Moderate TBI**

- Observation
  - Brain injury or depressed or basilar skull fracture
  - Persistent AMS with normal CT,
  - Persistent vomiting
  - Suspected inflicted injury
  - Extracranial injury requiring admission
  - Unreliable caretakers or suspected child abuse.
Management - Sports Related Concussions

- Pre sports physical along with neuropsychological testing
- Paper and pencil Testing
- Computer Based Testing
- Education about Concussions
- Immediate Evaluation for a Concussion
- Gradual Stepwise Return
- Earliest Return
  - No signs or symptoms of any kind during rest, Neuro exam is nml, and imaging is unremarkable when performed.
- Light Aerobic Activity
- Sports Specific Activities
- Non Contact Drills
- Contact Drills
- Game play

Management - Severe TBI

- Resuscitation
  - ABC’s
    - If less GCS < 8 then intubate
    - A decrease in GCS score by 3 points then intubate
    - Rapid Sequence Intubation
  - Sedation important to keep ICP down
  - Challenges of intubation
    - C-collar/spinal injuries
    - Facial fractures
    - Blood pressure
      - Need to maintain blood pressure to keep ICP

Primary Goals.

- Normocarbic
  - Hypercarbia - increase in blood flow
  - Hypocarbia - may cause brain ischemia
- Normonatremic
- Normothermic
  - Hyperthermia - increases cerebral metabolic demand
  - Scheduled Tylenol
  - Cooling blanket
- Normoxia
  - Hypoxia - increases in blood flow

ICP Management

- Hyperosmolar Therapy
  - Mannitol vs. Hypertonic saline
  - Sedation
  - Hypotension
  - Vasocative medications
  - Positioning
  - HOB elevated at 30 degrees

Seizure Prevention

- Causes hyperthermia, increased intracranial hypertension, and brain damage
- Pentobarbital coma
- Prevent hyperglycemia
  - Coorelation with higher mortality
  - Worse neurological outcomes
- Intracranial Hypertension
  - ICP Monitoring
  - Decompressive Craniotomy
  - Hypothermia
Learning Points

- Know the classifications of TBI
- Need for further Evaluation
  - Admission vs. No admission
- Management
  - Mild to Moderate TBI
  - Imaging
  - Sports Related Concussion
  - Severe TBI
    - Keep everything normo!!!!
    - Normocarbic, normoxia, normonatremic, normothermic
    - Maintain ICP between <20, Optimize CPP and CBF

References

8. www.uptodate.com
9. www.emedicine.com

Questions

- What are the classifications of TBI?
- Why is further evaluation needed after a TBI?
- What management strategies are considered for mild to moderate TBI?
- How is severe TBI managed?
- What is normocarbic, normoxia, normonatremic, and normothermic in the context of TBI?
- What is the goal for intracranial pressure (ICP) management in TBI?