Concussions In Adolescent Athletics

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Course Objectives

- At the conclusion of this session, the participant will be able to:
  - Better understand the mechanism(s) associated with mild traumatic brain injury (MTBI)/Concussion and Post-Concussion Syndrome(s)
  - Appropriately identify, diagnose and manage MTBI in the clinical setting
  - Outline standards for safety and initiate improved principles for optimal prevention of Concussion Syndrome

Traumatic Injuries

Major Causes of Traumatic Brain Injuries

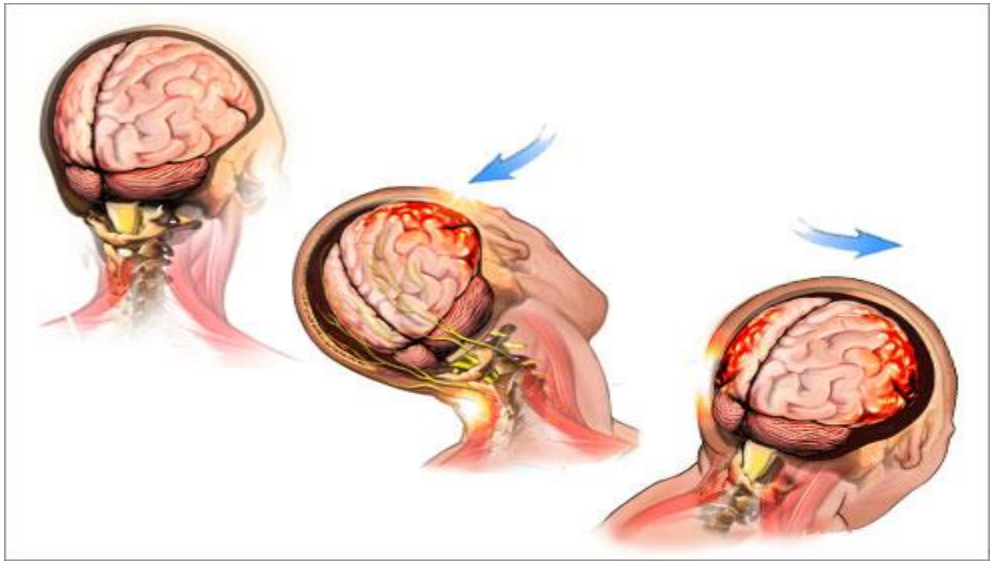
Source: National Center for Injury Prevention and Control, CDC

Traumatic Brain Injuries

- Mechanism of injury (MOI) includes blunt (bump, blow or "jolt" to the head) as well as penetrating injuries (GSW, et al) which disrupt normal brain function
- Severity varies
  - *Mild*: brief change in mental status
  - *Severe*: extended period of unconsciousness or amnesia after the injury
- The majority (**75-95%**) are Mild Traumatic Brain Injuries (MTBI)

TBI/MTBI

- Mild traumatic brain injury (concussion)
  - a short-lived loss of brain function due to head trauma
  - resolves spontaneously
  - function temporarily interrupted
  - no structural damage to the brain



Traumatic Brain Injuries

- 1.6-3.8 million **sports/recreation-related** TBIs occur in the USA each year
  - **Incidence of MTBI may be significantly higher due to unreported cases**

Case Study #1

- A 12 year old male presents to UC after being struck in the right temple area by a batted hardball, from a distance of 10'. The injury occurred over an hour earlier. There was a H/O LOC for ~5minutes.
- The child presents AAOx3 and in no distress but fails to recall the traumatic event
- Comprehensive neuro exam was unremarkable however physical exam shows a right-sided hemotympanum

Case Study #2

- A 10 Y/O male presents to the Emergency Room after a helmet to helmet collision with another football player. The child presents with no LOC but was *dazed* at the time of the event per coaches and his parents
- The injury occurred 3 hours PTA in the ED
- There is no associated injury: no head, neck or back pain; no visible injury
- The child is AAOx3 and the physical exam was unremarkable

Introduction

- Increased participation in sports
- ~30-45 million children and adolescents aged 6-18 years participate in organized sports
- More than one half of these participate in multiple sports
- ~7.7 million students participated in U.S. sports during the 2011-2012 school year

Introduction

- Sports- and recreation-related MTBI have increased by 60% over the past decade
- A 2012 study found that MTBI represented 13.2% of all reported sports injuries
- Each year, EDs treat an estimated 173,285 MTBI among children and adolescents aged birth-19 yrs
- Children and adolescents take longer to recover than their adult counterparts

Relative Causes of TBI

MVC	20-45%
Falls	30-38%
Occupational accidents	10%
Recreational accidents	10%
Assaults	5-17%

Introduction/Epidemiology

- Football is the #1 cause of sports head injuries in young athletes
  - 10% college
  - 20% HS
- Girls' soccer is #2
  - Followed by hockey, basketball, and wrestling

MTBI essentials

- **MTBI was responsible for an estimated $12 Billion in the USA in 2000**
- **Blasts are an important cause of MTBI among military personnel**
- Individuals with a history of concussion are at increased risk of subsequent concussion
- Studies show that recovery time from MTBI may be *longer* for children and adolescents

U.S. Military

- MTBI common among combat
- Study of 2525 Army infantry (1 year Iraq deployment)
  - 5% reported LOC
  - 10% reported injuries with an altered LOC
- MOI include (in order):
  - Blast/explosion
  - Falls
  - MVC
  - Fragments, shrapnel, & bullet wounds

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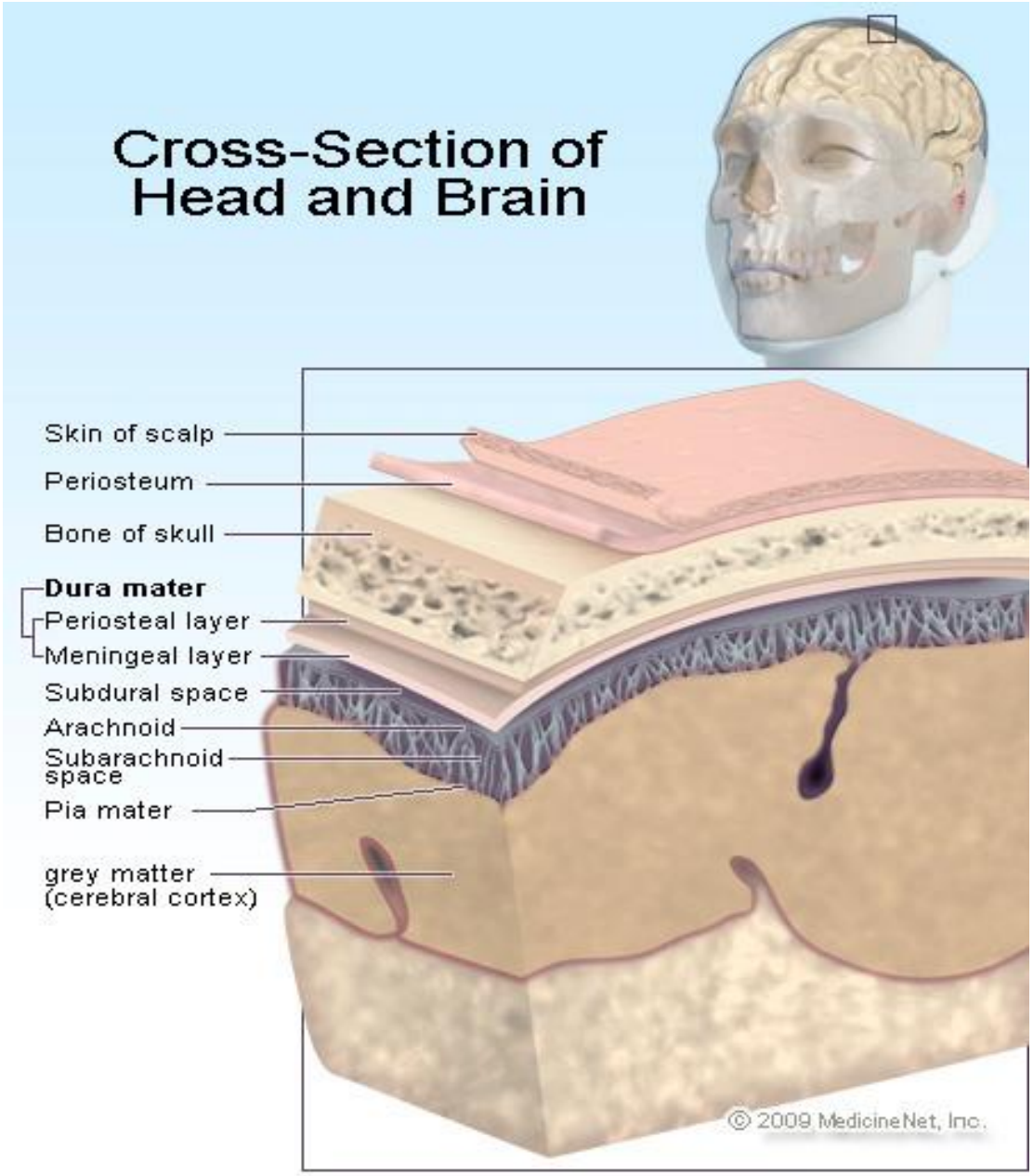
Gender, Age, & Risk Factors

- Males are more commonly head-injured
  - High risk activities
- Although some data suggests female soccer and basketball players have greater risk
- ~1/2 of patients wit MTBI are ages 15-34
- Moderate risk is listed at <5 years old and > 60 years of age
- Other risk factors include lower socioeconomic status, lower cognitive function and a H/O intoxication

MTBI


Cross-Section of Head and Brain
Skin of scalp
Periosteum
Bone of skull
Dura mater
Periosteal layer
Meningeal layer
Subdural space
Arachnoid
Subarachnoid space
Pia mater
grey matter (cerebral cortex)
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MTBI Defined

- Concussion:
  - Direct blow to the head, face, neck or a blow elsewhere on the body with a impulsive force transmitted to the head
  - Rapid onset of SHORT-LIVED impairment of neurological function that resolves spontaneously
    - s/s may evolve over minutes to hours
  - Clinical symptoms largely reflect a functional disturbance rather than a structural injury
  - May or may not involve LOC; Clinical and cognitive symptoms typically resolve in a sequential course

MTBI… continued

- The symptoms of a head injury may be as subtle as having a hard time concentrating in school, having difficulty with homework, or being more irritable at the dinner table
- Recurrent headaches, dizziness, and lethargy are more easily recognizable by parents or friends
- This lecture focuses on a “team” approach to MTBI recognition and management

Concussions in Adolecent Athletes

- Concussions in sports are more easily studied than in the general public
  - frequency
  - numerous studies on their evaluation and treatment
- Broad spectrum of symptoms and severity for concussions
- Risk of serious short and long-term sequelae
- Typically defined by a GCS of 13-15, measured ~30 minutes after the injury
- Most MTBI will resolve within a week or 10 days

Neuropathophysiology

- Unlike a severe TBI, the MTBI is related more to dysfunction of the brain metabolism rather than structural injury or damage
- Complex cascade of ionic, metabolic and physiologic events
- Clinical s/s (memory changes, speed of processing, fatigue, dizziness) result from this

Concussion

- Symptoms of MTBI may or may not involve loss of consciousness {~10%}
- Signs and symptoms are highly variable and may last from several minutes to days to weeks or months
- Disturbance in brain function is typically associated with normal neuroimaging exams (CT, MRI studies)
- The clinician should rely on physical, cognitive, emotional and/or sleep-related issues

MTBI: Clinical Features

- Hallmark s/s are **HA, confusion** and **amnesia** with or without LOC
- Present immediately or may appear moments later
- Amnesia almost always involves loss of memory for the event but frequently
  - Loss of recall for preceding events (retrograde)
  - As well as after (anterograde)
  - Evidenced by repeatedly asking a question already answered

Physical Exam

- **A loss of consciousness or having a seizure after a head injury is not common**
- **These syndromes do not predict the severity of the concussion**
- The purpose of the physical examination is to look for abnormalities that would point to bleeding in the brain, a neck injury and/or spinal cord damage
- Understanding the mechanism of injury (MOI) and the sequence of events **afterwards** is important in deciding the potential risk for determining the severity of the brain injury

Seizures

- Early post-traumatic seizures may occur within the first week post injury
- Considered acute symptomatic events and NOT epilepsy
- Occur in fewer than 5% of MTBI cases
- One-half occur within the first 24 hours
- ¼ within the first hour
  - Most are simple partial or focal
  - Complex partial are rare
  - Anticonvulsants may be used for early seizures

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Signs and symptoms

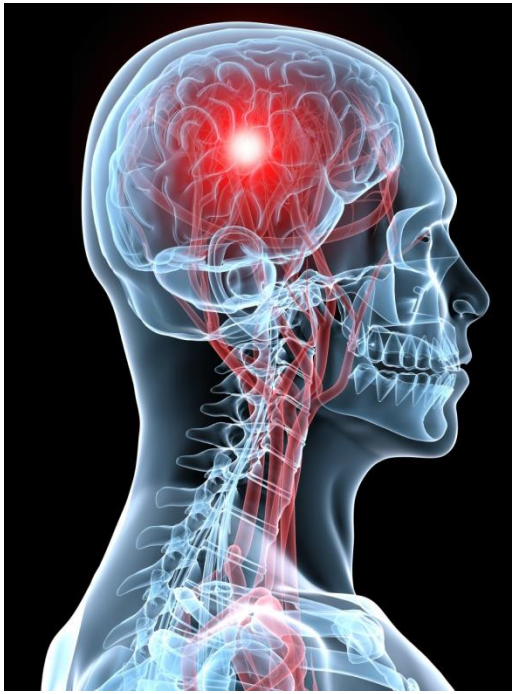
- **Physical**
  - Headache (HA): most commonly reported symptom
  - N/V
  - Balance disturbance
  - Dizziness
  - Fatigue
  - Sensitivity to light and/or noise
  - Numbness/tingling
  - Dazed or stunned appearance

Signs and symptoms

- **Cognitive**
  - Mentally “foggy”
  - Difficulty concentrating/remembering
  - Unable to recall recent information or conversations
  - Confusion re: recent events
  - Answers questions slowly
  - Repeats questions

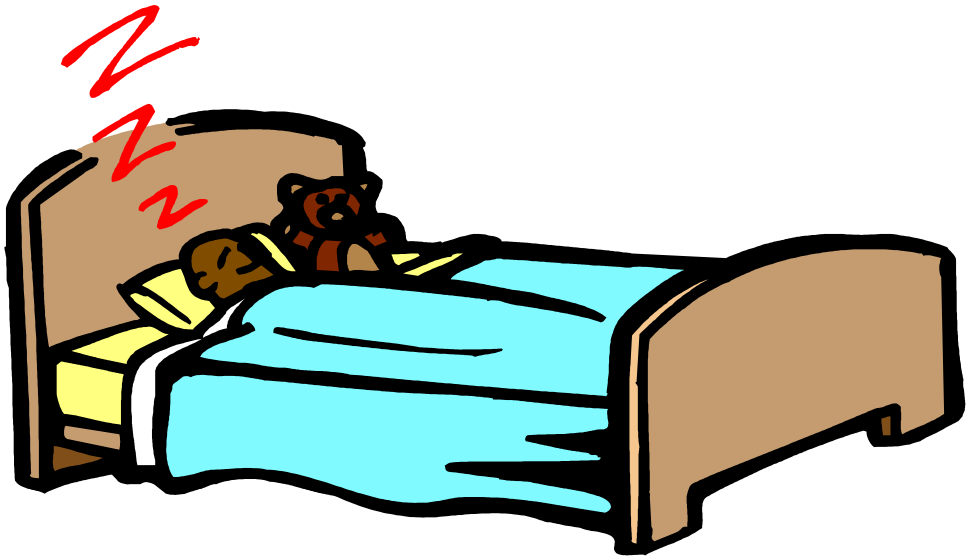
Signs and symptoms

- **Emotional**
  - Irritability
  - Sadness
  - Increased emotional affect
  - Nervousness



Signs and symptoms

- **Sleep**
  - Drowsiness
  - Sleeping less (or More) than usual
  - Trouble falling asleep



Complicated MTBI

- Uncomplicated MTBI reveals no evidence of structural injury on CT or MRI
- MTBI **can be** complicated by coexisting contusions and development of intracranial hemorrhage
- **Contusion**: areas of bruising associated with local ischemia, edema and/or mass effect
- S/S and recovery vary

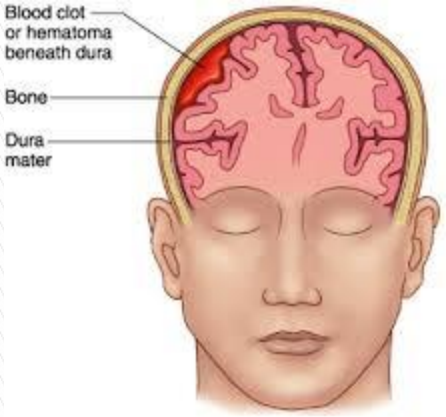
Complicated MTBI

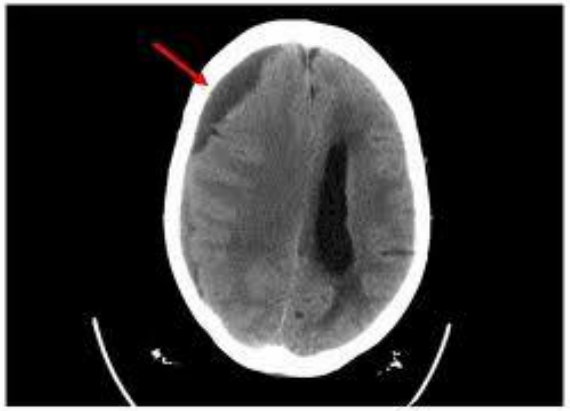
- Neurologic deterioration after a MTBI is highly suggestive of evolving intracranial hemorrhage
  - Intracerebral, subdural, epidural
    - Secondary to a tear in an artery or vein
- Signs include increased HA, focal neuro changes, worsening confusion/agitation and lethargy
- Progression to LOC may lead to death

Complicated MTBI

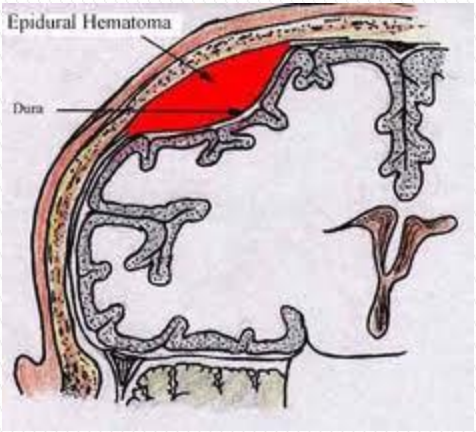
- Trauma that results in tearing of a bridging veins or dura
- May be acute, subacute or chronic

Subdural hemorrhage





Complicated MTBI



- Epidural (and Intracerebral hemorrhage) are usually arterial in origin
- Acute, abrupt onset
- Delayed by minutes to hours from the initial injury
- 20-50 % of epidural bleeds have a “lucid interval” following a brief LOC
- Worsening in S/S and deterioration of GCS would reclassify the injury to moderate or severe

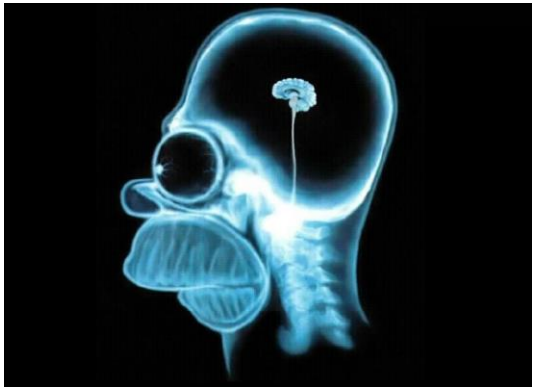
Epidural Hematoma

Complicated MTBI

- In addition to MTBI, Head Trauma may result in:
  - Injuries to other parts of the head and neck
    - Skull or facial bones fractures
  - Sine or spinal cord injuries
  - Eye injuries
  - Damage to blood vessels of the neck

Acute Evaluation and Management

- Initial evaluation (coach, athletic trainer, parent)
- Prompt evaluation by Health Care Professional (Physician, PA, CRNP, et al)
  - Neuro assessment and mental status evaluation
  - Prolonged LOC, persistent mental status alteration, ABD neuro exam constitutes urgent neuroimaging and/or neurosurgical consultation



Cognitive Assessment

- MTBI is frequently unrecognized particularly if no LOC
- Simple questions of orientation may be inadequate
- Some studies suggest that more than 80% of individuals with a past concussion have failed to recognize a MTBI as such
- A number of diagnostic tools are available however there is no substitution for a thorough H&P

Diagnosis

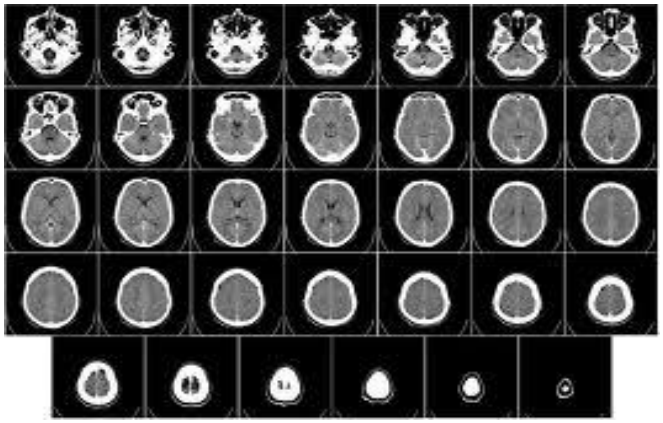
- Diagnosis is often challenging
  - S/S of MTBI are common to other medical disorders: PTSD, depression, HA syndromes, et al
- Onset and/or recognition of symptoms my occur days (or weeks) after the initial injury
- A systematic assessment of the injury is ***essential*** to proper management and reduced morbidity
  - Especially important concern among military personnel
- **Acute Concussion Evaluation (ACE)**

ACE (Acute Concussion Evaluation)

- Characteristics of the Injury
- Types and severity of the symptoms
- Risk factors
  - Protracted period of recovery

Neuroimaging

- **No imaging techniques can diagnose a concussion**
- CT Scan
- Literature review show
  - CT San abnormalities in 5% of patients with GCS of 15 and 30% of patients with GCS of 13
  - patients requiring neurosurgical intervention of about 1%



Neuroimaging: Choice of Test

- **Brain CT** is the test of choice for the ED evaluation
  - Most clinically important and ALL neurosurgical abnormalities are visible on CT
- **MRI**: more important role in evaluating persistent post-traumatic sequelae
  - More sensitive in showing small areas of contusion, petechial hemorrhage, axonal injury and small extra-axial hematoma
    - One study showed MRI abnormalities 30% of cases with normal CT
    - Most were consistent with axonal injury but small contusions and SAH were also described

Neuroimaging

- Patients with:
  - Neurological deficit
  - Seizure
  - Presence of bleeding or
  - Oral anticoagulant use

Neuroimaging

- In addition to it's diagnostic utility, CT studies are helpful for prognostic purposes and for determining a patient's disposition
- Neurologically normal patients with a normal scan are at low risk for neuro deterioration
- One recent study showed none of 542 pts with MTBI and an normal initial CT showed subsequent deterioration and none required surgery

Observation and Disposition

- Conservative approach vs. Observation for 24 hours
- Admission recommended
  - For pts. with:
    - GCS <15
    - ABN CT study
    - ICB, cerebral edema
    - Seizures
    - Oral anticoagulation
- Decision to transfer to neurosurgical services is case by case

Sequelae

- Prognosis for complete recovery is the goal
- Avoidance of activities which place athlete at risk for subsequent concussion should be avoided
- Second Impact Syndrome
  - Cerebral swelling which occurs after a second concussion
  - Usually while the athlete is still symptomatic from earlier injury
  - Similar to *shaken baby syndrome*

Sequelae continued

- Post concussion syndrome
  - Typically develop in the first days after MTBI and resolve in weeks to months
- Post-traumatic headache
  - HA occurs in 25-78% of patients after MTBI
  - Occurs within 7 days
- Post-traumatic epilepsy
  - Twofold risk of epilepsy for the first 5 years
  - ½ in the first year; 80% in 2 years
- Post-traumatic vertigo
  - Variety of mechanisms: direct injury, Labyrinthine concussion, BPPV, etc.

Sequelae continued

- Cranial nerve injuries
  - Anosmia and hyposmia
    - Impaired taste, smell with injury to olfactory filaments
  - Diplopia
    - MTBI: Cranial nerve IV most often injured (VI is 2nd)
  - Facial pain
    - Trigeminal nerve
  - Occipital neuralgia
    - Musculoskeletal injury to neck

Case #1 Resolution

Case #2 Resolution

Summary

- MTBI is a common injury
- Most individuals have an excellent prognosis
- Subtler degrees of neuro impairment may be unrecognized
- Repeated MTBI soon after the initial injury may lead to life-threatening cerebral edema and chronic impairment
- Post-concussion syndrome includes HA, epilepsy and vertigo

Summary

- Educate the young athlete and their parents about the serious nature of their injury
- Explain the details of the injury to all parties involved and provide realistic expectations
- When in doubt, sit them out…
- **No athlete who suffers a MTBI should ever return to play on the same day of an injury**

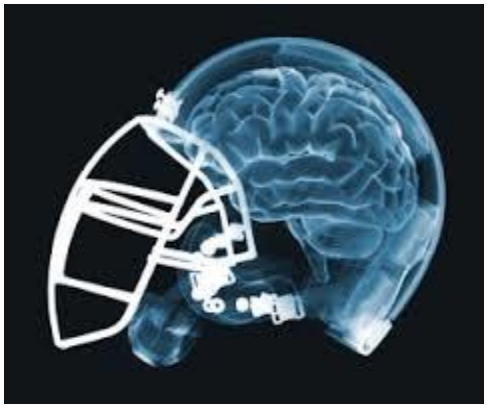
Recommendations

- Athletes with MTBI should be removed from play and evaluated by a licensed HCP
  - Consider an ER evaluation for athletes with LOC
- Athletes should be removed from all contact-risk activities until symptoms have resolved
- Being conservative is OK
- Individuals with a H/O multiple MTBI should undergo a more detailed evaluation and observed for neurobehavioral symptoms
  - If present, consider a neurological evaluation

When to Return to Play

- The cornerstone of MTBI management is physical and cognitive rest
- Time is the ally in concussion treatment since most symptoms resolve relatively quickly
- Treatment is directed at symptom control for headaches, nausea, dizziness, and insomnia
- **Brain rest** is an important concept. Limiting use of television, computers, and Smartphones/texting may be helpful in allowing the brain to recover more quickly

Patient Monitoring Instructions



- Observe for:
  - Inability to awaken patient
  - Severe or worsening HA
  - Somnolence or confusion
  - Restlessness, unsteadiness or seizures
  - Difficulties with vision
  - Vomiting, fever or stiff neck/pain
  - Incontinence of bowel or bladder
  - Weakness or numbness involving any body part

  - IMMEDIATE MEDICAL ATTENTION!

Prevention

- Injury prevention is paramount
- Workplace safety using helmets where required or recommended
- Using seatbelts in motor vehicles
- Wearing helmets while bicycling and motorcycle riding
- Head protection should be worn when participating in some sports
  - Proper technique is also important to prevent injuries

Future considerations

- Public education/awareness
  - Players, coaches, and parents need educated to recognize symptoms and prevent the return of the player to the field until it is safe
- Education in the workplace
- Screening tools
  - ~23 different apps (iphone alone) available for parents, coaches and HCP

Questions?

- Thank you!

Appendix: resources

- Immediate Post-Concussion Assessment and Cognitive Test: www.impacttest.com
- Axon Sports Computerized Cognitive Assessment Tool: www.axonsports.com
- Patient information: UpToDate
  - Concussion ("The Basics")
  - Head Injury in children and adolescents ("Beyond the Basics")

Neuroimaging

- Canadian CT Head Rule
  - CT with MTBI
    - GCS <15 two hours after injury
    - Suspected open or depressed skull Fx
    - ANY sign of a basilar skull Fx
    - Prolonged episodes of vomiting
    - 65 years or older
    - Amnesia before impact of 30 minutes or >
    - Dangerous MOI (deceleration/fall, MVC vs. pedestrian)

Neuroimaging

- New Orleans criteria:
  - Similar cohort
    - GCS of 15
    - CT if:
      - HA
      - Vomiting
      - Age > 60 years
      - Drug and/or alcohol on-board
      - Persistent anterograde amnesia
      - Or visible trauma above the clavicle

Other Assessment Tools

- Standardized Assessment of Concussion (SAC)
  - Scored football players pre- and post injury
  - Sensitivity and specificity of 80-94% and 76-91%, respectively
- Post-Concussion Symptom Scale and Graded Symptom Checklist
- Sports Concussion Assessment Tool2
- Westmead Post-Traumatic Amnesia Scale
  - Simple, <1 minute to perform in the ED setting

Glasgow Coma Score (GCS)

- The GCS was developed to assess a patient's neurologic status based on speech, eye opening, and movement
- The scale is used as part of the initial evaluation of a patient and is meant to be repeated over the course of the patient's care
- Example:
  - A normal awake patient has a GCS of **15**
  - A dead patient has a GCS of **3**

Glasgow Coma Score (GCS)

- **Eye Opening**
  - Spontaneous 4
  - To loud voice 3
  - To pain 2
  - None 1

Glasgow Coma Score (GCS)

- **Verbal Response**
  - Oriented 5
  - Confused, disoriented 4
  - Inappropriate words 3
  - Incomprehensible words 2
  - None 1

Glasgow Coma Score (GCS)

- **Motor Response**

• Obeys commands	6
• Localizes pain	5
• Withdraws from pain	4
• Abnormal flexion posturing	3
• Extensor posturing	2
• None	1