Traumatic Brain Injury (TBI)
- A form of acquired brain injury that occurs when a sudden trauma causes damage to the brain.
- Open head injury
  - Skull fractured
  - Skull penetrated – bullet (GSW)
- Closed head injury
  - Blunt trauma with deflection of skull but no fracture
  - Coup-Contrecoup injury
  - Diffuse Axonal Injury (DAI)
- Severity of TBI
  - TBI severity often judged based on Glasgow Coma Scale (GCS):
    - Mild TBI = GCS 13-15
      • 99.6% survive
    - Moderate TBI = GCS 9-12
      • 93% survive
    - Severe TBI = GCS 3-8
      • 42% survive
  - OSU TBI-ID Survey
    - Classification is based on severity of worst injury
    - Quantified by amount of time unconscious
      • No TBI: Score 1
      • Mild TBI:
        - 2 (dazed or memory lapse but no LOC)
        - Score 3 (LOC < 30 min)
      • Moderate TBI
        - Score 4 (LOC between 30min and 24hrs)
      • Severe TBI
        - Score 5 (LOC > 24hrs)

Mild Traumatic Brain Injury (mTBI)
- World Health Organization definition:
  - Closed acute brain injury resulting from mechanical energy to the head from external physical force with the following:
    - 1 or more of:
      • Confusion or disorientation
      • Loss of consciousness for 30min or less
      • Post traumatic amnesia for less than 24hrs
      • Other transient neurologic abnormalities (ex: seizures)
  - Glasgow Coma Scale (GCS) score of 13-15 ~30min after injury
  - Exclusion of other physical and mental causes
Concussion
- mTBI
- Typically associated with normal structural neuroimaging findings.
- Results in a constellation of physical, cognitive, emotional and/or sleep-related symptoms and may or may not involve LOC.
- Results in rapid onset of short lived impairment of neurologic function that resolves spontaneously
- Duration of symptoms is highly variable and may last from several minutes to days, weeks, or several months.

Biomechanics
- Sports Concussion
  - Acceleration – deceleration injury (linear)
  - Rotational
- Pathophysiology – “Energy Crisis”
  - Neurometabolic Changes
    - Hyperacute glutamate release
    - Potassium efflux
    - Sodium and calcium influx
    - Vasoconstriction and reduced blood flow to brain
    - Ionic flux and depolarization ultimately create a diffuse “spreading depression-like” state
    - Trying to restore ionic and cellular homeostasis shifts pumps into overdrive depleting energy reserves.
      - Important to not re-concuss or increase the brain’s energy demands during this time.
        - Greatest risk is in first 10 days

Epidemiology of Sports Concussion
- Occurs in approximately 300,000 Americans annually (treated in ED, +LOC)
  - 173,000 are children and adolescents (birth to 19 years)
- Estimated between 1.6-3.8 million sports and recreation related per year
- 5.8% of all collegiate sport injuries, 8.9% of high school athletic injuries
- Rates among 10-19 year olds increased by 100,000 annually between 2001 and 2009.
- 46.5 million American children and adolescents participate in sports annually
  - Highest concussion numbers, rate:
    - Males: Football – 55,007, 0.47 per 1000 athlete exposures
    - Females: Soccer – 29,167, 0.36 per 1000 athlete exposures

Symptoms of mTBI
- Somatic
  - Headache, dizziness, hearing problems, visual disturbances, noise or light sensitivity, sleep disturbance, and emotional or mental fatigue
- Cognitive
  - Problems with thinking, making decisions, memory, attention and concentration, abstract reasoning, and information processing
- Psychological
  - Depression, anxiety, mood swings, irritability, impulsiveness, loss of interest, agitation, and relationship difficulties

Remove from Play
- Signs observed by coaching staff:
  - Appears dazed or stunned (such as glassy eyes)
  - Is confused about assignment or position
  - Forgets and instruction or play
  - Is unsure of score or opponent
  - Moves clumsily or poor balance
  - Answers questions slowly
  - Loses consciousness (even briefly)
  - Shows mood, behavior, or personality changes
  - Can’t recall events prior to hit or fall
  - Can’t recall events after hit or fall

- Symptoms reported by athlete:
  - Headache or “pressure” in head
  - Nausea or vomiting
  - Balance problems or dizziness
  - Double or blurry vision
  - Sensitivity to light or noise
  - Feeling sluggish, hazy, foggy or groggy
  - Concentration or memory problems
  - Confusion
  - Does not “feel right” or is “feeling down”

Complications
- Post-Concussion Syndrome
  - Complex disorder where various symptoms last for weeks or months (rather than days) after the concussion has occurred.

- Second Impact Syndrome
  - Experiencing a second concussion before signs and symptoms of a first concussion have resolved that can result in rapid and usually fatal brain swelling

- Chronic Traumatic Encephalopathy
  - Progressive degenerative disease of the brain found in athletes with a history of repetitive brain trauma, including symptomatic concussions as well as asymptomatic subconcussive hits to the head.

Return to Play (RTP) Law
- Colorado’s RTP law went into effect on January 1, 2012
  - Coaches must complete annual concussion course
  - Requirements:
    - http://www.cde.state.co.us/sites/default/files/Final%20Concussion%20Guidelines%204%2024%2014.pdf
    - Removal from play if concussion suspected.
    - Removal from physical exertion: games, competitions, practices
    - A “health care provider” must evaluate and provide written clearance.
- An MD, licensed NP, DO, licensed PA, licensed PsyD with concussion or neuropsych training
- A chiropractor with concussion specialization

Protection, Prevention
- Protection
  - Helmets, face shields, mouth guards, etc
- Prevention
  - Proper coaching on technique
    - Football: tackling
    - Soccer: heading the ball
  - Rule changes

Concussion Assessment Tools
- Sports Concussion Assessment Tool 3 (SCAT3)
  - Developed by 2012 International Summit of Concussion in Zurich
  - Used in athletes 13yo and older (12 and younger use Child-SCAT3)
  - 8 subtests which comprise 2 test areas
    - SAC: Standardized Assessment of Concussion
    - BESS: Balance Error Scoring System
  - Can be used by licensed healthcare provider on sidelines or athletic trainers’ office
  - Used as a self comparison to a pre-injury score

King-Devick
- We know it as a clinical test of saccadic function
- Used as a rapid side-line screening test
- Anyone can be trained to administer
- Rapid number naming and reading aloud
  - Incorporates eye movements, attention and language
  - Higher time compared to baseline indicates worsening score
- Administered with 3 test cards, computer program or iPad app
- Studied in literature extensively
  - Most recently studied in conjunction with SCAT in UF athletes
    - 79% concussion patients had worsened K-D scores
    - When use K-D with SAC identify 89%
    - When combine K-D with SAC and BESS, 100% of concussions identified

Immediate Post-concussion Assessment and Cognitive Testing (ImPACT)
- Most widely used concussion evaluation system
- 20 minute online test
- Given before sport season and then post-concussion
- Validated
- Recommend return to play when score returns to baseline
- Sideline ImPACT
  - 5 minute screener
  - Not to be used for RTP
Acute Concussion Evaluation (ACE)
- Developed in conjunction with CDC Head’s Up campaign
- Symptom survey to be administered by clinician
- ACE Care Plan
  o Can be used to communicate with patient, family and school/work on return to normal activity plan

Management of Concussion: Action Plan
- CDC 4 Step Action Plan
  o Remove athlete from play
    ▪ “When in doubt, sit them out!”
  o Ensure that the athlete is evaluated by a health care professional experienced in evaluating for concussion.
  o Inform the athlete’s parents about the concussion and give them the fact sheet.
  o Keep the athlete out of play the day of the injury and until a health care professional experienced in evaluating for concussion, says they are symptom-free and its okay to return to play

Management of Concussion: Stepwise RTP
Optometric Management
- Need to know the background on concussion, so we understand what the patient has been through before coming to see us.
- Need to know what questions to ask.
- Need to know what to be looking for.
- Need to know what tests to perform.
- Need to know how to treat.
- Need to communicate and educate.

History
- Symptom Surveys
  o Convergence Insufficiency Symptom Survey (CISS)

Visual Sequelae
- Accommodative Dysfunction
  o Accommodative Insufficiency
  o Accommodative Spasm
  o Accommodative Infacility
  o Accommodative Instability
- Vergence Dysfunction
  o Convergence Insufficiency
    ▪ XP greater at near, low AC/A
  o Convergence Excess
    ▪ EP greater at near, high AC/A
  o Fusional Vergence Dysfunction
    ▪ Reduced positive (BO) and negative (BI) fusional ranges
    ▪ Vertical phoria
- Oculomotor Dysfunction
  o Saccadic Dysfunction
- Pursuit Dysfunction
- Photosensitivity
  - Light sensitivity and glare
    - Indoors – especially fluorescent lighting
    - Outdoors – sunlight
- Less common sequelae of mTBI
  - Ocular trauma
    - Orbital fractures
    - Corneal abrasions
    - Traumatic uveitis
  - Visual field loss
    - General constriction
    - Homonymous field losses
  - Cranial nerve palsies
    - CN IV – most common
    - CN VI
    - CN III

Educate
- Vision is complex
  - What goes into single, clear, asymptomatic vision?
- What components of the visual system are affected/not affected?
- This isn’t an easy fix
- Takes commitment
- Sometimes things never return 100% to how they used to be
  - Find a “new normal”

Communication
- School
  - Teachers
  - Counselors
- Therapists
  - Occupational
  - Physical
  - Speech and Language
- Doctors
  - Neurologist
  - Physiatrist
  - Psychiatrist/Psychologist