concussion
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disclosure

• I have no conflicts to disclose.
objectives

• At the conclusion of this presentation the participant will be able to:
  o define concussion
  o describe the epidemiology and pathophysiology of concussion
  o identify the signs and symptoms of a concussion
  o list steps to concussion recovery
  o identify steps to return to play and classroom accommodations
  o provide concussion education and resources for parents, coaches, and healthcare providers
concussion

• a traumatic brain injury induced by biomechanical forces
  o may be caused by a direct blow to the head, face, neck, or elsewhere on the body with an impulsive force transmitted to the head
  
  o typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously, some signs and symptoms may evolve over a number of minutes to hours
  
  o may result in neuropathologic changes, but the acute clinical signs and symptoms largely reflect a functional disturbance rather than a structural injury
  
  o a range of clinical signs and symptoms cannot be explained by drug, alcohol, medication use, other injuries, or other comorbidities
  
  o no longer graded
pathophysiology

- biogenetics include force of acceleration, deceleration, and rotation of the head.
- typically from a direct blow, but injuries to other body parts may transmit a secondary force to the head
- after the biomechanical injury there is potassium efflux from the neurons and an increase in extracellular glutamate that activates the N-methyl-D-aspartate receptor leading to a further potassium, calcium, and sodium influx-depressing neuronal activity
- sodium potassium ion pumps deplete the intracellular energy reserves in an attempt to restore homeostasis
Pathophysiology continued

- children and adolescents have reduced cerebral blood flow following concussion
- calcium is stored in the mitochondria leading to dysfunction and impairing oxidative metabolism
- the increase in glucose metabolism can cause a hypometabolic state that can last up to 4 weeks
- calcium influx can damage the cytoskeleton and cause axon injury in addition to the primary axonal injury from shear and tensile forces of trauma
- axonal injury reduces the conductive velocity through the neuron
myths

- you can’t have a concussion without being hit in the head and losing consciousness
- helmets and face guards prevent most concussions
- boys get more sports concussions than girls
- concussion symptoms are always immediately present
epidemiology

• an estimated 1.1 million to 1.9 million concussions occur annually in the US in children under the age of 18
• 75% of 5-17 year old patients with concussion are seen initially by their primary care provider
• an estimated 45-65% do not get evaluated
• incidence and reporting has increased over the last 2 decades
• more opportunities for sport participation with an increased injury exposure risk, and the increase in size, strength, and speed of athletes over the years.
age factors

- more force is needed to produce clinical symptoms in kids versus adults

- children’s developing brains are more vulnerable than a mature adult brain as myelination of the brain occurs throughout brain development

- diffuse cerebral swelling is more common in kids/teens

- children have may have weaker neck muscles that may impair the attenuation of force to the head and increase concussion risk
boys

• tackle football

• lacrosse

• ice hockey

• wrestling

girls

• soccer

• lacrosse

• field hockey

• basketball
Initial evaluation on field

- SCAT5 and SCAT5 Child
  - red flags
    - neck pain or tenderness
    - double vision
    - weakness or tingling/burning in arms or legs
    - severe or increasing headache
    - seizure or convulsion
    - loss of consciousness
    - deteriorating conscious state
    - vomiting
    - increasingly restless, agitated or combative
  - observed signs
  - memory
  - Glasgow Coma Scale
  - cervical spine assessment
    - a cervical spinal injury should be assumed if not lucid or fully conscious
imaging

- typically CT or MRI are normal

- normal imaging in the acute phase may not rule out a chronic subdural hematoma

- normal imaging does not predict subsequent neurobehavioral dysfunction or recovery time

- use if there is suspicion of a more severe intracranial injury or structural lesion

- evaluate for cervical spine injury, skull fracture, or any of the 4 types of intracranial hemorrhage (subdural, epidural, intracerebral, or subarachnoid)
imaging red flags

- GCS <15, acutely worsening headache, signs of basilar skull fracture, or signs of altered mental status are at highest risk for structural brain injury

- GCS of 15, loss of consciousness, vomiting, severe headache, or severe mechanism of injury carry 0.9% risk of structural damage, but CT is recommended verses observation
Timing of Imaging

- Likelihood of finding clinically significant intracranial hemorrhaging after 6 hours without deterioration in level of consciousness is extremely rare, 0.03% of patients.

- CT used in the first 48 hours:
  - Quick and cost effective
  - Exposure to radiation

- MRI for outside of the emergency period:
  - Superior in detection of cerebral contusion, petechial hemorrhage, and white matter injury
  - If clinically worsening or not improving to assess for other structural problems that may cause similar symptoms
  - 0.5% of pediatric patients had MRI findings compatible with traumatic injury
  - 14.3% had unrelated abnormal findings with most being benign.
office evaluation

- symptom burden scale or child/parent report
- cognitive screening
- neurological screening
- delayed recall
signs and symptoms

• <50% may not report immediate symptoms
• Somatic
  o **Headache**, nausea, vomiting, neck pain, light and sound sensitivity, vision changes
• Vestibular and/or oculomotor
  o Hearing problems and/or tinnitus, balance problems, **dizziness**
• Cognitive
  o **Confusion**, feeling mentally “foggy”, **difficulty concentrating** or remembering, answers questions slowly, repeats questions, loss of consciousness
• Emotional
  o Irritable, more emotional than usual, sadness, nervousness and/or anxious
• Sleep
  o Drowsiness and/or fatigue, feeling slowed down, trouble falling asleep, sleeping too much/little
pre-existing conditions

- specific attention to athletes with
  - migraine and/or headache disorders
  - learning disorders or attention-deficit/hyperactivity disorder
  - mental health conditions (depression and anxiety)
  - sleep disorders
reporting symptoms

• 70.6% of high school athletes report they would report their concussion symptoms

• 66% high school athletes report they would play through

• female athletes are more likely to report symptoms than males with similar knowledge of concussion symptoms and report a higher symptom burden than boys
scaling symptoms

• fill out the form independently if able

• athletes do not have to be at a total score of 0 to return to play if they had similar symptoms before the concussion

• there are currently no guidelines that determine the severity of a concussion on the basis of these scores
acute management 0-48 hours

• When in doubt, sit them out
  o if not removed from play they are **8.8 times** more likely to have a recovery longer than 21 days
  o athletes who sustain an additional head impact within 24 hours of the first had a greater symptom burden and a longer recovery time and risk of cerebral vascular congestion that can progress to diffuse cerebral edema and death

• Cognitive/physical rest for 48 hours
  o no stimulating activities- including homework, tv, texting, computer, video games, **driving**, or reading
  o increase rest, get good nutrition, and hydration
  o avoid loud, busy, or bright environment
49 hrs- 3 weeks

- may try any cognitive activity as tolerated
- may walk for 15 minutes daily, inactivity may result in a longer recovery and often continue to report higher symptom burden
- rest at the first sign of symptoms and rest until symptoms resolve
- may take headache abortive medication if rest is ineffective and continue resting if medication is needed
- gradual school return / sports return as symptoms improve per guidelines
- weekly visits to assess progress with subjective symptom score and objective BESS testing for balance and neurocognitive testing
- refer to physical therapy for cervical strain
- start melatonin for sleep
BESS testing

The Balance Error Scoring System (BESS)

Scoring the BESS: Each of the trials is 20 seconds. Count the number of errors (deviations) from the proper stance. The examiner should begin counting errors only after the individual has assumed the proper testing position.

Double Leg Stance
Single Leg Stance
Tandem Stance
Double Leg Stance
Single Leg Stance
Tandem Stance
Firm Surface
Firm Surface
Firm Surface
Foam Surface
Foam Surface
Foam Surface

Errors:
• Moving the hands off the hips
• Opening the eyes
• Step, stumble or fall
• Abduction or flexion of the hip beyond 30°
• Lifting the forefoot or heel off of the testing surface
• Remaining out of the proper testing position for greater than 5 seconds

The maximum total number of errors for any single condition is 10.

If a subject commits multiple errors simultaneously, only one error is recorded.

B.E.S.S. SCORECARD

<table>
<thead>
<tr>
<th>B.E.S.S. TOTAL: (Firm+Foam total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Leg Stance (feet together)</td>
</tr>
<tr>
<td>Single Leg Stance (non-dominant foot)</td>
</tr>
<tr>
<td>Tandem Stance (non-dominant foot in back)</td>
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</tbody>
</table>

Count Number of Errors max of 10 each stance/surface
FIRM Surface
FOAM Surface

dayton children’s
neurocognitive testing

• computerized testing
  • rapid and uniform

• baseline testing before the start of the season
  • may be more difficult or score lower with history of ADHD and off medicine, and those with severe depression

• ideally performed in a quiet environment that is free of distractions when they are well rested

• cannot predict recovery time
post concussion syndrome

• Referral to specialty (PMR or neurology)
• Consider treatment for symptoms
  o Vestibular rehabilitation
  o Psychology and or psychiatry
  o Ophthalmology
  o Avoid overuse of abortive medications, start amitriptyline, propanolol, topiramate, perform occipital nerve blocks
recovery time

• each concussion is unique

• no way to predict

• most report improvement in 1-4 weeks

• athletes with a second concussion in 1 year were found to have a longer recovery time compared to their first concussion

• longer recovery has been seen in adolescents and younger athletes compared to college athletes
risk for prolonged recovery

• study results are variable on risk factors for prolonged recovery (>28 days)
  o an initially overall high symptom burden score
  o ADHD
  o female
  o high cognitive symptom load
  o loss of consciousness
  o dizziness
  o early pubertal stage

• some studies reveal no increased risk
return to school

• prolonged removal or absence is discouraged

• communicate with teachers and school staff

• begin school return with accommodations

• return to full academic workload is expected prior to return to full sports participation
### School Implications

<table>
<thead>
<tr>
<th>Sign/Symptom</th>
<th>Potential Implications in School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Most common symptom reported in concussions&lt;br&gt;Can distract the student from concentration&lt;br&gt;Can vary throughout the day and may be triggered by various exposures, such as fluorescent lighting, loud noises, and focusing on tasks</td>
</tr>
<tr>
<td>Dizziness/lightheadedness</td>
<td>May be an indication of injury to vestibular system&lt;br&gt;May make standing quickly or walking in crowded environment challenging&lt;br&gt;Often provoked by visual stimulus (rapid movements, videos, etc)</td>
</tr>
<tr>
<td>Visual symptoms: light sensitivity, double vision, blurry vision</td>
<td>Troubles with various aspects of the school building&lt;br&gt;Slide presentations&lt;br&gt;Movies&lt;br&gt;Smart boards&lt;br&gt;Computers&lt;br&gt;Handheld computers (tablets)&lt;br&gt;Artificial lighting&lt;br&gt;Difficulty reading and copying&lt;br&gt;Difficulty paying attention to visual tasks</td>
</tr>
<tr>
<td>Noise sensitivity</td>
<td>Troubles with various aspects of the school building&lt;br&gt;Lunchroom&lt;br&gt;Shop classes&lt;br&gt;Music classes (band/choir)&lt;br&gt;Physical education classes&lt;br&gt;Hallways&lt;br&gt;Organized sports practices</td>
</tr>
<tr>
<td>Difficulty concentrating or remembering</td>
<td>Challenges learning new tasks and comprehending new materials&lt;br&gt;Difficulty with recalling and applying previously learned material&lt;br&gt;Lack of focus in the classroom&lt;br&gt;Troubles with test taking&lt;br&gt;Troubles with standardized testing&lt;br&gt;Reduced ability to take drivers education classes safely</td>
</tr>
<tr>
<td>Sleep disturbances</td>
<td>Excessive fatigue can hamper memory for new or past learning or</td>
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</tbody>
</table>
**School Accommodations**

<table>
<thead>
<tr>
<th>Sign/Symptom</th>
<th>Potential Adjustments in School Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Frequent breaks</td>
</tr>
<tr>
<td></td>
<td>Identifying aggravators and reducing exposure to them</td>
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<tr>
<td></td>
<td>Rests, planned or as needed, in nurses office or quiet area</td>
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<tr>
<td>Dizziness</td>
<td>Allow student to put head down if symptoms worsen</td>
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<tr>
<td></td>
<td>Give student early dismissal from class and extra time to get from class to class to avoid crowded hallways</td>
</tr>
<tr>
<td>Visual symptoms: light sensitivity, double vision, blurry vision</td>
<td>Reduce exposure to computers, smart boards, videos</td>
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<tr>
<td></td>
<td>Reduce brightness on the screens</td>
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<td></td>
<td>Allow the student to wear a hat or sunglasses in school</td>
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<td></td>
<td>Consider use of audiotapes of books</td>
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<td></td>
<td>Turn off fluorescent lights as needed</td>
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<td></td>
<td>Seat student closer to the center of classroom activities (blurry vision)</td>
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<tr>
<td></td>
<td>Cover 1 eye with patch/tape 1 lens if glasses are worn (double vision)</td>
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<tr>
<td>Noise sensitivity</td>
<td>Allow the student to have lunch in quiet area with a classmate</td>
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<td></td>
<td>Limit or avoid band, choir, or shop classes</td>
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<td>Avoid noisy gyms and organized sports practices/games</td>
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<td></td>
<td>Consideration of the use of earplugs</td>
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<tr>
<td>Difficulty concentrating or remembering</td>
<td>Avoid testing or completion of major projects during recovery when possible</td>
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<td>Provide extra time to complete nonstandardized tests</td>
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<td></td>
<td>Postpone standardized testing (may require that 504 plan is in place)</td>
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<td></td>
<td>Consider 1 test per day during exam periods</td>
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<tr>
<td></td>
<td>Consider the use of preprinted notes, notetaker, scribe, or reader for oral test taking</td>
</tr>
<tr>
<td>Sleep disturbances</td>
<td>Allow for late start or shortened school day to catch up on sleep</td>
</tr>
<tr>
<td></td>
<td>Allow rest breaks</td>
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return to play

• monitored by licensed health care professionals
• each step should take at least 24 hours
• if symptoms return, they should wait 24 hours
• once symptoms have resolved, return to the previous step that was completed without symptoms
• must be symptom free with school and ADLs for 24 hours
• premature return to contact sports increases the risk of a more severe injury, repeat injury, and prolonged recovery
steps for return to play

- **Step 1: Back to regular activities (such as school)**
  Athlete is back to their regular activities (such as school).

- **Step 2: Light aerobic activity**
  Begin with light aerobic exercise only to increase an athlete’s heart rate. This means about 5 to 10 minutes on an exercise bike, walking, or light jogging. No weight lifting at this point.

- **Step 3: Moderate activity**
  Continue with activities to increase an athlete’s heart rate with body or head movement. This includes moderate jogging, brief running, moderate-intensity stationary biking, moderate-intensity weightlifting (less time and/or less weight from their typical routine).

- **Step 4: Heavy, non-contact activity**
  Add heavy non-contact physical activity, such as sprinting/running, high-intensity stationary biking, regular weightlifting routine, non-contact sport-specific drills (in 3 planes of movement).

- **Step 5: Practice & full contact**
  Young athlete may return to practice and full contact (if appropriate for the sport) in controlled practice.

- **Step 6: Competition**
  Young athlete may return to competition.
concussion prevention

• Protective equipment
  
  o Helmets are designed to reduce severe injuries such as skull fractures, subdural hematomas, and brainstem contusion or hemorrhage
  
  o No data to support one brand or helmet model
  
  o No data to support attachments (bumpers, pads, or sensors) to prevent or reduce the severity of a concussion
legislation

• in 2009 the Zackery Lystedt Law was passed in the state of Washington
  o education of coaches, athletes, and their parents or guardians
  o removal from play
  o permission to play from a healthcare provider after a minimum of 24 hours
CONCUSSION SYMPTOMS

- Headaches
- Dizziness
- Blurred Vision
- Memory Loss
- Inability To Concentrate
education

- CDC HEADS UP training for coaches and healthcare providers
  - CDC HEADS UP Concussion and Helmet safety app
long term effects

• two studies have found no increased risk of dementia, parkinson disease, amyotrophic lateral sclerosis, or cognitive or depressive problems in former high school football players compared to classmates that did not play football
chronic traumatic encephalopathy

• no way to diagnose in a living individual-exclusively diagnosed in postmortem pathology

• former football players that donated their brains were studied and found that 21% of high school players had CTE stage 1 and 100% of the professional athletes
• there is no magic number or guideline of concussions that an individual has sustained to determine if they should not be allowed to participate in a sport

• this is an individualized decision
resources

- American Academy of Pediatrics


- CDC HEADS UP

  https://headsup.cdc.gov
questions and contact

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