Concussion Management

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Objectives

• Define concussion
  – Underlying physiology, signs and symptoms
• Diagnosis of concussion
• Differential diagnosis
  – Signs and symptoms needing emergent evaluation
• Concussion management
• Short term and long term effects of concussion
• Talking to parents about concussion
Defining Concussion

- 4th International Conference on Concussion in Sport
  - 3rd conference eliminated grading scales
- Concussion: “complex pathophysiologic process affecting the brain, induced by traumatic factors”
  - aka, trauma induced brain dysfunction
  - Direct blow to head or “impulsive” force transmitted to head
  - Typically results in rapid onset of short-lived impairment of neurologic function that resolves spontaneously
  - May result in neuropathologic changes, but acute symptoms reflect a functional disturbance rather than a structural injury
  - No abnormality on standard structural neuroimaging is seen in concussion
Pathophysiology

- Ion flux: efflux of K+, influx of Ca+
  - Depolarization – spreading depression
- Intracellular glucose delivery interrupted
- Decreased flow with increased demand
- Creates metabolic dysfunction

[Diagram showing brain activity over days from concussion, with labels for moment of injury, demand for glucose, blood flow, and oxygen metabolism.]

Boston Children’s Hospital

HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL
Signs and Symptoms of Concussion

• Any cognitive symptoms after impact
  – May be collective number of hits versus single injury

• Immediate symptoms
  – *Loss of consciousness in 5% or fewer of cases!*
    • Increased risk of structural injury, but little effect on concussion course
  – Headache, drowsiness, confusion
  – Tinnitus, blurry vision, nystagmus
  – Slurred speech, change in performance

• Delayed symptoms – may be days later
  – Headaches, sleep disturbance, fatigue
  – Confusion, trouble concentrating/reading
  – Depression, anxiety

• *Any suspicion of concussion requires immediate removal from play*
# Subjective Symptom Scale

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>“Pressure in head”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Neck pain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Balance problems or dizziness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Vision problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Hearing problems / ringing</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>“Don’t feel right”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Feeling “dinged” or “dazed”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Confusion</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Feeling like “in a fog”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Fatigue or low energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>More emotional than usual</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
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<tr>
<td>Irritable</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
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<tr>
<td>Difficulty concentrating</td>
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<td>1</td>
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<td>3 4</td>
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<tr>
<td>Difficulty remembering</td>
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<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Sadness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Nervous or anxious</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Sleeping more than usual</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
<tr>
<td>Other: ____________________</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 4</td>
</tr>
</tbody>
</table>
Making the Diagnosis – The Exam

• Impact site
  – Evidence of local trauma, contusion
  – General interaction – squinting, quiet, lying down
  – Responsiveness, mood, affect, speech patterns

• Cervical Evaluation

• Neurologic exam
  – CN II-XII, reflexes
  – Romberg, Finger-to-nose testing
  – Modified Balance Error Scoring System (BESS)
  – Strength to upper and lower extremities
Differential Diagnosis

• Exam for concussion is frequently normal
  – *Structural versus functional*

• Mostly used to differentiate from or identify structural injuries to the head and spine
  – May coexist with concussion, share same mechanism
    • Medical emergencies, can result in death
Epidural and Subdural Hematomas

• Likely to show changes in neurologic exam
  – Often progressive, over 24-72 hours

• If any of the following, seek emergent help
  – Loss of consciousness
  – Unequal pupils
  – Poor coordination
  – Personality changes
Spinal Injuries

• Concern for all concussions – especially if whiplash or hyperflexion to neck

• May go unrecognized in patient with altered mental status or distracting injury

• Use extreme caution in patients with:
  – Numbness or weakness, even if improving
  – Significant pain/tenderness to neck and/or back
Use of Imaging

• Uncommon to require imaging in concussion
  – Useful only for finding structural changes

• CT Scans
  – Loss of consciousness at time of injury
  – Focal neurologic deficit at initial exam

• MRI
  – May be used in prolonged symptoms (>4 weeks)
  – Evaluating for structural predispositions – not “severe or prolonged concussion”
  – Newer sequencing showing promise
    – Testing for diagnosis vs. resolution vs. clearance
Initial Management

• “Act like you’ve got the flu”

• Physical rest
  – Initially out of all exercise/sports involvement
    • Protection and energy conservation
  – Discuss return to play with Kathy Thornton

• Cognitive rest
  – May need time off school
  – Discuss return to learn with Dr. Kulberg
Prognosis

- 85-90% return to baseline within 7-10 days
  - 98%+ better within 4 weeks

- Predictors of longer symptoms (> 4 weeks)
  - **NOT** LOC (amnesia 4-10x more predictive)
  - Previous concussion history
  - Personal or family history of headaches/migraines
  - Cognitive/“Foggy” feeling as worst symptoms
  - Multiple collisions before removed (vs single blow)
  - Females > males; High School > Professional
Advanced Therapies

• Need versus want...
• Insomnia
• Headaches
• Cognitive deficits
• Dizziness, Imbalance
• Depression/Anxiety
Insomnia

- Sleep hygiene!!
- Melatonin – safe first line (start early)
  - 2-5mg PO qhs
  - Very limited side effect profile
- Trazadone
  - Not something I use in pediatric population
- Avoid Ambien/benzodiazepines
  - Slow processing speed, already impaired
Headaches

• Often poorly responsive to Ibuprofen/Tylenol
• Advanced medications considered if:
  – Symptoms past 4 weeks
  – Headaches predominant symptom
  – Interfering with academics, focus, concentration, sleep
• Temporary – need to remove before RTP

**Only treating headaches, not concussion

**All medications are off-label use in concussion
Headaches

• Amitriptyline
  – Start very low, can raise as necessary
  – Adverse effects:
    • Fatigue – often desired, can have hangover effect
    • Prolonged QT – always obtain prior EKG
    • Mood changes
Headaches

- Amitriptyline
- Topirimate
  - No heart effects, less interference with SSRIs
  - Less researched specifically in concussion
Headaches

• Amitriptyline
• Topirimate
• Propranolol
  – Concern in athletes if return to play – affects appropriate HR/BP response to exercise
Cognitive Deficits

• If chronic struggles academically (>4-6 weeks), especially if predominant symptom

• Amantadine
  – Teratogenic, consider UPT in postpubescent
  – Preferred in pediatrics

• Methylphenidate
  – Considered for adults/older adolescents
Other Symptoms

• Balance/Dizziness
  – Vestibular therapy

• Neck Pain
  – Craniosacral therapy, Cervical PT

• Depression/Anxiety
  – Cognitive Behavioral Therapy (CBT)
  – Standard therapy/counseling

*Beware some limitations/rest effects
Repeat Concussions

• After 1, patient 3x more likely to obtain 2\textsuperscript{nd} within same season than peers without (Guskiewicz 2000)
  – 92% of in-season repeats are within 10d of return (Guskiewicz, JAMA 2003)

• Worrisome patterns
  – Longer, more severe symptoms
  – Less mechanism required
  – Persistent cognitive dysfunction
Second Impact Syndrome

• Rare, possibly fatal complication of head injury
• Typically involves second injury while still recovering
  – Does NOT require significant blow or head trauma
  – Loss of regulation of blood flow – reversal of decreased cerebral perfusion
  – Severe diffuse edema, brain herniation, possible death
    • Survival often involves significant catastrophic neurologic injury
• Controversy over necessity of an initial injury
  – Versus separately described diffuse cerebral edema related to individual trauma
Cumulative Effects

• Some permanent effect with each concussion
  – Cannot see it or quantify it
  – Must be present to allow cumulative effect

• After one, much more likely to get another (3x)
  – Part selection bias, part real cumulative effect
  – Longer, more severe symptoms

• No way of predicting individual response – even within the same patient
Chronic Traumatic Encephalopathy (CTE)

• Distinct tauopathy of brain tissue
  – Unknown incidence in athletic populations

• Direct cause and effect relationship between CTE and concussions or exposure to contact sports has not yet been demonstrated
  – Few studies evaluating for this is general population
    • Noy et al (2016): 35% of normal population 18-60yo show at least minimal changes consistent with CTE
    • Alcohol use and head trauma seem to be significant factors
  – Caution in interpretation of causation in CTE case studies
  – Important to address the fears of parents/athletes
Cumulative Effects

• Concerns for multiple other syndromes attributable to concussions
  – Depression
  – Dementia
  – Parkinsonism
  – Alzheimer’s
  – Amyotrophic Lateral Sclerosis (ALS)

• NONE of these have been proven, with studies refuting increased risk
Advice to Parents/Patient

• Reassurance, reassurance, reassurance
  – “You should get back to 100%”
  – No reason to believe that every patient won’t completely return to normal after first concussion

• Functional versus structural injury
  – Down at the cellular level – won’t see it on any imaging modality – no bruising, swelling, etc.
  – Essentially represents an energy deficiency
    • Justification for physical cognitive rest
How Many is Too Many?

• No known answer – may never have one
  – 2 in same season, recommend done for season
• Varies based on age, level, future, etc.
  – Acceptance of risk...
Acceptance of Risk

• Perhaps most important disclosure/advice
  – Most concussion guidelines are based on expert recommendations rather than high level evidence

• Parents and patient have to know that all of these risks increase with any return to sport
Protective Gear

• At this point, we have no solid evidence that any piece of equipment has significant protection from concussion
  – Helmets
  – Bands
  – Mouthguards
Resources

• Literature
  – Meehan, WP and Bachur, R. Sport-Related Concussion. *Pediatrics* 2009; 123; (114-123)
  – CDC “Heads Up to Clinicians” training program (preventingconcussions.org)

• For Family and Parents
  – CDC “Heads Up” program for coaches