The Diagnosis and Management of Concussion

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Introduction

- CDC estimates 1.6-3.8 million sports-related concussions annually in USA
  - 5-9% of all sports injuries
- Increased rates over last decade
  - likely due to education and awareness
- Sports with majority of concussions:
  - Football
  - Wrestling
  - Boys’ and Girls’ Soccer
  - Girls’ Basketball
- Concussions also seen with:
  - Falls
  - Trauma
  - MVA’s
Concussion Guidelines

- 1st International Conference on Concussion in Sport held in Vienna in 2001
  - Consensus statement created
- 2nd: Prague – 2004
  - No more grading of concussion
  - Simple vs Complex
- 3rd: Zurich – 2008
  - All classifications removed
- Most recent – 4th: Zurich 2012
  - New tools – SCAT3, child version
  - Timing of treatments
- Next – 5th: Berlin Fall 2016
Definition of Concussion

- A complex pathophysiological process affecting the brain, induced by biomechanical forces, that may include:
  - May be caused by direct blow to head or body with impulsive force transmitted to head
  - Rapid onset of short-lived impairment of neurological function
  - Neuropathological changes with a functional disturbance, rather than structural injury
  - Graded set of clinical symptoms that may or may not involve LOC.
  - Subset of mild traumatic brain injury
Pathophysiology

- Forces to the brain are linear and/or rotational
Neurometabolic cascade
- Complex cascade of ionic and metabolic events accompanied by microscopic axonal injury
  - Causes vasoconstriction
- Requires energy to re-establish homeostasis
- Increased need for energy in the presence of decreased cerebral blood flow

Leads to “Energy Crisis”
- Brain has to work harder to meet same demands
Pathophysiology

- Brain has increased vulnerability in the post-concussion state
- 2\textsuperscript{nd} injury before brain is recovered may result in worse cellular changes and cognitive deficits
  - Second Impact Syndrome
- Excessive cognitive or physical activity before complete recovery may result in prolonged dysfunction
Risk Factors for Concussions

- Previous concussion
  - 2 - 5.8x higher risk of sustaining another concussion
  - May have progressively prolonged recovery with each concussion

- History of Migraines

- Sex
  - Female athletes sustain more concussions than males in sports with similar rules

- Age < 18yo
  - May have prolonged recovery compared to adults

- Sport and Position
  - Most common mechanism is player-to-player contact

- Mood disorders

- Learning and attention disorders
  - May complicate diagnosis and do worse on testing
Signs and Symptoms

- Physical
- Emotional
- Cognitive
- Sleep
Signs and Symptoms

Physical

- Headache
- Nausea
- Vomiting
- Balance problems
- Dizziness
- Visual Problems
- Fatigue
- Sensitivity to light
- Sensitivity to noise
- Numbness/tingling
- Dazed
- Stunned
Signs and Symptoms

Cognitive

- Feeling mentally “foggy”
  - Feels like standard TV, instead of HD TV
- Feeling slowed down
- Difficulty concentrating
- Difficulty remembering
- Forgetful of recent information
- Confused about recent events
- Answers questions slowly
- Repeats questions
Signs and Symptoms

**Emotional**
- Irritable
- Sadness
- More emotional
- Nervousness

**Sleep**
- Drowsiness
- Sleeping more or less than usual
- Difficulty falling asleep
Diagnosis of a Concussion

- Sideline
- Office
Diagnosis of a Concussion

- Symptoms
- Physical Signs
  - LOC or amnesia
    - LOC only occurs 10% of the time
  - Trouble with balance or vestibular system
- Behavioral changes
  - Irritability
- Cognitive impairment
- Sleep disturbance

If any one or more of these components are present, a concussion should be suspected.
Acute Assessment

- If the athlete is collapsed:
  - ABC’s
  - Assess for cervical spine injury
    - If concerned → immobilize the neck and transfer to ED
  - Assess for more serious brain injury
    - Deteriorating mental status
    - Focal neurological findings
      - Abnormal or unequal pupil reaction
      - Abnormal extraocular movement
      - Abnormal motor/sensory exam
    - If concerned → Send to ED for neuroimaging
Sideline Assessment

- If concussion suspected
  - Athlete should be removed from play
  - Evaluated by a physician or licensed healthcare provider
  - If none available
    - Should not return to play
    - Urgent referral to a physician should be arranged
Sideline Assessment

- If no evidence for concussion
  - Can return to play
  - Should still have serial evaluations to ensure decision was correct

- If diagnosed with concussion
  - Should not return to play
  - Arrange follow-up appointment
Patient Instructions - Acute

- No longer recommended to have frequent awakenings
  - Sleep is restorative
  - Desirable to let athlete sleep
- If level of consciousness is a concern
  - Athlete should be sent to ED for neuroimaging
  - Be monitored in hospital setting
- Avoid Aspirin or NSAIDs
  - Theoretical risk of bleeding
  - Possible rebound headaches
  - OK to use Acetaminophen
- Physical and Mental Rest
Office Management
Office Evaluation

- History
- Physical Exam
- Tools
Office Evaluation

- History
  - Event mechanism
  - Course of symptoms
  - Previous history of concussion
  - May need to speak with parents or athletic trainer if need more info

- Concerning symptoms for imaging
  - Worsening symptoms
    - Increased nausea and vomiting
  - Pronounced amnesia
Office Evaluation

- Physical Exam
  - Neuro exam
    - Evaluate for focal deficits
  - Balance
    - BESS Testing
  - Vestibular-Ocular Exam

- Concerning signs for imaging
  - Progressive balance dysfunction
  - Focal neurological deficits
Office Evaluation

- Tools
  - Symptom scores – SCAT3
    - Objective measure
    - May be helpful for serial monitoring
    - Designed for sideline use
  - Computerized neuropsychiatric testing (NP)
    - Tool to assess cognitive function
      - Usually follows clinical symptom resolution
    - Usually performed when clinically asymptomatic
      - May help early when deciding on school restrictions
Computerized NP Testing

- Zurich Guidelines
  - Not mandatory, but may be helpful
- AMSSM Position Statement
  - Majority of concussions can be managed appropriately without NP testing
- Aid to the clinical decision-making process
  - Should not be sole basis for management decisions
Neuroimaging

- Imaging is typically normal in concussed athlete
- Head CT
  - Used to evaluate for:
    - Intracranial bleeding
    - Skull fracture
- MRI Brain
  - May obtain if prolonged symptoms > 4 weeks
  - Used in concussion research
    - fMRI, PET scan, SPECT
    - Diffusion tension imaging
      - White matter fiber tracts
    - MR spectroscopy - neurometabolites
Concussion Management

- **Physical rest**
  - But don’t sit in dark room entire time

- **Cognitive rest**
  - May need school accommodations
    - No tests or homework
    - Half-days

- **Sleep**
  - 7-9 hours, limit naps

- **Regular diet and hydration**
Physical and Cognitive Rest

**Benefits of Strict Rest after Concussion?**

  - Age 11-22yo seen in Peds ED within 24 hours of concussion
- Strict Rest for 5 days vs Usual Care
- Strict rest group at day 10
  - More daily postconcussion symptoms
  - Slower symptom resolution
  - No difference in balance and neurocognitive outcomes
Acute Concussion Management

- **Medications**
  - Usually not started until 2-4 weeks post-concussion
  - Headaches
    - Can use acetaminophen

- **Avoid activities that exacerbate symptoms**
Concussion Recovery

- Majority of concussions resolve in 7-10 days: 80-90%
  - May be longer in adolescents
- Collins et al. Neurosurgery 2006
  - 134 High school football players
    - 40% at week 1
    - 60% at week 2
    - 80% at week 3
- Each concussion is unique
  - Even with the same athlete
Returning to School or Work

- Even if having symptoms, goal is to keep disruptions in patient’s life to a minimum
  - Return to school as soon as possible
    - But balance cognitive demands so no increase in symptoms
  - Is patient able to take time off from work?

- Need to keep communication open
  - Progress, regress, hold steady

- Can start with shorter days
  - Avoid certain classes or job duties

- Individualized approach is needed
When can they return to play?

- No symptoms
- Normal Physical Exam
- If NP testing done
  - Returned to baseline or normative data
- Off all medications
  - Symptoms cannot be masked
- Returned to regular class schedule

Then athlete can start return to play protocol
- Usually guided by ATC
Graduated RTP Protocol

<table>
<thead>
<tr>
<th>Rehabilitation stage</th>
<th>Functional exercise at each stage of rehabilitation</th>
<th>Objective of each stage</th>
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<tbody>
<tr>
<td>1. No activity</td>
<td>Symptom limited physical and cognitive rest.</td>
<td>Recovery</td>
</tr>
<tr>
<td>2. Light aerobic exercise</td>
<td>Walking, swimming or stationary cycling keeping intensity &lt; 70% MPHR, No resistance training.</td>
<td>Increase HR</td>
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<tr>
<td>3. Sport-specific exercise</td>
<td>Skating drills in ice hockey, running drills in soccer. No head impact activities.</td>
<td>Add movement</td>
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<tr>
<td>4. Non-contact training drills</td>
<td>Progression to more complex training drills e.g. passing drills in football and ice hockey. May start progressive resistance training</td>
<td>Exercise, coordination, and cognitive load</td>
</tr>
<tr>
<td>5. Full contact practice</td>
<td>Following medical clearance participate in normal training activities</td>
<td>Restore confidence and assess functional skills by coaching staff</td>
</tr>
<tr>
<td>6. Return to play</td>
<td>Normal game play</td>
<td></td>
</tr>
</tbody>
</table>

- 24 hours per step (therefore about 1 week for full protocol)
- If recurrence of symptoms at any stage, return to previous asymptomatic level and resume after further 24 hr period of rest
Patients with Prolonged Symptoms
Symptom Domains to Guide Treatments

- Headache
  - Migraine
  - Cervicogenic
- Emotional
- Ocular
- Cognitive
- Vestibular Dysfunction
- Sleep
Headaches

- Most commonly reported symptom
  - Up to 70% of concussed athletes
  - Can worsen with physical or cognitive exertion

- Types of Headaches
  - Myofascial tension or Cervicogenic
    - Pain located posterior neck
  - Post-traumatic migraine
    - Described as pressure in front or top of head
Migraine Headaches

- Medications
- Non-Medication Counseling
  - Find limits to what causes headache
    - How long with reading or TV?
    - School
      - Certain classes?
    - Work
    - Time on computer
  - Regular sleep pattern
  - Regular hydration
  - Stress management
  - Possible light walking or exercise
    - Depending on timing of recovery
Cervicogenic and Posterior Tension Headache

- Seen with whiplash associated injuries
- Refer to physical therapy
- Medications
  - Muscle Relaxants
- OMT
- Chiropractor treatment
- Relaxation techniques
- Biofeedback and behavior modification
- Trigger point injections
- Acupuncture
Cognitive Dysfunction
Cognitive Symptoms

- Fogginess
- Difficulty with concentration and focusing
- Slow thinking or processing
- Memory impairment
- Speech dysfunction
  - Stuttering
  - Word-finding difficulty
Cognitive Symptoms

- Mental and Physical Rest
  - Find limits of these activities

- Amantadine
  - Mild stimulant
    - Also used for the flu and Parkinson’s disease
    - Only medication studied so far for concussion treatment

- Cognitive/Speech Therapy
  - If significant speech or memory complaints
  - Consider starting if symptoms persist after ~4-6 weeks
Sleep Dysfunction

The Natural Sleep Process

Time/Stage 0  1  2  3  4  5  6  7  8

REM

NREM Stages

Stage 3

Stage 2

Stage 1

Emotional Resolution

Mental Relaxation

Physical Repair
Sleep Dysfunction

- Behavioral Strategies
  - Proper sleep hygiene
    - No TV, computer, phone, iPad at bedtime
  - Relaxation therapies
  - Sleep restrictions
    - Sleep 7-9 hours at night
    - Limit naps during the day

- Medications
  - Melatonin
Vestibular System

- Works with vision and somatosensory system to maintain balance
- Coordinates eye and head movements
- Affected by concussion injuries
Vestibular Dysfunction

- Referral to vestibular therapy
  - Usually will help rule out BPPV as well
  - Involves retraining:
    - Balance
    - Eye tracking
Ocular Dysfunction

- Can overlap with vestibular dysfunction
  - Convergence or tracking problem
- If does not resolve with vestibular therapy, consider referral to eye specialist with interest in concussions
  - Optometrist, Ophthalmologist, Neuroophthalmologist
  - Specific eye rehab available
Emotional disorder

- Patients are removed from regular routine
  - School
  - Extracurricular activities
  - Sports
  - Work
  - Hobbies

- Frustrated with not being themselves
  - Not as fast thinking as usual
  - Making mental mistakes

- Can lead to nervousness, irritability, sadness

- May already have underlying anxiety, depression, ADD/ADHD

- Research looking into symptoms similar to PTSD
Emotional disorder

- Treatment
  - Psychotherapy/Counseling
    - Especially if recurring thoughts with how brain injury occurred
      - MVA, Assaulted
  - Medications
    - If symptoms persisting for long period
      - (6 months)
Other treatments

- Subsymptom Threshold Exercise Training
  - If prolonged symptoms: 4-6 weeks
  - Still symptomatic, but start monitored exercise
    - Graded based on heart rate and symptoms
      - Stage 1: 30-40% Target Heart Rate
      - Stage 2: 40-60% THR
  - May help increase blood flow to brain to improve healing
    - Gets patient back closer to normal activities
  - Typically guided by Physical Therapy
  - Leddy CJSM 2010
    - Study compared 12 patients with prolonged sx
    - Helped improve symptoms, was safe
  - Research looking into starting earlier activity to help with symptoms
Chronic traumatic encephalopathy (CTE)

- Acknowledge potential for long-term problems in all athletes
- Unknown incidence of CTE in athletic populations
  - cause/effect not yet demonstrated between CTE and concussions or exposure to contact sport
  - May be due to long-term sub-concussive blows
Prevention??

- No evidence that special helmets or mouth guards protect against concussions
  - Making sure helmets are properly fitted is most important

- Proper technique in their sport
  - Football:
    - Tackling with head up

- Neck strengthening is being researched

- Educate athletes, parents, coaches, administrators, ATC’s
Patient Education

- With each subsequent concussion
  - Symptoms may last longer
  - Lower threshold for concussion

- Important to be aware of new symptoms and seek care right away
  - Don’t try to play through symptoms
  - May prolong recovery
CCHS Concussion Clinic

- Location: Center for Advanced Medicine at the Gateway Building
- Wilmington Hospital – 5th floor
- Fridays 8:00 a.m. to 12:00 p.m.
- Call to schedule: 302-623-3528
- Providers:
  - Kristopher Fayock, MD
  - Margaret Guest - Deshan, DO
  - Bradley Sandella, DO
Questions???
References