Update on Sport Related Concussion

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Disclosures

- Neither I, Sean T. Bryan, nor any family member(s), have any relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation.
- My presentation does mention potential off-label uses of certain medications for control of symptoms following sport related concussion (these medications are not FDA approved for these indications).
Previous versions of this talk have induced concussion-like symptoms in numerous sports medicine fellows, family medicine residents, and medical students!
Concussion is a Hot Topic

• Media coverage of high profile athletes
  – Mike Webster
  – Andre Waters
  – Sidney Crosby
  – Austin Collie
  – Junior Seau

• Professional leagues’ public relations and liability concerns
Concussion is a Metabolic Injury

- Energy mismatch
  - Supply ↓ & demand ↑
- Metabolic dysfunction
- Concussion is NOT a structural injury
Our Understanding of Sport Related Concussion Continues to Evolve

- American Academy of Neurology (AAN) Practice Parameter, 1997
- 1st International Conference on Concussion in Sport (ICCS) Summary and Agreement Statement, Vienna 2001
- 2nd ICCS Summary and Agreement Statement, Prague 2004
- 3rd ICCS Consensus Statement, Zurich 2008
- AAN Position Statement, 2010
- 4th ICCS Consensus Statement, Zurich 2012
- AMSSM Position Statement: Concussion in Sport, 2012
Definition

• Concussion is a traumatically induced transient disturbance of brain function and involves a complex pathophysiological process
  – May or may not involve loss of consciousness
  – Trauma can be direct or indirect (rotation, shear)
• Concussion is a subset of mild traumatic brain injury (MTBI) which is generally self-limited and at the less-severe end of the brain injury spectrum

Pathophysiology

• Animal and human studies support the concept of post-concussive vulnerability, showing that a second episode of trauma before the brain has recovered results in worsening metabolic changes within brain cells.

• Experimental evidence suggests the concussed brain is less responsive to usual neural activation, and when premature cognitive or physical activity occurs before complete recovery, the brain may be vulnerable to prolonged dysfunction.

Incidence

• As many as 3.8 million concussions are estimated to occur in the US per year during competitive sports and recreational activities – As many as 50% of concussions may go unreported

• Concussions occur in all sports with the highest incidence in football, hockey, rugby, soccer and basketball

Risk Factors

- A history of concussion is associated with a higher risk of sustaining another concussion
- A greater number, severity and duration of symptoms after a concussion are predictors of a prolonged recovery
- In sports with similar playing rules, the reported incidence of concussion is higher in female athletes than in male athletes
- Certain sports, positions and individual playing styles have a greater risk of concussion
- Youth athletes may have a more prolonged recovery and are more susceptible to a concussion accompanied by a catastrophic injury
- Diagnosis and management of concussion is complicated in those with underlying mood disorders, learning disorders, attention-deficit disorders (ADD/ADHD) and migraine headaches

Diagnosis

• Concussion remains a clinical diagnosis, and ideally should be made by a healthcare provider familiar with the athlete and knowledgeable in the recognition and evaluation of concussion

• Graded symptom checklists provide an objective tool for assessing a variety of symptoms related to concussions, while also allowing tracking of symptom severity over serial evaluations

• Standardized assessment tools provide a helpful structure for the evaluation of athletes with concussion symptoms, although limited validation of these tools is available

Sideline Evaluation & Management

• Any athlete suspected of having a concussion should be removed from playing and assessed by a licensed healthcare provider trained in the evaluation and management of concussions
• Recognition and initial assessment of a concussion should be guided by a symptoms checklist, cognitive evaluation (including orientation, past and immediate memory, new learning and concentration), balance tests and further neurological examination
• While standardized sideline tests are a useful framework for examination; the sensitivity, specificity, validity and reliability of these tests among different age groups, cultural groups and settings are not clearly defined, so their practical usefulness with or without an individual baseline test is not truly known

Sideline Evaluation & Management

• Balance disturbance is a specific indicator of a concussion, but not very sensitive, and balance testing on the sideline may vary from baseline tests because of differences in shoe/cleat-type, surface type, use of ankle tape or braces, or the presence of other lower extremity injury

• Imaging is reserved for athletes where intracranial bleeding is suspected

• There should be no same day return to play (RTP) for an athlete suspected to have, or diagnosed with, a concussion

• Athletes suspected to have, or diagnosed with, a concussion should be monitored for any deterioration of physical or mental status

Neuropsychological Testing

• Neuropsychological (NP) tests are an objective measure of brain–behavior relationships and are more sensitive for subtle cognitive impairment than physical exam.
• Most concussions can be managed appropriately without the use of NP testing.
• Computerized neuropsychological (CNP) testing should be interpreted by healthcare professionals trained and familiar with the type of test and the individual test limitations, including knowledge of assessment of the reliable change index, baseline variability, and false-positive and false-negative rates.
• Face to face paper and pencil NP tests can be more comprehensive, test different domains, and assess for other conditions which may masquerade as, or complicate the assessment of, a concussion.

Neuropsychological Testing

- NP testing should only be used as part of a comprehensive concussion management strategy and should not be used in isolation.
- The ideal timing, frequency and type of NP testing have not been scientifically determined.
- In some cases, properly administered and interpreted NP testing can add value to assessing cognitive function and recovery in the management of athletes with sports related concussions.
- It is unknown if use of NP testing in the management of athletes with sports related concussions helps prevent recurrent concussions, catastrophic injuries or long-term complications.
- Comprehensive NP evaluation can be helpful in the post-concussion management of athletes with persistent symptoms or complicated courses.

Return to Class

• Students will require cognitive rest and may require academic accommodations such as reduced school work load and extended time for tests while recovering from a concussion

Return to Play

- Concussion symptoms should be resolved before returning to exercise
- A RTP progression involves a gradual, step-wise increase in physical demands, sport-specific activities and risk of physical contact
- If symptoms occur with activity, progression of the protocol should be stopped and restarted at the preceding symptom-free stage
- RTP after concussion should only occur after medical clearance from a licensed healthcare provider trained in the evaluation and management of concussions

<table>
<thead>
<tr>
<th>Rehab Stage</th>
<th>Functional exercise at each stage of rehab</th>
<th>Objective of each stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No activity</td>
<td>Symptom limited physical &amp; cognitive rest</td>
<td>Recovery</td>
</tr>
<tr>
<td>2. Light aerobic exercise</td>
<td>Walking, swimming or stationary bike keeping intensity &lt; 70% max HR &amp; no resistance training</td>
<td>Increase HR</td>
</tr>
<tr>
<td>3. Sport-specific exercise</td>
<td>Examples: skating drills in hockey, running drills in soccer but no head impact activities</td>
<td>Add movement</td>
</tr>
<tr>
<td>4. Non-contact training drills</td>
<td>Progression to more complex training drills (example: passing drills) &amp; may start progressive resistance training</td>
<td>Exercise, coordination &amp; cognitive load</td>
</tr>
<tr>
<td>5. Full-contact practice</td>
<td>Following medical clearance, may participate in normal training activities</td>
<td>Restore confidence &amp; 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>
Risks of Returning Too Soon

• Concerns with early RTP are
  – Decreased reaction time leading to an increased risk of a repeat concussion or other injury
  – Potential for prolonging symptoms

Long Term Effects

• There is an increasing concern that head trauma exposure and recurrent concussions contribute to long-term neurological sequelae.

• Some studies have suggested an association between prior concussions and chronic cognitive dysfunction.

• Large-scale epidemiological studies are needed to more clearly define risk factors and causes of any long-term neurological impairment.

Disqualification from Sport

• There are no evidence-based guidelines for disqualifying or retiring an athlete from a sport after a concussion
• Each case should be carefully deliberated and an individualized approach taken to deciding if the athlete should be disqualified from sports participation or not

Education

• Greater efforts are needed to educate athletes, parents, coaches, officials, school administrators and healthcare providers in order to improve concussion recognition, management and prevention

• Physicians should be prepared to provide counseling regarding potential long-term consequences of a single concussion and recurrent concussions

Prevention

• Primary prevention of some injuries may be possible with rules modifications, rules enforcement, and fair play.
• Helmets, both hard (football, lacrosse and hockey) and soft (soccer and rugby) are best suited to prevent impact injuries (skull fracture, bleeding, laceration, etc) but have not been shown to reduce the incidence or severity of concussions.
• There is no available evidence that mouth guards reduce the severity of, or prevent, concussions.
• Secondary prevention may be possible through appropriate RTP management.

Legislation

• Legislative efforts provide a uniform standard for scholastic and non-scholastic sports organizations regarding concussion safety and management

Legislation

• New SC Concussion Law
  – (A) SC Department of Health and Environmental Control (DHEC) in consultation with SC Department of Education (DOE), shall post nationally recognized guidelines and procedures, as well as model policies that incorporate best practices, on its website
Legislation

• New SC Concussion Law
  – (B) Local school districts shall develop guidelines and procedures based on information referenced in subsection (A)
  – (C) School districts will provide coaches, volunteers, student athletes, parents/legal guardians an information sheet including risks and parent/legal guardian receipt will be documented in writing or electronically
Legislation

• New SC Concussion Law
  – (D)(1) A student athlete shall be removed from practice or competition at the time he or she is suspected to have sustained a concussion or brain injury
  – (D)(2) A student removed from play may return following on site evaluation by a qualified professional (ATC, MD/DO, PA, or NP) who determines the student athlete does not have any signs or symptoms of a concussion or brain injury
Legislation

• New SC Concussion Law
  – (D)(3) A student athlete removed from play and evaluated who is suspected of having a concussion or brain injury may not return to play until he/she has received written medical clearance by an MD/DO
  – (D)(4) SC DHEC, in consultation with health care provider organizations, shall post continuing education opportunities in concussion evaluation and management for providers making these medical determinations
Legislation

- **New SC Concussion Law**
  - (D)(5) The ATC, MD/DO, PA, or NP (if serving as a volunteer) who evaluates the student athlete during practice or competition and authorizes return to play is not liable for civil damages resulting from an act or omission in rendering this decision, other than acts or omissions constituting gross negligence or wilful, wanton misconduct
  - (E)(2) ‘Student athlete’ includes cheerleaders!
Future Directions

• Additional research is needed to validate current assessment tools, better define the role of NP testing, and improve identification of those at risk of prolonged post-concussion symptoms or other long-term complications

• Evolving technologies for the diagnosis of concussion, such as newer neuroimaging techniques (such as fMRI) or biological markers (CSF and/or serum) may provide new insights into the evaluation and management of sports related concussions

Future Direction?
Potential Complications of Concussions

- Convulsive motor phenomena
  - Posttraumatic seizures
    - Seizure occurs days to months after concussion
    - Does require seizure management and precautions
    - Usually requires anticonvulsant therapy
  - Tonic posturing or convulsive movements within seconds of a concussion
    - Dramatic but usually benign
    - Require no additional management beyond on-field ABCs
    - No anticonvulsant therapy required
Tonic Posturing

https://www.youtube.com/watch?v=kufy7Q1FVSA
Can Concussions Lead to Mental Illness?

- Depression?
    - Questionnaires were used to collect data from 2552 retired professional football players
    - A positive association was found between recurrent concussion and lifetime diagnosis of clinical depression (P < 0.005)
    - Compared to retired players with no history of concussion:
      - Retired players reporting 3 or more concussions were 3 times more likely to be diagnosed with depression
      - Retired players reporting 1 or 2 concussions were 1.5 times more likely to be diagnosed with depression
Controversial Topic #1

- Second Impact Syndrome (SIS)?
  - A second, even minor, head injury suffered while the symptoms of initial concussion are still present causes the brain to lose its ability to auto-regulate circulation of blood leading to vascular engorgement, uncontrolled brain swelling, uncal herniation and usually death (one suspected case led to persistent vegetative state)
  - Is extremely rare (17 suspected cases reported in the literature)
  - Existence as a true clinical entity disputed in CJSM article by Paul McCrory, MBBS, PhD in 2001
Controversial Topic #1

➢ Diffuse Cerebral Swelling (DCS)?


➢ Clinicians should abandon term SIS in favor of DCS, a well-recognized complication of traumatic brain injury more common in children and adolescents

TABLE 2. Probable second impact syndrome cases

<table>
<thead>
<tr>
<th>Ref</th>
<th>Age/sex</th>
<th>Sport</th>
<th>1st episode</th>
<th>Ongoing symptoms</th>
<th>2nd episode</th>
<th>Pathology</th>
<th>Criteria satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3)</td>
<td>16/M</td>
<td>Hockey</td>
<td>Struck back of head on ice; brief loss of consciousness; eyewitness description</td>
<td>Headache, unsteady, weakness</td>
<td>Checked heavily, causing loss of consciousness</td>
<td>Path: Occipital contusion (days), cerebral edema, small SDH, SAH</td>
<td>B, C, D</td>
</tr>
<tr>
<td>(4)</td>
<td>17/M</td>
<td>Football</td>
<td>Cantu Grade 1 concussion during football game; no loss of consciousness; headache post game</td>
<td>Headache</td>
<td>Head struck during successive plays; light head contact during next play and collapsed</td>
<td>Path: cerebral swelling, obstructive hydrocephalus, small SDH/SAH</td>
<td>B, C, D</td>
</tr>
<tr>
<td>(1)</td>
<td>17/M</td>
<td>Boxer</td>
<td>Headache after boxing match 2 days prior; using aspirin ++; motor vehicle accident causing head impact on morning of fight</td>
<td>Yes</td>
<td>Collapsed round 2; no knockdowns in fight</td>
<td>Path: small L frontal SDH, cerebral edema</td>
<td>B, C, D</td>
</tr>
<tr>
<td>19/M</td>
<td>Boxer</td>
<td>Knocked down in fight; post fight headache</td>
<td>Yes</td>
<td>Collapsed round 2 after “minor” blows</td>
<td>Path: Small R SDH, cerebral edema ++</td>
<td>B, C, D</td>
<td></td>
</tr>
<tr>
<td>17/M</td>
<td>Boxer</td>
<td>Several standing counts after being stunned by head blows; post fight psychiatric disturbance</td>
<td>Yes</td>
<td>Fight stopped in round 2 after several “standing counts”; collapsed minutes later</td>
<td>Path: Cerebral edema with brainstem herniation</td>
<td>B, C, D</td>
<td></td>
</tr>
</tbody>
</table>

SAH, subarachnoid hemorrhage; SDH, subdural hematoma.
Controversial Topic #2

- Chronic Traumatic Encephalopathy (CTE)
  - Review 47 cases of neuropathologically verified CTE in the literature
  - Document detailed findings of CTE in 3 professional athletes: one football player and 2 boxers
    - CTE associated with memory disturbances, behavioral/personality changes, Parkinsonism, and speech/gait abnormalities
    - CTE characterized by brain atrophy, ventricular dilatation and a fenestrated cavum septum pellucidum with extensive microscopic tau-immunoreactive neurofibrillary tangles, astrocytic tangles, and spindle-shaped and threadlike neurites throughout the brain
    - Neurofibrillary degeneration of CTE is distinguished from other tauopathies by preferential involvement of the superficial cortical layers, irregular/patchy distribution in the frontal and temporal cortices, propensity for sulcal depths, prominent perivascular/periventricular/subpial distribution, and marked accumulation of tau-immunoreactive astrocytes
    - CTE is a neuropathologically distinct, slowly progressive tauopathy with a clear environmental etiology
Controversial Topic #3

• Neuropsychological (NP) Tests
  – Tests designed to evaluate and measure various cognitive functions of the brain
  – Studies show that tests measuring the following neurocognitive processes have clinical value in concussed athletes
    • Attention
    • Memory
    • Reaction time
    • Visual processing speed
    • Post-concussive symptoms
NP Tests

• Traditional NP tests
  – “Face to face pen and paper” tests
  – Used in initial NFL and NHL concussion research programs
  – Limitations
    • Time consuming and expensive
      – Up to 5 or 6 test administrators needed
      – Can take several days to complete a battery of tests
    • Accuracy of results decrease as performance improves when athletes exposed to the same tests over time (practice effect)
    • Accuracy of tests measuring processing speed and reaction time dependent on the skill of the individual administering tests
Computer-based NP (CNP) Tests

• Advantages
  – Studies show good correlation with previously validated “pen and paper” tests
  – Test questions randomized to increase accuracy by decreasing practice effect
  – Processing speed and reaction time accurately measured by computer
  – Much less time to administer
  – Much more affordable
CNP Testing

• Examples of commercially available products
  – ImPACT (developed by Neuropsychologists at UPMC who spearheaded initial NFL and NHL concussion research programs)
    • www.impacttest.com
  – Cogstate Sport
    • www.cogstate.com/go/sport
  – Headminder
    • www.headminder.com
  – Concussion Vital Signs
    • www.concussionvitalsigns.com
Immediate Post-Concussion Assessment & Cognitive Testing

- Computerized tool
  - Infinitely random
  - No learning effect
  - Applicable to large numbers of individuals
  - Tool to help assess & manage
  - Tool to quantify and help communicate
    - Players, parents, coaches, teachers & school administrators

ImPACT™
Validity

ImPACT Testing

- ImPACT has good validity
  - Sensitivity 79.2%
  - Positive Predictive Value 90%
  - Negative Predictive Value 82%

Traditional Forms

- Symptoms & Balance
  - Sensitivity 62-68%
  - Young Athletes
    - Worst at estimating their level of cognitive function
    - Responses to history questions cannot always be trusted
- Complete battery of pen and paper Neuropsychological testing
  - Sensitivity 90%
  - Practice effect is an issue
  - Time and cost are also issues
Why a Good History and Physical Exam Isn’t Always Good Enough

• 2003 survey of Wisconsin high school football players
  – Reasons why players did not report concussion symptoms
    • Did not think it was serious enough (66.4%)
    • Did not want to leave the game (41.0%)
    • Did not know it was a concussion (36.1%)
    • Did not want to let teammates down (22.1%)

• History and exam are not always sensitive enough to detect subtle symptoms and brain dysfunction
CNP Testing

• The data suggest that the domains covered by ImPACT validate & support its use as a tool in concussion assessment & management

• What CNP is NOT!
  – Final say on making a diagnosis
  – Final say on return to play decisions
  – A substitute for a good history and physical examination
Post-Concussion Symptom Domains

- Neuropsychiatric
- Cognitive
- Migraine / Physical
- Sleep Disturbance
Symptom Domains

**Neuropsychiatric**
- More emotional
- Sadness
- Nervousness
- Irritability

**Cognitive**
- Attention Problems
- Memory dysfunction
- “Fogginess”
- Fatigue
- Cognitive slowing
Symptom Domains

Migraine / Physical

- Headaches
- Visual problems
- Dizziness
- Light sensitivity
- Noise sensitivity
- Nausea

Sleep Disturbance

- Difficulty falling asleep
- Sleeping less than usual
ImPACT concussion test

Sampling of the six phases: Athletes take test when healthy for baseline, and again when injured

1. WORD DISCRIMINATION

Water  House  Can  Nurse  Car  Lead  Ice

One at a time, 12 random, simple words appear for 1.5 seconds each. Then the same 12 words appear again for 1.5 seconds. Individual words then appear, and you have to remember if each was one of the original words, clicking yes or no with a mouse.

2. DESIGN MEMORY

One at a time, 12 random squiggly patterns appear for 1.5 seconds each. Then the same 12 appear again for 1.5 seconds.

Individual patterns then appear, and you have to remember if each was one of the original ones, clicking yes or no.

3. X’S AND O’S

A screen with about 30 X’s and O’s appears. Three of the letters are yellow, the rest are black.

Then there’s a speed test in which you hit the Q button as quickly as possible when a red circle appears, or the P button when a blue square appears.

The original X’s and O’s screen reappears, and you have to remember which three were yellow by clicking on them.
4. SYMBOL MATCHING

Nine boxes have a shape inside, and each is numbered. A single shape appears below, and you have to click number of the box that matches it.

After matching the shapes 27 times, the shapes disappear from the top box, and you have to remember where the shape was and click on the box.

5. COLOR MATCH

Three colored squares, either blue, red or green, appear on the screen. Another square appears below, and you have to click the color that matches.

Next you see blue, red or green boxes with a word inside. If the box color, word color and the word all match, you click in the box as quickly as possible.

If all three components don’t match, you don’t click.

6. THREE LETTER MEMORY

You are shown three letters in boxes and are asked to remember them.

Then as quickly as possible, you count backwards from 25 to 1 by clicking the box that matches.

You then have to remember the three letters and type them in the boxes.

THE FINAL TEST

Once all phases are completed — after about 20 minutes — you have to repeat phases 1 and 2 to see how many of the words and squiggly patterns you can remember.

Mirror graphic by Cory Giger/Photos courtesy St. Francis University
ImPACT & Symptom Domains

• Neurocognitive Composite Scores
  – Verbal Memory
  – Visual Memory
  – Visual-Motor Speed
    • “Processing Speed”
  – Reaction Time

• Likert Symptom Scale – 21 items
ImPACT & Symptom Domains

**ImPACT**
- Verbal Memory
- Visual Memory
- Visual-Motor Speed — “Processing Speed”
- Reaction Time

**Symptom Domains**
- Migraine Cluster
- Cognitive Cluster
- Neuropsychiatric Cluster
- Sleep Cluster
Can an Athlete Fake a Test? (Invalidity)

• Infinitely variable
  – Mitigates “mastering” or “learning” the test (practice effect)

• Baseline Testing
  – Raw Scores low cutoffs
    • Verbal (<70% correct)
    • Visual (<60% correct)
  – Impulse Control (>30)
  – Reaction Times >0.8 sec on baseline test suggest sandbagging
  – X&O’s, Word & Design Memory, Three Letters
    • Raw number cutoff flagged at end of report to review
How are the Composites Used?

• Can help to confirm a concussion diagnosis
  – Are the Reliable Change Indices (RCIs) abnormal?
  – How many domains are affected?
• Helps to identify areas where the athlete is suffering
  – Which domains are affected?
• Can we predict outcome with this data?
• Can we guide treatment with this data?
Can CNP help predict outcomes?

- **General Recovery**
  - 40% of concussed athletes recover by 1 week
  - 60% of concussed athletes recover by 2 weeks
  - 80% of concussed athletes recover by 3 weeks
  - 95% of concussed athletes recover by 5 weeks

- **Additional notes that complicate recovery after a concussion**
  - Learning disabilities
  - ADD/ADHD
  - Personal history of migraine headaches
  - Younger age

- **Is there something that can help determine who will take 2+ weeks to recover?**
Can CNP help predict outcomes?

• *2008 Clinical Journal of Sports Medicine* article by Iverson et al.
  
  – 3 or more abnormal Reliable Change Indices (RCIs)
    • 94% will take longer than 10 days to recover
  
  – Migraine Cluster
    • Increased specificity in predicting “quick” recovery
      – i.e. no abnormal RCI in verbal memory (migraine domain)
  
  – Athletes with prior concussion(s)
    • Not statistically more likely to have prolonged recovery
Can CNP help predict outcomes?

- More comprehensive information during the recovery phase
  - Severity
  - Prognosis
  - Current status of the recovery process
  - Helps guide considerations for treatment
  - Helps educate the athlete, parents, coaches, teachers, school administrators, etc.
Can symptoms help predict outcomes?

• We know a little more about who will take longer to recover once we have them in the office

• But....
  – Can we tell who will take longer to recover when they present acutely on the field?
  – Can we tell early on in the recovery (subacute phase) who will take longer to recover?
Can symptoms help predict outcomes?

• Loss of consciousness (LOC) less than 30 seconds is NOT predictive of anything

• Amnesia may help predict concussion severity
  – Retrograde amnesia is more predictive than anterograde amnesia

• But presence of amnesia did not necessarily predict a lengthy recovery time
Can symptoms help predict outcomes?

- Other symptoms that did predict a prolonged recovery time (>3wks)
  - Dizziness
  - Headache
- Sub-Acute Phase in the Office or Training Room
  - Symptom of “fogginess” found to be most important
Can symptoms help predict outcomes?

• Summarizing what symptoms might tell us
  – Amnesia noted on the field
    • Rough few days but most likely will recover in usual timeframe
  – Dizziness or headache noted on the field
    • Could take a little longer than usual to recover but not necessarily
  – Fogginess noted in the office
    • Probably going to take a little longer to recover than usual
Office Evaluation by Physician

• Clinical interview (history)
  – Covers the 4 symptom domains
  – Similar to CNP intake questions

• Examination of the ocular-vestibular system is essential!

• CNP testing and interpretation by physician (if can be compared to baseline CNP, my opinion)

• Treatment plan

• Return to play decision making
Exam of Ocular-Vestibular System

• Ocular-Motor
  – H-Test
    • Smooth Pursuit or saccades?
    • Nystagmus present?
• Vestibular-Ocular
  – Gaze stability testing
    • Horizontal – move head side to side while focusing on a stationary object
    • Vertical – move head up and down while focusing on a stationary object
    • Convergence and near point accommodation – how close can on object get to patient’s nose before it goes out of focus?
  • Does these cause:
    – Nystagmus?
    – Dizziness?
    – Other symptoms?

• Balance Testing
  – Feet together
    • Solid surface
    • Unstable surface (foam)
    • Eyes open
    • Eyes closed
  – Tandem Stance
    • Standing still
    • While walking
    • Eyes open
    • Eyes closed
Treatment Options for Concussion

• Cognitive rest
  – Academic accommodations
• Physical rest
  – Including no sports or physical education class
• Neuro-Vestibular Therapy
• Ocular Therapy (if available)
• Medications (Controversial Topic #4)
  – Use for controlling post-concussive symptoms is off-label (not FDA approved for this indication)
  – Who should prescribe?
• Return to play (RTP) criteria
Off-Label Medications

• Sleep Cluster
  – Trazadone
  – Zolpidem Tartrate
  – Melatonin

• Neuropsychiatric cluster
  – SSRIs
  – Anxiolytics
  – Cognitive behavioral therapy (CBT)

Generally speaking, relative cognitive and physical rest are the only treatments recommended in the first 3 weeks.
Formal Therapy Options

• For somatic symptoms persisting beyond 3 weeks
  – Dizziness & Abnormal Balance
    • Neuro-Vestibular Physical Therapy
  – Abnormal convergence and/or near point accommodation
    • Ocular Therapy (if available)
Headaches

• Tension type?
  – Whiplash (neck muscle strain/ligament sprain)?

• Migraine type?
  – New onset?
  – Migraine diagnosis established, but now more frequent and/or severe?

• Cognitive fatigue as trigger of headaches?
Cognitive Slowing

• Presentation
  – Headache with cognitive fatigue
  – “Fogginess”
  – Concentration
  – Memory deficits

• Medications (off-label use) for post-concussive cognitive slowing (not FDA approved for this indication)
  – Neurostimulants
    • Amantadine HCl
    • Methylphenidate, Dextroamphetamine
    • Atomoxetine HCl
    • Modafinil
Medications (Off-label) for Post-Concussive Cognitive Slowing

- Not FDA approved for this indication
- Mechanisms of action suggest increasing dopaminergic activity may help decrease this cognitive slowing
  - Amantadine HCl
    - Pre-synaptic increase in release
    - Post-synaptic decrease in uptake
    - 100mg daily increasing to twice daily
  - Methylphenidate
    - Increases dopamine and norepinephrine
  - Modafinil
    - Increases glutamate and dopamine
    - Mechanism of action not completely understood
Academic Accommodations

• Physical Exertion
  – Note prohibiting participation in physical education classes
  – Note prohibiting participation in sports (practices and games)
  – Separate notes often needed when cleared for return

• Cognitive Rest
  – Concentration, Memory & Fogginess
    • Class workload reduction
    • Increased time to return assignments
    • Breaks to control symptoms
    • Increase time for tests or postpone tests during recovery
“Fogginess” Post-Concussion

• May have physical triggers
  – Potential trigger for fogginess with nystagmus or fogginess with abnormal convergence/near point accommodation
    • Note taking at school
      – Vertical nystagmus with repeated looking up and writing
  – Potential motion triggers for fogginess
    • Large facilities such as long school hallways, shopping malls
    • Vehicles
      – May also cause motion sickness
    • Video games
      – May also cause motion sickness
      – May also lead to cognitive fatigue (tends to trigger headaches)
Return To Play Criteria

• Symptom Free!
  – At rest
  – With daily activities
  – And NOT taking any medication to remain symptom free

• NP testing, if done, confirms recovery
  – Return to baseline scores or better (my opinion)
  – Significant improvement in scores if no baseline testing done (controversial)

• Graduated return to play (RTP) protocol completed without recurrence of symptoms!
  – See 4th ICCS version on previous slide
Best Practice Model

• Pre-Season
  – Educate coaches, parents, athletes, teachers, school administrators, etc.
  – Get a multidisciplinary team in place
  – Baseline CNP testing for at-risk athletes (if available)

• After suspected concussion
  – Sideline assessment and monitor status frequently
  – Plan referral to someone with experience in concussion assessment, diagnosis and medical management
  – Only order imaging studies when indicated (suspicion of intracranial bleeding, mass effect, space occupying lesion)
Best Practice Model

• CNP testing and planning (if available)
  – Baseline CNP testing (supervised & reviewed for validity)
  – Consider CNP testing at 24 to 48 hrs post-injury to help confirm clinical diagnosis, use as educational tool for athlete and parents, and inform prognosis (controversial)
  – CNP testing when symptom free to document recovery
  – Coordination of care among the sports medicine team (Athletic Trainer, Primary Care and/or Sports Medicine Physician, Neuro-Vestibular Physical Therapist, Occular Therapist, Neuropsychologist or Sports Psychiatrist with expertise in CNP and/or NP testing)
  – Effective communication throughout the process with
    • Athlete and parents
    • Coaches, teachers and school administrators
Recommended Reading


Are you experiencing any concussion-like symptoms?
What Questions Do You Have?