

**SPORTS RELATED
CONCUSSION**
AN UPDATE ON DIAGNOSIS AND MANAGEMENT

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DISCLOSURES

- Neither I, Brandon Kakos, 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



OBJECTIVES

- Recognize that Concussion is a diverse/evolving injury requiring a multidisciplinary approach
- Identify the common symptoms of concussion and how to appropriately assess both on the sideline and in the office
- Understand the different sideline and office diagnostic modalities
- Implementing Individualized Treatment Strategies for return to daily activities/school/sport





- April 2015- Harris Poll- Assessing Current Level of Knowledge about concussions with adults in the US
 - Online Survey; 2,012 US adults >18 years
 - 948 respondents had school or college aged children
- Results:
 - 89% believed concussions are a moderate or serious health concern; 2% say it is no concern at all
 - 41% felt that getting a concussion is living a nightmare
 - 24% would be scared it would change their life forever if they got concussed
 - 22% would be anxious they wouldn't be able to live their life the way they want after a concussion
 - 18% felt that concussions aren't as bad as people think
 - 83% felt that people generally do not take concussions seriously enough
 - 32% of parents live in fear that their child will get a concussion
 - 25% of parents do not let their kids play some contact sports because of concussion concerns
 - 87% of US adults do not know how a concussion is defined
 - 79% believe there is no real way to recover from a concussion

Bojan Velickovic vs Nico Musoke

youtube.com/JFcombat

- "We always have concussion-like symptoms, (but) I've been in fights where I couldn't see, and I didn't say, 'I can't see,'"
 - *DePadilla L, Miller GF et al Self-Reported Concussions from Playing a Sport or Being Physically Active Among High School Students — United States, 2011. MMWR Morbidity and Mortality Weekly Report 2012;61:858-860.*
- "We have concussions all the time. Like all the time. We have mild ones from getting hit, even not getting hit. You'll be just kind of woozy today, or whatever. You just fight."
- "If I've got a fight, I'm fighting,"
- "If you're going to wheel me out there, put me in a wheelchair and drop me in there, I'm going to fight, dude."
 - *UFC Fighter Max Griffin-*



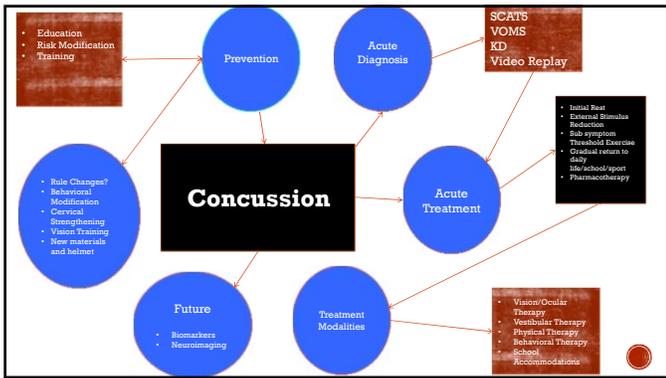
WHAT'S THE BIG DEAL?

- In 2017, the CDC estimated 2.5 million high school students reported having at least one concussion related to sports or physical activity during the year preceding the YRBS
- An estimated 1.0 million students reported having two or more concussions during the same time frame.
 - *DePadilla L, Miller GF et al Self-Reported Concussions from Playing a Sport or Being Physically Active Among High School Students — United States, 2011. MMWR Morbidity and Mortality Weekly Report 2012;61:858-860.*
- Underreporting remains a problem
 - In a study of high school athletes with concussions 40% reported that their coach was unaware of their symptoms
 - *Rosen FF et al. The effect of coach education on reporting of concussions among high school athletes after passage of a concussion law. Am J Sports Med 2014;42:1197-2003*
 - ~33% of athletes have sustained previously undiagnosed concussions, defined as a blow to the head followed by the signs and symptoms included in the PCSS
 - *Meehan PM, et al. The Prevalence of Undiagnosed Concussions in Athletes. CJSM. 2013 Sep; 23 (8): 339-342*



- Football, Ice Hockey and Lacrosse have high rates of concussion in high school male athletes
- Soccer, lacrosse and basketball have high rates of concussion in high school female athletes
 - *Gessell LM, et al. Concussions among united states high school and collegiate athletes. J Athl Train. 2007; 42 (4): 489-903*
- 63 % of boys and 73 % of girls engaged in some type of sport and playground activities, it is not surprising that over 300,000 athletes per year are involved in sports-related head injuries
 - *Webb, F. M., & Salinas, C. M. (2011). Sport neuropsychology for children. In A. Davis (Ed.), Handbook of pediatric neuropsychology (pp. 1095-1109). New York: Springer.*
- 90% of concussion occur without loss of consciousness
- 57% of athletes with concussions do not receive clinical care for their injury
- Athletes are four to six times more likely to experience a second concussion, and that the second concussion results from milder trauma
 - *Guskiewicz, K. M., McCrea, M. A., Marshall, S. W., Cantu, R. C., Randolph, C., Barr, W. B., et al. (2003). Cumulative effects associated with recurrent concussion in collegiate football players. Journal of American Medical Association, 290, 2849-2856.*







- ### CONCUSSION CHALLENGES
- Variable/Evolving Presentation of Symptoms
 - Individualized Treatment Based on Multiple Factors
 - Modifiers
 - Age/Gender
 - Medical History
 - ADHD/Learning Disability
 - Anxiety/Depression/Mood Disorder
 - Social/Family Support
 - Athletes Psychological/Emotional Response to Injury
 - Unknown length of time for recovery

- **Cross-sectional, observational study of 31,958 high school student athletes with no history of concussion** in the prior six months.
- All athletes completed preseason baseline testing.
- **Results**
 - Symptom reporting was more common in girls than boys, with 28% of girls reporting a symptom burden that resembles the ICD-10 diagnosis of post-concussion syndrome (PCS) compared to 19% of boys.
 - 80-82% of boys and 73-87% of girls with pre-existing conditions reported one or more symptoms, and those with preexisting conditions were more likely to endorse a symptom that resembled PCS (21%-47% boys; 33%-72% girls).
 - In boys, the strongest predictor for symptom reporting
 - 1. Prior treatment of a psychiatric condition
 - 2. History Of Migraines
 - In girls, strongest predictors
 - 1. Prior treatment of a psychiatric condition
 - 2. Substance Abuse
 - 3. ADHD
- The weakest independent predictor of symptom reporting in either sex was a history of prior concussions.
 - Iverson GL, et al. Factors associated with concussion-like symptom reporting in high school athletes *JAMA Pediatrics* 2015; 169 (12): 1136-1140



DEFINITION

- When a blow or a jolt to the head causes problems such as headaches, dizziness, being dazed or confused, difficulty remembering or concentrating, vomiting, blurred vision, or being knocked out
 - CDC- Youth Risk Behavior Survey
- **AMSSM Position Statement:**
 - Concussion is a traumatically induced transient disturbance of brain function and involves a complex pathophysiological process. Concussion is a subset of mild traumatic brain injury which is generally self-limited and at the less severe end of the brain injury spectrum
 - Hartman KG, Dreznier, JA et al. AMSSM Position Statement: Concussion in Sports 2013



DIAGNOSIS

- ## DIAGNOSTIC BARRIERS
- Wide variation in how the injury is sustained and timing of symptom presentation
 - Often classic symptoms can overlap with other MSK, psychological and neurologic diagnoses
 - A current lack of definitive diagnostic markers
 - Athletes desire to remain in the game
 - Coaches/Athlete/Parents/Organizational desire for continued participation...i.e the notion that winning supercedes health
 - Challenges in sports that do not allow subs (i.e. Soccer) so an adequate assessment can take place
 - Chaotic Onfield Environment: Athletes are bigger, stronger and faster which can make visualizing impact more difficult
 - Use of Video Technology in some sports is helping
 - AFL, NFL, NHL, NRL and rugby union use video to identify possible concussion events



- "Amrabat, who spent one night in hospital after Friday's game, revealed he had defied doctor's orders by playing yesterday. **"I am my own doctor,"** he declared before admitting he hoped he had not done himself any "long-term" damage. He also **disclosed he was suffering from memory loss** in what was an alarming echo of comments made by Christoph Kramer after the Germany midfielder collapsed during the last World Cup final. Amrabat said: **"From the first minute, 'til I wake up in the hospital. I think five, six hours, gone. Totally gone. When you think about it, it is a little bit scary."**
- "Manager Herve Renard defended his decision to pick the player, saying: **"He's a warrior; he wanted to play. It's because his spirit is amazing and I was lucky to have a player like this."**
 - Ben Rumsby- The Telegraph

SIDELINE HCP RESPONSIBILITY

- Recognize Injury
- Assess Symptoms
- Exam
- Serial Assessments
 - Don't leave athlete alone
- Detailed Concussion History

SIDELINE DIAGNOSIS-OVERVIEW

- **In suspected cases of concussion, the athlete should be immediately removed from play and assessed by a healthcare professional**
 - For optimal diagnosis you should remove the athlete from game action and perform the assessment in a quiet/well controlled environment
- Evaluation should include: symptom assessment, neurologic examination that addresses cognition, cranial nerve function, and balance.
 - Make sure to always rule out cervical spine/intracranial process first and initiate EAP if necessary
- Concussion is an evolving diagnosis in the acute phase and symptoms can fluctuate thereby necessitating serial assessments
- Sensitivity and Specificity variable amongst diagnostic modalities
- "When in doubt, sit them out"
- Players manifesting clear on-field signs of SRC (eg, loss of consciousness, tonic posturing, balance disturbance) should immediately be removed from sporting participation.



WHEN TO SEND TO ED

- Worsening Headache
- Weakness or tingling/burning in arms or legs
- Double vision
- Seizure or convulsions
- Deteriorating mental status/Very drowsy/Can't recognize people or places
- Severe or increasing HA
- Vomiting
- Increasingly restless, agitated or combative



SYMPTOMS



| Physical | Cognitive | Emotional | Sleep |
|---|--|--|--|
| <ul style="list-style-type: none"> • Headache • Nausea • Vomiting • Balance problems • Dizziness • Visual problems • Fatigue • Sensitivity to light • Sensitivity to noise • Numbness/ Tingling • Dazed or stunned | <ul style="list-style-type: none"> • Feeling mentally "foggy" • Feeling slowed down • Difficulty concentrating • Difficulty remembering • Forgetful of recent information or conversations • Confused about recent events • Answers questions slowly • Repeats questions | <ul style="list-style-type: none"> • Irritability • Sadness • More emotional • Nervousness | <ul style="list-style-type: none"> • Drowsiness • Sleeping less than usual • Sleeping more than usual • Trouble falling asleep |

Most Common Symptoms in High School and Collegiate Athletes

| | Symptom | Percent |
|----|--------------------------|---------|
| 1 | Headache | 78% |
| 2 | Difficulty Concentrating | 57% |
| 3 | Fatigue | 52% |
| 4 | Drowsiness | 51% |
| 5 | Dizziness | 49% |
| 6 | Foggy | 47% |
| 7 | Feeling Slowed Down | 46% |
| 8 | Photosensitivity | 45% |
| 9 | Balance Problems | 39% |
| 10 | Difficulty with Memory | 38% |

N=1428
1-7 days following concussion

Kontos, Elbin, Collins. *AJSM*, 2012

ARE ALL SYMPTOMS CREATED EQUAL?

- Lau BC, Kontos AP, Collins MW, Mucha A, Lovell MD. Which on-field signs/symptoms predict protracted recovery from sport-related concussion among high school football players? *AJSM*. 2011 Nov; 39 (11): 2311-18.
 - Cohort study (prognosis); Level of evidence- 2.
 - 107 male high school football athletes who completed computerized neurocognitive testing within an average 2.4 days after injury, and who were followed until returned to play as determined by neuropsychologists using international clinical concussion management guidelines.
 - Athletes were then grouped into rapid (≤ 7 days, n = 62) or protracted (≥ 21 days, n = 36) recovery time groups.
 - The presence of on-field signs and symptoms was determined at the time of injury by trained sports medicine professionals (i.e., ATC [certified athletic trainer], team physician)
 - **Dizziness** at the time of injury was associated with a 6.34 odds ratio (95% confidence interval = 1.94-23.91, $\chi^2(2) = 5.44, P = .02$) of a protracted recovery from concussion.
 - The remaining on-field signs and symptoms were not associated with an increased risk of protracted recovery

DIAGNOSTIC ASSESSMENT TOOLS

- Obtain/Identify clinical history/MOI
 - Removed from play? LOC?
 - Amnesia?
 - Previous Concussion (duration of recovery)
 - Scholastic Aptitude
 - PMHx
 - Migraine/HA/Sleep Disturbance
 - Mood Disorder/Anxiety/Depression
 - ADHD/LD
- Obtain Parental/Coach/Teammate Input regarding discrepancies in baseline behavior
- Sport Concussion Assessment Tool 5 (SCATS)
 - Graded Symptom Scale
- Vestibular Ocular Screening
- King Devick Test
- Balance Error Scoring System (BESS)
- Neuropsych Testing
 - Paper/Pencil
 - Computerized



- An evidence based recommendation for any single screening test or protocol is not possible
- Recognition of suspected concussion best approached using multimodal testing. The SCAT currently represents the most well-established and rigorously developed instrument
- K-D requires adequately powered diagnostic accuracy studies
- Current evidence does not support the use of sensor systems for real time concussion screening

Conclusion In the absence of definitive evidence confirming the diagnostic accuracy of sideline screening tests, consensus-derived multimodal assessment tools, such as the Sports Concussion Assessment Tool, are recommended. Sideline video review may improve recognition and removal from play of athletes who have sustained significant head impact events. Current evidence does not support the use of impact sensor systems for real-time concussion identification.

- Patricios et al. What are the critical elements of sideline screening that can be used to establish the diagnosis of concussion? A systematic review. BJSM 2017



SCAT 5- ON FIELD ASSESSMENT

STEP 1: RED FLAGS

- 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

STEP 2: OBSERVABLE SIGNS

| Witnessed <input type="checkbox"/> | Observed on Video <input type="checkbox"/> | | |
|--|--|---|---|
| Lying motionless on the playing surface | | Y | N |
| Balance / gait difficulties / motor incoordination: stumbling, slow / laboured movements | | Y | N |
| Disorientation or confusion, or an inability to respond appropriately to questions | | Y | N |
| Blank or vacant look | | Y | N |
| Facial injury after head trauma | | Y | N |



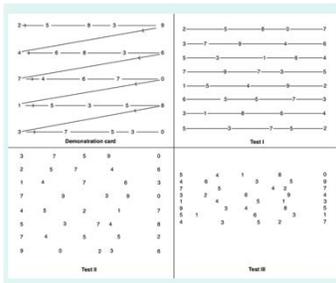
VOMS

- Anzalone AJ, et al. **A Positive Vestibular/Ocular Motor Screening (VOMS) Is Associated With Increased Recovery Time After Sports-Related Concussion in Youth and Adolescent Athletes.** *AJSM.* 2017. Feb; 45 (2): 474-479
 - Cohort study; Level of evidence 2
 - 167 patients (69 girls, 98 boys; mean \pm SD age, 15 \pm 2 years [range, 11-19 years]) presenting with SRC in 2014.
 - VOMS performed during initial visit
 - Found that positive symptom provocation in all VOMS subset except near point convergence was associated with delayed recovery
 - VOMS not only may augment current diagnostic tools but also could serve as a predictor of recovery time in patients with SRC.



KING DEVICK TEST

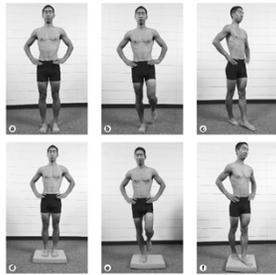
- Rapid vision-based performance measure of number naming
- Needs to have a baseline (repeated annually)
- No normative data
- Usually takes 60 seconds to complete and can perform immediately after injury
- Positive test if:
 - Time is worse than baseline
 - Any uncorrected errors



- Fuller GW, Cross MJ, Stokes KA, et al. **King-Devick concussion test performs poorly as a screening tool in elite rugby union players: a prospective cohort study of two screening tests versus a clinical reference standard.** *Br J Sports Med.* 21 March 2018. doi: 10.1136/bjsports-2017-098560
 - Prospective cohort study of elite English rugby athletes from 9/2016-5/2017
 - 145 head injury events were identified and the KD test was administered off field and results were compared to their baseline
 - The KD test demonstrated a sensitivity of 60% (95% CI 49.0 to 70) and a specificity of 39% (95% CI 26 to 54) in identifying players subsequently diagnosed with concussion.
 - The KD test demonstrated limited accuracy as a stand-alone remove-from-play sideline screening test for concussion



BESS (BALANCE ERROR SCORING SYSTEM)



1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec

*Max errors for any single position=10

FIGURE 12.3 Balance error scoring system (BESS). Top row, firm surface condition. Bottom row, soft surface condition. Left column, parallel stance. Middle column, single-leg stance. Right column, tandem stance.



| Examination | Sensitivity | Specificity |
|--|-------------|-------------|
| Vital signs including orthostatics | 0.21 | 0.75-0.90 |
| Neurological exam | 0.61 | 1.0 |
| Cranial nerve assessment | 0.22 | 0.95 |
| Manual muscle testing and reflexes | 0.20-0.30 | 1.0 |
| Balance testing | 0.34 | 0.56 |
| Vestibular-ocular exam | 0.60 | 0.70 |
| History + balance + vestibular testing | 0.80-1.0 | 0.83 |

Matuszak JM et al *Sports Health* 2016;8(3): 260-269
 Resch JE et *BMI Open Sport Exerc Med* 2016-2(1)



SORT: Strength of Recommendation Taxonomy
A: consistent, good-quality patient-oriented evidence
B: inconsistent or limited-quality patient-oriented evidence
C: consensus, disease-oriented evidence, usual practice, expert opinion, or case series

| Clinical Recommendations | SORT Evidence Rating |
|---|----------------------|
| Instead of a comprehensive neurologic examination after concussion, a focused neurologic and physical examination may be performed | C |
| Screening ocular examination should include: evaluation of the eyes for nystagmus, saccades, smooth pursuits, and near point of convergence | A |
| Funduscopy for evaluation of papilledema is probably of low yield in the concussion evaluation and may be reserved for cases where there is clinical concern. | C |
| If dizziness or imbalance is present, consider orthostatic vital signs | B |

Matuszak JM et al *Sports Health* 2016;8(3): 260-269



NEUROPSYCH TESTING

- Shouldn't be used alone to make diagnosis or "clear" athlete to play
 - "One Tool in the Toolbox"
 - Used as an adjunct to clinical assessment and judgment
- More sensitive for subtle cognitive impairment than clinical exam
- Paper and pencil NP tests tend to be more comprehensive however also more expensive and more time to administer
- NP testing has shown cognitive deficits can last longer than athletes are symptomatic
 - Baseline (when to repeat)
 - Interval for Repeating Post Concussion
- IMPACT
 - FDA approval in August 2016
 - Developed by clinicians at UPMC
 - 8 neurocognitive measures that comprise four clinical composite scores
 - Visual Memory
 - Verbal Memory
 - Processing Speed
 - Reaction Time
 - Built in validity measures to identify "sandbagging"
 - Contains normative data even if no baseline obtained
 - Based on athletes scholastic aptitude



Schatz P, Sandel N. Sensitivity and Specificity of the online version of ImpACT in high school and collegiate athletes. *American Journal of Sports Medicine*, 2013

- **Concussed symptomatic athletes**
 - 182 athletes
 - 81 concussed athletes (diagnosed by ATC/Physician)
 - 81 carefully matched controls (non-concussed) matched on specific basis of gender, sport, concussion history, absence of LD/ADD
 - Discriminate Function Analysis on subscale scores; no clinician input Testing completed within 3 days post injury
- Sensitivity (91.4%)
 - Probability that a concussion is present when test is positive)
- Specificity (70.1%)
 - Probability that a concussion is not present when test is negative)
- **Asymptomatic concussed athletes**
 - 74 athletes
 - 37 athletes diagnosed with on-field concussion by ATC/physician, seen within 3 days of injury, and symptom score of 0
 - 37 carefully matched controls (non-concussed) matched on specific basis of gender, sport, concussion history, absence of LD/ADD
 - Discriminate Function Analysis on Subscale scores; no clinician input Testing completed within 3 days post injury Sensitivity/Specificity of Computerized Neurocognitive Testing determined
- Sensitivity (94.6%)
- Specificity (97.3%)



IMAGING

- Neuroimaging (CT, MRI)
 - Currently does not contribute to concussion diagnosis
 - Use when suspicion of intra-cerebral or structural lesion exists:
 - focal neurologic deficit
 - worsening symptoms
 - prolonged disturbance of conscious state
- Other modalities such as fMRI correlate with symptom severity and recovery and although not routinely could provide additional insight
 - MRI demonstrates neuronal dysfunction by measuring regional changes in blood oxygenation patterns measures in response to a specific task that the individual performs while in the scanner
 - Diffusion Tensor Imaging (DTI)
 - High Definition Fiber Tracking (HDFT)
- Alternative imaging technologies are still at early stage of development in concussion and not recommended other than in the research setting
 - PET and single-photon emission CT (SPECT) which measure cerebral glucose uptake and regional cerebral blood flow

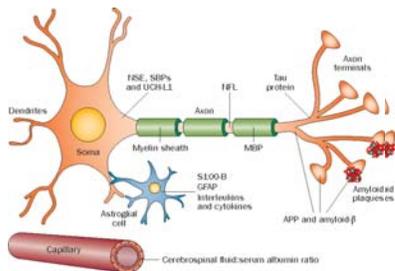


BIOMARKERS

- Emerging field however much more research required prior to application
- Ideally would help with identification/diagnosis
 - Potential to determine severity of injury
- Group of biomarkers pertaining to SRC
 - Most studied candidates
 - S100B
 - UCH-L1
 - GFAP
 - NFL
- Most research on these biomarkers done in relation to TBI (not in sports setting)



BIOMARKERS



TREATMENT



TREATMENT GOALS

- **DEVELOP AN INDIVIDUALIZED PLAN**
 - Concussion is a complex neurological injury and a uniform "cookbook" approach to management and treatment is not effective
- Prevent cumulative effects of injury/development of Post Concussive Syndrome
- Timely and safe return to daily activities, return to school and return to play
- **EFFECTIVE COMMUNICATION**
 - Athlete
 - Parents/Coaches/Athletic Trainer/Teachers/Counselors
 - Need to be working in unison to ensure safe and optimal recovery
- Utilize Multidisciplinary Approach
 - Early referral for specialized modalities if necessary
 - Vestibular/Physical Therapy
 - Ocular Therapy
 - Speech Therapy
 - Behavioral/Clinical Psych



MULTIDISCIPLINARY TEAM

- Concussion Healthcare Provider (Neurologist/PMR/Primary Care, etc.)
- ATC
- Clinical Neuropsychologist
- Physical/Vestibular Therapist
- Optometrist/Ophthalmologist
- Speech and Language Pathologist
- Occupational Therapist
- Clinical or sports psychologist



PITFALLS

Establishing recovery after SRC is a difficult task

- Limited by subjective symptom scores and imperfect clinical & NP testing.
- "Clinicians have to determine if these are pre-morbid maladies, downstream effects of SRC, or unrelated while being mindful of the potential for repeat injuries when returning patients to sports too early"
- Recent data suggests physiological time of recovery may dilate time for clinical recovery. The consequence of this unknown, but possibility is that athletes may be exposed to additional risk by RTP while ongoing brain dysfunction.
 - Possible hazards include repeat injury, prolonged symptoms, increased risk of musculoskeletal injury, more severe physiological dysfunction or conceivably increasing risk for neurodegenerative disease

Concussion magnifies pre existing issues

- Vestibular:
 - Personal or Family History of Motion Sensitivity (Suzumoto et al, CJSM 2016)
- Ocular:
 - Personal or Family History of Strabismus, Nystagmus or Lazy Eye (Amblyopia) Pearce et al, AJSM, 2015)
- Cognitive/ Fatigue:
 - History of Learning Disability (Collins et al, JAMA 1999)
- Post Traumatic Migraine:
 - Personal or Family History of Migraine (Kontos et al, AJSM 2014)
- Anxiety/ Mood:
 - Personal or Family History of Anxiety or Mood-Related Symptoms (Kontos et al, AJSM 2016)



CONTINUING TO PLAY WITH CONCUSSION

- Prospective Study
- 95 athletes (aged 12–19 years) seeking care for an SRC at a concussion specialty clinic between September 1, 2014, and December 1, 2014
- They compared neurocognitive performance, symptoms, and recovery time between 35 athletes (mean ± SD age, 15.61 ± 1.65 years) immediately removed after an SRC compared with 34 athletes (mean ± SD age, 15.35 ± 1.73 years) who continued to play with SRC. Neurocognitive and symptom data were obtained at baseline and at 1 to 7 days and 8 to 30 days after an SRC.
- High school athletes who continued to play with a concussion took two times longer to recover than those who were removed or removed themselves from play (44 days vs 22 days)
- Athletes were 9x more like to have a longer recovery if they stayed in the game or practice-even if only for a few minutes
 - Elbin RJ, et al. Removal from play after concussion and recovery time. *Pediatrics* 2016 Sep; 138 (3)



INITIAL MANAGEMENT

- Remove from play for appropriate assessment
 - Ideally, this is in a quiet environment removed from external stimulus
 - No same day return to play
- Serial exams throughout the remainder of the event
 - Have them record daily symptom score log to track progress until follow up
- Ensure safe and adequate return home with appropriate monitoring
 - DO NOT wake up repeatedly throughout the night
- Ensure adequate follow up and athlete/family are aware of signs/symptoms of when to go the ED
 - Headaches that worsen
 - Severe neck pain
 - Looks very drowsy
 - Can't recognize people or places
 - Deteriorating consciousness
 - Increasing confusion and irritability
 - Repeated vomiting
 - Slurred speech
 - Focal neurological signs
 - Unusual behavior change
 - Seizures:



MANAGEMENT

- Initial period of rest (24-48 hrs) until acute symptoms resolve
 - Prolonged "strict brain rest" is not beneficial as this may lead to social isolation, anxiety, and problems with self-esteem
 - Be mindful of athletes emotional well being as potential loss of academic standing, exacerbation of symptoms, physical deconditioning amongst other things can complicate treatment course
 - Need to find balance
- Physical Rest
 - No training, playing, weights
- Cognitive Rest
 - Limit television, extensive reading, video games, computer, phone, public venues (restaurants/concerts/sporting events, etc)
 - Berlin CISC 2016
- Optimize sleep and nutrition
 - Caution Daytime
 - Omega 3 FA, Turmeric, Vitamin C-D-E are being used however evidence is lacking



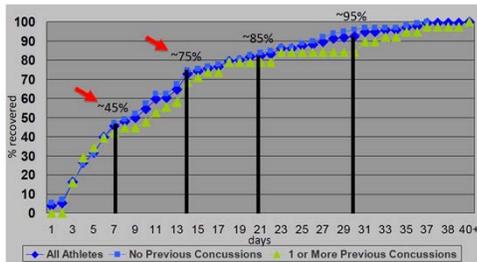
REST

Insufficient evidence that prescribing complete rest until symptom free is necessary

- After initial 24- 48 hours of rest after injury, patients encouraged to become gradually & progressively more active while staying below their cognitive & physical symptom exacerbation thresholds (i.e. activity level should not bring on or worsen sx/s).
 - McCrory BJSM 2017
- Activity that is controlled (below symptom threshold) has been shown to be safe and may facilitate recovery
 - Buffalo Concussion Treadmill Test
 - Identify symptom exacerbation threshold
 - Exercise at 80% symptom exacerbation threshold HR without symptom exacerbation
 - Safe with a reduction in symptoms
 - Leddy JJ, et al. CJSM 2010

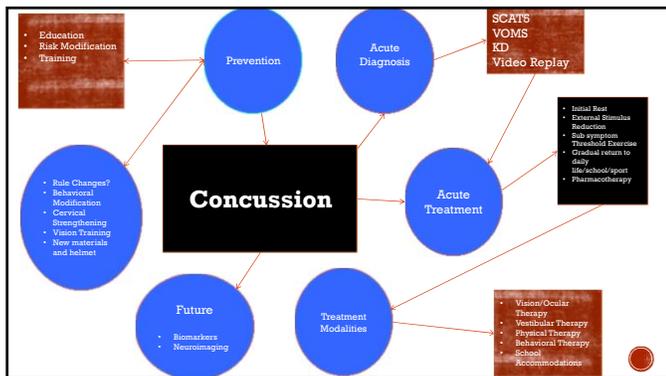


Clinical Recovery as published in *Neurosurgery* in 2006



N=134 High School Male Football Athletes (Collins et al., 2006, Neurosurgery)





| Cognitive Techniques | Balance Techniques | Visual Techniques | Dual-Task Techniques |
|--|---|--|--|
| <p>Simple Math 1+2, 3+1</p> <p>Stroop Say yes if color the same as the word – BLUE</p> <p>N-Back State if the letter you see is the same as the one you immediately saw before- A → B → A → A</p> <p>Serial 7s Count backwards from 100 by 7: 7→14→21, etc</p> | <p>Foam EC: DL, SL, Tandem</p>  <p>Bosu Ball</p>  | <p>Gaze Stability</p>  <p>Ball Toss</p>  <p>Pencil-Push</p>  | <p>Rocker Board + Stroop</p>  <p>Bosu/Dynadisc lunges + COWAT</p>  |

Collision Type and Player Anticipation Affect Head Impact Severity Among Youth Ice Hockey Players

WHAT'S KNOWN ON THIS SUBJECT: Young hockey players sustain head impacts as severe as those observed for collegiate football players. Increasingly severe head impacts are likely to cause head injuries in athletics.

WHAT THIS STUDY ADDS: This study adds to the body of evidence by addressing the potential importance of collision anticipation in mitigating the severity of head impacts sustained by youth hockey players.

OBJECTIVE: The objective was to determine how body collision type and player anticipation affected the severity of head impacts sustained by young athletes. For anticipated collisions, we sought to evaluate different body position descriptors during delivery and receipt of body collisions and their effects on head impact severity. We hypothesized that head impact biomechanical features would be more severe in unanticipated collisions and open ice collisions, compared with anticipated collisions and collisions along the playing boards, respectively.

KEY WORDS: youth concussion injury, physical activity, sports, trauma

ABBREVIATIONS: DICE—Candice Hockey Evaluation of Children's Checking; DL—Dynamic Lunge Test; SI—Head Impact Severity; SI_{top}—Head Impact Severity severity profile; SI₀—concussion status

www.pediatrics.org/cgi/doi/10.1542/peds.2009.2048
doi:10.1542/peds.2009.2048

Pediatrics, 2010

PHARMACOTHERAPY

- For the vast majority of patient this is unnecessary
- Limited evidence that any particular medication is effective in treating the acute symptoms of concussion
- Can consider use in pts with:
 - Prolonged symptoms (sleep disturbance, anxiety, cognitive deficits) are exceeding the typical recovery period
 - Symptoms are negatively affecting the patients life
- Again, Tylenol for headache and AVOID aspirin/nonsteroidal anti-inflammatories due to increased bleeding risk
- Upon starting return to play progression patient should not be on medication that could mask symptoms
 - Antidepressants
 - Melatonin, Elavil, Amantadine

RETURN TO LEARN

Table 2 Graduated return-to-school strategy

| Stage | Aim | Activity | Goal of each step |
|-------|--|---|--|
| 1 | Daily activities at home that do not give the child symptoms | Typical activities of the child during the day as long as they do not increase symptoms (eg, reading, texting, screen time). Start with 5–15 min at a time and gradually build up | Gradual return to typical activities |
| 2 | School activities | Homework, reading or other cognitive activities outside of the classroom | Increase tolerance to cognitive work |
| 3 | Return to school part-time | Gradual introduction of schoolwork. May need to start with a partial school day or with increased breaks during the day | Increase academic activities |
| 4 | Return to school full time | Gradually progress school activities until a full day can be tolerated | Return to full academic activities and catch up on missed work |

- No standardized guidelines for returning patients to school or how long to hold them out for
- Every patient should be evaluated on an individual basis and the combination of their exam, history and neuropsych testing should determine if and for how long they are held out of school
- Certain patients being out of school can lead to increased anxiety with falling behind and dropping grades
- Remain in close communication with school and provide documentation stating restrictions
- Schools/teachers are usually very accommodating as long as an open line of communication remains
- **School SRC policy should include education on prevention & management, should offer academic accommodations/support (CDC developed educational materials for educators and school administrators that are available on their website)**
- Do not start Return to Play Progression until they have returned to their "academic baseline"



| Signs/Symptoms | Potential Adjustments in School |
|--------------------------|--|
| Headache | Frequent breaks Identify aggravators and reduce exposure Plan rest and quiet time in school (nurse's office) |
| Dizziness | Allow student to place head down Allow student to avoid crowded hallways |
| Visual Symptoms | Reduce exposure to computers, videos, smart boards Reduce brightness of screens Audiotapes of books |
| Noise Sensitivity | Lunch in a quiet area No band, choir, or shop classes No noisy gyms, earplugs |
| Difficulty Concentrating | Extra time to complete tasks Oral test taking or reduce number of written tests to one per day |
| Sleep Disturbances | Allow for late start and/or shortened day Allow rest breaks |

Adapted from Halstead M et al Pediatrics. 2013;132(5):948-957



RETURN TO PLAY- GOAL

- Athlete should be back to baseline both physically and cognitively
- Progressed in a step wise manner

GOAL

The goal is to return an injured or ill athlete to practice or competition without putting the individual at undue risk for injury or illness. The team physician's duty is to protect the health and welfare of the athlete. To accomplish this goal, the team physician should have knowledge of and be involved with:

- Establishing an RTP process.
- Evaluating injured or ill athletes.
- Treatment and rehabilitation of injured or ill athletes.
- Returning an injured or ill athlete to play.

Herring et al, TPCC 2012



MICHIGAN LAW

- Michigan was the 39th U.S. state to enact a law that regulates sports concussions and return to athletic activity.
- Went into full effect on June 30th, 2013, and was amended in October of 2017.
- The sports concussion legislation requires **all coaches, employees, volunteers, and other adults** involved with a youth athletic activity to complete a concussion awareness on-line training program, which must be **re-taken every three years**, or more frequently as determined by DHHHS.
- The organizing entity **must provide educational materials on the signs/symptoms and consequences of concussions to each youth athlete and their parents/guardians** and obtain a signed statement acknowledging receipt of the information for the organizing entity to keep on record.
- The law also requires **immediate removal of an athlete from physical participation** in an athletic activity who is **suspected of sustaining a concussion**. The student athlete must then receive **written clearance** from an appropriate health professional before he or she can return to physical activity.
 - Michigan Department of Health and Human Services

