PEDIATRIC SPORTS RELATED CONCUSSION:

WHEN AND WHAT TO DO IF STRUGGLING TO RETURN TO SCHOOL, DRIVING AND SPORTS.

SCOTT ANNETT AND FRANKLIN SEASE
GREENVILLE HEALTH SYSTEM / UNIVERSITY OF SOUTH CAROLINA

GOALS AND OBJECTIVES

• Goals
  — RECOGNIZE and MANAGE concussions.
• Objectives
  — DEVELOP a concussion history and physical that IDENTIFIES symptoms needing intervention/referral (i.e. sleep, focal neurologic deficits, vestibular symptoms, executive function, driving, and tolerating school).
  — DESIGN your multidisciplinary team to help manage your concussed patient.

DISCLOSURES

• NO Disclosures

THE R’S OF CONCUSSION

• Recognize
• Remove
• Re-evaluate
• Rest
• Rehabilitation
• Rule
• Recover
• Return to sport
• Reconsider
• Residual effects and sequelae
• Risk reduction

Adopted from the:
“Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016”

WHAT IS A CONCUSSION

Recognize

• A traumatic brain injury induced by biomechanical forces
• Direct blow to head or even body so long as impulsive force transmitted to the head
• Rapid onset impairment of neurological function that appears to resolve spontaneously
• Neuropathological changes from a functional disturbance rather than structural injury
• A sequential course and range of signs and symptoms that may or may not include LOC

THE PEDIATRIC BRAIN

• Studies suggest physiologic differences in our younger athletes
• More pronounced and diffuse cerebral swelling after traumatic brain injuries
• Immature brain up to 60% more sensitive to glutamate
  — Neurotransmitters involved in metabolic cascade following concussion
  — Results in longer recovery times
THE NUMBERS

- 3,800,000 concussions reported in 2012, double what was reported in 2002
- 33% of all sports concussions happen at practice
- 1 in 5 high school athletes will sustain a sports concussion during the season
- 4 to 5 million concussions occur annually, with rising numbers among middle school athletes
- 90% of most deglued concussions do not involve a loss of consciousness
- An estimated 3.3 million Americans live with a traumatic brain injury-related disability
- 2x concussions reported over 10 years
- 2x ED visits for concussions under age 13
- Female > Male; about 2:1

WHY SHOULD WE KNOW...

INITIAL EVALUATION

Remove

- History & physical
- SCAT5: A sideline rapid assessment tool
- Remove students from classes or schoolwork that provoke symptoms
- Remove athletes from play
- Remove drivers from their vehicles
- SC Law prevents an athlete from returning to play on the day of injury

Who needs to go to the hospital?

- Sustained LOC, fracture or bleeding risk, worsening mental status, cervical spine concern, uncomfortable with patient condition

You do NOT need imaging for every patient

VALIDATED ANALYSIS

Neuropsych test designed for sideline use

- 5-10 minutes
- Sensitivity 80-94%
- Specificity 76-91%
- Can be used to supplement other tests

SCAT5

- Most recent
  - SCAT5, also child SCAT
- Combines several concussion tools
  - PCS
  - SAE
  - GCS
  - Maddocks score (Immediate Memory)
  - BISS (Balance)
  - Cervical spine, neurological/ coordination screen

SIGNS AND SYMPTOMS

- Chaotic or unusual
- Confused
- Dizzy or unsteady
- Seizure or abnormal seizure
- Loss of consciousness
- Slurred speech
- Change in personality
- Memory problems
- Headache
- Nausea
- Photophobia
- Blurred vision
- Paresthesia
- Dizziness
- Communication, memory problems
- Personality change...
CLINICAL FOLLOW UP

Re-Evaluate

- History and Physical
  - Eye Signs
  - Cerebral testing (impaired visual-gustatory integration, impaired cognitive processing, impaired executive function, and aphasia)
- Neuroimaging
  - MRI: May be abnormal
  - CT: Usually normal

CONCUSSION PHYSICAL EXAMINATION

- NeuroTech Testing
  - M.T.E.A.: Computer based neurocognitive assessment

PHYSICAL EXAMINATION FINDINGS

MANAGEMENT: FROM COCOON TO SUBTHRESHOLD

- There is currently insufficient evidence that prescribing complete rest is needed.
- After a brief period of rest during the acute phase (24-48 hours) after injury patients can be encouraged to become gradually and progressively more active while staying below their cognitive and physical symptom-exacerbation thresholds.
- It is reasonable for athletes to avoid vigorous exertion while they are recovering.
- The exact amount and duration of rest is not yet well defined in the literature and requires further study.

INITIAL MANAGEMENT

- Close observation overnight every few hours
- No need to wake them up!
- No stimulating activity
- No texting, tv, video games, reading, school work…
- No physical activity
- Limit medication overnight
- Don’t mask symptoms of worsening condition or confusion, theoretical increase risk of brain bleed (NSAIDs); Tylenol ok for headaches
- If any worsening of symptoms, call physician or go to the ED

MANAGEMENT: SUB-THRESHOLD ACTIVITY

- Rehabilitation
  - Closely monitored active rehabilitation programs involving controlled sub-symptom threshold, submaximal exercise have been shown to be safe and may be of benefit in facilitating recovery
  - Can be used to classify PCS sub-types, verify recovery and guide treatment
  - Performs a standardized incremental aerobic treadmill test (Buffalo Concussion Treadmill Test)
  - Persistent concussion symptoms not assuaged by treadmill test
  - Vestibular-ocular or cervicogenic
  - Rapid and visible onset of symptom exacerbation in those not fully recovered
- Clinical studies
  - Both pediatric and adult concussion patients show high rate of symptom improvement with submaximal exercise prescription

Reprints of this article available at www.Cureus.com
MANAGEMENT: PERSISTENT SYMPTOMS

PERSISTENT SYMPTOMS

• Persistent symptoms (post-concussive syndrome)
  - Symptoms typically resolve in about 2 weeks
  - Kids may take longer, often 3-4 weeks
  - Occurs immediately after the occurrence of a traumatic brain injury and persists past the acute post-injury period
  - Pathophysiology unclear
  - Depression/deconditioning may mimic post-concussive syndrome
  - Strongest predictor: severity of symptoms on Day 1
  - Utilizes a multidisciplinary team
    - Concussion specialists
    - Neuropsychologists
    - OT/PT (particularly with c-spine or vestibular symptoms)

POST CONCUSSIVE SYNDROME

• Physiological
  - Global pounding headache at rest
  - Dizziness, nausea, fatigue, drowsiness, photophobia, phonophobia
  - Vestibulo-ocular
    - Headache and eye strain
    - Intermittent blurred vision, diplopia, dizziness, drowsiness, motion sensitivity, difficulty focusing or concentrating
    - Intermittent vertigo during certain head positions
  - Cervicogenic
    - Headache elicited/exacerbated by activities with prolonged neck stabilization or movement
    - Neck pain, stiffness, decreased range of motion, dizziness, and postural imbalance

MEDICAL MANAGEMENT: POST CONCUSSIVE SYNDROME

• Sleep Disturbances
  - Sedatives
• Headache
  - Analgesics
• Vestibular Dysfunction
  - Vestibular rehab
• Cervical Pain
  - Cervical rehab
• Ocular Dysfunction
  - Ocular rehab, glasses
• Emotional Dysfunction
  - Antidepressants
• Cognitive Impairment
  - Stimulants

MEDICATION USE IN CONCUSSIONS

• Sleep Disturbances
  - Melatonin 3-10mg PO qhs
  - Trazodone 25-50mg PO qhs

• Headache/Migraines
  - NSAIDs/Tylenol 69% improvement when discontinued
  - Elavil 10-25mg PO qhs 82% reported improvement headache
  - Topamax 25mg PO daily to 50mg PO bid

• Emotional/Depression
  - Zoloft 12.5-25mg PO daily
  - Celexa 10-20mg PO daily

• Cognitive
  - Methylphenidate ER 18mg PO daily
  - Amantadine 100mg PO bid

CLINICAL COURSE

• The large majority of injured athletes recover from a clinical perspective within the first month of injury
• Neurological recovery may take longer
• Children, adolescents, and young adults with a pre-injury history of mental health problems or migraine headaches appear to be at somewhat greater risk of having symptoms for more than 1 month
• Those with attention deficit hyperactivity disorder or learning disabilities might require more careful planning and intervention regarding returning to school but they do not appear to be at substantially greater risk of persistent symptoms compared to other athletes
• Very little research to date has been carried out on children under the age of 13
• There is some evidence that the teenage years of high school might be the most vulnerable time period for having persistent symptoms—with greater risk for girls than boys

MEDICAL MANAGEMENT: EXPERT OPINION

Recovery

• The large majority of injured athletes recover from a clinical perspective within the first month of injury
• Neurological recovery may take longer
• Children, adolescents, and young adults with a pre-injury history of mental health problems or migraine headaches appear to be at somewhat greater risk of having symptoms for more than 1 month
• Those with attention deficit hyperactivity disorder or learning disabilities might require more careful planning and intervention regarding returning to school but they do not appear to be at substantially greater risk of persistent symptoms compared to other athletes
• Very little research to date has been carried out on children under the age of 13
• There is some evidence that the teenage years of high school might be the most vulnerable time period for having persistent symptoms—with greater risk for girls than boys
A MULTI-DISCIPLINARY CONCUSSION MANAGEMENT TEAM

- **Team Members**
  - Family team: Student, parents, guardians, grandparents, peers, teammates, and family friends
  - Medical team: Emergency department, primary care provider, concussion specialist (primary care sports medicine physicians, neurologists, neurosurgeons, etc.), clinical psychologist, neuropsychologist, team and/or school physician
  - School academic team: Teacher, school counselor, school psychologist, social worker, school nurse, school administrator, school physician
  - School physical activity team: School nurse, athletic trainer, coach, physical education teacher

- All members listed for a team do not need to be involved for successful concussion management. An individual such as an emergency department physician may only be involved in the initial assessment and suggestion for academic adjustments. Some members may serve roles on various teams. Some schools may have access to only certain individuals suggested for a team. This list is meant to serve as a framework to help pediatricians and others involved with concussion management possible roles they can see for a student with a concussion.

GREENVILLE RETURN TO LEARN

**Return to Learn**

A student is in their first week of concussion.

**BERLIN STATEMENT**

- **Table 2 Graduated return-to-school strategy**
  - **Stage**
    - 0 Initial rest period
    - 1 Return to school activities
    - 2 Return to school
  - **Aim**
    - Gradually return to school
  - **Activity**
    - Gradual return
  - **Goal of each step**
    - Gradually increase involvement

**RETURN TO LEARN PROTOCOL: GREENVILLE COUNTY SCHOOLS**

**Concussion Academic Accommodation Form**

<table>
<thead>
<tr>
<th>Task Revisions in the Classroom</th>
<th>Task Revisions in the Classroom</th>
</tr>
</thead>
</table>

1. **Steps before Returning to Learn**
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance

2. **Steps for Returning to Learn**
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance

3. **Steps after Returning to Learn**
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance

4. **Steps for Follow-Up**
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance

**GREENVILLE RETURN TO LEARN**

**BERLIN STATEMENT**

- **Table 2 Graduated return-to-school strategy**
  - **Stage**
    - 0 Initial rest period
    - 1 Return to school activities
    - 2 Return to school
  - **Aim**
    - Gradually return to school
  - **Activity**
    - Gradual return
  - **Goal of each step**
    - Gradually increase involvement

**RETURN TO LEARN PROTOCOL: GREENVILLE COUNTY SCHOOLS**

**Concussion Academic Accommodation Form**

<table>
<thead>
<tr>
<th>Task Revisions in the Classroom</th>
<th>Task Revisions in the Classroom</th>
</tr>
</thead>
</table>

1. **Steps before Returning to Learn**
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance

2. **Steps for Returning to Learn**
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance

3. **Steps after Returning to Learn**
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance

4. **Steps for Follow-Up**
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
   - Identify the student
   - Review the student's current academic performance
   - Set-up accommodation
   - Determine the student's current academic performance
RETURN TO LEARN: ADJUSTMENTS IN THE CLASSROOM GREENVILLE

RECOMMENDATIONS FOR PARENTS FOR RTL (COLORADO REAP)

- **MAXIMUM REST = MAXIMUM RECOVERY**
  - STAY HOME
  - If your child’s symptoms are so severe that he/she cannot concentrate for even 10 minutes, he/she should stay home on total bed rest – no reading, no driving, no video games, no homework. At home TV is unusual for this state but beyond a few days. Consult a physician if this state lasts more than 2 days.
  
- **STAY HOME – LIGHT ACTIVITY**
  - If your child’s symptoms are improving but he/she can still only concentrate for up to 20 minutes, he/she should be kept home but may need total bed rest. Your child can start light mental activity (e.g. doing puzzles, watching TV). Light reading, as long as symptoms do not worsen. If they do, cut back the activity and build in more rest. NO physical activity allowed.

- **TRANSITION BACK TO SCHOOL**
  - When your child is beginning to tolerate 30 to 45 minutes of light mental activity you can consider returning them to school.
  
- **MAXIMUM REST = MAXIMUM RECOVERY**
  - STAY HOME
  - If your child’s symptoms are improving but he/she can still only concentrate for up to 20 minutes, he/she should be kept home but may need total bed rest. Your child can start light mental activity (e.g. doing puzzles, watching TV). Light reading, as long as symptoms do not worsen. If they do, cut back the activity and build in more rest. NO physical activity allowed.

- **EDUCATIONAL SUPPORT TIMELINE**

- **RETURN TO SPORT PROTOCOL: BERLIN STATEMENT**

  - **Table 1** Graduated return to sport (RTS) strategy
    - **Stage**
      - **1** Symptom-limited activity
        - **Goal of each step**
          - Daily activities that do not provoke symptoms
    
      - **Stage**
        - **2** Light aerobic exercise
          - **Goal of each step**
            - Increase heart rate
    
      - **Stage**
        - **3** Sport-specific exercise
          - **Goal of each step**
            - Add movement
    
      - **Stage**
        - **4** Non-contact training drills
          - **Goal of each step**
            - Exercise, coordination and increased thinking
    
      - **Stage**
        - **5** Full-contact practice
          - **Goal of each step**
            - Restore confidence and assess functional skills by coaching staff
    
      - **Stage**
        - **6** Return to sport
          - **Goal of each step**
            - Normal game play

  - **NOTE:** An initial period of 24–48 hours of both relative physical rest and cognitive rest is recommended before beginning the RTS progression. There should be at least 24 hours (or longer) for each step of the progression. If any symptoms worsen during exercise, the athlete should go back to the previous step. Resistance training should be added only in the later stages (stage 3 or 4 at the earliest). If symptoms are persistent (e.g., more than 10–14 days in adults or more than 1 month in children), the athlete should be referred to a healthcare professional who is an expert in the management of concussion.
RETURN TO DRIVE: RESEARCH

- Post-concussion impairments may lead to unsafe driving performance. Little research is available to guide consensus on when concussed individuals should resume driving.
- The purpose of this study was to compare driving performance between individuals with and without a concussion and to explore relationships between neuropsychological and driving performance.
- Fourteen participants with concussion (age 20.2 ± 0.9 years old) and 14 non-concussed age- and driving experience-matched controls (age 20.4 ± 1.1 years) completed a graded symptom checklist, a brief neuropsychological exam, and a 20.5 km driving simulation task. Participants with a concussion completed driving simulation within 48 h of becoming asymptomatic (15.9 ± 9.0 days post-concussion).
- Despite being asymptomatic, concussed participants exhibited poorer vehicle control, especially when navigating curves.
- Driving impairments may persist beyond when individuals with a concussion have returned to driving.
- Our study provides preliminary guidance regarding which neuropsychological functions may best indicate driving impairment following concussion.

THE CHILD AND ADOLESCENT ATHLETE

Reconsider

- Schools are encouraged to have an SRC policy that includes education on SRC prevention and management for teachers, staff, students, and parents, and should offer appropriate academic accommodation and support to students recovering from SRC.
- Students should have regular medical follow-up after an SRC to monitor recovery and help with return to school, and students may require temporary absence from school after injury.
- Children and adolescents should not return to sport until they have successfully returned to school.
- However, early introduction of symptom-limited physical activity is appropriate.

SC CONCUSSION LAW

- Athletes must be removed from sport if there is suspicion of concussion or brain injury.
- Athletes may return to play if medical professional determines there is no concussion.
- School districts must have policies in place and make information available to students, parents, coaches, etc.

SEQUELA

Residual Effects and Sequela

- Second impact syndrome:
  - Second head injury in close succession to initial injury
  - Increased brain edema > brain herniation
  - Severe neurocognitive dysfunction or death
- Chronic traumatic encephalopathy
- Prolonged cognitive deficits
- Cognitive impairment
- Prolonged memory loss
- Distinct entity or edema from single traumatic impact

CHRONIC TRAUMATIC ENCEPHALOPATHY

- The potential for developing chronic traumatic encephalopathy (CTE) must be a consideration, as this condition appears to represent a distinct tauopathy with an unknown incidence in athletic populations.
- A cause-and-effect relationship has not yet been demonstrated between CTE and SRCs or exposure to contact sports.
- As such, the notion that repeated concussion or subconcussive impacts cause CTE remains unknown.

PREVENTION: HELMETS AND MOUTHGUARDS

Risk Reduction

- Helmets
  - Difficult to study because mandatory regulations
  - Sufficient evidence in skiing/snowboarding to reduce head injury
- Mouthguards
  - Meta-analysis suggests a non-significant trend towards a protective effect in collision sports
PREVENTION: BODY CHECKING AND OTHER EQUIPMENT

- The strongest and most consistent evidence evaluating policy is related to body checking in youth ice hockey (i.e., allowing body checking under age 13), which demonstrates a consistent protective effect in reducing the risk of SRC.
- Limiting contact in youth football practices has demonstrated some promising results in reducing the frequency of head contacts, but there is no evidence to support the translation of these findings to a reduction in SRC.
- Evaluation of fair play rules in youth ice hockey tackle training without helmets and shoulder pads in youth American football, and tackle technique training in professional rugby do not lead to a reduction in SRC risk.
- A recommendation for stricter rule enforcement of red cards for high elbows in heading duels in professional soccer is based on evidence supporting a reduced risk of head contacts and concussion with such enforcement.

REFERENCES

- O’Kane. “Is Heading in Youth Soccer Dangerous?”. Sport Concussion: 3(1-4(2)):190-4
  - There is limited evidence that heading in youth soccer is a cause of concussion.
  - A reasonable approach towards Li’s Youth Soccer recommendation is to teach heading after age 13 in controlled settings.
  - Helmets and mouthguards should be delayed until skill acquisition and positional mastery allow the young player to head correctly with confidence.
  - Overall, 227 concussions were sustained during 1,924,753 athlete exposures (AEs) among girls (4.50 per 10,000 AEs) and 412 concussions were sustained during 2,043,654 athlete exposures (5.47 concussions per 10,000 AEs).
  - Although heading is the most common activity associated with concussions, the most frequent mechanism was athlete–athlete contact.
  - Although heading from soccer wear would likely prevent some concussions, reducing athlete–athlete contact across all phases of play would likely be a more effective way to prevent concussions as well as other injuries.

RESOURCES

- Colorado REAP (Remove/Educate, Educate/Adjust/Accommodate, Pace) a community-based concussion management program for additional information (McAvoy, 2013c).
  [http://www.scdhec.gov/Health/TeenHealth/Concussions/AthleteConcussionLaw/]
- SC Concussion Law Overview: [http://www.scereap.org/SCConcussionLaw/]
- CDC Heads Up: [https://www.cdc.gov/headsup/youthsports/index.html]