Concussion 101
Southern Maine School Nurse Association
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Concussion

“Any alteration of mental function following a blow to the head that may or may not involve a loss of consciousness”

American Academy of Neurology, 1997
What is a Concussion?

- Mild Traumatic Brain Injury (mTBI)
- Neurological impairment which has *rapid onset*, and is *self-resolving* and *short-lived* (usually)
- More of a functional rather than structural disturbance (normal head imaging studies)
- Caused by a direct hit or indirect “jarring” of the head
3. Rebound (contre-coup) Injury to occipital lobe.

1. Brain moves forward in skull.

2. Frontal lobes strike inside of skull (contusion)

DECELERATION INJURY (LINEAR)

stretching / tearing or neurons in brain stem and throughout brain
1. Brain rotates on axis causing stretching/tearing of axons
2. Stretching / tearing of blood vessels results in hematomas
3. Brain strikes skull causing contusion

ROTATIONAL INJURY
Neurometabolic Cascade Following Cerebral Concussion

(Giza & Hovda, 2001) 

Cerebral Blood Flow

% of normal

Calcium

K+

Glucose

Glutamate

UCLA Brain Injury Research Center
What is a Concussion:

Microscopic Level

- Concussion physiology is not entirely understood - described as a complex cascade of biochemical, metabolic, and gene expression changes.
- No cell death – unlike ischemic stroke, but do have period of susceptibility after hit (concussive penumbra).
What is a Concussion:

Microscopic Level

Disruption of the communication mechanisms in the brain, leading to...

- Direct nerve swelling on the microscopic level.
- Free radical formation, leading to damage to the nerves.
What is a Concussion:

Microscopic Level

Disruption of the communication mechanisms in the brain, leading to...

- Traumatic changes in how transmitters affect nerves??
- Release of excitatory neurotransmitters (glutamate, acetylcholine)??
What is a Concussion:

Microscopic Level

- Different people react differently to similar injuries
- The same person may react differently to the same injury at a different time.
Epidemiology

Who Gets Concussed?

- 1.4 million TBIs occur in the US each year (2004).
- 248,418 annual ED visits for nonfatal TBI’s related to sports and recreation activity in persons aged ≤19. (MMWR 2011)
- Up to 80% of concussions go undiagnosed and untreated.
- Concussions represent 8.9% of all high school athletic injuries and 5.8% of all collegiate athletic injuries. (Gessel, et. al., 2007)
- The rates of concussions were highest in football and ice hockey/LAX (~10% of participants/season).
Incidence of Sports-Related Concussion

- 53% of high school football players who suffer a concussion do not report it –
  - Not aware it was a concussion
  - Underestimate the seriousness of the injury
  - Don’t want to be withdrawn from competition

McCrea, et. al., Clin J Sport Med, 2004
### MTBI Signs & Symptom

#### Concussion Signs
- Appears dazed
- Confused about play
- Moves clumsily
- Answers question slowly
- Personality/behavior change
- Forgets plays prior to hit
- Retrograde amnesia
- Forgets plays after hit
- Anterograde amnesia
- LOC

#### Concussion Symptoms
- Headache
- Nausea
- Balance problems
- Double vision
- Feeling sluggish
- Feeling foggy
- Change in sleep pattern
- Cognitive changes
Commonly Reported Symptoms

High School & College Athletes - within 3 days of injury

# 1  Headache  71%
# 2  Feeling slowed down  58%
# 3  Difficulty concentrating  57%
# 4  Dizziness  55%
# 5  Fogginess  53%
# 6  Fatigue  50%
# 7  Visual Blurring/double vision  49%
# 8  Light sensitivity  47%
# 9  Memory dysfunction  43%
# 10 Balance problems  43%

Lovell, Collins et al., 2004; N = 215
Tools for Concussion Diagnosis

- Evaluation by a trained health care professional
- Neurocognitive computerized testing (ImPACT, CogSport)
- Many others including:
  - Sports Concussion Assessment Tool (SCAT2)
  - Standardized Assessment of Concussion (SAC)
  - King-Devick Sideline Concussion Test
  - NHL Physician Evaluation Form
  - McGill Abbreviated Concussion Evaluation (ACE)
  - Colorado Medical Society Guidelines
  - Maddocks Questions
  - AAN Sports Palm Card
Concussion Management
Concussion
The Diagnostic and Return to School/Play Dilemma

How to recognize the moods of an Irish setter
Concussion management by primary care providers.


• 2004 – Eleven item questionnaire to all PCP’s in ME. 50.8% (367/723) response rate.

• 70% of responders used published guidelines as a tool in concussion management.

• 16% of responders had access to NS tests within one week of the concussion.
Maine Concussion Management Initiative

"The Mission of MCMI is to improve the safety of Maine’s youth by reducing activity related concussions."
Our Goal

Provide Consistent Concussion Management through:

- Establishing a network of Maine professionals trained in concussion management
- Increasing education about concussion in sports
- Standardizing return-to-function (play) guidelines
- Offering computerized neurocognitive testing (ImPACT) to assist with concussion evaluation and management
Free CDC Tool Kit on Concussion for High School Coaches!

- If you think your athlete has sustained a concussion... don’t assess it yourself. Take him/her out of play, and seek the advice of a health care professional.

- [http://www.cdc.gov/ncipc/tbi/Coaches_Tool_Kit.htm](http://www.cdc.gov/ncipc/tbi/Coaches_Tool_Kit.htm)
HEADS UP!  FREE CDC Tool Kit on Concussion for High School Coaches

DID YOU KNOW?

X Each year, as many as 3.8 million sports- and recreation-related concussions occur in this country.

X Athletes who have had at least one concussion are at increased risk for another concussion.

X A repeat concussion that happens before the brain fully recovers from the first can result in brain swelling, permanent brain damage, and even death. This is called “second impact syndrome.”

The Centers for Disease Control and Prevention (CDC) has created a free tool kit, Heads Up: Concussion in High School Sports, that provides useful tools and information to help coaches, as well as athletic directors and trainers, prevent, recognize, and manage concussions.

The tool kit contains practical, easy-to-use information including:

- A video and DVD;
- A coach’s guide with information about preventing and managing concussion;
- A wallet card and clipboard sticker for coaches;
- Posters to hang in locker rooms;
- Fact sheets in English and Spanish for athletes and their parents; and
- A CD-ROM with downloadable kit materials and additional concussion-related resources.

To order or download this tool kit free-of-charge, go to: http://www.cdc.gov/nclpc/tbi/Coaches_Tool_Kit.htm.

For more information or questions on the Heads Up: Concussion in High School Sports tool kit, please contact CDC at 1-800-CDC-INFO (232-4636) or email at cdcinfo@cdc.gov.

It’s better to miss one game than the whole season.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
“Concussion in Sport - What You Need to Know”

www.nfhslearn.com
NFHS Suggested Guidelines for Management of Concussion

See Appendix B in all of the 2011-12 NFHS Rules Book
1st-3rd International Symposium on Concussion in Sport (Vienna, Prague, Zurich): Clinical Points of Emphasis

1. Abandonment of grading scale approach, recommend individualized management of injury.

2. When player exhibits any signs/symptoms of concussion, he/she should be removed from contest and **not allowed** to return to play in that same contest *(Zurich allows RTP in same game in athletes >18 years after prudent evaluation)*.

3. Following concussion, athlete should engage in stepwise exertional progression prior to RTP.

4. Objective tools (e.g. neurocognitive/balance testing) should augment post-injury clinical evaluation. **No athlete should return to play if any symptoms, neurocognitive, or balance deficits persist at rest or with exertion.**
Concussion in Sports: Post concussive Activity
Levels, Symptoms, and Neurocognitive Performance

Exertion

• **Conclusions:** Activity level after concussion affected symptoms and neurocognitive recovery.

• Athletes engaging in high levels of activity after concussion demonstrated worse neurocognitive performance.

• Those engaging in moderate levels of activity demonstrated the best performance.
Exertion

• School work and sports both count as a form of exertion, as do video games, text messaging, loud music, bright lights and commotion (i.e. shopping at the mall, going to a dance or game).
# Guidelines for Post-Concussion Academic Accommodations

<table>
<thead>
<tr>
<th>Stage</th>
<th>Goals/Key Ideas</th>
<th>Expected Duration</th>
<th>Teacher’s Actions</th>
<th>Student’s Actions</th>
</tr>
</thead>
</table>
| I     | Complete rest   | 2-6 days          | • Contacted by school nurse  
• Explanation of injury and current plan of care | • Out of school  
• Strict limits for use of computer, cell phone, texting, video games  
• No Physical/Sports Activity |
| II    | Significant deficits in processing and concentration. Cognitive activity as tolerated | 2-14 days | Develop lists of three categories for all assignments:  
1. Excused: Not to be made up.  
2. Accountable: Responsible for content, not process. May be notes or work shared by a classmate, or may be covered in a review sheet.  
3. Responsible: Must be completed by student and will be graded. | • In school as tolerated  
• When present, observing not participating. Get copies of notes, handouts, etc.  
• Communicate with teachers about progress/challenges.  
• Be patient with slow recovery, just do your best.  
• No Physical/Sports Activity |
| III   | Gradual increase of time and energy, slowly resuming full workload | Variable duration. Hopefully 3-7 days, possibly more. | • Prioritize assignments with student, both make-up work and new work.  
• Continue to use lists with the three categories for assignments until all work is completed, and assist with setting a timeline for completion of assignments. | • Communicate with teachers on your progress with assignments. Communicate with teachers and parents on the pace of resuming a full workload and completing make-up work.  
• No Physical/Sports Activity |
| IV    | Complete resumption of normal activities | | • Monitor completion of assignments.  
• Communicate with parents and staff as to when student is caught up with assignments and working at the same pace as their classmates.  
• Communicate with Guidance Office as grades are updated | • Resume all normal activities.  
• Progress with athletic trainer – supervision resumption of participation in athletics. |
Later Signs of Concussion

Post-Concussion Syndrome

- Chronic Headache
- Decreased Processing Speed
- Short-Term Memory Impairment
- Concentration Deficit
- Irritability/Depression
- Fatigue/Sleep Disturbance
- General Feeling of “Fogginess”
- Academic Difficulties
Definition

“Post concussion syndrome is an ill-defined, ambiguous, poorly understood, syndromic cocktail of myriad symptoms and/or cognitive deficits lasting anywhere from a few weeks to a few years...maybe.”

There is considerable controversy in the literature disputing the cause, nature, treatment and existence of post-concussion syndrome.

(Kutcher 2010, personal communication)
Symptoms of PCS

Cognitive
Mood
Sleep
Physical
Second Impact Syndrome

- Catastrophic increase in intracranial pressure secondary to auto-regulatory dysfunction.
- Vasomotor paralysis, edema, massive swelling, uncal herniation, death.
- Most often occurs in athletes <21 y/o.
- Neuro-chemical processes appear to differ in developing brain.
Second Impact Syndrome

- Occurs in athletes with prior concussion following relatively minor second impact, seen when athlete returns to competition before resolution of MTBI.
- Second impact has been shown to occur up to 14 days post-injury.
Protective Equipment

Mouth guard use demonstrated no effect in reducing neurocognitive deficits or symptoms of sports concussion

Football Helmets

• Helmets are designed to prevent skull fractures, not concussions.
• “New helmet technology” offers no proven protection from concussion.
• Proper fit is most important aspect of a helmet.
Riddell Revolution Helmet
Does Gender Matter?
“Concussion Studies Show Girls Are More Vulnerable”

“...According to a study to be published in the Journal of Athletic Training, in high school soccer, girls sustained concussions 68 percent more often than boys did. Female concussion rates in high school basketball were almost three times higher than among boys. Girls also consistently took longer for their symptoms to resolve and to return to play...”

NY Times, October 2, 2007

- Girls had a higher rate of concussions than boys (0.36/1000 A-Es vs. 0.22/1000 A-Es) in HS soccer. ($P=0.03$)
- Concussions represented a greater proportion of total injuries among girl high school soccer players than boys (15.1% vs. 9.4%) ($P<0.01$)
In HS basketball, girls had a higher rate of concussion (0.21/1000 A-Es) than boys (0.07/1000 A-Es, $P<.01$), and concussions represented a greater proportion of total injuries among girls (11.7%, $P<.01$) than boys (3.8%).
Gessel, et. al., *Journal of Athletic Training, 2007*

- The explanation for the observed sex differences in concussion is most likely multifactorial:
  - Biomechanical differences – smaller head to ball ratio, weaker necks, head and neck acceleration differences, differences in style of play.
  - Cultural differences – traditionally, US society tends to be more protective of female athletes.
Framing the Issues: What We Know

- Clinical symptoms/cognitive deficits appear linked to brain-related changes in physiology
- Changes in physiology lead to period of vulnerability
- During period of vulnerability, less biomechanical force results in more serious injury
- During period of vulnerability, physical and cognitive exertion protracts and complicates recovery
Framing the Issues: What We Know

• Certain risk factors likely heighten risk of sustaining concussion and exhibiting complicated recovery
• As we learn more, management becomes more conservative
• Comprehensive evaluation with objective tools are critical to determine clinical/academic management and safe return to function/play
What We Still Don’t Know…

- Appropriate thresholds to define injury - When is the brain truly concussed?
- How long is period of physiologic vulnerability?
- Does the brain truly recover?
- What are the exact risk factors for complicated outcomes?
- Does proper management of injury mitigate all risk of recurrent injury?
What We Still Don’t Know…

- What is true morbidity of concussive injury in terms of academic effects, chronic symptoms, neurobehavioral presentation?
- What are potential long-term effects of concussive injury, if any?
- What do we do in the interim, until questions are resolved?
Thank you!