Concussion and Return to Play Considerations

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Diagnosing Concussion

- Diagnostic challenge is the fact that every concussion is unique
- Difficult to establish a single “gold standard” test for concussion
  - Some signs and symptoms of concussion may not be present immediately, but may evolve over several hours to days after a concussive episode
- Concussion remains a clinical diagnosis based on a constellation of signs and symptoms and requires a high index of suspicion

A concussion is a brain injury affecting multiple clinical domains.

Headache
Dizziness
Blurred vision
Noise / Light sensitivity

Balance problems
Fatigue

Drowsiness
Irritable
Sadness

Difficulty remembering
Difficulty concentrating
Feeling “slowed down”

Insomnia

Clinical Domains
-Symptoms
-Physical signs
-Behavioral changes
-Cognitive impairment
-Sleep Disturbance

Most symptoms resolve within 7-10 days for a typical concussion.
Baseline Testing

Concussion

Sideline Evaluation

Follow-Up Evaluation 24-72 Hours

Symptoms Persist

Reeval 2-7 Days with Symptom Scale

Symptoms Resolved

Written Clearance to Return to Play

Begin Graduated Return to Play

1 ATC/DO/MD/RN with Concussion Symptom Assess and Balance Testing (SCAT 3), and ImPACT Neuropsychological Testing
2 ATC/DO/MD with SCAT 3
3 DO/MD Only
4 Consider Concussion Program
5 See MCPS Concussion Protocol; if progress without symptoms then cleared to return to full activity by ATC/DO/MD. Obtain new Baseline Testing with ImPACT

See Montgomery County Public Schools Concussion Policy for more details
Gender Differences

- Data demonstrates a higher incidence for women than men
  - Soccer, basketball and ice hockey
- Several studies in 2009-10, concluded that female soccer players performed worse than males on post-concussive neurocognitive testing
- Women also were shown to report more post-concussive symptoms
- The explanation of this trend is unknown and may include biomechanical, hormonal, and cultural factors

**TABLE 1** Concussion Rates in High School Sports

<table>
<thead>
<tr>
<th>Sport</th>
<th>Injury Rate, per 1000 Athlete Exposures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>0.47–1.03(^{a,b})</td>
</tr>
<tr>
<td>Girls’ soccer</td>
<td>0.36(^{a})</td>
</tr>
<tr>
<td>Boys’ lacrosse</td>
<td>0.28–0.34(^{c,d})</td>
</tr>
<tr>
<td>Boys’ soccer</td>
<td>0.22(^{a})</td>
</tr>
<tr>
<td>Girls’ basketball</td>
<td>0.21(^{a})</td>
</tr>
<tr>
<td>Wrestling</td>
<td>0.18(^{a})</td>
</tr>
<tr>
<td>Girls’ lacrosse</td>
<td>0.10–0.21(^{c,d})</td>
</tr>
<tr>
<td>Softball</td>
<td>0.07(^{a})</td>
</tr>
<tr>
<td>Boys’ basketball</td>
<td>0.07(^{a})</td>
</tr>
<tr>
<td>Boys’ and girls’ volleyball</td>
<td>0.05(^{a})</td>
</tr>
<tr>
<td>Baseball</td>
<td>0.05(^{a})</td>
</tr>
</tbody>
</table>

Children

- The developing brain has a unique set of physiologic variables that are changing continuously as children grow
- It is unclear how ongoing brain development affects a child’s susceptibility to concussion
- Nonetheless, we are more careful when making return-to-play decisions in children because of the uncertainty of dealing with a developing brain
  - Patient’s baseline cognitive function**
  - Potential unreliability of pediatric patients in reporting subjective symptoms
- Input of parents, teachers, and coaches, may be helpful, to provide additional clarity as to the history

What kinds of impacts do we see in practice?
What kinds of impacts do we see in games?
## Football Age Group Comparisons

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Players</th>
<th>Impacts per Season</th>
<th>50&lt;sup&gt;th&lt;/sup&gt; % Accel. (g)</th>
<th>95&lt;sup&gt;th&lt;/sup&gt; % Accel. (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6 to 13 years old</strong></td>
<td>3,500,000</td>
<td>107</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td><strong>High School</strong></td>
<td>1,300,000</td>
<td>565</td>
<td>18</td>
<td>56</td>
</tr>
<tr>
<td><strong>College</strong></td>
<td>100,000</td>
<td>1000</td>
<td>19</td>
<td>68</td>
</tr>
<tr>
<td><strong>NFL</strong></td>
<td>2,000</td>
<td>19</td>
<td>50&lt;sup&gt;th&lt;/sup&gt; % Accel. (g)</td>
<td>95&lt;sup&gt;th&lt;/sup&gt; % Accel. (g)</td>
</tr>
</tbody>
</table>

*Note: The diagram illustrates the number of players and the impact per season for each age group.*
5,000,000 Football Players in US

Majority of football players are between 6 and 13 years old

- NFL: 2,000 Players
- College: 100,000 Players
- High School: 1,300,000 Players
- 6 to 13 years old: 3,500,000 Players
Example MTBI Event

Clinically diagnosed concussion

Peak G = 136 G
Another Example MTBI Event
Another Example MTBI Event

Peak G = 139 G

Clinically diagnosed concussion
“Medical Observer Policy”

Football Bowl Subdivision Medical Observer Policies

2015-16

• Conferences and teams have begun to give consideration to use of “medical observers”
• Located in press box or on the sideline

ACC, American, Big Ten, Big 12, C-USA, MAC, MWC, Pac-12, SEC, SunBelt
### Medical Observer Policy

<table>
<thead>
<tr>
<th>Conference</th>
<th>Policy</th>
<th>Medical Observer</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ACC</strong></td>
<td>Required for all games. Jurisdiction is its team only</td>
<td>Team Specific Medical Observer</td>
<td>Press Box for <strong>ALL</strong> games Home and Away.</td>
</tr>
<tr>
<td></td>
<td>Selected by each respective institution’s chief athletics medical officer</td>
<td>Communication to its team's bench only</td>
<td>Non-Conference visiting Team access upon request</td>
</tr>
<tr>
<td></td>
<td>Monitor for any potential injury and in accordance with their institution’s athletics medical plan.</td>
<td>Cannot stop the game for an injury timeout</td>
<td>One (1) seat per team, not in a working press area</td>
</tr>
<tr>
<td><strong>AMERICAN</strong></td>
<td>Utilized at the <strong>Team’s discretion</strong>. Jurisdiction is its team only</td>
<td>Team Specific Medical Observer</td>
<td>Can be located on the field or in the press box but not the Instant Replay Booth.</td>
</tr>
<tr>
<td></td>
<td>Selected by the institution</td>
<td>Communication to its team’s bench only</td>
<td>Access to the live audio and video of the TV broadcast</td>
</tr>
<tr>
<td></td>
<td>Refer any player showing symptoms of head or neck trauma to the appropriate medical professional for evaluation</td>
<td>Cannot stop the game for an injury timeout</td>
<td>Conference or non-Conference team access upon request and only if available – this will not be required and will be at host institutional discretion</td>
</tr>
</tbody>
</table>
Review of all of the evidence based scientific literature related to athletes with multiple concussions and return to play…

• There isn’t any…
• “Studies of management of concussion were so poor…”
• So what do we do?
• Rely on “Expert Opinion” based on clinical practice, the relevant available medical and scientific literature and currently available diagnostic testing.

Physical Rest

- Broad restrictions of physical activity should be recommended
  - Including the sport or activity that resulted in the concussion
  - Any weight training
  - Cardiovascular training
  - Physical education classes

A Review of Return to Play Issues and Sports-Related Concussion
Cognitive Rest

• Athletes with concussion often have difficulty
  – Attending school
  – Focusing on schoolwork and taking tests
  – Especially in math, science, and foreign-language classes
  – Reading, even for leisure, commonly worsens symptoms
• Rest may include
  – A temporary leave of absence from school
  – Shortening of the athlete’s school day
  – Reduction of workloads in school
  – Allowance of more time for the athlete to complete assignments or take tests
• Other activities that require concentration and attention, including playing video games, using a computer, and viewing television, should also be discouraged

A Review of Return to Play Issues and Sports-Related Concussion
Cognitive Rest…what you might not know about…

• A recent poll of concussed high school athletes found them engaging in the following activities during “recovery”:
  – Snowboarding
  – Running a 5 km race
  – Playing touch football
  – Prolonged use of electronic visual interfaces
    • Texting, emailing, You Tube, watching movies

Art Maerlender: Personal Communication
Risk of Recurrence

• Significantly increased risk of sustaining a repeat concussion when an athlete is still recovering from a previous concussive injury
  – A second impact, often of less or even minimal force, then produces signs and symptoms that can be much more severe
  – In extreme cases, it is likely that this same scenario produces the “second impact syndrome”
    • Pediatric and Adolescent athletes seem to be a greatest risk
• Guskiewicz et al. showed that high school football players who suffered a concussion were three times more likely to sustain a second concussion during the same season
• Delaney, et al. showed that athletes who experienced concussion with a loss of consciousness were six times more likely to sustain another concussion than those who had been concussed but never lost consciousness

Mood Disorders

- Anxiety and depression are well recognized to occur after traumatic brain injury
  - Active disagreement as to the degree of causative effect
  - Retired football players reporting a history of 3+ previous concussions were 3X more likely to be diagnosed with depression

- No study has been published that suggests patients with a preexisting mood disorder such as depression or generalized anxiety are at a higher baseline risk of being concussed


Concussion Associated Brain Dysfunction

- Retired football players reporting a history of 3+ previous concussions were 5X more likely to be diagnosed with mild cognitive impairment
- Increased prevalence of Alzheimer’s Disease in retired football players

Migraine Headaches

• It is possible that *migraine headache* is a risk factor for concussion

• It also is possible that concussion leads to the development of migraine headaches
  – Or that migraine headaches are being misdiagnosed as concussions

• Athletes with migraines may have more severe and prolonged concussion courses after injury

Return To Play

- Return-to-play decisions are made with the risks of possible symptom exacerbation and prolongation of recovery, subsequent concussion, or catastrophic injury in mind.

### TABLE 1. Graduated Return to Play Protocol

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


• Athletes at a variety of levels of participation will have a series of baseline physiologic parameters that can aid clinicians as they begin the step wise rehabilitative protocol.
• A variety of speed, power and agility data are usually collected.
• Our experience is that athletes can usually begin the progression at about 75% of their typical maximum effort and gradually progress
• This provides objective data to initiate the protocol as well as gauge the athlete’s progress.
Return To Learn Protocol

• Progression through gradually increasing cognitive demands
  – Increasing amount of time in school
  – Increasing the nature and amount of work, length of time spend on work, and difficulty of work
  – If symptoms *do not* worsen, demands may continue to gradually increase
  – If symptoms *do* worsen, activity should be stopped and student allowed to rest

• **Student-athlete** shall progress to where no longer needs academic modifications/support PRIOR TO FULL return to competition
Return to Learn and Activity

RECOVERY STAGE 1
Re-Start School/Extracurricular
- Light Cognitive Activity - ≤ 30 Min
- Limit Tech Usage
- Avoid Heavy Backpacks
- No Tests or homework
- No activity
- No Driving
- Monitor Symptons
- Rest at home

Eligibility for Return
- Approaches threshold for progression
- Complete Physical Assessment/Health Clearance
- No School
- No Activity
- Limited Tech Usage

RECOVERY STAGE 2
Return to School
- Light Activity with Academic Accommodations
- No Physical Activity
- Limit Tech Usage
- No PE, Band or Chorus
- Monitor Symptoms
- Reduced homework
- Built-in breaks
- Return to Light aerobic activity (walking, bike)

Symptom Free for 24hrs?
- YES - Begin Stage 3
- NO - Continue Resting until Symptom Free

RECOVERY STAGE 3
Return to School Full Time with Academic Accommodations
- Light Level Physical Activity
- Full Day School
- Increased Academic Workload
- Gradually Reduced Homework
- Built-in breaks
- Return to Play (light activity)

Symptom Free for 24hrs?
- YES - Begin Stage 4
- NO - Continue Resting until Symptom Free

RECOVERY STAGE 4
Full Recovery to Academics
- Normal Level Physical Activity
- Full Day School
- Full Activity at School
- Normal Routines
- Return to Play (all activities)

Symptom Free for 24hrs?
- YES - Begin Stage 5
- NO - Continue Resting, return to Stage 3

RECOVERY STAGE 5
Full Recovery to Academics
- Heavy, Non-Contact Activity
- Full Day School
- Full Activity at School
- Resume Normal Activities
- Return to Play (full-contact)

Symptom Free for 24hrs?
- YES - Begin Full Participation
- NO - Continue Resting, return to Stage 3

RECOVERY STAGE 6
Full Recovery to Academic
- Full Contact Practice
- Full Day School
- Full Activity at School
- Resume Normal Activities
- Return to Play (full-contact)

Assessment to be made in collaboration with the child/adolescent and their healthcare providers.

ATC/L (Parent/Teacher):
__________

PHYSICIAN:
__________

SCHOOL NURSE:
__________

ATC/L (Parent/Teacher):
__________

PHYSICIAN:
__________

SCHOOL NURSE:
__________

ATC/L (Parent/Teacher):
__________

PHYSICIAN:
__________

SCHOOL NURSE:
__________

ATC/L (Parent/Teacher):
__________

PHYSICIAN:
__________

SCHOOL NURSE:
__________

Date:
__________

Location: 2013
RTP…Other Considerations

- **Age**
  - discussed above…generally more conservative
    - Must rely more on input from parents and coaches

- **Social Pressure**
  - Teammates, coaches and parents

- **Multiple Concussions**
  - No specific number has been established to mandate season ending injury or retirement.
  - Worrisome group
    - Decreased time between concussions
    - More prolonged recovery from each subsequent concussion
    - Concussions resulting from progressively decreased biomechanical forces

- **Persistent Headache**
  - Must differentiate “post concussive” from “cervicogenic” or “cranial” dysfunction
  - Consider PT/OMT to address cervical and upper thoracic dysfunction

- **With these last two groups may need to consider full neuropsych evaluation as well as other testing as indicated**
Regarding Headache…

• Neck Injuries
  – It is not uncommon for the neck to be injured concurrently with a concussion.
  – Neck injuries often have associated headaches, which may be difficult to separate from a post-concussive headache.
    • Cervicogenic headaches are worse with neck motion or prolonged postures.
    • Post-concussive headaches are aggravated by any physical or cognitive exertion.
Concussion Biomechanics and RTP

- Heading a soccer ball can result in head accelerations
  - From 16 to 20g lasting 25 ms
- The average collegiate football impact
  - From 21 and 32g lasting 14-15 ms
- Impacts to the top of the head yielded the greatest linear acceleration and impact force magnitude
  - Improper tackling techniques
- Offensive and Defensive line players sustained the lowest-magnitude impacts but the highest number of impacts during games and practices

RTP...other considerations

- Gait abnormalities exist following concussion and can persist for up to 2 months\(^2,3\)

- Increased frequency of *any* injury (including another head injury) after concussion for up to one year\(^4\)


What we did...

- Did a **pilot study** to identify the **frequency of lower extremity injuries post concussion amongst student athletes** at Virginia Tech and compare to non-concussed teammate controls
How we did it…

• Cross-sectional study of athletes at Virginia Tech from August 2008 – February 2014
• Analyzed injury records to identify frequency of LE sprains and strains in 90 days following concussion
• Compared proportion of concussed athletes that suffered LE injury to the proportion of non-concussed teammates who suffered a LE injury during the same 90 day time frame
What we found out...

- 107 total concussions found across 15 sports
- 17 of 107 (15.9%) experienced LE sprain or strain within 90 days
- 10.2% of non-concussed teammates suffered LE sprain or strain in same 90 day window
Hmmmm….now what?

SINGLE VS. DUAL-TASK TURNING IN RECENTLY CONCUSSED ATHLETES AND MATCHED CONTROLS: PRELIMINARY RESULTS

• Typical sports-related concussion symptoms resolve within 7-10 days post-concussion
• Use of challenging motor control tasks indicate that deficits can persist beyond this typical timeframe
• This study examined turning in recently concussed collegiate athletes and matched controls after the athletes were cleared to return to play to examine differences in path curvature and Medial/Lateral inclinations.

• Four recently concussed athletes and four healthy matched controls were tested a mean of 23 days after each concussion
• Controls were selected from the same team as each concussed athlete and matched based on position, age, stature and weight.
• Participants walked continuously around a course marked with 1.5 m tall pylons and consisting of straight and non-straight segments with ~90° turns
  – Participants walked at their normal pace (single task = ST) around the course 14 times, seven laps in each direction
  – Participants then repeated the procedure while serially subtracting by sevens (dual task = DT).
What we did…

The set up…

- Kinematic data was sampled at 120 Hz for each lap using four ProReflex (Qualysis, Sweden) cameras located around the middle pylon.
- Reflective markers were placed over the xiphoid process, approximate T9 vertebra, and on each calcaneus (heel).
- The upper body center-of-mass ($\text{COM}_{UB}$) location was estimated as the mean of the xiphoid process and T9 vertebral markers.

Depiction of the 18 m long course. Triangles indicate pylons, and the hexagon indicates the pylon location where motions were tracked.
What we found out...

- **Turning strategy** (inside vs. outside stance limb), task (ST vs. DT), velocity of the COM<sub>UB</sub>, and all group-paired interactions were included in the model as covariates, with significant interactions retained in the final models.
- Significant differences in mean curvature were found between groups ($p = 0.012$), COM<sub>UB</sub> velocities ($p < 0.001$), and turning strategy ($p < 0.001$).
- Recently concussed athletes take wider, less abrupt turns that may inhibit their ability to respond to competitive demands.
- The decreased $\theta_{\text{Pre}}$ suggests delayed anticipation of the turn that may manifest in declined performance and / or increased injury risk.
- Unclear whether these differences are caused by the neurophysiology of the concussion or due to potential detraining during recovery.

Example overhead view of a turning stride (dotted line) connecting the left-right-left heel contacts around the apex. Black circles show the location of the COM<sub>UB</sub> at each heel contact.
Other Considerations

• Do “supplements” help?
  – *Maybe….*
  – *There are studies underway.*

• Role Of DHA (theory)
  – **Docosahexaenoic acid**
  – The major Omega 3 fatty acid
  – DHA indirectly protects neurons from axonal injury and cell death by reducing the inflammation caused by brain trauma
  – DHA directly protects neurons against apoptosis or cell death
  – DHA may counter head injury-induced cognitive impairments including memory via its role in synaptic transmission

• Dosage
  – 2 grams daily (1 gm BID)

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*Bailes et al; J of Neurotrauma 27: 1617-1624 (Sept 2010) DHA reduces traumatic axonal injury in a rodent head injury model*

*Yurko-Mauro et al: Alzheimers and Dementia (2010) Beneficial effects of DHA in age related cognitive decline*
Post Concussion Syndrome

- This Dx is a function of the length of symptom persistence
  - 3 months duration of at least 3 symptoms
- Retired NFL players who were diagnosed with post-concussion related depression
  - 87% continued to have lifelong symptoms
- Medications that address symptoms may be considered in the treatment of PCS
  - Dosing should begin low and titrated upward slowly

<table>
<thead>
<tr>
<th>Cognitive</th>
<th>Physical</th>
<th>Behavioral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slowed response speed</td>
<td>Headache</td>
<td>Depression</td>
</tr>
<tr>
<td>Mental fogginess</td>
<td>Nausea</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Poor concentration</td>
<td>Vision changes</td>
<td>Panic attacks</td>
</tr>
<tr>
<td>Distractibility</td>
<td>Light sensitivity</td>
<td>Irritability</td>
</tr>
<tr>
<td>Trouble learning</td>
<td>Tinnitus</td>
<td>Personality changes</td>
</tr>
<tr>
<td>Memory difficulty</td>
<td>Noise sensitivity</td>
<td>Increased emotionality</td>
</tr>
<tr>
<td>Disorganization</td>
<td>Dizziness</td>
<td>Clinginess</td>
</tr>
<tr>
<td>Problem-solving difficulty</td>
<td>Vertigo</td>
<td>Apathy</td>
</tr>
<tr>
<td></td>
<td>Balance problems</td>
<td>Lowered frustration tolerance</td>
</tr>
<tr>
<td></td>
<td>Fatigue</td>
<td>Increased sensitivity to alcohol</td>
</tr>
<tr>
<td></td>
<td>Sleep disturbance</td>
<td></td>
</tr>
</tbody>
</table>

Summary of Gunnar’s clinical treatment Pearls for PCS

• Remember that dx and tx is a “team event”
  – Psychologists, neurologists, PM&R, PT’s and ATC’s can all be involved
• You are treating “symptoms”
• For mild insomnia with head/neck pain
  – Flexeril 10mg at hs
  – Elavil 10-25mg at hs
• For headache
  – NSAIDs
  – Topamax 25-50mg BID
• For depression with diffuse “body pain”
  – Effexor and Cymbalta (SNRI’s)
  – Tricyclics
  – SSRI’s don’t seem to work well
• For “fogginess”
  – Omega 3 supplements
  – Antioxidants
    • Alpha Lipoic Acid 100mg QD
    • B Complex
    • Co Q 10 100-200mg QD
  – Amantadine
    • 100-200mg BID
• Remember to include physical therapy and neurocognitive rehab as appropriate
• In general avoid narcotics

Placebo-Controlled Trial of Amantadine for Severe Traumatic Brain Injury; Gianco et al; N Engl J Med 2012; 366:819-826
March 1, 2012 DOI: 10.1056/NEJMoa1102609
Does “Advanced Imaging” help? Maybe….

- **Functional MRI**
  - Measures neuronal glucose uptake while the patient performs a “task” in the magnet
  - Can see changes in brain activation patterns for “acutely injured” patients vs controls
Does “Advanced Imaging” help? Maybe….

• **Diffusion Tensor Imaging**
  - can identify structural changes in the white matter of the brain that correlates to cognitive deficits even in patients with mild traumatic brain injury.
  - When white matter is damaged, other areas of the brain may appear healthy but they are actually "unplugged" and cannot function optimally.

Kraus, Little, Susmaras et al; Brain: Oct 2012
What about repetitive “sub concussive” impacts?

• **Millions of individuals have played contact sports for many years without obvious functionally significant adverse effects, and without developing progressive neurodegenerative disorders.**

• Nevertheless, we are concerned that repetitive head impacts may have an adverse effect on some athletes.
  – It is reasonable to speculate that individual differences such as polymorphisms in genes modulating response to neurotrauma (e.g., *APOE, BDNF, ANKK1*) or other host factors may play a role
  – it is tempting to hypothesize that risk of chronic traumatic encephalopathy or other long term effects of contact sports may represent a gene–environment interaction between repetitive mild neurotrauma and genetic vulnerability to heightened injury response or attenuated neural repair.

What is Chronic Traumatic Encephalopathy???

• Dementia Pugilistica...
  – “Punch Drunk Syndrome”

• Accumulation of Tau Protein in neurologic tissue
  – Genetically determined?
  – Head trauma triggered?
  – “Over-production” vs “Inadequate Clearance”?

• Is NOT Alzheimer’s Disease

• Relationship to Lou Gehrig’s Disease?

Brain tissue from 18-year-old multi-sport athlete

BU Center for the Study of Traumatic Encephalopathy
Clinical Considerations for Athletes with Multiple Concussions

• To date, no specific number of concussions has been established to mandate season ending injury or retirement.

• Experts understand that repetitive concussions can be associated with significant and prolonged neurocognitive deficits
  – decreased time between concussions
  – increased recovery time
  – concussions resulting from decreased biomechanical forces

• Clinicians may wish to consider a full neuropsychological evaluation and the use of advanced diagnostics and imaging techniques in these athletes.

Clinical Considerations for Athletes with Multiple Concussions

• When to remove an athlete from the competitive season or recommend permanent retirement from competition?
  – Must be managed in on individualized basis and multiple factors taken into account
  – Utilize the sports medicine team and appropriate diagnostic modalities
    • “One opinion is no opinion”

“The current literature is unclear and contradictory regarding specific therapeutic approaches. Sports clinicians are left to develop an approach to management of concussion that is based on currently available best practices that have little scientific evidence to support them.”

P.G. Brolinson; management of sport related concussion review and commentary; Clin J Sport Med Journal Club issue 24(1) -Jan 2014.
Clinical Considerations for Athletes with Multiple Concussions

Remove for Season

• Prolonged post concussive symptoms
• 3 “simple” concussions in a single season
• 2 or more “complex” concussions in a single season
• decreased academic and athletic performance
• clinically relevant imaging abnormality.

Career Ending

• Pathologic abnormality such as Chiari malformation
• Intracranial hemorrhage
• Clinically relevant imaging abnormality
• Diminished academic performance or cognitive abilities
• Persistent prolonged post-concussion syndrome
• Decreased threshold for concussion
• 3 or more “complex” concussions during career
• Persistent neuropsychiatric symptoms

So what do we do to mitigate concussion risk and enhance recovery?
Star Football Helmet Ranking System

• STAR is first system to account for ALL impacts over the course of a season
  – 1000 impacts
  – Four directions
  – Six severity levels
• Weighted values based on exposure
  – Higher weights for lower severity given the higher number of lower impacts

STAR Testing Process

For each model, 3 new helmets are tested twice at the 20 STAR matrix (2x20x3 = 120)

The two peak accelerations for each testing configuration are averaged.

A STAR value for each helmet is determined from the average accelerations for that helmet.

The overall STAR value is determined by averaging the three Individual STAR values.

Statistical significance between helmet models is determined using the average and variance in the three individual STAR values.
Consider Two Helmets

Which helmet would you choose?

For Identical Impacts:
- **Helmet A**
  - 90 g
  - 1% risk of concussion
- **Helmet B**
  - 200 g
  - 59% risk of concussion
Pop Warner Football

- June 2012
  - Pop Warner issued new rules that put restrictions on the amount of contact players can have in practice.
  - Jon Butler, the executive director of Pop Warner, said that research would continue to drive the organization’s rules changes as it tries to limit concussions.
  - has more than 285,000 children ages 5 to 15 in its leagues.
  - it has produced more than two-thirds of the players now in the National Football League.
Pop Warner Football

• Rules Changes for 2012 Season
  – contact will not be allowed for two-thirds of each practice
    • 9 hours total practice time each week so can have full contact 3 hours
  – no drills that involve full-speed, head-on blocking and tackling that begins with players lined up more than three yards apart
  – No intentional head to head contact
Identifying High-Risk Head Impacts

**Year 1**

Majority of high head acceleration impacts occurred during practice

Pop Warner instituted new rules to limit contact in practices

**Year 2**

Compared teams that adopted new rules with teams that didn’t

Observed nearly a 50% reduction in head impact exposure
~3 million youth football players in the US

~150 impact reduction per player

~450,000,000 fewer youth head impacts per year
Enhanced Rehabilitative Protocols to address potential “motor control” issues…

Soccer specific…

Other possibilities…

Ball work: (10 minutes)
1) Juggling ball, footwork (2 minutes)
2) Dribbling ball, straight line (2 minutes)
3) Dribbling (2 minutes)

4) Dribbling (2 minutes): Clockwise and counterclockwise

5) Dribbling with change of direction (2 minutes): run forward, backward, sideways
More “motor control” training...
Preventive Strategies...Strengthening

4 Way Neck

Shoulder Shrugs
“Functional Neck Strengthening”
Skill and Drill Development

- What are you trying to teach?
  - Emphasize skill development and safety!

- Break the skill down
  - Head to Toe
  - Toe to head

- Teaching system (Time: Safety)
  - Instruct 50%
  - Demo 10%
  - Walk Thru 30%
  - Live 10%

- Frequency
  - Time (Minimal)
  - Reps (Maximal)

- Intensity
  - 50%
  - 75%
  - 100%

- Web Help
- Don’t reinvent the wheel
Always block and tackle with your head UP! See What You Hit!

1) HIT!
The tackler is to drive his shoulder into the ball carrier's thigh pad, and nowhere else! His head should be across the runner's body and up. His hips should be under him. There should be no bend or arch to the tackler's back.

2) WRAP!
The tackler should fling his arms around the ball carrier's legs and pull the runner towards him with a sharp motion. His fingers should be grabbing cloth wherever possible.

3) LIFT!
The tackler should lift the ball carrier slightly (roughly an inch or so). This serves three purposes: it keeps the tackler on his feet, preventing dives and misses; it breaks the runner's balance and contact with the ground, and it makes the next point easier.

4) DRIVE!
With short choppy steps the tackler should power the ball carrier across, rather than back along, his initial motion.
The established policies shall require:

- An **annual review** of concussion information provided by the school division to both student-athletes and parents/guardians.

- After reviewing the short and long term health effects of concussions, each **student-athlete and the student-athlete’s parent or guardian shall sign a statement** acknowledging receipt of such information, in a manner approved by the Board of Education.

- Student-athletes suspected by their coach, athletic trainer, or team physician of sustaining a concussion or brain injury in a practice or game **shall be removed from the activity at that time.**

  A **student-athlete who has been removed from play, evaluated, and suspected to have a concussion or brain injury shall not return to play that same day nor until (i) evaluated by an appropriate licensed health care provider as determined by the Board of Education and (ii) in receipt of written clearance to return to play from such licensed health care provider.**

- It is strongly encouraged that the language included in any policy adopted by a school/school division for 2010-2011 **reference practice as well as contest situations.**

“Institutions shall have a concussion management plan on file such that a student-athlete who exhibits signs, symptoms or behaviors consistent with a concussion shall be removed from practice or competition and evaluated by an athletics healthcare provider with experience in the evaluation and management of concussion. Student-athletes diagnosed with a concussion shall not return to activity for the remainder of that day. Medical clearance shall be determined by the team physician or their designee according to the concussion management plan.

In addition, student-athletes must sign a statement in which they accept the responsibility for reporting their injuries and illnesses to the institutional medical staff, including signs and symptoms of concussions. During the review and signing process student-athletes should be presented with educational material on concussions.”

-- NCAA Memorandum
April, 2010

www.ncaa.org/health-safety
Summary

- Data suggest that female athletes may have a higher incidence of concussion and experience more severe concussive symptoms.
- The presence of preexisting mood or learning disorders can confound pre-injury baseline testing as well as concussion diagnosis and management.
- Migraine headache and concussion have similar presentations.
  - Athletes who have migraines also may be at a higher risk of being concussed but not know if this is a “cause and effect” relationship.
- Address cervical and thoracic somatic dysfunction.
- The genetics of concussion remain a mystery, and the role of factors such as the ApoE promoter gene are being investigated.
- There are some data to suggest that concussion risk may increase as an athlete fatigues or if he or she continues to participate in the sport after sustaining an initial mild traumatic injury.
- Consider advanced rehab protocols and neuromuscular retraining.
Recommendations

- Educate student-athletes annually
- Educate coaches and staff annually
  - [http://www.cdc.gov/concussion/HeadsUp/online_training.html](http://www.cdc.gov/concussion/HeadsUp/online_training.html)
- Educate parents annually
- Develop an Action Plan
- Preventive action
  - Educate
  - Proper Coaching
  - Neck strengthening
  - Baseline concussion symptom score (at PPE)
  - Baseline neuropsych testing of some type (at PPE)
  - Baseline balance testing (at PPE)
- Reduce the number of hits and severity in practice and games (rules enforcement)
- *Returning athletes to play safely is complex and based on a number of clinical and diagnostic variables and is best done utilizing a “team approach”*