CURRENT CONCEPTS IN SPORTS CONCUSSION

Zurich Consensus Update and Beyond

Jeffrey R. Bytowski DO IADSM
Head Medical Team Physician
Duke University

EVALUATION

On Field Assessment

Class Follow-up Evaluation

TREATMENT/RTP

CTE

PRE-SEASON SCREENING

BASELINE TESTING

PATHOPHYSIOLOGY

EPIDEMIOLOGY

OBJECTIVES

Epidemiology

Pathophysiology

Pre-symptomatic Screening

Magnetic Resonance Imaging (MRI)

Cystic Fibrosis

Cone Beam Computed Tomography (CBCT)

X-ray

FUTURE DIRECTIONS

- Advanced imaging techniques
- Multilingual concussion assessments
- Enhanced injury detection tools
- Biomechanical studies
- Clinical outcome tracking
CURRENT CONCEPTS IN SPORTS CONCUSSION

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Disclosures

Nothing to disclose
Objectives

- Epidemiology
- Pathophysiology
- Pre-season Screening
- Evaluation
- Neuropsychological Testing
- Treatment/RTP
- CTE
- Prevention/Online Resources

2013 Consensus Statements

American Academy of Neurology
American Medical Society for Sports Medicine
Zurich 4th International Conference
2013 Consensus Statements
American Academy of Neurology
American Medical Society for Sports Medicine
Zurich 4th International Conference
EPIDEMIOLOGY

Scope of the Problem
1.6-3.8 million annually in US

Under-reported

Culture Change needed at All Levels

Education is KEY!

Fact or Fiction

Second Impact Syndrome really exists.

Concussion Data

- 85-90% of college concussed players have symptom resolution in 7 days (mean 3-5 days)
- History of 3 or more... 30% had symptoms more than a week
- Players with a history of concussion are 3.4 times more likely to have another one
- Greatest risk for repeat concussion is in first 10 days

TABLE: Annual Deaths by Cause in 1- to 21-Year-Olds in the United States

<table>
<thead>
<tr>
<th>Cause</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor vehicle injuries</td>
<td>3973</td>
</tr>
<tr>
<td>Fireplaces</td>
<td>468</td>
</tr>
<tr>
<td>Drown</td>
<td>7841</td>
</tr>
<tr>
<td>Suicide and parasuicide</td>
<td>336</td>
</tr>
<tr>
<td>Condemnatory</td>
<td>342</td>
</tr>
<tr>
<td>Arrowheads</td>
<td>23</td>
</tr>
<tr>
<td>Accidental death poisoning</td>
<td>29</td>
</tr>
<tr>
<td>Sport-related violent death</td>
<td>13</td>
</tr>
<tr>
<td>Lightning strikes</td>
<td>0</td>
</tr>
<tr>
<td>Sport-related head trauma</td>
<td>52</td>
</tr>
</tbody>
</table>

*Data from: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control*
Scope of the Problem

1.6-3.8 million annually in US

Education is KEY!

Media Driven vs Scientific Evidence

Under-reported

Culture Change needed at All Levels

| TABLE. Annual Deaths by Cause in 1- to 21-Year-Olds in the United States |
|---------------------------------|---|
| Motor vehicle trauma         | 8973 |
| Homicide                   | 4088 |
| Suicide                     | 2841 |
| Influenza and pneumonia     | 356  |
| Cerebrovascular             | 246  |
| Meningitis                  | 67   |
| Accidental alcohol poisoning| 38   |
| Sport-related cardiovascular events | 38 |
| Lightning strikes           | 10   |
| Sport-related head trauma   | 6-9²,6 |

Unless indicated, data are from 1999 to 2009 average National Center for Injury Prevention and Control."
Concussion Data

- 85-90% of college concussed players have symptom resolution in 7 days (mean 3-5 days)
- History of 3 or more... 30% had symptoms more than a week
- Players with a history of concussion are 3.4 times more likely to have another one
- Greatest risk for repeat concussion is in first 10 days
Fact or Fiction

Second Impact Syndrome really exists.
Second Impact Syndrome

Malignant cerebral edema from concussive blow
Children and adolescents
17 published case reports with poor data
Could be from just one hit
**PATHOPHYSIOLOGY**

**CONCUSSION CASCADE**

- K+ and glutamate release with initial cell injury
- Increased glucose utilization to bring K+ back into cell through ATP pumps
- CBF decreases = less glucose = METABOLIC MISMATCH, which exacerbates injury
- Ca++ accumulates which inc. protease activation and results in cell death

**"ENERGY CRISIS" IN CONCUSSION**

Graph showing changes in brain activity and energy levels over time after concussion.
CONCUSSION CASCADE

K+ and glutamate release with initial cell injury

Increased glucose utilization to bring K+ back into cell through ATP pumps

CBF decreases = less glucose = METABOLIC MISMATCH, which exacerbates injury

Ca++ accumulates which inc. protease activation and results in cell death

Axonal “shear injury” is also discussed with acute injury and post-concussion syndromes
"ENERGY CRISIS" IN CONCUSSION
PRE-SEASON SCREENING
BASELINE TESTING

WHAT IS IT?
Symptom checklist
Cognitive assessment (SAC, SCAT3, Child SCAT3)
Balance assessment (BESS, Sway app, C3 iPad)
Neuropsychological assessment if available
  • ImPACT, CogSport, CNS Vital Signs
Education of Players/Coaches/Parents

WHEN?
HS - may do every other year
College - may do as freshman
Consider repeat baseline if concussion in previous year
EVALUATION

On Field Assessment

Acute Management

- Have a standardized method of assessment
- Document it
- Pocket Concussion Management Tool
- Immediate management

Return to Play Decisions

- Athletes whose symptoms and on-field testing are consistent with concussion injury should not return to play that day
- Especially true for younger athletes
- Education and culture change essential for athlete honesty and appropriate care

Clinic Follow-up Evaluation

- History (include previous injuries)
- Cognitive Testing (SCAT3, Child)
- Vestibular system evaluation
- Postural Testing (BESS)
- Physical exam (Neuro)
- Neuropsych testing (if indicated)

If they were all that easy....

Established Constitutional Risk Factors

- Gender
- Migraine History
- Age
- Learning Disability
- Repeated Concussions

Not established:
- acute illness
- dehydration
- sleep deprivation
On Field Assessment

Acute Management

Have a standard method of assessment
And document it

Pocket Concussion Recognition Tool
- Visible Clues
- Signs and Symptoms
- Memory Function

Return to Play Decisions

Athletes whose symptoms and on-field testing are consistent with concussive injury should not return to play that day:
- especially true for younger athletes
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Acute Management

Have a standard method of assessment
And document it

Pocket Concussion Recognition Tool
- Visible Clues
- Signs and Symptoms
- Memory Function
Pocket CONCUSSION RECOGNITION TOOL™
To help identify concussion in children, youth and adults

RECOGNIZE & REMOVE
Concussion should be suspected if one or more of the following visible clues, signs, symptoms or errors in memory questions are present.

1. Visible clues of suspected concussion
Any one or more of the following visual clues can indicate a possible concussion:
- Loss of consciousness or responsiveness
- Lying motionless on ground / Slow to get up
- Unsteady on feet / Balance problems or falling over / Incoordination
- Grabbing / Clutching of head
- Dazed, blank or vacant look
- Confused / Not aware of plays or events

2. Signs and symptoms of suspected concussion
Presence of any one or more of the following signs & symptoms may suggest a concussion:
- Loss of consciousness
- Seizure or convulsion
- Balance problems
- Nausea or vomiting
- Drowsiness
- More emotional
- Irritability
- Sadness
- Fatigue or low energy
- Nervous or anxious
- “Don’t feel right”
- Difficulty remembering
- Headache
- Dizziness
- Confusion
- Feeling slowed down
- “Pressure in head”
- Blurred vision
- Sensitivity to light
- Amnesia
- Feeling like “in a fog”
- Neck Pain
- Sensitivity to noise
- Difficulty concentrating

3. Memory function
Failure to answer any of these questions correctly may suggest a concussion.
- “What venue are we at today?”
- “Which half is it now?”
- “Who scored last in this game?”
- “What team did you play last week / game?”
- “Did your team win the last game?”

Any athlete with a suspected concussion should be IMMEDIATELY REMOVED FROM PLAY, and should not be returned to activity until they are assessed medically. Athletes with a suspected concussion should not be left alone and should not drive a motor vehicle.

It is recommended that, in all cases of suspected concussion, the player is referred to a medical professional for diagnosis and guidance as well as return to play decisions, even if the symptoms resolve.

RED FLAGS
If ANY of the following are reported then the player should be safely and immediately removed from the field. If no qualified medical professional is available, consider transporting by ambulance for urgent medical assessment:
- Athlete complains of neck pain
- Increasing confusion or irritability
- Repeated vomiting
- Seizure or convulsion
- Weakness or tingling / burning in arms or legs
- Deteriorating conscious state
- Severe or increasing headache
- Unusual behaviour change
- Double vision

Remember:
- In all cases, the basic principles of first aid (danger, response, airway, breathing, circulation) should be followed.
- Do not attempt to move the player (other than required for airway support) unless trained to do so
- Do not remove helmet (if present) unless trained to do so.

DUKE SIDELINE CONCUSSION EVALUATION

Athlete: ______________________ Date: __________________

SYMPTOMS
headache    nausea    dizziness
blurred vision    light sens.    noise sens.
drowsiness    fatigue    neck pain

MEMORY AND RECALL
BALL     BALL
FLAG     FLAG
TREE     TREE
SUGAR     SUGAR
WAGON     WAGON

ORIENTATION
At what venue are we at today?
Which half is it?
Who scored last?
Who was your last opponent?
Did we win our last game?
Month, day, date and year

CONCENTRATION
4-9-3   6-2-9   3-8-1-4   3-2-7-9
WORLD backwards    DLRow
DEC-NOV-OCT-SEP-AUG-JUL
JUN-MAY-APR-MAR-FEB-JAN

BALANCE TESTING
Stand heel-to-toe with non-dominant foot forward with hands on hips and eyes closed. Evaluate for 20 seconds.
# of errors 1 2 3 4 5 >5

VESTIBULAR TESTING
H pursuit nl nystagmus
Saccades H nl dizzy V nl dizzy
Convergence ___cm bl ___ cm 2x
Return to Play Decisions

Athletes whose symptoms and on-field testing are consistent with concussive injury should not return to play that day:
  • especially true for younger athletes
  • education and culture change essential for athlete honesty and appropriate care
If they were all that easy....
Established Constitutional Risk Factors

Gender
Migraine History
Age
Repeated Concussions
Learning Disability

Not established:
acute illness
dehydration
sleep deprivation
Clinic Follow-up Evaluation

- History (include previous injuries)
- Cognitive Testing (SCAT3, Child)
- Vestibular system evaluation
- Postural Testing (BESS)
- Physical exam (Neuro)
- Neuropsych testing (if indicated)

Neuropsychological Testing

- FACT or FTSQ
- General Considerations
- Clinical Considerations
- Neuropsych Testing Issues
- Neurocognitive tests
- Neuroimaging

Neuroimaging

- CT initially to r/o bleed
- MRI for post-concussion symptoms
  - structural changes
- DTI, fMRI, SPECT investigational still

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Clinic Follow-up Evaluation

- History (include previous injuries)
- Cognitive Testing (SCAT3, Child)
- Vestibular system evaluation
- Postural Testing (BESS)
- Physical exam (Neuro)
- Neuropsych testing (if indicated)
HISTORY

Obtain history surrounding current injury

Symptoms (HA, dizziness, LOC, PTA, photophobia, nausea, fatigue, etc)

Length of time, worsening vs improving

Previous injury? How long for recovery?

Sleep, eating, affect, schoolwork
COGNITIVE TESTING
Similar to acute SAC, SCAT3 questions
- WORLD, Months backwards
- Math (serial 7s, digits backwards)
- Immediate and delayed word recall
VESTIBULAR TESTING

Pursuits - "H test"

Saccades vertical and horizontal

Gaze stability - vertical and horizontal

Convergence

• Blurriness and double vision

• Both should be less than 10 cm
POSTURAL TESTING
Firm surface and Foam surface
20 sec each, eyes closed
Baseline comparison if possible
  • Double leg stance
  • One-leg stance (non-dominant)
  • Tandem stance (non-dominant in back)

<table>
<thead>
<tr>
<th>Balance Error Scoring System – Types of Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hands lifted off iliac crest</td>
</tr>
<tr>
<td>2. Opening eyes</td>
</tr>
<tr>
<td>3. Step, stumble, or fall</td>
</tr>
<tr>
<td>4. Moving hip into &gt; 30 degrees abduction</td>
</tr>
<tr>
<td>5. Lifting forefoot or heel</td>
</tr>
<tr>
<td>6. Remaining out of test position &gt;5 sec</td>
</tr>
</tbody>
</table>

The BESS is calculated by adding one error point for each error during the 6 20-second tests.
PHYSICAL EXAM
Head trauma
Cervical spine tenderness
Neuro exam
  • Romberg, pronator drift
  • Pupil reaction
  • MS/DTR/Sensation
Neuropsychological Testing

**FACT or**

Neuropsych testing should be the cornerstone of any concussion program

**General Considerations**

Measures function not injury
even limb injuries can cause decrease in NP scores (expert NP can tell)

Does it become standard of care to use NP testing?
obvious medico-legal implications

Do the results really change our management?
select cases (symptom reporting)

**Neuropsych Testing Issues**

"bagging" the baseline
test-retest reliability
When do you test?
Only asymptomatic?
practice effect
more studies needed by non ImPACT personnel

**Neuropsych Evaluation**

ImPACT

Paper and pencil
• time consuming
Computer Based
• more practical

<table>
<thead>
<tr>
<th>Composite Scores</th>
<th>Percentile score</th>
</tr>
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<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>89</td>
</tr>
<tr>
<td>Memory composite (visual)</td>
<td>70</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>35.8</td>
</tr>
<tr>
<td>Reaction time composite</td>
<td>0.59</td>
</tr>
<tr>
<td>Impulse control composite</td>
<td>1</td>
</tr>
<tr>
<td>Total Symptom Score</td>
<td>7</td>
</tr>
<tr>
<td>Cognitive Efficiency Index</td>
<td>0.39</td>
</tr>
</tbody>
</table>
Neuropsych testing should be the cornerstone of any concussion program
Table 1
Cognitive and physical symptom resolution following sports-related concussion

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample Size</th>
<th>Population</th>
<th>Tests Used</th>
<th>Total Days Cognitive Resolution</th>
<th>Total Days Symptom Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellman et al 2005</td>
<td>95</td>
<td>Pro (NFL)</td>
<td>Paper and pencil NP</td>
<td>1 d</td>
<td>1 d</td>
</tr>
<tr>
<td>McCrea et al 2003</td>
<td>94</td>
<td>College</td>
<td>SAC</td>
<td>&gt;1 d</td>
<td>7 d</td>
</tr>
<tr>
<td>McCrea et al 2003</td>
<td>94</td>
<td>College</td>
<td>Paper and pencil NP</td>
<td>5-7 d</td>
<td>7 d</td>
</tr>
<tr>
<td>Echemendia 2001</td>
<td>29</td>
<td>College</td>
<td>Paper and pencil NP</td>
<td>3 d</td>
<td>3 d</td>
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<tr>
<td>Guskiewicz et al 2003</td>
<td>94</td>
<td>College</td>
<td>Balance BESS</td>
<td>3-5 d</td>
<td>7 d</td>
</tr>
<tr>
<td>Bleiberg et al 2005</td>
<td>64</td>
<td>College</td>
<td>Computer</td>
<td>3-7 d</td>
<td>Did not evaluate</td>
</tr>
<tr>
<td>Iverson et al 2006</td>
<td>30</td>
<td>High school</td>
<td>Computer</td>
<td>10 d</td>
<td>7 d</td>
</tr>
<tr>
<td>McClincy et al 2006</td>
<td>104</td>
<td>High school</td>
<td>Computer</td>
<td>14 d</td>
<td>7-10 d</td>
</tr>
<tr>
<td>Lovell, et al 2007</td>
<td>208</td>
<td>High school</td>
<td>Computer</td>
<td>26 d</td>
<td>17 d</td>
</tr>
</tbody>
</table>

Abbreviations: BESS, balance error scoring system; NP, neuropsychological testing; SAC, the standardized assessment of concussion.
General Considerations

Measures function not injury
   even limb injuries can cause decrease in NP scores (expert NP can tell)

Does it become standard of care to use NP testing?
   obvious medico-legal implications

Do the results really change our management?
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Neuropsych Evaluation

ImPACT

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Cognitive Efficiency Index: 0.39

Paper and pencil
  - time consuming
Computer Based
  - more practical
Neuropsych Testing Issues

"bagging" the baseline

test-retest reliability

When do you test?
Only asymptomatic?

practice effect

more studies needed by
non ImPACT personnel
Neuroimaging

- CT initially to r/o bleed
- MRI for post-concussion symptoms
  - structural changes
- DTI, fMRI, SPECT investigative still
FACT or FICTION

Complete rest (cognitive and physical) from concussion injury is the best evidence-based approach to concussion management.

Acutely

Physical Therapy

Physical Rest

NSAIDS/Tylenol PRN

Treat cervical symptoms

Cognitive Rest

OMT

Cervical, Cranial/Neck

Post-Concussion Syndrome

Symptomatic medication

DHA

Mild to moderate exercise

Vestibular PT

Dizziness

Gait, Balance issues

Hyperbarics

OMT

LEGISLATION

Be aware of your state's law

GEFFLER-WALLER CONCUSSION AWARENESS ACT

Enacted and implemented to protect the safety of student-athletes in North Carolina and was signed into law on June 10, 2012

S.184 (House)

Education (Coaches/Parents/Athletes)

Emergency Action Plan

Return to Play

returntoplaync.org

Matthew Geffler's Story:

- Son of Dr. Sean Geffler
- Played football at Hoggard High School, August 27, 2008
- Severe concussive symptoms
- 21 days later

When to Retire?

- Experience level?
- Position
- Physical condition
- Mental condition
- History of head injury
- Other factors
FACT or FICTION

There are no evidence based guidelines for RTP with concussion
Complete rest (cocoon therapy) is conceptually impossible and impractical
More anxiety about missed class, etc.

Complete rest (cognitive and physical) from concussion injury is the best evidence based approach to concussion management.
There are no evidence based guidelines for RTP with concussion

Complete rest (cocoon therapy) is conceptually impossible and impractical

More anxiety about missed class, etc.
Acutely

Physical Rest

Cognitive Rest

Physical Therapy
Vestibular (if dizziness is a symptom)
Cervical (if headache or neck pain)

NSAIDS/Tylenol PRN
Treat cervical symptoms

OMT
Cervical
Craniosacral

DHA
Post-Concussion Syndrome

Symptomatic medication
ADHD, migraine, depression, etc

Vestibular PT
Eye Head Coordination exercises
Static Balance exercises
Ambulation exercises
Canalith Maneuvers (rarely)

DHA

Moderate exercise

Hyperbarics

OMT
# Return to Play

## 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% MP HR; 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>
LEGISLATION

Be aware of your state's law

GFELLER-WALLER CONCUSSION AWARENESS ACT

Drafted and implemented to protect the safety of student-athletes in North Carolina and was signed into law on June 16, 2011

3 Major Areas:
- Education (Coaches/Parents/Athletes)
- Emergency Action Plan
- Evaluation/RTP

Matthew Gfeller's Story

- Helmet to helmet hit in first varsity FB game at R.J. Reynolds HS August 22, 2008
- never regained consciousness
- died 2 days later

http://tbicenter.unc.edu/MAG_Center/gwlaw.html
When to Retire?

Box 1
Decisive factors for retirement

Season Ending
- Prolonged post concussion syndrome
- 3 or more concussions in single season
- 2 or more major concussions in single season
- Diminished academic performance
- Diminished athletic performance
- CT or MRI brain scan abnormality

Career Ending
- Chiari malformation
- Intracranial hemorrhage
- Diminished academic performance or cognitive abilities
- Persistent prolonged post concussion syndrome
- Lowering of threshold for concussion (as judged by physicians, athletes, coaches, certified athletic trainers)
- 3 or more major concussions
- CT or MRI scan documentation of structural brain injury
- Nonresolving functional MRI scan deficits
- CTE symptoms

* All return to play and retirement decisions are individualized. Some features are relative contraindications for return to play.
* Major concussion: symptomatic for greater than 1 week.
CTE

What we don't know...

- overall incidence and magnitude of the problem
- no consensus on diagnostic criteria
- unknown severity of hits or concussion cause it
- why latent period then unstoppable symptom progression...
- Stay tuned!

What do we know?

- repetitive brain trauma in susceptible athletes
- buildup of neurofibrillary tangles and tau proteins (similar to Alzheimer's)
- diagnosis is post-mortem
- progression of psychiatric symptoms that occur AFTER their playing career
- NO definitive neuroimaging
The spectrum of disease in chronic traumatic encephalopathy.


VA Boston HealthCare System, 150 South Huntington Avenue, 151-C Boston, MA 02130, USA. ann.mckee@va.gov.
<table>
<thead>
<tr>
<th></th>
<th>Stage I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>focal epicenters</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>adjacent cortex</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
</tr>
<tr>
<td>amygdala</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>L</td>
</tr>
<tr>
<td>hippocampus</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>P</td>
</tr>
<tr>
<td>nucleus basalis of Meynert</td>
<td>Q</td>
<td>R</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>substantia nigra</td>
<td>U</td>
<td>V</td>
<td>W</td>
<td>X</td>
</tr>
<tr>
<td>locus coeruleus</td>
<td>Y</td>
<td>Z</td>
<td>AA</td>
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<th>Acute Concussion</th>
<th>Postconcussive Syndrome</th>
<th>Prolonged Postconcussive Syndrome</th>
<th>Chronic Traumatic Encephalopathy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical symptoms (headache, dizziness, hearing loss, balance difficulty, insomnia, nausea/vomiting, sensitivity to light or noise, diminished athletic performance)</td>
<td>Persistent concussion symptoms</td>
<td>Symptoms lasting over 6 months</td>
<td>Latency period (usually 6-10 years)</td>
</tr>
<tr>
<td>Cognitive deficits (loss of short-term memory, difficulty with focus or concentration, decreased attention, diminished work or school performance)</td>
<td>Usually lasting 1-6 weeks after MTBI</td>
<td>Lowered concussion threshold</td>
<td>Personality disturbances</td>
</tr>
<tr>
<td>Emotional disturbances (irritability, anger, fear, mood swings, decreased libido)</td>
<td>Self-limiting</td>
<td>Diminished athletic performance</td>
<td>Emotional lability</td>
</tr>
<tr>
<td></td>
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<td>Diminished work or school performance</td>
<td>Marriage/relationship failures</td>
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<td>Depression</td>
</tr>
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<td>Alcohol/substance abuse</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Suicide attempt/completion</td>
</tr>
</tbody>
</table>
PREVENTION & ONLINE RESOURCES

Helmets
- prevent skull fracture
- inconclusive on preventing concussions

Mouthguards
- may prevent dental injuries
- does not prevent concussion

Neck Strengthening
- may prevent concussion due to decreased head velocities

Rule Changes
- no helmet to helmet contact
- no spearing
- youth hockey - no checking

Clinicians
www.cdc.gov/concussion/headsup/clinicians/

Parents and Coaches
www.cdc.gov/concussion/HeadsUp/youth.html
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Concussions and Our Kids

America's leading expert on how to protect young athletes and keep sports safe

Robert Cantu, M.D.

and Mark Hyman
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FUTURE DIRECTIONS

- US cerebral reactivity measurements
- More hyperbaric treatment studies
- Vestibular PT efficacy
- Imaging
- Sideline evaluation
- CTE research

What can we do now?

- Education (everyone)
  - awareness
  - culture changes
- Prevention
  - rule changes
  - physical fitness/strength
  - equipment
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"He can go back in the game. It's just a bruise."
QUESTIONS?