

Assessment of Brain Function in Sports Concussion

C. Munro Cullum, PhD
 Professor of Psychiatry & Neurology
 Director of Neuropsychology

University of Texas
 Southwestern Medical Center


STARS Brain Science Symposium 10-13-12

Concussions reported in NFL up 20 percent from 2010-2011 season

SUGGESTED GUIDELINES FOR MANAGEMENT OF CONCUSSION IN SPORTS

HEADS UP CONCUSSION IN HIGH SCHOOL SPORTS

The Facts



- A concussion is a **brain injury**.
- All concussions are **serious**.
- Most concussions occur **without** loss of consciousness.
- Concussions can occur **in any sport** or recreation activity.
- Recognition and proper response to concussions when they **first occur** can help prevent further injury or even death.

CDC

Sports Neuropsychology

- New sub-field of neuropsychology
- Application to all levels/sports
- Consultation with trainers, coaches, physicians

•Baseline vs postconcussion Evaluations

•Standard protocols

- NHL
- NFL
- MLS



Sports Concussion Epidemiology

- CDC estimates 300,000 sports concussions / year
- 822 Sports Concussions / day
- 75% "Mild" but 9% require hospitalization
- Sports & recreation brain injuries cause 900 deaths / year

Collegiate Sports Concussion



- NCAA survey 1997-2000
- 40,547 physical injuries
- 6.2% (2,502) were concussion



Covassin et al., 2003, *Applied Neuropsychology*, 10, 12-22

Sports Concussion Statistics: NCAA Injury Surveillance System data

➤ Concussion accounted for the following % of sports injuries during 2002-2003:

- Ice Hockey 12%
- Football 8%
- Soccer 5%



Dick, 2003, National Collegiate Athletic Association

High School Athletic Concussions

Boys

- 1. Football
- 2. Wrestling
- 3. Soccer
- 4. Basketball
- 5. Baseball

Girls

- 1. Soccer
- 2. Basketball
- 3. Softball
- 4. Field Hockey
- 5. Volleyball



Powell & Barber-Fox, 1999, *JAMA*, 282, 958-963

What happens to the brain?



Assessment of the Concussed Athlete

- How are concussion sxs determined?
 - Can be challenging for many reasons
- LOC in $\leq 10\%$ of cases
- Normal CT/MRI in majority of cases
- Disruption in normal brain *function*
 - demonstrated by behavior change
 - assessed by neurobehavioral examination
 - Standardized Cognitive Screening
 - Role of Neuropsychology

Acute Signs of Concussion

- LOC not necessary for dx
- Confusion, Disorientation
- Motor/balance problems
- Nausea/vomiting
- Amnesia for recent information
- Visual problems (blurring, photosensitivity)
- Headache
- Behavior change*
- Sxs may be subtle



Assessment of Concussion Severity

	Severity		
	Grade I	Grade II	Grade III
Cantu	NO LOC PTA < 30 m	LOC < 5 min PTA > 30-24 hr	LOC ≥ 5 min PTA ≥ 24 hr
Colorado Med Society	Confusion NO LOC NO Amnesia	Confusion NO LOC Amnesia	LOC
AAN	Confusion NO LOC Sxs < 15 m	Confusion NO LOC Sxs > 15 min	LOC

More Serious Signs

One pupil larger than the other
Is drowsy or cannot be awakened
A headache that not only does not diminish, but gets worse
Weakness, numbness, or decreased coordination
Repeated vomiting or nausea
Slurred speech
Convulsions or seizures
Cannot recognize people or places
Becomes increasingly confused, restless, or agitated
Has unusual behavior
Loses consciousness (a brief loss of consciousness should be taken seriously).

CDC

Late Potential Concussion Symptoms

Most symptoms usually resolve within a week, but some may persist, e.g.

- Decreased processing speed/ slowed thinking
- "Feeling foggy"
- Short term memory impairment
- Decreased frustration tolerance & irritability*
- Fatigue
- Sleep disturbance
- Depression

Note: Some sxs may be difficult to distinguish from other conditions such as being a teenager*

What is Neuropsychological Assessment?

- Quantitative samples of cognition derived from carefully developed tests
- Measurement of cognitive abilities
- Involves principles of neurology & psychology, with influence of cognitive psychology & neuroscience

Neuropsychological Testing

- Standardized tests
- Documented validity & reliability
- Scores allow comparison x time
- Most sensitive means of assessing brain function
- Accepted neurodiagnostic procedure*

*Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology (1996)

Neurocognitive Testing Caveats

- Brief screening can be insensitive to cognitive impairment
- Cognitive deficits most reliably detected via detailed testing
- Pts may under*- or over-report sx's; thus, objective scores useful (though not infallible, as they depend on effort)

Interpretation of neurocognitive tests

- Issue of baseline assessment
- Test-retest ("practice") effects
- Preexisting and co-existing factors may influence test results
 - Situational factors (effort, medications, pain, fatigue)
 - Sociodemographic, linguistic, educational, ADD, LD, intellectual

"Quarterbacks are not geniuses, a genius is some guy like Norman Einstein"

(Famous former NFL player)

***Neurocognitive Tests:
What are they like?***

- Pencil-paper, question-answer, and/or computerized tests requiring various cognitive skills.

Neurocognitive Domains

- Global Functioning / IQ
- Language
- Visuospatial
- Attention/ Concentration*
- Learning & Memory*
- Executive Functioning
- Perceptual Motor

*most sensitive to concussion

Examples of Neurocognitive Screening Tests used in Assessment of Concussion

- Sideline Assessment of Concussion (SAC; McCrea et al.)*
- Sport Concussion Assessment Tool-2 (SCAT-2)
- **IMPACT**: Immediate Post-Concussion Assessment and Cognitive Testing
- **CNS Concussion Signs**
- **Headminder** Concussion Resolution Index
- **CogSport**
- **ANAM**: Automated Neuropsychological Assessment Metrics Sports Medicine Battery
- NHL & NFL Neuropsychological Test batteries (standard tests)

Assessment of Concussion



- **Standardized clinician-administered, downloadable tool**
- **Physical signs, GCS, balance testing, symptom ratings, cognitive screen**

SCAT-2 Cognitive Screener

- Standardized performance-based testing
- Includes Standardized Assessment of Concussion (SAC; McCrea):
 - Orientation (Maddocks score)
 - Working memory (digits backward)
 - Recent memory (5-item word list x 3 trials + delay)*
 - Months reverse

[http://www.cces.ca/files/pdfs/SCAT2\[1\].pdf](http://www.cces.ca/files/pdfs/SCAT2[1].pdf)

Typical Testing Scheme for Sports Neuropsychology Programs



Computerized Neurocognitive Testing Advantages



- Widely used across age levels
- Only way to screen large #s of players
- Can be group-administered*
- Widely available & Cost efficient
- Available in multiple languages
- Results databased*
- Quick scoring/feedback

Computerized Neurocognitive Testing Caveats:

- Subject effort may be suboptimal
- Preexisting cognitive +/- not factored in
- Comorbid or situational factors may affect results
- Limited range of cognitive skills tested
- Individual scores may be unreliable
- Results may be misinterpreted

Computerized Neurocognitive Testing Caveats

- Group testing limitations
- Where's testing taking place?
- Who's monitoring? (parents? coaches?)
- Quality assurance of results (validity?)
- Where are data stored? How accessed?
- Who's interpreting?
- Sometimes results don't make sense!

ImPACT Composite Scores

- Verbal Memory
- Visual Memory
- Visuomotor Speed
- Reaction Time
- Impulse Control

- Symptom Checklist

Critical Factors in use of Computerized Cognitive Testing

- Emphasize purpose & importance
- Encourage good effort & attention
 - (eg, *read all instructions!*)*
- Ok for groups <5 (fewer = better)
- Quiet environment*
- Requires proctoring*

Practical Issues in Computerized Neurocognitive Testing in Sports

- Who should/can interpret computerized screening test results?
- Is “workshop training” for interpretation adequate?
- When to seek consultation?

Practical Issues

- Whomever is interpreting computer screening results must be familiar with:
- Psychometric issues (reliability, validity sensitivity / specificity) & limitations of tests
- Identification of poor effort/invalid profiles
 - May not be reflected in “warning” scores
 - Need to examine subtests as well as global scores

Practical Issues

- Whomever is interpreting computer cognitive screening results must be familiar with:
- Do results make sense vis a vis injury?
- Awareness that “normal” scores can = impairment
- Not all “impaired” scores = a deficit

Practical Issues

- Whomever is interpreting computer cognitive screening results must be aware of:
- Relevant clinical cormorbidities
 - What else could explain / influence results?
- When to request consultation in interpretation*
- When to recommend further evaluation*

*Neuropsychology should be part of the Concussion Team

Practical Issues in Computerized Neurocognitive Testing in Sports

- How to interpret test results?
- What if:
 - *Results not back to baseline? What if they are?*
 - *There is no baseline?*
 - *There are many retest scores?*
 - *Only one subtest score declines or is abnormal?*
 - *Everything else is normal but computer results remain abnormal?*

Neuropsychological Evaluation

- Assist with return to play
- May be particularly useful in cases that remain symptomatic beyond expected recovery period
- May help explain questionable computerized cognitive screening results
- Assist with return to school/work planning

How to decrease concussions?



- Awareness & information
- Protection (equipment, rules)
- Policy

Sports Neuropsychology

NFL urging states to pass youth football concussion laws.
Texas bill passed in 2011



Baseline vs postconcussion Evaluations

- Recovery
- Return to Play
- Retirement
- Future risks?
- Research Needed



Practical Issues:

Identifying a consulting neuropsychologist:

- Licensed psychologist with specialized training and experience in evaluating brain-behavior issues.
- Local referrals/reputation in sports-related evals
- General neuropsychologist listings at
 - www.theAACN.org
 - www.nanonline.org
 - Sports Neuropsychology Society*
