Balance Assessment in the Concussion Management Program

Rod Walters
Walters Inc. – Consultant in Sports Medicine
Disclosure

• Athletic Training Education Opportunity seminars (confirmed for 2012)
  - Multi Radiance Medical
  - Flexall-Bushwalker
  - Andover
  - Concussion Health
  - HcFX
  - CSMI
  - Neurotech
  - DJO Global

• Consultant: Biodex, Sutton Medical, DJO Global

• Royalty Income: DJO Global
Objectives

- Review definitions and history of concussions;
- Overview of Assessment of the Injury;
- Role of Balance in Assessment of Concussion.
Goals of Rehabilitation

- Range of Motion
- Strength
- Function
- Sport Specific Conditioning
Baseline Tests - Orthopaedic Considerations

• Pre-season balance measurement (postural sway) is a predictor of ankle sprain susceptibility. (McGuine, Greene et al. 2000)

• Postural sway relates difficulties in static balance to the frequency of falls. (Lehmann, Boswell et al. 1990)

• Total rehabilitation includes implementing a balance program to train proprioceptively. (Tropp, Askling et al. 1985; Tropp, Odenrick et al. 1987; Ekstrand and Tropp 1990)
Concussion Definitions

- **Noun** - Mild or traumatic brain injury defined as:
  - complex pathophysiologic process affecting the brain,
  - induced by traumatic biomechanical forces secondary to direct or indirect forces to the head.

- **Verb** - 1490, from L. concussionem (nom. concussio), pp. of concutere "shake violently," from com- "together" + quatere "to shake." Modern brain injury sense is from 1540. (Websters)
Facts

- Concussion is a brain injury and all are serious
- Can occur without LOC and in any sport
- Recognition and proper management when a concussion first occurs can help prevent further injury and even death
- Symptoms vary; no blood test or brain scan to detect injury
Concussions present in different ways. (Leddy, Kozlowski et al.; Willer, Dumas et al. 2004; Willer and Leddy 2006; Willer and Leddy 2007)

There is an additive effect such that concussions occur with less and less impact. (16)

What Happens to the Brain During a Concussion?

• It is a mild traumatic brain injury (mTBI)
• Most often no damage to brain anatomy (this is why don’t see anything on MRI or CScan)
• There is a disturbance to brain physiology
Epidemiology

• Sport concussion: between 1.6 and 3.8 million injuries annually in US. (Langlois, Rutland-Brown et al. 2006; CDC 2011)

• At high school level, 9% of all athletic injuries (Gessel, Fields et al. 2007) while majority of (80% to 90%) symptoms abate after 7 to 10 days. (McCrory, Meeuwisse et al. 2008)

• One of six ED visits for an injury results from participation in sports or recreation
• Athletes who experienced concussion and loss of consciousness were 6 times more likely to sustain another concussion than those concussed but never losing consciousness. (Delaney, Lacroix et al. 2000)
Why the Interest in Concussion?

- NFL acknowledgement
- Congressional hearings
- Attention in media
- Many states and local governments passing legislation
- Recent NCAA guidelines
Suggestions to Reduce Brain and Spinal Injuries

• Preseason physical exams for all participants.
  - Identify during the physical exam athletes with history of previous brain or spinal injuries.
  - If physician questions athlete’s readiness to participate, the athlete should not be allowed to play.

• Venue specific Emergency Action Plan for all Practice and Game Sites
  - Howard B, Gillis J. High school sports participation increases for 20th consecutive year. [cited 2010 September 13, 2010.].
Suggestions to Reduce Brain and Spinal Injuries

- Proper conditioning exercises which will strengthen their neck muscles. (Howard and Gillis)
- Coaches should drill the athletes in the proper execution of the fundamentals of the football skills to keep the head out of football. (Howard and Gillis, Levy, Ozgur et al. 2004)
- Many head injuries in athletes are the result of improper techniques. (Cantu 1996)
Suggestions to Reduce Brain and Spinal Injuries

- Take special care to see that the players’ equipment is properly fitted, particularly the helmet. (Howard and Gillis)
- With NOCSAE standards, fatalities decreased 74% and serious head injuries decreased from 4.25 per 100,000 to 0.68 per 100,000. (Levy, Ozgur et al. 2004)
- Research data has led to changes in helmet design and new technology, with ability to monitor forces. (Collins, Lovell et al. 2006)
History of Concussion

- Football safety records attributed to the application of more stringent tackling regulations and evolving football helmet. (Levy, Ozgur et al. 2004)
- When evaluating concussion, symptoms of headache >3 hours, difficulty concentrating >3 hours, retrograde amnesia, or loss of consciousness may indicate a more severe injury or prolonged recovery; great caution should be exercised before returning these athletes to play. (Asplund, McKeag et al. 2004)
Incidence of Repeat Injuries

• Players with a previous concussion in football were 5.10 times more likely to experience a concussion than players without a previous concussion. (Levy, Ozgur et al. 2004)

• During the 1997 Canadian Football League season, players with a previous loss of consciousness in football were 6.15 times more likely to experience a concussion than players without a previous loss of consciousness. (Levy, Ozgur et al. 2004)

• Incidence of concussion among HS football players dropped from 19% in 1983 to 4% in 1999. (Levy, Ozgur et al. 2004)
Not Just a “Ding”

- In 12-17 YO, a concussion with less than 15 minutes of symptoms at time of injury required 7 days for neurocognition to return to baseline and symptoms to resolve. (Lovell, Collins et al. 2003)

- In a study done between 2005-2008, 41% of concussed athletes returned too soon
  - Original Research: Nessler, T. Center for Injury Research and Policy 2009
Second Impact Syndrome

- Not completely understood
- Second injury is sometimes associated with an accumulation of blood in the brain, but not always.
Second Impact Syndrome

- Clear guidelines are also presented as to when to discontinue collision sport competition for the remainder of the season after multiple concussions.

- Due to concern for the second impact syndrome, the requirement to never allow an athlete with post-concussion syndrome symptoms to return to competition is emphasized. (Cantu 1992)
Second Impact Syndrome

• To avoid cumulative brain damage and SIS, no athlete still suffering post-concussion symptoms should return to competition (Cantu 1992, Cantu, 1998)

• Most commonly reported in football, the SIS can occur during any sport that can produce head blows. (Cantu 1998)

• Less than 20 cases in the literature.
Second Impact Syndrome

- Any student with signs of a concussion should receive medical evaluation and not be allowed to return to play in the current game or practice. (Cobb and Battin 2004)
- With exception of boxers, SIS has not been reported in anyone over the age of 20.
- May occur same day as injury or days later.
Post-Concussive Syndrome

- Players with a history of previous concussions are more likely to have future concussive injuries than those with no history;
- One in 15 players may have additional concussions the same season; and may be associated with slower recovery of neurological function. (Guskiewicz 2003; McCrea, Guskiewicz et al. 2003)
Guskiewicz and colleagues reported that high school football players who suffered a concussion were 3 times more likely to sustain another concussion during the same season, as compared to their nonconcussed teammates. (Guskiewicz, McCrea et al. 2003)
High School Sports

- Basketball - Girls had a higher rate of concussion (0.21 concussions per 1000 A-Es) than boys (0.07 concussions per 1000 A-Es) (Gessel, Fields et al. 2007)

- Soccer - Girls had a higher rate of concussion (0.36 concussions per 1000 A-Es) than boys (0.22 concussions per 1000 A-Es) (Gessel, Fields et al. 2007)
History of concussion and gender may account for significant differences in postconcussive neurocognitive test scores in soccer players and may play a role in determining recovery. (Colvin, Mullen et al. 2009)
Girls Suffer more Concussions than Boys

- Girls were more susceptible to concussions in sports like soccer and basketball than boys. (Gessel, Fields et al. 2007)
- Concussion rate for girls in soccer is higher (33.0 per 100,000 AEs versus 19.2 per 100,000 AES in the 2009-2010 school year). (3)
- Concussion rate for basketball is higher for boys (21.2) than girls (18.6). (Meehan, P. et al. 2011)
Changes in Definition of Concussions

- Colorado Medical Society guidelines were published in 1991 in response to the death of a high school athlete due to what was thought to be second-impact syndrome.

- Guidelines devised in 1997 by the American Academy of Neurology (AAN) based on the Colorado Medical Society.

- International symposia:
  - Vienna - 2001
  - Prague - 2004
  - Zurich - 2008
Zurich Consensus Statement

- Revision and update of the 1\textsuperscript{st} and 2\textsuperscript{nd} International Symposia on Concussion in Sport
- Panel of concussion experts to further develop understanding of concussions
- Developed for use by physicians, therapists, certified athletic trainers, health professionals and coaches
Concussion is “a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces.”

Experts also updated 5 characteristics about concussions.
Experts agreed ...

1. A concussion may be caused by a direct blow to the head, face, neck or elsewhere on the body with an “impulsive” force transmitted to the head.

Q: What are mechanisms of injury?

- **Indirect** - No direct blow to the head but “impulsive” force transmitted to the head (e.g., whiplash)
- **Direct** - Resulting in a direct blow to the head.
Variety of Forces

- **Linear**
  - Head’s center moves along a straight line

- **Rotational**
  - Head’s center moves around its center of gravity
  - Thought to be most prevalent with concussions and force that results in more severe concussions

- Combination of the two
2. A concussion typically results in the rapid onset of short-lived impairment of neurological function that typically resolves spontaneously.

Q: What are common signs and symptoms of the short-lived impairments?
2008 Zurich Statement: Experts agreed...

3. A concussion may result in changes within the brain but the common symptoms at injury largely reflect a functional disturbance rather than a structural injury.

Q: What is the difference between a functional disturbance vs. a structural injury?

**Functional Disturbance**
- No structural damage observed
- Results in a cascade of functional limitations
- Not visualized on standard imaging

**Structural Injury**
- Injury can physically be observed in X-ray, imaging, etc.
- Rare with concussions
4. A concussion results in a graded set of clinical findings that may or may not involve a loss of consciousness, which typically resolve but in a small number of cases may result in post-concussion syndrome.

Q: What are examples of clinical findings?
5. A concussion is typically associated with grossly normal structural neuroimaging studies.

Note: Other sports injuries such as fractures or torn ligaments are structural injuries that can be detected with imaging. The changes, however, caused by a concussion occur at the microscopic level and cannot be detected by MRI or CT scans.
Zurich: “Gold Standard”

• Developed for physicians, therapists, certified athletic trainers, health professionals and coaches
• Highlights importance of baseline (pre-season) testing, time of injury assessment, post-injury assessment from qualified healthcare provider, and graded return to play (RTP) protocol
• Balance testing was also recommended as a RTP indicator in conjunction with symptom checklist and cognitive testing
## Common Signs and Symptoms

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<th>Cognitive Symptoms</th>
<th>Emotional Symptoms</th>
<th>Physical Signs</th>
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<tbody>
<tr>
<td>Headache</td>
<td>Confusion</td>
<td>Depression</td>
<td>Loss of Consciousness</td>
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<tr>
<td>Dizziness</td>
<td>Amnesia</td>
<td>Irritability</td>
<td>Poor Coordination</td>
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<tr>
<td>Nausea</td>
<td>Disorientation</td>
<td>Moodiness</td>
<td>Easily Distracted</td>
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<tr>
<td>Feeling ‘Unsteady’</td>
<td>Poor Concentration</td>
<td></td>
<td>Slow Responses</td>
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<tr>
<td>Feeling ‘Dinged’</td>
<td>Memory Disturbance</td>
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<td>Vomiting</td>
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<tr>
<td>Feeling ‘Stunned’</td>
<td></td>
<td></td>
<td>‘Glassy-eyed’</td>
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<tr>
<td>Feeling ‘Dazed’</td>
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<td>Photophobia</td>
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<tr>
<td>Feeling ‘Bell run’</td>
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<td>Aphasia</td>
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<tr>
<td>Seeing ‘stars’</td>
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<td></td>
<td>Personality change</td>
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<tr>
<td>Visual Disturbances</td>
<td></td>
<td></td>
<td>Inappropriate Behavior</td>
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<tr>
<td>Tinnitus</td>
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<td></td>
<td>Impaired physical ability</td>
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<td>Diplopia</td>
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</table>
Concussions Present in Different Ways

**Neurobehavioral**
- Drowsiness
- Fatigue/lethargy
- Sadness/depression
- Nervousness/Irritability
- Trouble falling asleep

**Somatic Symptoms**
- Blurred Vision
- Balance and Dizziness
- Headaches
- Light and Noise Sensitivity

**Cognitive**
- Feeling slowed down
- Feeling in a fog or dazed
- Difficulty concentrating
- Difficulty remembering


40. Willer and Leddy, 2006 Current Treatment Options in Neurology
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Findings from Concussed Patients

• Symptoms of Alzheimer’s and Parkinson’s are well documented in retired soccer players and boxers. Boxers have described motor, cognitive, and behavioral impairments. (Critchley 1957; Roberts 1969; Mendez 1995)

• Clinically, such cases have been termed chronic TBI, dementia pugilistica, and chronic traumatic encephalopathy. (Rabadi and Jordan 2001; Omalu, DeKosky et al. 2006; McKee, Cantu et al. 2009)
Chronic Traumatic Encephalopathy

progressive neurological disorder which is a direct result of repetitive head injuries

• Single-photon emission computed tomography (SPECT) scanning may reveal perfusion defects associated with higher cognitive functions (attention, impulse control, and memory).

• APOE4, a risk factor for Alzheimer disease, is associated with severe chronic TBI in boxers. (Jordan, Relkin et al. 1997)

Brown protein tangles (Tau Proteins) are similar to those seen in elderly Alzheimer’s patients.

(CTSE Boston University School of Medicine)
Concussions and Memory Impairment in the NFL

- Self reported survey of symptoms
- Retired professional football players with a history of 3 or more concussions are 5 times more likely to demonstrate mild cognitive impairment, earlier onset of Alzheimer disease, and clinical depression. (Guskiewicz, Marshall et al. 2005; Guskiewicz, Marshall et al. 2007)
NFL Experience

- Defensive secondary, kick unit, running back, and linebacker had highest incidence of repeat concussion.
- 2002-2007: more than half of players with repeat concussion were removed from play, and only a fraction immediately returned.
- Positions with the highest odds for being out 7+ days were quarterbacks, linebackers, and wide receivers.
- In the more recent 6-year period, more players were managed conservatively by being held out 7+ days, even though the signs and symptoms of their concussions were similar to those in the earlier period. (Casson, Viano et al. 2011)
• Most recent 6 years of NFL concussion data show similarity to the earlier period.

• Significant decrease in percentage of players returning to the same game, and players were held out of play longer.

• Multiple factors may have played a role in causing these differences, including the efforts by the NFL, the Players Association, athletic trainers and physicians, and safety equipment manufacturers to minimize the effects of head injury on NFL players. (Casson, Viano et al. 2011)
Canadian Football League Study

- Some athletes appear to have a propensity for concussive injury, and recognizing that propensity can be clinically useful. (Kutcher 2011)
- In 1997 season, 44.8% of CFL players experienced concussion symptoms. (Delaney, Lacroix et al. 2000)
  - 18.8% of concussed players recognized they had suffered a concussion. 69.6% of all concussed players experienced more than one episode.
  - Symptoms lasted at least 1 day in 25.8% of cases.
  - Odds of experiencing a concussion increased 13% with each game played.
  - Loss of consciousness while playing football and a recognized concussion while playing football were associated with increased odds of experiencing a concussion during the 1997 season.
Baseline Neuropsych Testing

- Predictive value of neurocognitive tests (Lau, Lovell et al. 2009, Schatz, Pardini et al. 2006) as a useful tool for the assessment of the neurocognitive and neurobehavioral sequelae of concussion. (Schatz, Pardini et al. 2006)

- Mandated at various levels of play for hundreds of thousands of athletes each year.

- Not likely to diminish risk, and the use of these measures may increase that risk in some cases. (Randolph 2011)
Neuropsych Testing

- Neuropsychological testing is used within the overall medical evaluation and care of NFL athletes.
- Players who experience MTBI demonstrate rapid recovery of neuropsychological performance, although poorer neuropsychological test results were related to on-field memory dysfunction.
- NFL players did not demonstrate evidence of neurocognitive decline after multiple (three or more) MTBIs or in those players out 7+ days.
- MTBI in this population is characterized by a rapid return of neuropsychological function in the days after injury. (Pellman, Lovell et al. 2004)
Self-Reporting Symptoms

- Reliance on patients' self-reported symptoms after concussion is likely to result in under-diagnosis of concussion and may result in premature return to play.
- Neurocognitive testing increases diagnostic accuracy when used in conjunction with self-reported symptoms. (Van Kampen, Lovell et al. 2006)
Pathophysiology of Concussion

- Available pathophysiologic data from basic science and clinical studies have increased the evidence base for concussion management strategies—the approaches to which may differ between young athletes and adults.

- Concussion is a complex injury that results in a series of metabolic events within the brain, including phases of injury and recovery. (Giza and DiFiori 2011)
Pathophysiology of Concussion

- Phases of concussive injury have been observed in the clinical setting using advanced neuroimaging.
- Studies of animals and humans: following concussive brain injury, a vulnerable period to repeat injury exists.
- Unique aspects of cerebral development in children and adolescents suggest that the pathophysiologic effects of concussion may be different than in adults. (Giza and DiFiori 2011)
Pediatric Concerns

- When all causes are considered, children have the highest incidence of MTBI. (Barlow, Crawford et al.)
- Recent reports estimate that MTBI occurs in .69% (692 of 100,000) of children younger than 15 years. (Guerrero, Thurman et al. 2000)
- Young Brain may be 60 times more sensitive to glutamate (Pickles 1950)
Young Athletes May Be at Greater Risk

- Greater brain H₂O content
- Higher brain-blood volume
- Degree of myelination
- Skull geometry
- Less neck strength (Kirkwood, Yeates et al. 2006)
What is the Neurochemical Reaction?

- All the cells in the brain fire at once
- Massive electrical discharge
- Excitatory neurotransmitters called glutamate released
- In turn, the cells release potassium
- Calcium replaces potassium in the mitochondria
- The brain call for glucose but the calcium impairs mitochondrial metabolism (Giza and DiFiori 2011)
Neurochemical Reaction

- Arteries constrict slowing blood flow
- Ca+ floods the energy producing areas of the brain – blocking Oxygen and glucose rich blood
- Brain gets sluggish
- Athlete gets confused, has slower reaction times
- Second blow compounds this.

- (Giza and DiFiori 2011)
Recurrent Concussions

- Athletes who have sustained one concussion are 4 to 6 times more likely to sustain a subsequent concussion.
- 92% of recurrent concussions happen within 10 days of first concussion. (Guskiewicz, McCrea et al. 2003)
- Athletes who experienced concussion with a loss of consciousness were found to be 6 times more likely to sustain another concussion than were those who had been concussed but never lost consciousness. (Delaney, Lacroix et al. 2000)


Typical Rate of Recovery?

This information was provided by the University of Pittsburgh Medical Center for sports-related concussions. (12/16/10)

40% within 7 days
60% within 14 days
80% within 21 days

Q: Of the remaining 20% who have symptoms >21 days, who is considered to be “at risk?”
Balance/Postural Stability Testing

- Published studies have identified postural stability deficits lasting approx 72hrs post concussion (McCrory, Meeuwisse et al. 2008)
- Sensory feedback from visual, vestibular and somatosensory systems is not properly processed during the first few days after injury, therefore the motor domain of neurological function should be assessed along with cognitive domain after concussions. (Guskiewicz, Ross et al. 2001)
- Lehmann et al noted TBI population relies more on visual cues for balance than an able-bodied population. (Lehmann, Boswell et al. 1990)
BESS Test
Balance Error Scoring System

- Scores increase with concussion, functional ankle instability, external ankle bracing, fatigue, age and neuromuscular training program.
- Static balance involves feedback from the somatosensory, visual, and vestibular systems to achieve steadiness. (Nashner, Black et al. 1982; Goldie, Bach et al. 1989)
- Baseline testing for postural control using the BESS should be conducted in the setting or environment in which testing after injury will most likely be conducted. (Onate, Beck et al. 2007)

Balance Error Scoring System (BESS)
Clinical Test Battery
- Six 20 sec trials using 3 different stances (double, single, tandem) on 2 different surfaces (firm, foam)

Recorded errors
- Hands lifted off iliac crests
- Opening eyes
- Step, stumble, or fall
- Moving into >30 deg. of hip flexion or abduction
- Remaining out of testing position for >5 secs.
Why mCTSIB?
(Modified Clinical Test for Sensory Integration of Balance)

- Guskiewicz et al demonstrated persistent decreases in postural stability for 3 – 5 days after injury in athletes with mMHI using the CTSIB. (Guskiewicz, Perrin et al. 1996)
- Postural stability is measured by recording postural sway. The mCTSIB quantifies sway under four sensory conditions.
  - Eyes Open, Firm Surface: somatosensory, visual and vestibular.
  - Eyes Closed, Firm Surface: somatosensory and vestibular are available
  - Eyes Open, Unstable Surface: visual and vestibular are available and accurate.
  - Eyes Closed, Unstable Surface: vestibular information is available and accurate.
Management
How Do You Sort It Out?

- Confusing to medical professionals, athletes, coaches, parents and teachers.
- A lot of information – can be overwhelming.
April 29, 2010

TO:  NCAA Head Athletic Trainers.
FROM:  Debra Runkle, Chair NCAA CSMAS

SUBJECT: Concussion Management Plan.

“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.”
NCAA Recommended Best Practices for a Concussion Management Plan

- Institutions should have a concussion management plan that specifically outlines the roles of athletics healthcare staff. In addition …
- Coaches must understand the concussion management plan, their role within the plan and that they received education about concussions.
- Athletics healthcare providers should practice within the standards as established for their professional practice.
Best Practices in Concussion Management

Recent research makes it clear - best practices in concussion management:

1. **Symptoms checklist** used immediately after injury and follow-up settings.

2. **Neurocognitive assessment** - tests attention span, memory, response rates and more.

3. **Balance assessment**
   - Relationships among self-reported symptoms, computerized neuropsychological testing, and postural stability are well documented in the concussion literature.
   - Separately, tools demonstrated sensitivities of 68%, 79%, and 62%, while together, greater than 90% sensitivity was achieved. (Broglio, Macciocchi et al. 2007, Resch, May et al.)
Concussion Management Is Not Novel

- NATA has had concussion protocols for many years (SAC, SAC2)
- The problem has been only a small percentage of Athletic Trainers follow the guidelines and only use a small portion of the available tools (Notebaert and Guskiewicz 2005)
Why?

- Information and protocols that are out there are likely too overwhelming.
- Possible underestimation of the issues related to concussion and discounting the need for following a clinical protocol.
- It was suggested, not mandated; now it’s mandated!
The American Academy of Neurology (AAN) Position Statement On Sports Concussion October 2010

• Athlete suspected to have suffered a concussion should be removed from participation until evaluated by a physician with training in the evaluation and management of sports concussions.
• No athlete should be allowed to participate in sports if he or she is still experiencing symptoms from a concussion.
• Following a concussion, neurologist or physician with proper training should be consulted prior to clearing for activity.
• A certified athletic trainer should be present at all practices and games, where athletes are at risk for concussion.
• Education efforts should be maximized to improve the understanding of concussion by all athletes, parents, and coaches.
Basis of Testing

- Currently recommended concussion-assessment batteries accurately identified decrements in one or more areas in most of the athletes with concussion.
- Findings support previous recommendations that sports-related concussion should be approached through a multifaceted assessment with components focusing on distinct aspects of the athlete's function. (Broglio, Macciocchi et al. 2007)
Return-to-Play Decisions

- The effects of cerebral concussion on postural control appear to persist for longer than 3 to 4 days, even among athletes with no signs of unsteadiness.
- Changes in neurophysiologic or mechanical constraints on postural control, provides distinct, valuable measurement alternative in the return-to-play decision. (Cavanaugh, Guskiewicz et al. 2006)
- Sensory feedback from visual, vestibular and somatosensory systems is not properly processed during the first few days after injury, and the motor domain of neurological function should be assessed along with the cognitive domain post-concussion. (Guskiewicz, Ross et al. 2001)
### Baseline Testing Cognitive and Balance Testing Are Cornerstones

<table>
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<th>Neuro-Cognitive (ImPact, CogSport, Headminders)</th>
<th>Neuro-Physical/Balance Testing</th>
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<tr>
<td>• Ease of use</td>
<td>• BESS test</td>
</tr>
<tr>
<td>• Increased access</td>
<td>- Good for sideline</td>
</tr>
<tr>
<td>• Measure reaction time</td>
<td>- Not intended to replicate more sophisticated balance tests</td>
</tr>
<tr>
<td>• Objective</td>
<td>• Biodex, Neurocom</td>
</tr>
<tr>
<td>• Cognitive deficits last more than 4 days</td>
<td>- CTSI</td>
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Neuropsychological testing has proven to be a valuable tool in concussion management, it is most useful when administered as part of a comprehensive assessment battery including grading of symptoms and clinical balance tests.

Evaluation should be conducted in a systematic manner, whether on the field or in the clinical setting and includes:

- History for specific details about the injury (eg, mechanism, symptomatology, concussion history),
- Assess neurocognitive function, and
- Balance.

The objective measures from balance testing can provide clinicians with an additional piece of the concussion puzzle, remove some of the guesswork in uncovering less obvious symptoms, and assist in determining readiness to return safely to participation. (Guskiewicz 2011)
Sideline Assessment

- Graded symptoms checklist
- Cognitive Tests
- Ocularmotor
- Dynamic visual acuity testing
- Rhomberg
- 20 Yd jog
- Repeat
• Objective vs. Subjecting
• Comparison to Baseline Test
• Postural Sway
• mCTSIB
<table>
<thead>
<tr>
<th>Condition</th>
<th>Sway Index</th>
<th># of Errors</th>
<th>Sway Index</th>
<th># of Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Feet-Shoulder Width Apart, Eyes Open, Firm Surface</td>
<td>1.43</td>
<td>1-2</td>
<td>1.00</td>
<td>3-4</td>
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<tr>
<td>2 Feet-Shoulder Width Apart, Eyes Closed, Firm Surface</td>
<td>0.63</td>
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<td>1.06</td>
<td>5-6</td>
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<td>9-10</td>
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<td>11-12</td>
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<td>4 Left, Firm Surface, Eyes Closed</td>
<td>0.15</td>
<td>13-14</td>
<td>0.00</td>
<td>15-16</td>
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<tr>
<td>5 Right, Firm Surface, Eyes Closed</td>
<td>2.03</td>
<td>17-18</td>
<td>0.46</td>
<td>19+</td>
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<td>6 Feet-Shoulder Width Apart, Eyes Open, Foam Surface</td>
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<td>DNC</td>
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<tr>
<td>7 Feet-Shoulder Width Apart, Eyes Closed, Foam Surface</td>
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<td>1-2</td>
<td>0.49</td>
<td>3-4</td>
</tr>
<tr>
<td>8 Feet-Shoulder Width Apart, Foam Surface, Eyes Closed, Head Shake</td>
<td>0.57</td>
<td>9-10</td>
<td>0.80</td>
<td>11-12</td>
</tr>
<tr>
<td>9 Left, Foam Surface, Eyes Closed</td>
<td>0.39</td>
<td>13-14</td>
<td>0.23</td>
<td>15-16</td>
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<tr>
<td>10 Right, Foam Surface, Eyes Closed</td>
<td>0.27</td>
<td>17-18</td>
<td>0.39</td>
<td>19+</td>
</tr>
<tr>
<td>Condition</td>
<td>Trial 1</td>
<td>Trial 2</td>
<td></td>
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<td>Sway Index</td>
<td># of Errors</td>
<td>Sway Index</td>
<td># of Errors</td>
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<td>1</td>
<td>0.38</td>
<td>1-2</td>
<td>0.42</td>
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<tr>
<td>2</td>
<td>1.08</td>
<td>5-6</td>
<td>0.67</td>
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<td>7-8</td>
<td>0.76</td>
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<td>2.34</td>
<td>9-10</td>
<td>1.38</td>
<td>11-12</td>
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<tr>
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<td>3.78</td>
<td>13-14</td>
<td>2.01</td>
<td>15-16</td>
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<tr>
<td>6</td>
<td>3.00</td>
<td>17-18</td>
<td>2.64</td>
<td>19+</td>
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<tr>
<td>7</td>
<td>3.66</td>
<td>19+</td>
<td>4.22</td>
<td>DNC</td>
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<tr>
<td>8</td>
<td>4.96</td>
<td>15-16</td>
<td>2.58</td>
<td>3-4</td>
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<tr>
<td>9</td>
<td>4.13</td>
<td>5-6</td>
<td>3.30</td>
<td>13-14</td>
</tr>
<tr>
<td>10</td>
<td>3.37</td>
<td>17-18</td>
<td>7.82</td>
<td>19+</td>
</tr>
</tbody>
</table>
Report Comparing Baseline to Serial Testing
## Graded Symptoms Checklist

**Graded Symptom Checklist (GSC)**

### Scoring Instructions:
Grade the severity of each symptom on a scale of 0-6, where 0 = not present, 3 = moderate, and 6 = very severe.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Baseline</th>
<th>Time of Injury</th>
<th>15 Minutes Post Injury</th>
<th>24 Hours Post Injury</th>
<th>48 Hours Post Injury</th>
<th>72 Hours Post Injury</th>
<th>Post Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date/Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blurred Vision</td>
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<td></td>
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</tr>
<tr>
<td>Dizziness</td>
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<tr>
<td>Headache</td>
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<tr>
<td>Irritability</td>
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</tr>
<tr>
<td>Loss of Consciousness</td>
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<tr>
<td>Loss of Orientation</td>
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<td>Memory Problems</td>
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<tr>
<td>Nausea</td>
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<tr>
<td>Nervousness</td>
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<tr>
<td>Personality Change</td>
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</tr>
<tr>
<td>Poor Balance/Coordination</td>
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<td></td>
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<tr>
<td>Poor Concentration</td>
<td></td>
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<tr>
<td>Ringing in Ears</td>
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<tr>
<td>Sadness</td>
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<td></td>
</tr>
<tr>
<td>Sensitivity to Light</td>
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<tr>
<td>Sensitivity to Noise</td>
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<td>Sleep Disturbances</td>
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</tr>
<tr>
<td>Vomiting</td>
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<td></td>
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</tr>
</tbody>
</table>

Note: The GSC should be used only for the initial evaluation, and for each subsequent follow-up assessment until all signs and symptoms have cleared at rest and during physical exertion. In lieu of simply checking each symptom present, the ATC can ask the patient to grade or score the severity of the symptoms on a scale of 0-6.
Post Injury Assessment

- Compared to Baseline, time of injury and every 24hrs post injury (minimum 72 hrs)
- Graded Symptom Check list
- CTSIB Balance test
- Neuro-cognitive test
- Asymptomatic then Graduated Return to Play and Medical Clearance
Graduated Return to Play Protocol (JAT Zurich 2008)

<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</td>
<td>Walking, swimming, or stationary cycling, keeping intensity to &lt;70% of max predicted heart rate; no resistance training</td>
<td>Increase heart rate</td>
</tr>
<tr>
<td>3 Sport-specific</td>
<td>ie: skating drills in hockey, running drills in soccer (no head impact activities)</td>
<td>Add movement</td>
</tr>
<tr>
<td>4 Non-contact training</td>
<td>Progression to complex training drills, eg, passing drills in football and ice hockey; may start progressive weight 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 athlete's confidence; Coaching staff assesses functional skills</td>
</tr>
<tr>
<td>6 Return to play</td>
<td>Normal game play</td>
<td></td>
</tr>
</tbody>
</table>

(McCrory, Meeuwisse et al. 2008)
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software, community and
on-going clinical support

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about the Concussion Health program

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WHO
HOW

FEATURED
see more >>

PLAY IT SAFE® mobile concussion assessment app now available in the
App Store
June 16, 2011  concussion assessment, iOS, mHealth, mobile,
This page represents ALL patients/clients that are currently being treated at 360 Balance for concussion management.
This date represents date of entry into system

Note: if circle not filled in then no data available
Questions - Discussion
References

References


Thank you

Rod Walters

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