

# The Role of the Speech-Language Pathologist in the Management of Acute and Chronic Concussion Symptomatology Part I

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## Background

- The Centers for Disease Control and Prevention (CDC) estimates that of the 1.7 million traumatic brain injuries that occur annually in the US, 75% of them are mild TBIs or concussions (CDC, 2015).
  - 1.4 million individuals in the United States who sustain a TBI are treated and released from the ED on the same day (Faul et al., 2010)
  - 300,000 are individuals between the ages of 15-25 years of age.
  - ED visits are increasing as knowledge increases (CDC, 2015)
- It is estimated that 50% of these may go unreported (Harmon et al., 2013).
- While a single concussion has been considered less severe when compared to other forms of brain injury, a second impact to the head prior to brain recovery may result in greater or more prolonged neurocognitive dysfunction impacting athletic, academic, and social activities of daily life (Harmon et al., 2013).

## Purpose

- The purpose of this presentation is to illustrate through research and case studies, evidence based procedures used by speech-language pathologists and a multi-disciplinary team to manage the neurobehavioral and neurocognitive symptoms associated with concussion.
- Participants will be able to:
  - describe the neurophysiology of concussion, risk factors, and post-injury neurobehavioral and neurocognitive symptoms,
  - identify key factors that can prolong recovery time following concussion, and
  - explain evidence based diagnostic and treatment protocols used to manage acute and chronic post-concussion symptoms.

## Concussion Defined:

- Concussion is a complex pathophysiological process affecting the brain, induced by biomechanical forces.
- Concussion can be caused by a direct blow to the head, face, neck or elsewhere on the body with an "impulsive" force transmitted to the head (McCrorry et al., 2013).
  - Causes:
    - Sport Related: football, hockey, rugby, basketball, cheerleading, etc.
      - High Impact vs Low Impact
    - Work-related injuries: military service, construction, etc.
    - Recreational activities
    - Non-Sport Related:
      - Motor vehicle accidents
      - Falls
      - Violence
      - Other...

## Concussion vs Mild Traumatic Brain Injury

- Some debate between researchers (Harmon et al., 2013; McCrory et al., 2012; McKinley, Bishop & McLellan, 2011)
  - Sport Related
  - Non-Sport Related
    - Greater risk for more prolonged symptoms (post-concussion syndrome)
    - Psychosocial and emotional symptoms

## Pathophysiology

- Rapid acceleration and deceleration forces that are applied to the moving brain can cause cellular damage.
- Rotation to the head adds to the shearing forces and distortion of vascular and neuronal elements in the brain.
- Cellular Damage
  - Pathogenesis of axonal dysfunction
    - Involves neuronal depolarization, release of excitatory neurotransmitters (glutamate), ionic shifts, inactivation of sodium and potassium pumps, changes in glucose metabolism and dissociation of metabolism and cerebral blood flow (Giza & Howda, 2001).

## Pathophysiology

- Concussion may result in neuropathologic changes, but the acute clinical symptoms more often reflect a functional disturbance rather than a structural injury detected via neuroimaging.
  - In some cases, symptoms can evolve over a number of minutes to hours.
  - Typically result in the rapid onset of short lived impairment of neurologic function that resolves spontaneously (McCrory, 2013).
- MRIs and CT scans are often not sensitive enough to detect subtle neurocognitive and neurophysiological changes associated with concussion. (McCrory et. al, 2009)
- Both medical and clinical professionals must rely on other diagnostic methods.

## Post-Concussion Symptoms:

- Neurologic changes and symptoms experienced following a concussion can vary in **degree** and **extent** based on the severity and location of the impact (Dashaw, Patraglia & Bailes, 2012; Harmon et al., 2013; Hanson, Stracciolini, Mannix & Meehan, 2014).
- The suspected diagnosis of concussion can be made based on the symptoms that are **outwardly observed** by support staff (e.g. athletic trainers, colleagues, teammates) or directly **experienced** by the individual.
  - Symptoms can be physical, cognitive, neurobehavioral, or sleep-related.

## Post-Concussion Symptoms

- **Headache**
- Fatigue
- Reduced coordination/Balance problems
- Decreased oculomotor control
- Depression
- Sadness
- Irritability
- Hypersomnia or insomnia
- Loss of consciousness\*\*
- Dizziness
- Confusion
- Nausea
- Vomiting
- Slurred or incoherent speech
- Sensitivity to light
- Sensitivity to noise
- Nervousness
- Feeling more emotional

## Post-Concussion Symptoms:

- **Neurocognitive**
  - **Attention**
  - Immediate and delayed **verbal memory**
  - Immediate and delayed visual memory
  - **Speed of processing**
  - Impulse control
  - Orientation
  - Executive function
- Influence on academic performance...

## Underreporting Post-Concussion Symptoms:

- 45% of athletes surveyed did not report their post-concussion symptoms to others due to a variety of internal and external factors
  - Personal drive to perform at peak levels
  - Unwillingness to leave a practice or game early
  - Fear of letting teammates down
  - External pressure from teammates, coaches, parents and/or fans
- 64% failed to report their suspected injury because they did not believe their symptoms were severe enough to signify a concussion (Davis & Bird, 2015).
- Suggests that athletes are not consistently reliable in reporting concussion-like symptoms making them at risk for repeated and more significant injury (Kroshus et al., 2015)

## Knowledge of Collegiate Varsity Athletes, Recreational Athletes, and Non-athletes on the Definition, Symptoms and Support Services Available following Concussion

- Recent Findings:

## Consequences of Concussion:

- Returning to high-impact activity before post-concussion symptoms have resolved can leave the individual at risk for:
  - more severe symptoms and a longer recovery period (Harmon, 2013)
  - Post-concussion syndrome
- Second Impact Syndrome (SIS)
  - Occurs when an individual suffers repeated concussions without adequate time to heal between concussions.
    - Brain is in a vulnerable state and when injured again, due to impaired cerebral autoregulation, cerebral edema and herniation can occur.
    - Uncommon but can lead to death (Edwards & Bodle, 2014)

## Multi-disciplinary Management

- The appropriate management of concussions requires a multi-disciplinary team approach in order to:
  - assess the individual's pre- and post-injury neurocognitive status
  - determine readiness for return to play, academic and occupational requirements
  - prevent unfavorable consequences and avoid the potential long-term effects of repeated brain injury
  - implement appropriate accommodation, strategies and supports during recovery
  - education

## Miami University Concussion Management Program:

- Developed in 1999 between the Department of Speech Pathology and Audiology and Intercollegiate Athletics.
- Goal: provide an multi-disciplinary team approach to the assessment, diagnosis, management, and prevention of the neurocognitive and physical sequelae resulting from sports-related concussions.
- Challenges associated with working with multi-disciplinary team:
  - Delineating the roles of team members
  - Identification of similarities and differences in philosophical perspectives
  - Identification of barriers to successful collaboration (e.g., scheduling)

## Multi-disciplinary Team Approach: Acute Post-Injury Management

- **Speech-Language Pathology**
  - Completes all neurocognitive baseline and post-concussion testing.
  - ImPACT<sup>®</sup>, Controlled Oral Word Association Test, Grooved Pegboard, Post-Concussion Symptom Rating Scale, King-Devick, and BESS.
  - Provides pre- and post-concussion education to the athlete.
  - Provides recommendations for academic accommodations to faculty.
- **Athletic Trainer**
  - Assesses athletes immediate medical needs and administers BESS and King-Devick sideline screening assessment.
  - Makes the initial referral to SLP for neurocognitive testing within 24-48 hours of the event.
  - Provides the SLP with details concerning the injury.
  - Monitors the athlete daily and relays any changes to the team.
- **Physician**
  - Medically monitors the athlete throughout the recovery process.
  - Makes all final return to play decision.
- **Athlete**

## Neurocognitive Testing Protocols

- Neurocognitive and neurobehavioral testing protocols completed post-concussion have been shown to be 82% effective in identifying performance consistent with a concussion 72 hours post-injury (Schatz et al., 2006).
  - Clarification: Neurocognitive tests do not diagnose concussion; rather they demonstrate the effects of the concussion by highlighting cognitive changes in performance.
- Importance of collecting baseline data:
  - You can compare post-concussion neurocognitive results to age and gender-based norms.
  - Effectiveness is ENHANCED with established baseline data (McCrorry et al., 2012; Schatz et al., 2006)

## Neurocognitive Testing Protocols: Paper-based Assessments

- MU initial testing protocol used in 1999 was based on the Pittsburgh Steelers Neuropsychological Battery (PSNB).
  - Adopted by the National Football League and the National Hockey League.
  - Battery consists of well-established formal tests.
  - Assess areas that have been found to be vulnerable to the effects of minor brain injury or concussion.
    - Verbal learning
    - Delayed recall
    - Attention
    - Cognitive speed
    - Cognitive flexibility
    - Motor and graphomotor speed
    - Verbal fluency
    - Executive function

## Neurocognitive Testing Protocols: Paper-based Assessments

### Neurocognitive Testing

- Hopkins Verbal Learning Test: Initial Learning and Delayed Recall
  - Verbal working memory, retention and recognition memory
    - Example: List of 12 words provided – Trumpet, sugar, violin, coal, garlic, kerosene, vanilla, wood, clarinet, flute, cinnamon, gasoline.
    - Immediate recall x 3; delayed recall; recognition recall
- Trail Making Test: A & B
  - Visual scanning, cognitive speed and mental flexibility
- Controlled Oral Word Association Test (COWAT)
  - Word fluency and retrieval/executive function

Based on the Pittsburgh Steelers Neuropsychological Battery, Lovell & Collins, 2008

## Neurocognitive Testing Protocols: Paper Based Assessment

### Neurocognitive Testing

- Wechsler Memory Scale-Revised: Digit Span
  - Attention span and verbal working memory
    - Example: digits forward and digits backward
- Symbol Digit Modalities
  - Visual scanning, visual motor speed and impulse control

Based on the Pittsburgh Steelers Neuropsychological Battery, Lovell & Collins, 2008

## Neurobehavioral Testing Protocols: Paper Based Assessments:

- The Concussion Questionnaire
  - 29 questions regarding the participant's history of concussion  
(Geffen, Hinton-Bayre, Geffen and Geffen, 1998)
- Post-Concussion Rating Scale (PCRS)
  - Rating of the neurobehavioral symptoms of concussion
  - Standardized procedure to organize a player's subjective symptoms after concussion.
  - Uses language that can easily be understood by athletes. (e.g., sensitivity to light vs photophobia)
  - Ratings are given based on a 7 point likert scale with scores from 0 (i.e., symptoms not present) to 6 (i.e., symptoms are severe).  
Modified by Lovell and Collins (1998) from an original scale by Rosenthal and Mayer (1998)

- Assessment protocols are needed which assess a variety of neurocognitive, neurobehavioral and vestibular symptoms.
  - Variety of disorder types and severities
  - Inconsistent symptoms reporting by athletes

## Neurocognitive Testing Environment

- Environment:
  - Individualized baseline and post-injury neurocognitive testing
    - Quiet and distraction free
  - Tested outside of the athletic environment
    - No interactions with coaching staff
    - Objective testing environment
  - Observation
    - Baseline: possible sandbagging of baseline scores
    - Post-injury: behaviors (irritation, fear, light sensitivity, etc.)
      - Consistencies between athletic trainer and athlete
- Education
  - Pre and post-injury

## Computer-based Assessments: Immediate Post-Concussion Assessment and Cognitive Test (ImPACT)®

- Began using at MU in 2005
- Content: 3 main parts
  - Demographic data
    - Sport, academic, medical/concussion history
  - Neurocognitive Test
    - Provides 5 separate composite scores: verbal memory, visual memory, visuomotor processing speed, reaction time and impulse control (Majerske et al., 2008)
  - Post-Concussion Symptoms Scale (PCSS)

## Computer-based Assessment: ImPACT<sup>®</sup> strengths/benefits

- Assess similar neurocognitive areas as paper based tests
- Multiple test versions provided
- Easy to administer for comparison baseline and post-injury performance levels
- High degree of inter-rater/intra-rater reliability when used as intended
- High degree of sensitivity and specificity (Schatz, 2006)
- Used by 90% of athletic trainers surveyed (Kelly et al., 2014).
- Proper implementation required

## Computer-based Assessment: ImPACT<sup>®</sup>

- Word Memory
    - Verbal recognition memory (learning and retention)
  - X's and O's
    - Visual working memory, cognitive speed, and impulse control
  - Three Letter Memory
    - Verbal working memory and cognitive speed
  - Color Match & Symbol Match
    - Impulse control and visual-motor speed
  - Design Memory
    - Spatial recognition memory (learning and retention)
- (Lovell et al., 2002)

## Estimated Cost:

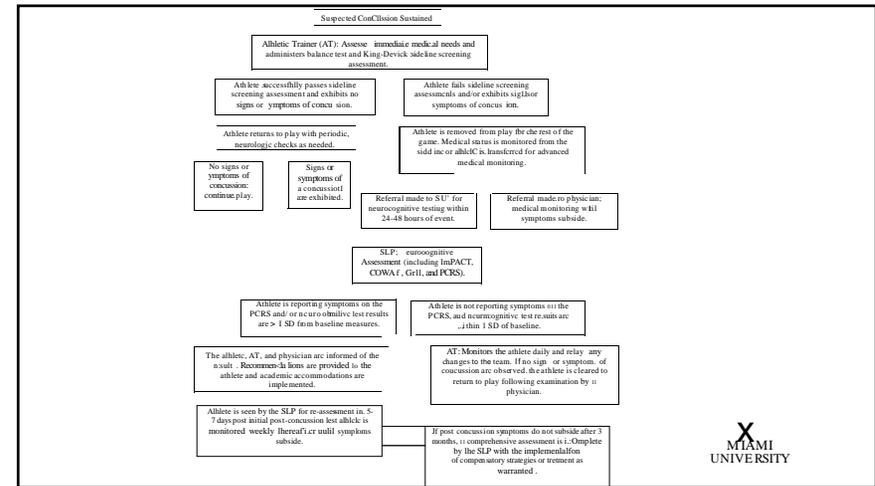
- Testing Materials:
  - King-Devick: Cost: \$199 King-Devick Test Android Tablet
  - BESS: \$61.95 for foam mat
  - Grooved Peg Board: \$95.00
- ImPACT: Does require a yearly subscription
  - 100 baseline with 15 Post Injury Tests: \$400
  - 300 baseline with 60 Post Injury Tests: \$600
  - 500 baseline with 100 Post Injury Tests: \$800
  - 800 baseline with 150 Post Injury Tests: \$1200
- Paper-based Assessments:
  - Hopkins Verbal Learning Test: Initial Learning and Delayed Recall: \$375
  - Wechsler Memory Scale-Revised: Digit Span: \$779 for basic kit
  - Controlled Oral Word Association Test (COWAT): -
  - Trail Making Test: A & B: -

## Sideline Assessments: Performed by ATC

- Standardized Assessment of Concussion (SAC)
  - Quickly assesses athlete's cognitive function
  - Can only be administered within 48 hours of the injury
  - High sensitivity and moderate to high specificity (Guskiewicz & Teel, 2015)
- King-Devick Test (Devick, 2010)
  - Assesses eye movement, attention, and language
  - Athlete orally reads numbers off a series of 3 cards and is timed
- Balance Error Scoring System (BESS)
  - Moderate to good sensitivity and high specificity
  - Most common balance test used (Kelly et al., 2014; Guskiewicz & Teel, 2015).
- Sport Concussion Assessment Tool-3
  - Several concussion assessment components
  - Includes GCS, symptoms, neuropsychological measures (SAC), balance (modified BESS), and neck and coordination deficits
  - Moderate to high sensitivity and specificity (Guskiewicz & Teel, 2015)

## Miami University Concussion Protocol: SLP

Baseline Testing Protocol	Post-Concussion Testing Protocol
ImPACT: medical, concussion, and academic history, symptom score and neurocognitive testing	ImPACT
Grooved Pegboard Test	Grooved Pegboard Test
Controlled Oral Word Association Test (COWAT)	Controlled Oral Word Association Test (COWAT)
King-Devick Test	Graded Symptom Checklist
Balance Error Scoring System (BESS)	History regarding recent injury: when, where, how and the location of the hit.



## Consequences of Concussion:

- Resolution of the clinical and cognitive symptoms typically follows a sequential course.
  - 80-90% of concussions resolve in a short 7-14 day period if managed appropriately.
  - Impact on the student
- 10-20% of individuals experience persistent concussive symptoms (PCS) (Jotwani & Harmon, 2013)
  - Debate: 1 week to 3 months
  - Greater risk with non-sport related injuries

## Factors Negatively Impacting Recovery:

- Gender
  - Neck Strength
- History of Learning Disability
- Number of previous concussions
- History of migraines
- Children and Adolescents
- Varsity vs. Club Sport/Recreational Athletics

Harmon et al., 2013, Knollman-Porter & Musille, 2016, & Zuckerman et al. 2014

## Case Examples:

## Post-Concussion Recommendations: Acute

### **Academic Instructor:**

- Delayed or postponement of exams and assignments
- Extended time provided for exams and assignments
- Environmental Accommodations: Based on the unique symptoms reported by the athlete
  - Preferential classroom seating
  - Modification to classroom environment due to noise or light sensitivity
  - Use of quiet, distraction free environment for exams and in-class assignments

### **Athlete Directed:**

- Take additional rest breaks during the day
- Complete required activities in a quiet, distraction free environment
- Reduced cognitively strenuous activity
- Refrain from:
  - All high impact physically strenuous activity\*
  - Attending and participating in activities in loud, distracting environments
  - Excessive electronic gaming activities
- Report any increase in symptoms to physician or athletic trainer immediately.

## Discussion

- Successful management of concussions requires a multi-disciplinary team approach with professionals observing and analyzing symptoms and behaviors in a variety of scenarios and settings to make the best return to play/work and post-injury recovery decisions.
- Speech-language pathologists have the training in the diagnostic and treatment methods necessary to be an active participant in the concussion management team.
- Persistent symptoms can cause individuals to have difficulty with academic, social, occupational, and athletic activities.
- Appropriate and timely management is warranted to help individuals return to their pre-injury academic and athletic endeavors successfully.

## Questions

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