Interpretation and Discussion of Protracted Concussion Symptoms in Pediatric Populations: The Role of Neuropsychology and Psychoeducation in Clinical Care.

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Trauma to the Head Caused by external mechanical force

Concussion
Commotio Cerebri
Transient loss or alteration of consciousness in the absence of structural brain damage

Minor Head Injury
Includes cranio-cerebral trauma and extracranial injury

(Mild) Closed Head Injury
Head injuries which do not include penetration of the skull

Mild Traumatic Brain Injury
Implies presence of cerebral injury
• American Congress of Rehabilitation Medicine (ACRM) definition most widely accepted definition of concussion:

• “Mild Traumatic Brain Injury (mTBI) results from a traumatically induced physiological disruption of brain function involving one or more of the following:
  • Loss of Consciousness
  • Loss of memory for events immediately before or after the injury
  • Alteration of mental state at time of injury
  • Focal neurological deficits
Physical Functioning Following Concussion

- Sufficient mechanical force to the head can cause a multi-tiered neuro-metabolic response characterized by:
  - Ionic shifts
  - Abrupt neuronal depolarization
  - Release of excitatory transmitters,
  - Alterations in glucose metabolism
  - Reduced cerebral blood flow
  - Disturbed axonal functioning

- These are often also accompanied by transient cognitive and behavioral symptoms such as changes in attention and mood lability.
Imaging

- While standard structural neuroimaging studies usually show normal results in mTBI, researchers have been working to develop methods to determine whether observable structural brain changes occur following concussion. Overall, studies done with structural imaging techniques have shown that results are variable.
  - FMRI studies have showed mixed results with (i.e., increased/ decreased) blood oxygen levels among mTBI populations in working memory tasks (Jantzen, 2010).
  - Some structural MRI studies have shown group differences in global axonal gray matter atrophy as compared to controls (Karr, Areshenkoff, & Garcia-Barrerra, 2014).
  - DTI methods show relationship between axonal injury in dorsolateral prefrontal cortex (Lipton et al 2009) and frontal temporal white matter damage characteristic of mTBI; however, studies have also shown that changes in these areas have also been related to depression and anxiety.

- Many studies include individuals with more severe head injuries, thereby clouding the results.

- While new neuroimaging techniques have demonstrated potential for characterizing these alterations, *none have accumulated sufficient evidence to warrant widespread clinical use*.

- Serum Biomarkers
- Magnetic Resonance Spectroscopy (MRS)
- Quantitative Electroencephalography (qEEG)
- Magnetoencephalography
- Single Photon Emission
- Computerized Topography (CT)
- Positron Emission Tomography (PET)
- Functional Magnetic Resonance Imaging (fMRI)
- Diffusion Tensor Imaging (DTI)
- Magnetization Transfer Imaging.
Incidence and Anticipated Trajectory

Among American intercollegiate athletes mTBI accounts for 6.2% of all sports related concussions with contact sports having the highest risk for injury (Covassin, Swanik & Sachs, 2003).

Across all high school sports 2.5 concussions occur for every 10,000 games/practices (Guerriero, Proctor, Mannix & Meehan, 2012).

While most experience full symptom resolution within a fairly rapid recovery period (e.g., 10 days) approximately 10% of individuals suffer prolonged symptoms also known as post-concussive symptoms.

While there are anecdotal reports regarding a relationship between multiple concussions and later psychopathology, few studies have fully explored cumulative outcomes for mTBI.

Moreover, researchers have yet to identify a threshold (i.e., number of injuries) which would put an individual at risk for future issues.

Overall effect of multiple mTBI compared to single concussions remains small (d=.06) demonstrating that there is a limited cumulative impact of multiple minor head injuries.
Post Concussion Symptoms

- **Somatic**
  - Low energy
  - Headache
  - Nausea/Emesis
  - Photo/phonophobia
  - Dizziness
  - Fatigue

- **Emotional**
  - Mood Lability
  - Behavioral Dysregulation

- **Cognitive**
  - Difficulties concentrating
  - Forgetfulness
  - Mental “slowing”
Considerations in Characterizing Post-Concussion Symptoms

• Important to highlight that many of these symptoms are non-specific and have been found to occur in individuals in the general population with no history of brain injury (Kirkwood et al 2008)

• Important to assess the presence of these factors prior to the injury as McNally et al (2013) found that ratings of pre-injury symptoms were the strongest predictors of post-injury symptoms across time

• This is particularly true when looking at patients who present with marked emotional symptoms as it is particularly difficult to parse out if an individual’s self-reported symptoms are a result of affective distress or are post-concussion symptoms

• Moreover, it must be emphasized that perceived cognitive impairment are hallmark features of emotional stress and studies have shown that some patients with depression, anxiety, and post-traumatic stress exhibit neurophysiological and cognitive changes

• Kontos and colleagues (2012) found that male and female college athletes experienced depressive symptoms which coincided with neurocognitive difficulties in reaction time and visual memory.

• Iverson (2006) found that “Approximately 9 out of 10 patients with depression met liberal self-report criteria for a post concussion syndrome [despite having no history of injury] and more than 5 out of 10 met conservative criteria for the diagnosis”
Known Risk Factors for Developing PCS

• Premorbid Symptoms Ratings
• Learning Disabilities
• Behavioral Problems
• Maladaptive Coping Strategies
• Comorbid Bodily Injury
• Pain
• Parental Anxiety
• Family Stress

Kirkwood et al. 2014
Perception of Symptoms

- Research indicates that the effect of injury related factors tends to diminish over time and not all PCS symptoms are driven by injury related neurologic factors.

- It is important to emphasize that clinicians often rely upon patients’ self-reported symptoms. Therefore, we must consider factors which may influence how clients interpret their experiences:
  - Attributions and Appraisals
  - Coping Strategies
  - Premorbid Personality Characteristics
  - Family Factors
  - Expectations of the Trajectory of Recovery
  - Attributions
Attributions & Appraisals

• Wise-Bjornstal et al (1998) noted that both personal and situational factors influence recovery though cognitive appraisals and emotional responses.

• Studies have found that the **beliefs** about illness duration and consequence were significant predictors of symptomatic outcome even more than depression and post-traumatic symptoms (Silver, 2012)

• Cognitive Appraisals
  • Stallard and Smith (2007) found that an individual’s negative interpretation of symptoms (e.g., “I’m going crazy”), sense of injustice (e.g., “This isn’t fair”), and belief that the injury represents a permanent change or increased likelihood of future difficulties may contribute to how he or she understands their injury and recovery.
"Good Old Days” Bias

- Defined as the tendency to view oneself as healthier in the past and misperceive one’s past functioning by underestimating the impact of premorbid emotional, somatic, and cognitive issues.

- Found to be an important factor in understanding adult recovery
  - Studies have found that when compared to back injury and general trauma patients, those with mTBI appeared to overestimate the degree of change by retrospectively recalling fewer pre-injury symptoms than the base rate of the general population.

Lange, Iverson, & Rose 2010
Coping Strategies

- These factors are related to an individual’s perception of the magnitude of the problem as well as his or her perceived ability to manage this demand. Also have been found to be an established predictor of PCS in adult populations
  - Problem focused and disengagement coping strategies have been found to moderate the relationship between mTBI and chronic PCS

- Inappropriate post-injury management can adversely impact recovery following mTBI and exacerbate stress
  - Iatrogenesis
Personality Characteristics

- **Athletic Identity**
  - Individuals who have a high athletic identity and who suffer an injury could be at risk as this injury may threaten their self-concept

- **Performance Anxiety**
  - Individuals with performance anxiety may have greater sensitivity to physical symptoms because poor performance may delay return to play until athlete is fully confident of achieving pre-injury performance
  - Premorbid anxiety is a risk factor for worse outcomes and could contribute to hypervigilance of even slight changes in functioning.

- **Amotivation**
  - Individuals who are amotivated to return to activity may be negatively reinforced for not participating

- Athletes that report a high athletic identity, amotivation, and performance anxiety are most likely to present with continued symptomatology up to 28 days post injury

O'Rourke et al 2017
Considerations for Traumatic Stress

- When understanding the role of traumatic stress it must be emphasized that the magnitude of stressor is less relevant to individual outcomes following the event than the perception of life threat.

- Subjective factors such as strong sense of fear, life threat, or loss of control during or after injury puts individuals at higher risk.

- Thus, if an individual perceives that an injury may put him or her at risk for serious injury or that the injury represents a permanent change or increased likelihood of future difficulties may contribute to how individuals understand their injury and recovery.
Family Factors

- Family factors particularly parental adjustment consistently predicted parent ratings of PCS.

- Parental support and parental factors are also key factors in recovery as parents may have poor coping strategies which interfere with their ability to support children recovering from an injury.

- Effective communication with patients and family is essential as individuals may assume all PCS result from permanent, irreversible brain damage and may underestimate premorbid symptoms and instead misattribute all symptoms to the injury.

- Social support affects self-reported concussion symptoms as social support influence cognitive appraisals and are part of one’s perceptions of individual resources to cope and motivate return to play.

- Thus keeping individuals isolated could exacerbate stress, reduce confidence, and may contribute to hypervigilance of benign symptoms.
Methods of Concussion Management

- Recommendations for Return to Learn have focused primarily on cognitive rest (e.g., complete mental rest or “cocoon therapy”) wherein an individual is restricted from as much mental stimulation as possible (e.g., restriction from social interactions, use of electronics, and academic work).

- The underlying assumption supporting this technique is that individuals who have sustained a concussion must limit their cognitive exertion in order to allow the brain to heal and reduce the likelihood of exacerbating symptoms.

- However, evidence does not consistently support his method and some studies suggest that it may reduce the quality of life for an individual, result in physical deconditioning, and contribute to iatrogenesis.

Thomas et al., 2015
Acute

- At individual level, the clinician should focus on ensuring that the individual has an adequate understanding of what happened and what can be expected.

- Misconceptions about injuries are common and many parents have reported not receiving appropriate amount of education regarding their child’s condition and what to expect
  - What is the patient’s understanding of his/her injury and the symptoms that follow?
  - Emphasis should be placed on fact that many individuals recover fully in short period of time.
  - Set stage for positive recovery and prevent secondary psychiatric/stress symptoms (avoid iatrogenesis)
  - In adults, the provision of education, advice and reassurance is strongest empirical support of any medical or psychological treatment.

- The development of intensive school services or support often premature
Post-Acute

- In this stage, the only evidence based intervention found to improve outcome is proper education and reassurance. Patients should be reassured that their symptoms are part of normal recovery not permanent.

- **Behavioral Prescription** specific recommendations to assist patient in effectively balancing symptoms with environmental demands to cope with school work reengage in social activities:
  - Too slow to return to school can protract recovery as patient may fall behind be away from friends
  - Management and intervention will depend on the unique factors contributing to this individual’s presentation
Physical Activity

• Among patients with acute concussion (5-18 years) physical activity within seven days of acute injury was associated with reduced risk of PCS as compared to individuals who did not engage in any activity.

• This supports theories which suggest that gradual return to activity (not immediate strenuous exercise) is more beneficial than protracted cognitive rest or cocoon care.

• Found no difference in balance or neurocognitive profiles of individuals (ages 11-22) in experimental or control groups. However, those in experimental group reported more daily post-concussive symptoms as well as slower symptom resolution.

Thomas et al. 2015
What is a Neuropsychologist?

- Neuropsychologists specialize in the assessment and characterization of brain-behavior relationships.

- Assessment of neurocognitive functioning includes evaluation of intellectual functioning, language, nonverbal reasoning, dexterity and fine motor coordination, attention, executive functioning, memory, academic performance, and social-emotional states.

- This is performed using paper and pencil as well as computerized measures.
What Role do Neuropsychologists Play in Concussion?

• In the acute stage of concussion, comprehensive assessment often not clinically warranted

• Since individual’s profile is not necessarily stable in post-acute phase a comprehensive evaluation is not always routinely required. An abbreviated neuropsychological evaluation may be useful if child showing symptoms after two weeks.

• Goal is to assist in identifying factors producing problems, ensure accurate diagnoses, and develop treatment plan
  • Must include comprehensive premorbid history to identify additional factors which may influence recovery
  • Must include measures of things not thought to be related to concussion like crystallized skills word reading.
  • Important to correctly characterize injury (LOC >15-30 MIN/GCS>13/ Neuroimaging findings) to see if patient suffered more severe injury than anticipated

• Non-injury factors must be considered carefully including preexisting psychosocial or emotional problems which may mimic or maintain symptoms
Performance Validity Testing

- Performance validity tests involve freestanding and embedded cognitive measures which aim to determine whether an individual’s performance on a test battery can be interpreted as a valid reflection of his or her general level of functioning.

- It is important to note that while these measures are sensitive to pick up on whether motivation fluctuates, they are not able to determine *why* an individual may not be putting forth optimal effort.

- Researchers have found that up to 12% of a pediatric sample failed Performance Validity Tests (PVT) and these individuals reported significantly more PCS than others. This indicates that it is important to know how to detect and present suboptimal performance as a considerable subset of this patient population may not put forth appropriate effort on neuropsychological evaluations.

- 40% of ability based variance was accounted for by PVT performance in children after mTBI. This indicates that some of the cognitive effects attributed to pediatric mTBI likely explained by non-credible effort.
What is “Non-Credible Performance”?

- Non-Credible performance can be understood as a circumstance in which an individual, whether purposely or unknowingly, is not fully engaging in or complying with the parameters of an assessment. As a result, all test data is viewed as being an invalid representation of his or her proficiency in cognitive domains.

- Research has indicated that non-credible performance cannot be detected by clinical judgement alone, therefore, freestanding and embedded measures have been developed to enable clinicians to quantitatively assess whether individuals are putting forth their best effort.

- There are distinctions in how non-credible performance is understood depending on the circumstances of the testing and patient presentation.

- **Malingering**: a term used to indicate that an individual is purposefully underperforming (e.g., faking bad) in order to obtain a secondary gain. Typically, the goal in these instances is for an individual to “…intentionally create the appearance of a disability.” (Heilbronner et al 2009)

- **Symptom Magnification** (Symptom Exaggeration)- Intentional amplification of symptoms.
Non-Credible Performance in Pediatric Populations

- Fewer children are apt to display non-credible performance for the purpose of financial gain or secondary gain.

- Rather, other factors are often related to underperformance.
  - Children may not want to put forth adequate effort because they don’t want to be at the examination.
  - Psychological factors including boredom, defiance, and immaturity must also be taken into account.
  - Hunger, fatigue, and pain should also be considered.
  - Some patients may perceive that they are not able to put forth good performance due to their injury (i.e., they may perceive themselves to be impaired).

- Just because non-credible does not mean purposeful poor performance
How is Non-Credible Performance Explained?

- Conceptualize non-credible performance in the context of the circumstances of the assessment and patient presentation.
  - This includes considering unique personality characteristics, the nature of the injury, and other extraneous factors

- Be clear about findings while also being compassionate to the unique experiences of each individual.
  - Important to emphasize that these symptoms are real to the individual experiencing them but that they may be a reflection of an unexpected source.
  - Remember that in pediatric populations, poor effort can be due to any number of factors.

- Avoid the “Gotcha!” reflex.
Case Study 1

• Joe*

• 10 y/o

• One lifetime concussion sustained while playing with his friends. He was believed to have hit the back of his head falling off a couch. Immediately after the injury, parents reported that he had difficulty putting sentences together, exhibited an unsteady gait, and seemed “confused”

• No loss of consciousness or amnesia

• He was taken to the emergency room and a CT scan performed at that time was read as normal (later neurological workups were also normal)

• Since the injury, he complained of daily headaches, sensitivity to light and sound, blurry vision (described as “triple vision”) and mood changes.

• He reportedly also exhibited changes in his ability to read and struggled to identify common sight words

• Removed from school for two weeks and although a part-time return to school was attempted, he was repeatedly sent home due to severe headaches.
Case Study 2

- *Betsy
- 19 y/o female
- Struck on the head by a piece of scenery in a school play she was rehearsing for.
- She did not experience any loss of consciousness and continued with rehearsal without difficulty.
- Later that evening, she reported experiencing a headache and her mother took her to the emergency room where a CT scan was read as normal.
- The next day she reported experiencing a severe headache and her mother reported that she exhibited a “slowed” rate of speech and fatigue. She was sent home from school and subsequently developed a pain in her neck and back with “pins and needles” in her arms and legs.
- She reported dizziness, balance problems, severe phono/photophobia, distractibility, mood lability, sleep changes, and severe balance disruptions
References


References


• O’Rourke, D. J., Smith, R. E., Punt, S. Coppell, D. B., Breiger, D (2017) Psychosocial correlates of young athletes self-reported concussion symptoms during the course of recovery. Sport, Exercise, and Performance Psychology. 6 (3) 262-276 doi:10.1037/spy0000097


